FINAL

Focused Feasibility Study
Operable Unit 1
Cornhusker Army Ammunition Plant, Nebraska

APRIL 2023

Contract W912DF-18-D0020
Delivery Order W912DF-18-F0041

Prepared for:

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ACRONYMS AND ABBREVIATIONS

µg/L	micrograms per liter
%	percent
ARAR	applicable or relevant and appropriate requirement
bgs	below ground surface
Brice	Brice Engineering, LLC
BW-URS	Bay West LLC and URS Group Inc.
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
CHAAP	Cornhusker Army Ammunition Plant
COC	contaminant of concern
COPC	chemical of potential concern
EW	extraction well
FFS	Focused Feasibility Study
GAC	granular activated carbon
gpm	gallons per minute
GRA	General Response Actions
GWTF	Groundwater Treatment Facility
HAL	Health Advisory Level
HE	high-explosive
HMX	octahydro-1,3,5,7-tetranitro-1,3,5,7-tetrazocine
LL	Load Line
LTM	long-term monitoring
LUC	land use control
MEC	munitions and explosives of concern
MKM	MKM Engineers, Inc.
MNA	monitored natural attenuation
NCP	National Contingency Plan
NDEE	Nebraska Department of Environment and Energy
O&M	operations and maintenance
OU	Operable Unit
RAO	remedial action objective
RI/FS	Remedial Investigation/Feasibility Study
ROD	Record of Decision
RDX	hexahydro-1,3,5-trinitro-1,3,5-triazine
TBC	to be considered
TMV	toxicity, mobility, or volume
TNT	2,4,6-trinitrotoluene
UFP-QAPP	Uniform Federal Policy-Quality Assurance Project Plan
URSGWCFS	URS Greiner Woodward-Clyde Federal Services
USACE	U.S. Army Corps of Engineers

ACRONYMS AND ABBREVIATIONS (CONTINUED)

USAEC	U.S. Army Environmental Center
UU/UE	unlimited use/unrestricted exposure
WJE	Watkins-Johnson Environmental, Inc.

1.0 INTRODUCTION

1.1 Project Work Authority

The U.S. Army Corps of Engineers (USACE) has contracted Brice Engineering, LLC (Brice) to complete a Focused Feasibility Study (FFS) for the Operable Unit (OU) 1 on-post explosives plume at the Cornhusker Army Ammunition Plant (CHAAP) near Grand Island, Nebraska (Figure 1). Work for this assignment is being performed under Brice's Contract Number W9128F-18-D-0020, Delivery Order F0041.

1.2 Objective

The overall objective of this FFS is to develop, screen, and perform analysis of remedial alternatives using data collected from the recently completed Rebound Study to support the termination of the pump and treatment system. This FFS report is the basis for recommending to the public a technically feasible and cost-effective remedial action that is protective of both human health and the environment. The overall objective of the remedial action proposed for OU1 is to achieve the remedial action objectives (RAOs) (Section 3.3).

The FFS process consists of the following steps:

- Revise the RAO that specifies the contaminants and media of concern and exposure pathways.
- Revise the estimated volumes or areas of media to which General Response Actions (GRAs) may be applied.
- Revise the identification and screening of technology process options based on effectiveness, implementability, and relative cost to select a representative process option for each technology type.
- Revise the assembly of representative technologies into alternatives representing a range of GRA combinations, as appropriate.
- Revise the detailed analysis, evaluate retained alternatives based on nine criteria as specified by U.S. Environmental Protection Agency (EPA) guidance (EPA 1988) and 40 Code of Federal Regulations 300.430(e)(9)(iii):
  - Overall protection of human health and the environment
  - Compliance with applicable or relevant and appropriate requirements (ARARs)
  - Long-term effectiveness and permanence
  - Reduction of toxicity, mobility, or volume (TMV) through treatment
  - Short-term effectiveness
  - Implementability
  - Cost
  - State acceptance
  - Community acceptance

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2.0 SITE DESCRIPTION

OU1 consists of explosives-contaminated groundwater plumes at CHAAP (i.e., plumes with explosives concentrations exceeding regulatory action levels). Health Advisory Levels (HALs) were established for the following explosives compounds: hexahydro-1,3,5-trinitro-1,3,5-triazine (RDX), 2,4,6-trinitrotoluene (TNT), and octahydro-1,3,5,7-tetranitro-1,3,5,7-tetrazocine (HMX). The HALs, presented in Table 1, were established as regulatory action levels for CHAAP in the OU1 Interim Action Record of Decision (ROD) (U.S. Army Environmental Center [USAEC] 1994) and the subsequent OU1 ROD Amendment (URS Greiner Woodward-Clyde Federal Services [URSGWCFS] 2001). The HALs are 2 micrograms per liter (µg/L) for RDX and TNT and 400 µg/L for HMX. The primary contaminants of concern (COCs) (i.e., compounds with historical concentrations in groundwater exceeding their corresponding HAL) are RDX and TNT. HMX has not exceeded the HAL during past groundwater monitoring. The current OU1 remedy for the on-post explosive plume is pump and treatment.

2.1 Environmental Setting

2.1.1 Topography and Surface Features

CHAAP is situated within the alluvial plain of the Platte River basin. Most of the ground surface within the OU1 RAO Load Line Treatment Areas is relatively flat, with an elevation range from approximately 1,895 feet above mean sea level at the northeast corner of LL1 to 1,917 feet above mean sea level at the southwest corner of LL4. Silver Creek drains a small area on the west and north sides of the facility. Large drainage ditches on the east side of LL1 and LL2 flow from south to north and drain surface water to Silver Creek. Groundwater flow direction is generally toward the northeast within the OU1 RAO Load Line Treatment Areas.

At LL1 through LL5, few site features remain related to former site activities, with the exceptions of asphalt and gravel access roads and extraction well (EW) buildings associated with the groundwater extraction system (EW1 through EW6). Load line properties have been sold to the public and redeveloped, including removal of former site features, modification to existing utility configurations, and conversion to strictly agricultural cropland. Only LL3, purchased by Hornady Manufacturing, has been developed to support manufacturing, research and development, and storage processes, which included the construction of multiple buildings, utility modifications such as electric, natural gas, and supply water, and fencing/access restrictions. Additionally, multiple irrigation wells and center pivot systems have been installed on the agricultural cropland where fertilizer applications are likely conducted. Where undeveloped, the load lines support a grass-dominated vegetation community with minimal trees and shrubs.

2.1.2 Geology

The geology summarized here was interpreted from soil boring logs completed during the installation of on- and off-post monitoring wells (Watkins-Johnson Environmental, Inc. [WJE] 1993, Woodward-Clyde 1999) as well as regional data from the Soil Survey for Hall County (U.S. Department of Agriculture 2004). The geologic units underlying the CHAAP study area include the following, listed in descending order from the surface:

- Alluvial silty clay and topsoil near the ground surface (from ground surface to approximately 5 feet below ground surface [bgs])
- Alluvial sands and gravels of the Grand Island Formation (estimated 50 - 60 feet thick from approximately 5 feet bgs to 55 - 65 feet bgs)

- A low-permeability, alluvial silty clay unit of the Fullerton Formation (estimated 5 to 15 feet thick from approximately 55 - 65 feet bgs to 70 - 80 feet bgs) (also referred to as the "blue clay" unit in previous reports [WJE 1993])
- Alluvial sands and gravels of the Holdrege Formation (reported to be up to 200 feet thick to an estimated depth of up to 280 feet bgs)

These geologic units are laterally extensive across the CHAAP facility.

2.1.3 Hydrogeology

2.1.3.1 Grand Island Formation Aquifer

Shallow groundwater underlying CHAAP occurs as an unconfined water table aquifer within the alluvial sands and gravels of the Grand Island Formation. The total saturated thickness of the water table aquifer in the OU1 RAO Load Line Treatment Areas averages approximately 41 to 51 feet (Brice-AECOM 2022a). Hydraulic conductivity values average 300 to 400 feet per day (URS 2001).

The Grand Island Formation aquifer is used regionally as a water supply source for irrigation and potable water. Locally, there are only two active irrigation wells near the on-post plume (Nebraska Department of Natural Resources 2021). However, historical contaminant migration data and plume geometry indicate irrigation wells have not significantly impacted the groundwater flow over time. Near the historical off-post plume, all private domestic water is supplied by the City of Grand Island. Per the OU1 ROD Amendment (URSGWCFS 2001), on-post institutional controls prohibit the use of groundwater as a potable water source, as well as drilling, within the plume areas.

2.1.3.2 Fullerton Formation Aquitard

The underlying Fullerton clay unit is a relatively low-permeability unit that appears to act as a barrier to vertical groundwater flow (i.e., aquitard) in the CHAAP study area. Justification for this interpretation includes:

- The presence of head differences across the Fullerton clay unit, as measured between the Grand Island Formation aquifer and the underlying Holdrege Formation aquifer at locations with nested monitoring wells installed (i.e., one monitoring well screened within each formation)
- The absence of contamination below the Fullerton clay unit at locations where contamination is present at the base of the Grand Island Formation aquifer

2.1.3.3 Holdrege Formation Aquifer

The sands and gravels of the Holdrege Formation exist as a confined aquifer unit, confined by the overlying Fullerton clay unit within the OU1 RAO Load Line Treatment Areas. Based on historical annual water level data from the deep monitoring wells, the Holdrege Formation is not hydraulically connected to the overlying Grand Island Formation. No explosives contamination has been detected in the wells screened in this deeper aquifer unit.

2.2 Facility Description and History

CHAAP is located on an 11,936-acre tract approximately 2 miles west of Grand Island, Nebraska (Figure 1). CHAAP was constructed and became fully operational in 1942 as a U.S. government-owned, contractor-operated facility.

CHAAP, shown on Figure 2, includes five former load lines, LL1 through LL5 (Section 2.3). Other former sites include the Administration Base Housing Area, two Magazine Areas, the Fuze Line, storage and dock facilities, Shop Area, Nitrate Area, CHAAP-05 Open Burning/Open Detonation Burning Grounds, Abandoned Burning Area, Sanitary Landfill, and Pistol Range Burning Grounds/Decant Station Area.

Currently, activities at CHAAP are limited to groundwater remediation at the Groundwater Treatment Facility (GWTF); leasing property for agriculture; leasing buildings for storage and limited manufacturing; wildlife management; and minor maintenance of the grounds, roads, and leased facilities. The majority of CHAAP property has been transferred to the public over the past 10 to 15 years.

The area surrounding CHAAP is primarily rural and agricultural. The City of Grand Island, with a population of approximately 50,000, lies directly east of the plant.

2.3 Load Line Area Description and History

LL1, LL2, LL3, and LL4 were primarily used as load, assemble, and pack facilities, and LL5 produced micro-gravel mines. LL1 through LL5 are shown on Figure 2. Production at CHAAP began with the pouring of the first 1,000-pound bomb at LL3 on 11 November 1942. Loading operations ceased on 14 August 1945, after production of 330,562 1,000-pound bombs; 20,698 2,000-pound bombs; 6,951,205 90-pound and 1,506,373 50-pound fragmentation bombs; 11,476,545 105-millimeter projectiles; 677,380 boosters; and 6,234,850 supplementary charges.

During the period from September 1945 to February 1950, the plant was declared surplus, then placed in standby status under the control of the Ordnance Corps, U.S. Army. Use of the buildings was primarily for grain storage, except for the Nitrate Area, which was used to manufacture fertilizer until April 1948.

In April 1950, CHAAP again became an active installation with the rehabilitation of LL1 and applicable operations for the production of 3.5-inch high explosive (HE) rockets. In December 1950, LL2, LL3, and LL4; the Fuze Line; storage and dock facilities; the administration area; and appurtenant utilities were rehabilitated. LL1 began production in January 1951 when the first HE rocket warheads were poured at the plant. These warheads were then combined with pre-assembled, pre-loaded rocket motors that were delivered to the plant as motor units. Production totals for the period between 1951 and 1954 were: 21,413,244 HE anti-tank and practice 3.5-inch rockets; 1,162,828 HE 4.5-inch rockets; 14,000,000 M404A1 and A2 fuzes; and 1,253,499 155-millimeter HE projectiles. In January 1966, production of bombs began and in 1967, the production of a new end product, the Micro-Gravel Mine XM45, began at LL5. The plant was laid away in 1974 but maintained in a high state of readiness until January 1989 when the plant was declared in excess.

2.4 Remedial Action History

From 1987 to 1988, the U.S. Army completed an incineration project designed to excavate and treat soil beneath the unlined leach pits and cesspools at the CHAAP load lines. The purpose was to remove the soil sources of explosives contamination. The project reduced the explosives contamination at these source areas; however, explosives concentrations remained greater than action levels at 29 of the 58 excavation locations due to excavations terminating at or just below the water table. Excavations were completed between 10 and 15 feet bgs, and in some cases excavations extended up to 5 feet below the water table. Because action levels were not achieved at all excavation locations, some locations existed as continuous source areas until future source area remedial actions (e.g., explosives-contaminated soil removals and subsurface injections [described below]) were completed.

An on-post groundwater extraction and treatment system was constructed in Summer 1998, and full-time operation began in December 1998. The groundwater extraction system included EW1 through EW6, with a total extraction rate of 750 gallons per minute (gpm). Based on the recommendations of the OU1 ROD Amendment (URSGWCFS 2001), EW7 was installed in March 2000. Additionally, pumping at EW1, EW2, and EW3 was discontinued in 2000 due to non-detection of explosive compounds; however, the overall flow rate to the GWTF was maintained at 750 gpm with EW7 operational. The GWTF formerly treated groundwater for explosives using granular activated carbon (GAC) absorption technology for treatment, then discharged the treated water to the two on-post drainage canals leading to Silver Creek. The most recent National Pollutant Discharge Elimination System Permit for CHAAP requires semi-annual sampling of the GWTF. Operations at the GWTF ceased in October 2019, and no sampling has taken place at the GWTF since the system was placed in "standby" status.

The OU1 ROD Amendment also included the implementation of monitored natural attenuation (MNA) for the off-post distal plume. The MNA alternative replaced off-post extraction and treatment originally planned for the distal plume. The long-term monitoring (LTM) program and MNA details are presented in annual reports, most recently the Draft *2022 Annual Groundwater Monitoring and Subsurface Injection Report* (Brice-AECOM 2022a).

Between 2000 and 2005, thermal decomposition, demolition, and 5X certification of LL1, LL2, LL3, and LL5 were completed by MKM Engineers, Inc. (MKM) (MKM 2004, 2005a, 2005b). Thermal decomposition, demolition, and 5X certification of LL4 were completed by PIKA (formerly MKM) in 2006 (PIKA 2007). 5X certification is defined as the decontamination of property, facilities, equipment, and soil so that they are free of any explosives hazards and can be released for general use or to the general public (MKM 2004). Thermal decomposition and demolition activities included burning and removal of all buildings and their floor slabs; however, concrete foundations and footers were left in place. MKM/PIKA sampled soil underneath the load line floor slabs for explosives, performed electromagnetic geophysical investigations, and completed munitions and explosives of concern (MEC) clearance.

Soil was sampled as part of the 5X certification process to determine if explosives concentrations were greater than 10 percent (%) by weight. Soil with explosives concentrations greater than 10% by weight was mixed with adjacent clean soil until explosives concentrations were less than 10%. Explosives-contaminated soil investigations and soil excavations at LL1, LL2, and LL3 were completed in 2006 and at LL4 in 2007. These excavations addressed explosives-contaminated surface soil and subsurface soil at previously identified source areas. Soil with explosives concentrations greater than the CHAAP industrial risk soil remediation levels was excavated and disposed at an approved offsite disposal facility. The CHAAP industrial risk soil remediation levels were determined and described in the CHAAP OU3 and OU4 RODs. All property within the fenced areas at LL1, LL2, LL3, LL4, and LL5 has been 5X certified; therefore, MEC support and 5X certification activities are not required during on-post intrusive field activity.

Under the direction of USACE, the OU1 RAO subsurface injection project began in Spring 2007 and was performed through 2016; and again in 2019 and 2020. The purpose is to enhance anaerobic in situ bioremediation processes and cometabolically degrade RDX and TNT at the primary source areas near EW1, EW4, EW5, and EW6; and residual concentrations near EW7 (in 2019 and 2020). Subsurface injection project results and recommendations have been submitted annually in the subsurface injection annual reports (2007 through 2016) and in OU1 Rebound Study Letter Reports for 2019 and 2020. The most recent injections (2020) are included in the *OU1 Rebound Study Letter Report – Quarter 4 Event* (Brice-AECOM 2021).

Based on the explosive mass reduction trends and model-predicted results from 2007 to 2009, it was determined that additional injection would be beneficial within the load line source areas in LL1 and LL2. As a result, pumping was reduced and eventually discontinued at EW4, EW5, and EW6 to allow source treatment via subsurface injection. To maintain hydraulic control and plume capture at the former CHAAP boundary, the pumping rate at EW7 was increased to 500 gpm and remained at or near that pumping rate from July 2009 until November 2015, when the pumping rate was reduced to 450 gpm. This reduction in pumping rate was recommended in the *2014 Annual Groundwater Monitoring and Subsurface Injection Report* (BW-URS 2015) based on groundwater modeling. The modeling demonstrated a decreased pumping rate was appropriate and would continue to provide hydraulic control of the on-post plume, based on the reduction in plume size/width since the initiation of subsurface injections. Groundwater modeling results and the recommendation to reduce the pumping rate to 300 gpm were included in the *2016 Annual Groundwater Monitoring and Subsurface Injection Report* (BW-URS 2017). The flow rate at EW7 was reduced to 300 gpm following EPA and Nebraska Department of Environment and Energy approval of that report in November 2017. In October 2019, the EW7 pumping was temporarily discontinued (set to 0 gpm), and the GWTF was winterized. It will be maintained in a "standby" status initiated during the OU1 Rebound Study (approximately 2-year duration) with additional OU1 subsurface injection activities. Details are provided in the OU1 Rebound Study Work Plan (Brice-AECOM 2019).

Recent groundwater monitoring and subsequent statistical analysis have shown explosives concentrations near the former facility boundary between EW6 and EW7 have significantly declined based on comparison to historical concentrations over the past 24 years. Additionally, numerical groundwater modeling predictions have indicated that operation of EW7 is not needed to prevent the on-post plumes from migrating downgradient. Based on these results, in October 2019, an OU1 Rebound Study was initiated, which included temporary discontinuation of EW7 and GWTF and completion of on-post subsurface injections (voluntary action) to expedite OU1 remediation and reduce cleanup timeframes while continuing to meet cleanup objectives and goals.

2.5 Rebound Study

Based on previous statistical analysis and historical numerical groundwater modeling simulations, an OU1 Rebound Study was performed to temporarily discontinue pumping at EW7 and monitor groundwater near the former facility boundary. Eight total groundwater sampling events (one baseline and seven quarterly events) were completed to closely monitor potential migration of the RDX and TNT plumes and to document any increases/decreases in explosives concentrations in groundwater. The objective of the OU1 Rebound Study was to establish a sufficient data set to initiate further identified Decision Points and Contingency Actions as presented in the OU1 Rebound Study Work Plan (i.e., groundwater extraction is no longer needed, groundwater extraction should be resumed, alternative actions should be taken) (Brice-AECOM 2019).

Concurrent with the OU1 Rebound Study, subsurface injections (a voluntary action) were completed in 2019 in the area of highest RDX and TNT concentrations near the former facility boundary, and in 2020 for on-post areas with remaining residual RDX and TNT concentrations greater than HALs, to accelerate remedial timeframes. Four total groundwater sampling events (at approximate quarterly frequency) were completed for each injection event to closely monitor performance of the subsurface injections and remediation of the RDX and TNT plumes, and to document any increases/decreases in explosives concentrations in groundwater.

Results of the OU1 Rebound Study presented in the *Rebound Study Letter Report – Quarter 8 Event* (Brice-AECOM 2022b) have shown on-post TNT concentrations greater than its HAL (2 µg/L) decrease or

remain consistent with previous events, with only minor increases observed. During direct push groundwater sampling events, off-post TNT concentrations (greater than the HAL) were identified directly downgradient of EW7 that were likely present prior to the shutdown of EW7. These off-post concentrations generally decreased during the sampling events and did not show migration further downgradient. Off-post monitoring wells, downgradient of the feedlot, remained non-detect for RDX and TNT for all events. Based on the OU1 Rebound Study events, and in accordance with the *OU1 Rebound Study Work Plan* (Brice-AECOM 2019) Decision Points, Contingency Actions, and Inputs, it was recommended to discontinue the OU1 Rebound Study, continue annual groundwater monitoring at OU1 in accordance with the *Uniform Federal Policy – Quality Assurance Project Plan* (UFP-QAPP) (BW-URS 2015) and its *Addendum 3 UFP-QAPP* (Brice-AECOM 2019), and proceed with an FFS.

2.6 Chemicals of Potential Concern

As discussed in the OU1 Interim Action ROD (USAEC 1994) and the subsequent OU1 ROD Amendment (URSGWCFS 2001), the chemicals of potential concern (COPCs) are chemicals that may have been released into groundwater from past site activities including munitions loading, assembly, and packing operations and may be significant contributors to human health risks. Based on current sampling results from the *Rebound Study Letter Report – Quarter 8 Event* (Brice-AECOM 2022b), analytes identified as COPCs in the OU1 on-post explosive plume are:

- RDX
- TNT
- HMX
- 1,3,5-trinitrobenzene
- 1,3-dinitrobenzene
- 2,4-dinitrotoluene
- 2-amino-4,6-dinitrotoluene (2-Am-DNT)
- 4-amino-2,6-dinitrotoluene (4-Am-DNT)
- mono-nitroso-RDX (MNX)

2.7 Summary of Site Risk Assessment

The Remedial Investigation/Feasibility Study (RI/FS) report (ICF Kaiser 1996) included a risk assessment to estimate current and future risks to human health and the environment from exposures to contaminated groundwater. Although the levels of explosives in on-post groundwater were elevated, there are many uncertainties in predicting the risk estimates, including the assumption that residents would actually consume on-post groundwater on a regular basis.

Estimated risks for carcinogens (potentially cancer-causing chemicals) were compared to the National Contingency Plan (NCP) acceptable range (i.e., the target risk range of one in a million to one in ten thousand [$1x10^{-6}$ to $1x10^{-4}$] for human health protection at Superfund sites). Chemicals with completed pathways that exceed a risk of one in one million ($1x10^{-6}$) usually warrant remedial action under Nebraska ARARs.

Non-carcinogen chemical concentrations were compared to a hazard quotient of 1.0. Chemicals that are present in concentrations that exceed a hazard quotient of 1.0 usually warrant remedial action. An estimation of risks presented in the 1996 RI/FS are summarized below.

2.7.1 Estimated On-Post Groundwater Risks

For ingestion of explosives-contaminated on-post groundwater, the risk estimates indicated excess lifetime cancer risks greater than the $1x10^{-4}$ risk level. In addition, it was determined that unacceptable levels of adverse non-carcinogenic effects associated with explosives in groundwater may occur. This exposure pathway was eliminated because CHAAP implemented deed restrictions prohibiting drinking water supply wells on excessed property in the vicinity of the plume.

- Future cancer risk estimates associated with the future ingestion of crops irrigated with on-post groundwater were at the low end of the $1x10^{-6}$ to $1x10^{-4}$ risk range, and the non-carcinogenic hazard indices were less than 1.0. These low risk estimates demonstrate, based on the assumptions made in the risk assessment, that no unacceptable cancer risks and no unacceptable adverse health effects are likely to occur from exposure to explosives in vegetables that have been irrigated with CHAAP groundwater.
- There are no estimated risks to ecological receptors because on-post groundwater is considered inaccessible to ecological receptors at CHAAP.
- Risks associated with all other organic and inorganic chemicals in groundwater were estimated to be at acceptable levels.

2.7.2 Estimated Off-Post Groundwater Risks

- Lifetime groundwater risk estimates for off-post residents were lower than or at the low end of the $1x10^{-6}$ to $1x10^{-4}$ risk range, and hazard indices were less than 1.0, except for a child's ingestion of groundwater. The need for groundwater use as a drinking water supply has been eliminated because all residences in the affected areas connect to the city water supply.
- There are no estimated risks to ecological receptors because off-post groundwater is considered inaccessible to ecological receptors near CHAAP and in the city.

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3.0 REMEDIAL ACTION OBJECTIVES

Pursuant to NCP Section 300.430(e)(2)(i), RAOs are established to assist in the development of alternatives. RAO(s) specify the COCs and media; exposure pathways and receptors; and preliminary cleanup goals.

3.1 Contaminants of Concern

The COCs in groundwater for OU1 include explosives compounds RDX, TNT, and HMX. These compounds were selected for the OU1 COCs because of their historical use, frequency of occurrence, magnitude of detected concentrations, and potential adverse health effects. RDX, HMX, and TNT have migrated east-northeast with the predominant direction of groundwater flow. The more mobile compounds, RDX and HMX, have migrated the greatest distance. Highly sorbing compounds such as TNT have migrated shorter distances.

3.2 Site-Specific Cleanup Goals

HALs for explosive compounds RDX, HMX, and TNT were established as cleanup goals for CHAAP in the OU1 ROD (USAEC 1994) and the subsequent OU1 ROD Amendment (URSGWCFS 2001) and remain unchanged. HMX has never been detected at concentrations greater than the HAL.

OU1 HALs:

- 2 µg/L for RDX and TNT
- 400 µg/L for HMX

3.3 Summary of Remedial Action Objectives

The OU1 ROD (USAEC 1994) and the subsequent OU1 ROD Amendment (URSGWCFS 2001) established the following RAOs for explosives in groundwater at CHAAP:

- Protect human health and the environment
- Clean up groundwater to below health advisory levels
- Contain high concentrations of explosives in groundwater on-post

The RAOs for CHAAP have been revised for the new Proposed Remedy and are now:

- Protect human health and the environment
- Clean up groundwater to less than health advisory levels
- Monitor on-post explosives plume for potential increasing trends or downgradient migration
- Monitor natural attenuation parameters to confirm natural attenuation is occurring

The OU1 ROD (USAEC 1994) and the subsequent OU1 ROD Amendment (URSGWCFS 2001) established RAOs for explosives in groundwater at CHAAP and have been revised for the new Proposed Remedy.

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4.0 IDENTIFICATION AND SCREENING OF TECHNOLOGIES

Remedial technologies were identified and screened to develop representative process options for assembly into a range of alternatives. The development of remedial action alternatives for CHAAP consists of the following:

- Developing GRAs that address the RAO
- Identifying candidate technologies and process options applicable to the various GRAs
- Screening the identified technology process options based on effectiveness, implementability, and relative cost to select representative process options for each technology type
- Selecting and assembling representative technologies into remedial action alternatives representing a range of GRA combinations (Section 5.0)

Each of these components is presented below or in Section 5.0.

4.1 General Response Actions

GRAs are broad classes of medium-specific actions intended to satisfy the RAO. The media of concern at CHAAP is groundwater impacted at concentrations that pose a risk to human health under the current and future use scenarios and does not allow for unlimited use/unrestricted exposure (UU/UE). The following response actions may be implemented alone or in combination. The following GRAs are potentially applicable to contaminated media at CHAAP:

- No Action – Leave the site "as is" with no provisions for monitoring or control. This GRA will be considered and carried through the FFS process as a baseline for comparison of the other identified alternatives pursuant to NCP Section 300.430(e)(2)(i)(A).
- Land Use Controls (LUCs) – Impose institutional controls consisting of legal or administrative measures to reduce or minimize potential for exposure to contaminants or disturbance of containment measures.
- Natural Attenuation – Implement actions that rely on natural attenuation processes to reduce mass, TMV, and/or concentration of contaminants in a carefully controlled and monitored site cleanup approach.
- Containment – Implement actions that result in a contaminated groundwater plume being contained or controlled, thereby minimizing or eliminating the migration of contaminants and preventing exposure to contamination.
- Treatment – In situ and ex situ remedial actions taken to treat contaminated groundwater to reduce the TMV of contaminants.

In the following sections, these GRAs will be further defined through the screening and evaluation of remedial technologies and process options. Following this screening, the GRAs will be assembled into remedial action alternatives in Section 5.0 aimed at achieving the proposed RAO.

4.2 Identification and Screening Technologies and Process Options

Several remedial technologies and technology process options were identified for the various GRAs. The term remedial technology refers to a category of technologies capable of achieving its GRA. The term process option refers to a specific process within the remedial technology category.

The candidate remedial technologies and process options were evaluated for applicability to CHAAP. This was done to screen out those technologies or process options that were not technically feasible or applicable to existing site conditions. The evaluation of applicability considered the practical nature of implementation given the physical site conditions (e.g., location, configuration, geology, hydrogeology) and the waste or contaminant characteristics (e.g., contaminant types and extent). Candidate remedial technologies and process options were assembled based on experience at similar sites and following a review of applicable EPA documents, pertinent textbooks and published articles, and remediation equipment vendor information.

Table 2 presents the groundwater remedial technologies and process options that are potentially applicable and results of the initial screening evaluation. Table 2 also provides screening comments, and each process option is identified as being potentially applicable or not potentially applicable.

4.3 Detailed Screening of Technologies and Process Options

The potentially applicable process options carried forward from Section 4.2 were evaluated in greater detail and screened. The purpose of this detailed screening was to narrow the field of potential process options to a minimum of viable representative process options and facilitate the assembly of remedial alternatives. The criteria for screening of process options consisted of effectiveness, implementability, and cost, as described below.

4.3.1 Effectiveness

The evaluation of effectiveness focused on three primary considerations:

- Ability to handle the estimated areas or volumes of contaminated media and to meet remediation goals
- Potential effects on human health and the environment during implementation
- Reliability and proven performance with respect to site conditions and contaminants

4.3.2 Implementability

The evaluation of implementability included consideration of the technical and administrative feasibility of a process option. Implementability is characterized as readily implemented, moderately difficult, or difficult to implement relative to other process options under consideration, based on experience. The following factors were considered as part of the implementability evaluation:

- Ability to obtain necessary permits
- Availability of equipment and skilled workers needed to implement the process option

4.3.3 Cost

The cost evaluation was limited to a qualitative cost comparison that considers the capital cost and the operations and maintenance (O&M) costs of a particular process option. Costs are characterized as low, moderate, or high in comparison to other process options within a technology, based on experience and engineering judgment.

4.3.4 Summary of Screening Process Options

The evaluation and screening of process options is presented in Table 3. The process options with favorable effectiveness, implementability, and lower relative costs were retained as the representative

process options. Table 3 also provides comments regarding effectiveness, implementability, and relative cost. Process options are identified as being retained or not retained, and screening comments are provided to justify exclusion of certain process options.

The technologies and process options that were retained in Table 3 were assembled into remedial alternatives in Section 5.0.

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5.0 ALTERNATIVE DEVELOPMENT

This section describes the development of remedial alternatives for CHAAP using the technology process options that were retained during the detailed screening process (Table 3). The alternatives are designed to satisfy the RAO developed in Section 3.0. The alternatives were screened using effectiveness, implementability, and cost criteria to limit the number of alternatives carried forward to Section 6.0 for detailed analysis.

5.1 Assembly of Remedial Action Alternatives

Remedial action alternatives were assembled from combinations of process options and technologies that survived the screening process in Section 4.0. The alternatives were assembled to provide a range from No Action to active treatments that would reduce the TMV of contaminants at CHAAP. Although LUCs, including information devices and site controls, were retained during the detailed screening process (Table 3), LUCs were not included as a stand-alone remedial action alternative due to the inability of LUCs alone to meet the RAO. The screening of remedial action alternatives is summarized in Table 4.

5.2 Description of Remedial Action Alternatives

This section provides detailed descriptions of each remedial alternative for CHAAP.

5.2.1 Alternative 1: No Action

Alternative 1 assumes that no remedial action would be implemented. This alternative is required by the NCP and serves as a baseline against which other alternatives are compared.

Under No Action, contaminants would not reduce in concentration, and risks to potential human receptors from exposure to groundwater would remain for an indefinite period. Alternative 1 would not achieve the RAO.

5.2.2 Alternative 2: Monitored Natural Attenuation with Land Use Controls

Alternative 2 consists of MNA and LUCs. The plume would be monitored for attenuation of contamination using the monitoring well network. Monitoring would include collecting groundwater elevations, screening data (including field measurements), and groundwater samples for laboratory analysis at the monitoring wells and direct push groundwater sampling locations shown on Figures 3 through 5. The remediation timeframe for the plume is estimated at approximately 8 years based on groundwater modeling, and it is assumed that groundwater monitoring would occur over the full amount of time. The monitoring well network would be sampled annually for 18 years. It is expected that the number of monitoring wells that require sampling and the frequency of the sampling would decrease as the plume recedes.

LUCs would continue to restrict access to groundwater contaminated with COCs at concentrations greater than cleanup goals.

5.2.3 Alternative 3: Monitored Natural Attenuation with Land Use Controls and Subsurface Injections

Alternative 3 continues treatment of COCs in groundwater with subsurface injections, MNA, and LUCs. The areas with remaining residual concentrations would be treated by injecting a combination of

blackstrap molasses mixed with whey, hydrolyzed vegetable oil, and cornsteep into the subsurface to enhance anaerobic in situ bioremediation processes and cometabolically biodegrade the explosives in the plume. Naturally occurring processes would reduce concentrations of COCs in groundwater within and outside of the treatment area once injections are completed.

After injections are complete, MNA would be implemented for the entirety of the plume at the monitoring wells and direct push groundwater sampling locations shown on Figures 3 through 5, as described in Section 5.2.2. The remediation timeframe for the plume is estimated at approximately 6 years based on groundwater modeling and site sampling after previous injection events. The monitoring well network would be sampled annually for 16 years. It is expected that the number of monitoring wells that require sampling and the frequency of the sampling would decrease as the plume recedes.

LUCs would continue to restrict access to groundwater contaminated with COCs at concentrations greater than cleanup goals.

6.0 DETAILED ANALYSIS OF ALTERNATIVES

The remedial action alternatives for CHAAP, described in Section 5.0, were analyzed in detail using the evaluation criteria contained in NCP Section 300.430(e)(9)(ii). Because a manageable list of alternatives was developed, intermediate screening of alternatives was not necessary. The criteria used for detailed analysis are described in Section 6.1. The alternatives are analyzed and compared in Section 6.2.

6.1 Detailed Analysis Criteria

Remedial action alternatives for CHAAP were analyzed in detail through evaluation of the nine criteria established in NCP Section 300.430(e)(9)(iii), described below.

6.1.1 Overall Protection of Human Health and the Environment

This criterion provides a final check to assess whether each alternative would result in adequate protection of human health and the environment, focusing on how each risk and associated pathway would be eliminated, reduced, or controlled. The assessment on overall protection draws from the assessments conducted under other criteria, especially long-term effectiveness and permanence, short term effectiveness, and compliance with ARARs. This evaluation allows for consideration of whether an alternative poses any unacceptable short-term or cross-media impacts resulting from remediation.

6.1.2 Compliance with Applicable or Relevant and Appropriate Requirements

Identification of and compliance with ARARs are mandated by the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA). Remedial alternatives, including the No Action Alternative, are evaluated to assess the degree to which they attain or exceed ARARs. This process is intended to provide a measure of the effectiveness of remedial alternatives in relation to protection of human health and the environment.

ARARs include standards, requirements, criteria, or limitations established under federal environmental law, or standards, requirements, criteria, or limitations promulgated under state (Nebraska) law. “Applicable” standards are those cleanup standards, standards of control, and other substantive environmental protection requirements, criteria, or limitations promulgated under federal or state laws that specifically address a hazardous substance, contaminant, remedial action, or locational circumstance. “Relevant and appropriate” standards are those that apply to circumstances sufficiently similar to those encountered at a CERCLA site that, although otherwise not legally required, their application is appropriate at that specific site. If a requirement is found to be relevant and appropriate, it will be treated in the same way as an applicable requirement. “To be considered” (TBC) standards are non-promulgated advisories, proposed rules, criteria, or guidance documents issued by federal or state governments that do not have the status of ARARs. These advisories and guidance are to be considered when determining protective cleanup levels where no ARAR exists, or where ARARs are not sufficiently protective of human health and the environment.

The onsite portion of a selected remedial action must comply with all ARARs. Offsite, all requirements legally applicable at the time the action is carried out must be met.

Based on EPA guidance, ARARs are categorized as action-specific, chemical-specific, or location-specific:

- Chemical-specific ARARs include laws and requirements that establish levels that are considered protective of human health and the environment for specific chemicals in specific media. They are used to help determine the level of remediation and the allowable levels of residues following treatment.
- Location-specific ARARs establish restrictions that are related to the geographic location of the site and surrounding areas, such as wetlands, sensitive habitats, floodplains, and historic places.
- Action-specific ARARs are not established for a specific contaminant; rather, they define treatment and disposal activities for hazardous substances and control remedial actions to limit the release of hazardous substances to the environment during the action. Performance levels, actions, or remedial technologies are established for discharge of residues, in addition to specific contaminant levels. Each action-specific requirement will differ depending on the RAO.

As a general rule, response actions that meet ARARs are effective in preventing or minimizing the release of contaminants, and thereby reduce present and future risk to public health and the environment. The list of ARARs established in the 2001 OU1 ROD Amendment (URSGWCFS 2001) has been reduced to include ARARs related to the remedial alternatives proposed in this FFS. Appendix A presents the list of ARARs and TBCs, as well as comments regarding the applicability or relevance and appropriateness.

If an identified ARAR is not met by an alternative, then an evaluation on the appropriateness of a waiver should be made. Waivers could be applied in any of six circumstances identified by CERCLA (EPA 1988).

6.1.3 Long-Term Effectiveness and Permanence

This criterion addresses the risk remaining at the site associated with each alternative after remedial action has taken place and objectives have been met. The focus is on risk posed by residuals and/or untreated wastes after the cleanup criteria have been reached. The primary components of this criterion include consideration of the magnitude of residual risk and the adequacy and reliability of controls.

6.1.4 Reduction of Toxicity, Mobility, or Volume through Treatment

This criterion addresses the statutory preference of CERCLA for remedial actions involving treatment technologies that permanently and significantly reduce the TMV of the principal hazardous substances at a site. This preference is satisfied when treatment is used to reduce the principal threats by destroying toxic contaminants, irreversibly reducing contaminant mobility, or reducing the total volume of contaminated media.

6.1.5 Short-Term Effectiveness

This criterion assesses the short-term effectiveness of each alternative by assessing the risk to the community, workers, and environment during construction and implementation of the remedial action, and the time required to achieve the RAO.

6.1.6 Implementability

Implementability is evaluated in terms of technical feasibility, administrative feasibility, and availability of services and materials. Technical feasibility assesses the ability to construct, operate, monitor, and, if needed, expand an alternative. Administrative feasibility assesses the activities needed to coordinate with

other agencies or obtain permits. Availability of services and materials considers locally available resources and availability of technologies.

6.1.7 Cost

The cost of each alternative is evaluated by considering the capital cost, O&M cost, and periodic costs. Costs that were common to all alternatives (e.g., relating to a change in remedy, including preparation of a ROD Amendment) were not included in the comparison, as they would be the same for every alternative.

The feasibility-level cost analysis is provided in Appendix B. The present worth costs provide a common basis for comparing alternatives. Present value is the amount of money needed in the base year to cover the future costs associated with a particular time period at a particular interest or discount rate. For each alternative to provide a common basis for comparing alternatives, present value is developed at a discount rate of 0.1% for a project of 1-year duration, 0.4% for a project of 5-year duration, and 1.4% for a project of 30-year duration, as specified in the current U.S. Office of Management and Budget (OMB) guidance (OMB 2014) for real interest rates. A feasibility-level cost estimate, intended to provide an accuracy range of -30 to +50% of actual cost, was prepared for each alternative using EPA guidance (EPA 2000). The final project cost of the selected alternative will depend on actual labor and material cost, productivity, competitive market conditions, final project scope and schedule, and other variable factors.

As a result of these factors, the final project cost is likely to vary from the estimates provided in this FFS. Funding needs should be carefully reviewed before final remedial action budgets are established. The selected alternative and corresponding cost estimates should be further refined in the remedial design stage. As such, the estimates provided in this FFS should not be used for final project budgeting.

6.1.8 Regulatory Acceptance

Regulatory acceptance is not considered as part of the FFS. EPA and the Nebraska Department of Environment and Energy (NDEE) will evaluate this criterion concurrently through the comment and response period for the Proposed Plan. EPA/NDEE acceptance will indicate that both agencies agree with the preferred alternative in the Proposed Plan.

6.1.9 Community Acceptance

Community acceptance is not considered as part of the FFS. This criterion will be evaluated through the public comment and response period for the Proposed Plan. Community acceptance will be evaluated once public comments on the Proposed Plan have been received.

6.2 Detailed Analysis of Alternatives

Three alternatives that address groundwater at CHAAP have been carried forward to detailed analysis:

- Alternative 1: No Action
- Alternative 2: MNA with LUCs
- Alternative 3: MNA with LUCs and Subsurface Injections

Table 5 presents the results of individual detailed analysis of the CHAAP alternatives completed using the criteria described in Section 6.1. Appendix B provides cost estimate summaries for each alternative, as well as cost worksheets completed for selected cost elements. Comparative analysis is provided in the following subsection.

6.2.1 Overall Protection of Human Health and the Environment

Alternative 1: No Action would not provide any protection and would not mitigate the potential unacceptable risks to human health and the environment as outlined in the risk assessment (Section 2.7). Alternative 2: MNA with LUCs would limit exposure pathways through the use of LUCs and provide monitoring as an early warning if the plume were to migrate. Alternative 3: MNA with LUCs and Subsurface Injections would reduce risk and support restoration of groundwater with the subsurface injections in addition to providing the same protections as Alternative 2. The explosives are not expected to have a negative impact on the ecosystem because the groundwater is considered inaccessible to ecological receptors.

Alternatives 2 and 3 both reduce risks at the site to UU/UE.

6.2.2 Compliance with Applicable or Relevant and Appropriate Requirements

Compliance with ARARs is not applicable for Alternative 1: No Action as CERCLA Section 121, "Cleanup Standards" applies only to remedial actions that EPA determines should be taken under CERCLA Sections 104 and 106 authority. Alternatives 2 and 3 would be expected to meet ARARs upon completion of the remedial action, and waivers would not be required.

6.2.3 Long-Term Effectiveness and Permanence

Alternative 1: No Action would not provide long-term protection of human health and the environment and would leave a residual risk.

Alternative 2: MNA with LUCs and Alternative 3: MNA with LUCs and Subsurface Injections have the potential to provide a long-term and permanent remedy that would achieve the cleanup goals. The magnitude of the natural attenuation processes would be governed by the prevailing site conditions and the nature of the compounds.

6.2.4 Reduction of Toxicity, Mobility, or Volume through Treatment

Through Alternative 1: No Action, the TMV of contaminants would not be reduced.

Alternative 2: MNA with LUCs would reduce the TMV of COCs in groundwater over time through naturally occurring processes, without additional treatment, and would not generate a waste stream. Modeling indicates that there would be a natural reduction of the plume.

Alternative 3: MNA with LUCs and Subsurface Injections would reduce the TMV of COCs in groundwater. The hot spots would be treated with injections to enhance anaerobic in situ bioremediation processes and cometabolically biodegrade the explosives in the plume. Modeling indicates there would be continued reduction of the plume.

6.2.5 Short-Term Effectiveness

Alternative 1: No Action would not result in short-term impacts because no remedial action would be implemented.

The remediation timeframe is estimated to be 18 years for Alternative 2 and 16 years for Alternative 3. Since the plume is away from residential areas, potential short-term impact on the community is low for both Alternatives 2 and 3. Site workers would need to take proper safety precautions during monitoring and/or subsurface injection activities.

6.2.6 Implementability

Alternative 1: No Action is technically and administratively feasible since there is nothing to implement.

Alternative 2: MNA with LUCs is technically and administratively feasible since it would require monitoring the plume for natural attenuation using the existing monitoring well network. It is unlikely to negatively affect natural resources and would require limited O&M.

Alternative 3: MNA with LUCs and Subsurface Injections is technically and administratively feasible using conventional and available equipment for subsurface injections and the existing monitoring well network for MNA. It is unlikely to affect natural resources and would require limited O&M.

Alternative 1 is considered the easiest of the three alternatives to implement since there is nothing to implement. However, because the monitoring well network is already in place, Alternatives 2 and 3 would be implemented easily with some coordination with the landowners.

6.2.7 Cost

The estimated total costs for each alternative are presented in Table 5. The total costs are:

- **Alternative 1:** $0 No capital, O&M, or periodic costs
- **Alternative 2:** $8,735,185 Associated with monitoring and LUCs
- **Alternative 3:** $10,668,544 Associated with monitoring, LUCs, and subsurface injections

6.3 Assumptions and Uncertainties

Several assumptions were made and uncertainties were identified during the FFS process. The assumptions and uncertainties discussed in this section should be addressed prior to or during implementation of remedial actions under consideration at CHAAP.

- The cost estimates were completed with the intended FFS-level accuracy of -30% to +50%. A detailed design and cost estimate should be prepared for the selected alternative prior to implementation.
- Present value cost estimates are based on the estimated time of remediation for Alternatives 2 and 3.
- For Alternative 3, two rounds of subsurface injections were assumed to be required. If more injections are needed, the projected costs would increase.

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TABLES

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Table 1
Contaminants of Concern and Site-Specific Cleanup Levels

Chemical	Health Advisory Levels (µg/L)
HMX	400
RDX	2
TNT	2

Notes:

Groundwater cleanup levels are from the 2001 ROD Amendment (URSGWCFS 2001).

µg/L – micrograms per liter

HMX – octahydro-1,3,5,7-tetranitro-1,3,5,7-tetrazocine

RDX – hexahydro-1,3,5-trinitro-1,3,5-triazine

TNT – 2,4,6-trinitrotoluene

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Table 2
Initial Screening of Technologies

General Response Action	Technology	Process Option	Description	Potentially Applicable?
No Action	None	None	Do nothing to achieve remedial action objectives.	Yes
LUCs	Institutional Controls	Government Controls	Authority normally exercised by local governments as delegated by the state including land use planning, zoning, site development permitting, construction codes, and ordinances. Also may include documents required to meet state or federal administrative code for implementation of land use restrictions at sites where environmental contamination has occurred.	Yes
		Proprietary Controls	Contractual mechanisms usually established in a deed (deed restrictions) or contract for sale in the form of covenants, easements, or equitable servitude; these mechanisms usually require a property owner to do or refrain from doing something and can be used to impose a duty on the landowner to comply with the use restriction.	Yes
		Informational Devices	Includes registries established by state legislatures that contain information about properties (i.e., State Registries of Hazardous Waste Sites). Also includes advisories, usually issued by public health agencies, either at the federal, state, or local level, that provide notice to potential users of land, surface water, or groundwater of some existing or impending risk associated with their use.	Yes
		Alternate Water Supply	Alternate water supply is provided to prevent the use of contaminated water.	No
Containment	Hydraulic Containment	Pump and Treat	Intercepts a contaminated groundwater plume by pumping groundwater to the surface. Once at the surface, the water is either disposed of or treated and then discharged.	Yes
Treatment	Intrinsic Remediation	Monitored Natural Attenuation	Naturally occurring processes (e.g., dispersion, volatilization, biodegradation, adsorption, and chemical reactions) are allowed to reduce contaminant levels.	Yes
	Biological	Enhanced Biodegradation	Acclimated microorganisms and/or nutrients are added to the groundwater via injection well or drill rig to increase biological activity.	Yes
	Physical/Chemical	Extraction	Extraction wells are used to removed contaminated groundwater; the groundwater is treated with granular activated carbon, granular media filtration, chemical precipitation, and constructed wetlands; the effluent is discharged.	Yes
		Injections	A drill rig is employed to inject treatment or stabilizing agents into the groundwater.	Yes

Notes:
LUC – land use control

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Table 3
Evaluation of Potentially Applicable Technologies

General Response Action	Technology	Process Option	Description	Effectiveness	Implementability	Relative Cost	Screening Comments
No Action	None	None	Do nothing to achieve remedial action objectives.	The current status would remain unchanged. May achieve remedial objectives after long period of time due to natural processes.	None	No capital. No O&M.	Retained. Required for comparison with other alternatives.
Land Use Controls	Institutional Controls	Government Controls	Authority normally exercised by local governments as delegated by the State including land use planning, zoning, site development permitting, construction codes, and ordinances. Also may include documents required to meet state or federal administrative code for implementation of land use restrictions at sites where environmental contamination has occurred.	Effective at preventing some human exposure. Would not reduce contamination onsite.	Readily implemented.	Low capital. Low O&M.	Retained.[1]
		Proprietary Controls	Contractual mechanisms usually established in a deed (deed restrictions) or contract for sale in the form of covenants, easements, or equitable servitude; these mechanisms usually require a property owner to do or refrain from doing something and can be used to impose a duty on the landowner to comply with the use restriction.	Effective at preventing some human exposure. Would not reduce contamination onsite.	Readily implemented.	Low capital. No O&M.	Not retained. Would not prevent all human exposures. Would not reduce contamination onsite.
		Informational Devices	Includes registries established by state legislatures that contain information about properties (i.e., State Registries of Hazardous Waste Sites). Also includes advisories, usually issued by public health agencies, either at the federal, state, or local level, that provide notice to potential users of land, surface water, or groundwater of some existing or impending risk associated with their use.	Complimentary effectiveness with other land use controls as an overall strategy to inform the public.	Readily implemented. Have a very short useful life. Do not create any enforceable restrictions.	Low capital. No O&M.	Retained.[1]
Containment	Hydraulic Containment	Pump and Treat	Intercepts a contaminated groundwater plume by pumping groundwater to the surface. Once at the surface, the water is either disposed of or treated and then discharged.	Effective at reducing contaminant concentrations. Multiple rounds of application may be required, which would extend timeframe to site closure.	Relatively easy to implement.	High capital. Low O&M.	Not retained. Option unlikely to be implemented due to rebound study being completed and demonstrating that other process options are effectively reducing contamination.
Treatment	Intrinsic Remediation	Monitored Natural Attenuation	Naturally occurring processes (e.g., dispersion, volatilization, biodegradation, adsorption, and chemical reactions) are allowed to reduce contaminant levels.	Periodic groundwater sampling can be conducted to assess the effectiveness of the natural attenuation.	Sampling is readily implemented.	Low capital. No O&M.	Retained.[1]
	Biological	Enhanced Biodegradation	Acclimated microorganisms and/or nutrients are added to the groundwater via injection well or drill rig to increase biological activity.	Effective at removing contaminants from groundwater. Multiple rounds of application may be required, which would extend timeframe to site closure.	Relatively easy to implement.	Medium capital. Low O&M.	Retained.[1]
	Physical/ Chemical	Extractions	Extraction wells are used to removed contaminated groundwater; the groundwater is treated with granular activated carbon, granular media filtration, chemical precipitation, and constructed wetlands; the effluent is discharged.	Effective at reducing contaminant concentrations. Multiple rounds of application may be required, which would extend timeframe to site closure.	Relatively easy to implement.	High capital. Low O&M.	Not retained. Option unlikely to be implemented due to rebound study being completed and demonstrating that other process options are effectively reducing contamination.
		Injections	A drill rig is employed to inject treatment or stabilizing agents into the groundwater.	Amendment injections would be effective at treating contamination onsite.	Relatively easy to implement.	Medium capital. Low O&M.	Retained.[1]

Notes:
[1] Would be required to be used in conjunction with other general response actions to meet the remedial action objective.
LUC – land use control
O&M – operations and maintenance

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Table 4
Screening of Remedial Action Alternatives

General Response Action	Technology	Process Option	Alternative 1: No Action	Alternative 2: MNA with LUCs	Alternative 3: MNA with LUCs and Subsurface Injections
No Action	None	None	X		
LUCs	Institutional Controls	Government Controls		X	X
		Informational Devices		X	X
Treatment Onsite	Intrinsic Remediation	MNA		X	X
	Biological	Enhanced Biodegradation			X
	Physical/Chemical	Injections			X
Alternative Carried Forward to Detailed Analysis?			Yes	Yes	Yes

Notes:
LUC – land use control
MNA – monitored natural attenuation

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Table 5
Detailed Analysis of Remedial Action Alternatives

Evaluation Criterion	Alternative 1: No Action	Alternative 2: MNA with LUCs	Alternative 3: MNA with LUCs and Subsurface Injections
Overall Protection of Human Health and the Environment			
Human Health Protection	Would not reduce risk to human health.	Would reduce potential risk to human health by reducing the level of explosives in groundwater.	Would reduce potential risk to human health by reducing the level of explosives in groundwater.
Environmental Protection	The explosives are not expected to have a negative impact on the ecosystem because the groundwater is considered inaccessible to ecological receptors.	The explosives are not expected to have a negative impact on the ecosystem because the groundwater is considered inaccessible to ecological receptors.	The explosives are not expected to have a negative impact on the ecosystem because the groundwater is considered inaccessible to ecological receptors.
Compliance with ARARs			
Compliance with ARARs	Not applicable.	Would comply with ARARs.	Would comply with ARARs.
Appropriateness of Waivers	Not appropriate because equivalent standard of performance would not be attained.	None should be required.	None should be required.
Long-Term Effectiveness			
Magnitude of Residual Risk	Risks to potential future residents would remain indefinitely.	Residual contamination will pose no unacceptable human health or environmental risk.	Residual contamination will pose no unacceptable human health or environmental risk.
Adequacy and Reliability of Controls	Not applicable.	MNA is field proven and is expected to meet long-term remedial objectives.	MNA and subsurface injections are field proven and are expected to meet long-term remedial objectives.
Reduction of TMV			
Treatment Process Used	None.	MNA	MNA with injections and enhanced biodegradation
Reduction of TMV	None.	TMV would be reduced by contaminant destruction overtime.	TMV would be reduced by biodegradation of contaminates overtime.
Short-Term Effectiveness			
Time Required to Achieve Remedial Action Objective	Indefinite.	The remediation timeframe for the plume is estimated at approximately 8 years based on groundwater modeling. The monitoring well network would be sampled annually for 18 years. As the plume recedes, it is expected that the number of monitoring wells that require sampling and the frequency of sampling will decrease.	The remediation timeframe for the plume is estimated at approximately 6 years. The monitoring well network would be sampled annually for 16 years. As the plume recedes, it is expected that the number of monitoring wells that require sampling and the frequency of sampling will decrease.
Protection of Community During Remedial Action	No action taken.	Because the plume is within base boundaries and away from residential areas, potential impact to community would be low.	Because the plume is within base boundaries and away from residential areas, potential impact to community would be low. Injections would be used to prevent migration of the plume.
Protection of Workers During Remedial Action	No action taken.	Workers would need to take proper safety precautions during site activities.	Workers would need to take the proper safety precautions during site activities.

Table 5
Detailed Analysis of Remedial Action Alternatives

Evaluation Criterion	Alternative 1: No Action	Alternative 2: MNA with LUCs	Alternative 3: MNA with LUCs and Subsurface Injections
Implementability			
Ability to Construct and Operate	Not applicable.	Manpower is readily available. Sampling and analysis are easily implemented with existing monitoring well network.	Subsurface injection equipment, supplies, and manpower are readily available. Sampling and analysis are easily implemented.
Technical Feasibility	Not applicable.	Feasible.	Technology is reliable. Equipment and materials are available.
Cost			
Estimated Total Costs	$0	$8,735,185	$10,668,544

Notes:
ARAR – applicable or relevant and appropriate requirement
MNA – monitored natural attenuation
TMV – toxicity, mobility, or volume

FIGURES

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Note: Figures were reproduced from Brice-AECOM 2022 Annual Groundwater Monitoring Report (Brice-AECOM 2022a) for this FFS

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Brice ENGINEERING

FIGURE 1. SITE LOCATION AND VICINITY

DATE:	PROJECT NUMBER:
12/15/2022	**570101**

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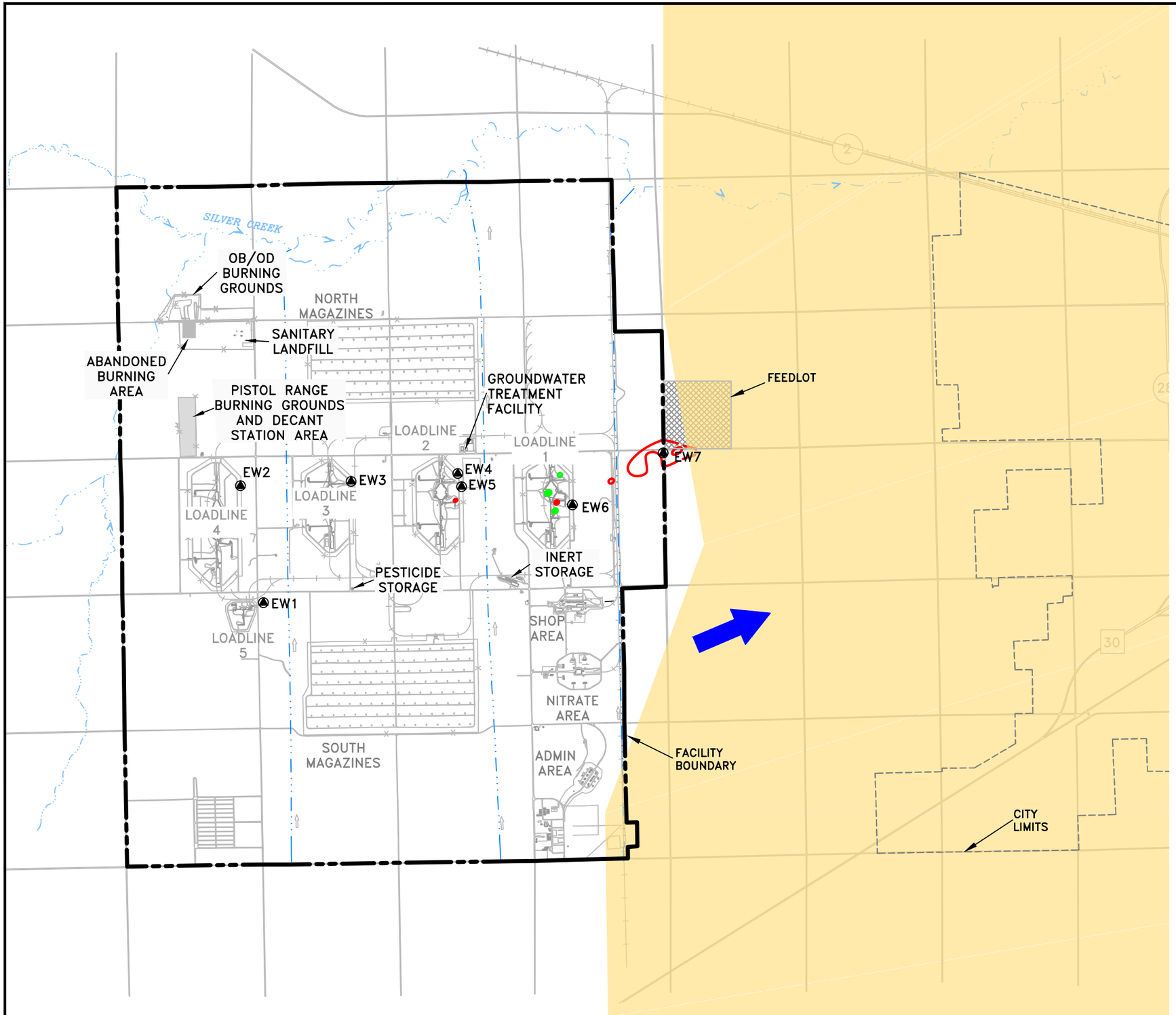

LEGEND:

- ROADS
- FENCE
- FACILITY BOUNDARY
- SURFACE DRAINAGE
- DRAINAGE DITCH FLOW DIRECTION
- GRAND ISLAND CITY LIMITS
- GRAND ISLAND CITY ORDNANCE – OVERLAY ZONE (INCLUDES TWO-MILE JURISDICTION AREA OUTSIDE CITY LIMITS)
- ABANDONED BURNING GROUNDS, SANITARY LANDFILL, PISTOL RANGE BURNING GROUNDS, AND FEEDLOT
- INACTIVE GROUNDWATER EXTRACTION WELL
- 281 STATE ROUTE
- 30 U.S. ROUTE
- 2 INTERPRETED HORIZONTAL EXTENT OF EXPLOSIVES (TNT CONCENTRATIONS >2μg/L) MAY 2022
- 20 INTERPRETED HORIZONTAL EXTENT OF EXPLOSIVES (TNT CONCENTRATIONS >20μg/L) MAY 2022
- 2 INTERPRETED HORIZONTAL EXTENT OF EXPLOSIVES (RDX CONCENTRATIONS >2μg/L) MAY 2022
- 20 INTERPRETED HORIZONTAL EXTENT OF EXPLOSIVES (RDX CONCENTRATIONS >20μg/L) MAY 2022
- GENERAL GROUNDWATER FLOW DIRECTION

N

0 4000 8000

SCALE FEET

Note: Figures were reproduced from Brice-AECOM 2022 Annual Groundwater Monitoring Report (Brice-AECOM 2022a) for this FFS

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FIGURE 2. SITE LAYOUT

DATE:	PROJECT NUMBER:
12/15/2022	**570101**

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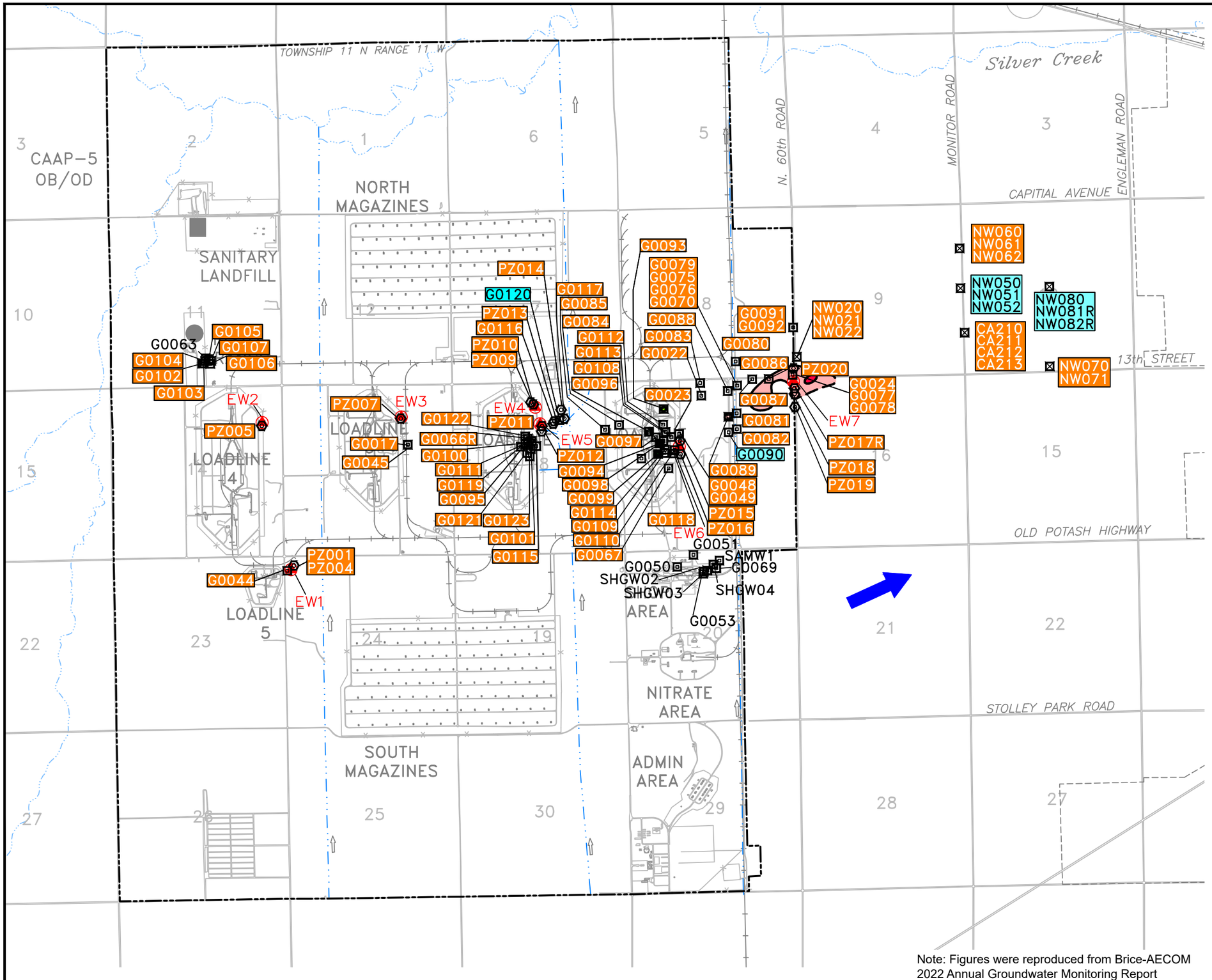

LEGEND:

- ON–POST GROUNDWATER MONITORING WELL
- OFF–POST GROUNDWATER MONITORING WELL
- ON–POST PIEZOMETER
- INACTIVE GROUNDWATER EXTRACTION WELL
- G0121 — OU1 GROUNDWATER SAMPLING LOCATIONS – ANNUAL (MARCH 2023)
- NW050 — OU1 MONITORING WELL ABANDONMENT LOCATIONS (MARCH 2023)
- GENERAL GROUNDWATER FLOW DIRECTION
- ROADS
- FACILITY BOUNDARY
- GRAND ISLAND CITY LIMITS
- SURFACE DRAINAGE
- 281 — STATE ROUTE
- 30 — U.S. ROUTE
- 2 — INTERPRETED HORIZONTAL EXTENT OF EXPLOSIVES (TNT CONCENTRATIONS >2µg/L) MAY 2022
- 20 — INTERPRETED HORIZONTAL EXTENT OF EXPLOSIVES (TNT CONCENTRATIONS >20µg/L) MAY 2022
- 2 — INTERPRETED HORIZONTAL EXTENT OF EXPLOSIVES (RDX CONCENTRATIONS >2µg/L) MAY 2022
- 20 — INTERPRETED HORIZONTAL EXTENT OF EXPLOSIVES (RDX CONCENTRATIONS >20µg/L) MAY 2022

NOTE: EXPLOSIVES PLUME BASED ON 2022 SAMPLE RESULTS (ANNUAL AND QUARTERLY OU1 REBOUND STUDY/PERFORMANCE MONITORING)

* G0090 IS RECOMMENDED FOR MAINTENANCE OR ABANDONMENT/RE–INSTALLATION, IF NECESSARY.

N

0 3000 6000

SCALE FEET

Note: Figures were reproduced from Brice-AECOM 2022 Annual Groundwater Monitoring Report (Brice-AECOM 2022a) for this FFS

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FIGURE 3. OU1 ON-POST/ OFF-POST WELL SAMPLING AND ABANDONMENT LOCATIONS

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200 100 0 200
SCALE IN FEET

200 100 0 200
SCALE IN FEET

BETWEEN EW6 AND EW7

LOAD LINE 2

LOAD LINE 1

COUNTY ROAD 24

ALDA ROAD

3rd AVENUE

NORTH 60th ROAD

G-130593

G-123999

EW4 (INACTIVE)

EW3 (INACTIVE)

EW7 (INACTIVE)

INTERPRETED HORIZONTAL EXTENT OF EXPLOSIVES (TNT CONCENTRATIONS >2µg/L) MAY 2022

INTERPRETED HORIZONTAL EXTENT OF EXPLOSIVES (TNT CONCENTRATIONS >20µg/L) MAY 2022

INTERPRETED HORIZONTAL EXTENT OF EXPLOSIVES (RDX CONCENTRATIONS >2µg/L) MAY 2022

INTERPRETED HORIZONTAL EXTENT OF EXPLOSIVES (RDX CONCENTRATIONS >20µg/L) MAY 2022

LEGEND

- OU1 GROUNDWATER SAMPLING LOCATIONS – ANNUAL (MARCH 2023)
- OU1 MONITORING WELL ABANDONMENT LOCATIONS (MARCH 2023)
- OU1 DIRECT PUSH GROUNDWATER SAMPLING LOCATIONS (ON-POST) (MARCH 2023)
- DASHED WHERE INFERRED
- TNT CONCENTRATION (µg/L)
- RDX CONCENTRATION (µg/L)
- ND NON DETECT
- NS NOT SAMPLED
- WESBLEND 66-10 TREATMENT WALL LOCATION (9.8% BY VOLUME) (OCTOBER/NOVEMBER 2020)
- WESBLEND 66-10 TREATMENT WALL LOCATION (9.8% BY VOLUME) (OCTOBER/NOVEMBER 2019)
- WESBLEND 66-10 TREATMENT WALL LOCATION (9.8% BY VOLUME) (2016)
- GENERAL GROUNDWATER FLOW DIRECTION
- BLDG 14 FORMER SITE FEATURES
- FACILITY BOUNDARY
- FENCE
- SURFACE DRAINAGE
- EW3 (INACTIVE) EXTRACTION WELL
- NW020 OFF-POST GROUNDWATER MONITORING WELL
- G0015 ON-POST GROUNDWATER MONITORING WELL
- PZ007 ON-POST PIEZOMETER
- 2018, 2016, 2015 DIRECT PUSH GROUNDWATER SAMPLING LOCATION
- ACTIVE IRRIGATION WELL

300 150 0 300
SCALE IN FEET

N

Notes:
Explosives plume based on 2022 sampling results (Annual and Quarterly OU1 Rebound Study/ Performance Monitoring

*G0090 is recommended for maintenance or abandonment/re-installation, if necessary.

Figures were reproduced from Brice-AECOM 2022 Annual Groundwater Monitoring Report (Brice-AECOM 2022a) for this FFS

FIGURE 4. OU1 ON-POST DIRECT PUSH AND WELL SAMPLING AND ABANDONMENT LOCATIONS

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N. 60th Road

13th Street

Monitor Road

9

10

NW060
NW061
NW062

NW050
NW051
NW052

NW050R

NW080
NW081R
NW082R

CA210
CA211
CA212
CA213

NW070
NW071

G0091
G0092

NW020
NW021
NW022

G0080

PZ020

G0024
G0077
G0078

G0087

G0086

OS001

OS002

OS003

OS004

EW7

PZ017R

PZ018

PZ019

G0079
G0075
G0076
G0070

G0081

G0082

20

2

LEGEND:

- ON-POST GROUNDWATER MONITORING WELL
- OFF-POST GROUNDWATER MONITORING WELL
- ON-POST PIEZOMETER
- INACTIVE GROUNDWATER EXTRACTION WELL
- OS001 — OU1 DIRECT PUSH SAMPLING LOCATIONS (OFF-POST) – ANNUAL (MARCH 2023)
- G0029 — OU1 GROUNDWATER SAMPLING LOCATIONS – ANNUAL (MARCH 2023)
- NW050 — OU1 MONITORING WELL ABANDONMENT LOCATION (MARCH 2023)
- OU1 DIRECT PUSH SAMPLING LOCATIONS – OU1 REBOUND STUDY, QUARTER 4 (SEPTEMBER 2020)
- OU1 DIRECT PUSH SAMPLING LOCATIONS – OU1 REBOUND STUDY, BASELINE (OCTOBER 2019)
- GENERAL GROUNDWATER FLOW DIRECTION
- ROADS
- FACILITY BOUNDARY
- GRAND ISLAND CITY LIMITS
- SURFACE DRAINAGE
- 281 — STATE ROUTE
- 30 — U.S. ROUTE
- FEEDLOT
- 2 — INTERPRETED HORIZONTAL EXTENT OF EXPLOSIVES (TNT CONCENTRATIONS >2µg/L) MAY 2022
- 20 — INTERPRETED HORIZONTAL EXTENT OF EXPLOSIVES (TNT CONCENTRATIONS >20µg/L) MAY 2022
- DASHED WHERE INFERRED

N

800 400 0 800

SCALE IN FEET

Notes:
Explosives plume based on 2022 sampling results (Annual and Quarterly OU1 Rebound Study/ Performance Monitoring

Figures were reproduced from Brice-AECOM 2022 Annual Groundwater Monitoring Report (Brice-AECOM 2022a) for this FFS

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FIGURE 5. OU1 OFF-POST DIRECT PUSH AND WELL SAMPLING AND ABANDONMENT LOCATIONS

DATE: **12/15/2022**

PROJECT NUMBER: **570101**

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APPENDIX A
APPLICABLE OR RELEVANT AND APPROPRIATE REQUIREMENTS

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Table A-1 Applicable or Relevant and Appropriate Requirements

Standard, Requirement, Criteria, or Limitation	Citation	Description	Rationale
Chemical-Specific ARARs/TBCs			
Federal			
Federal Health Advisory Levels (HALs)	Drinking Water Regulations and Health Advisories	Estimates of acceptable drinking levels for a chemical substance based on health effects information.	HALs are not included in a promulgated regulation. HALs are TBCs used as guidance to establish RAOs for chemicals without established MCLs.
Safe Water Drinking Act	42 USC Section 300		
National Primary Drinking Water Regulations and National Revised Primary Drinking Water Regulations	40 CFR Part 141	Establishes MCLs, health-based standards for specific contaminants. MCLs are applicable for drinking water as supplied to the end users of public water applies.	MCLs are relevant and appropriate for contamination of groundwater that is or may be used as drinking water. MCLs that have been published as final but are not yet in effect are TBCs. MCLs are relevant for deriving NPDES discharge levels.
National Primary Drinking Water Implementation Regulations	40 CFR Part 142	Establishes procedures for granting variances from MCL requirements. Specifies best technologies for treatment of various pollutants.	Requirements relevant and appropriate for determining cleanup goals for certain contaminants, if the MCL is not used or is available.
National Secondary Drinking Water Standards	40 CFR Part 143	Establishes secondary MCLs which are guidelines for public drinking water systems to protect the aesthetic quality of the water. Secondary MCLs are not Federally enforceable.	TBC if any of these constituents are addressed by a remedial action alternative, or if any treated and discharged groundwater is to be used as a source of drinking water. Relevant for deriving NPDES discharge levels.
Maximum Contaminant Level Goals (MCLGs)	40 CFR Parts 141, 142	Establishes non-enforceable health goals for drinking water quality at a level at which no adverse health effects may arise with an adequate margin of safety.	TBC for determination of groundwater cleanup levels and NPDES discharge levels. The MCL is the controlling ARAR.
Solid Waste Disposal Act, as amended	42 USCA Section 6901-6992K		
Identification and Listing of Hazardous Waste	40 CFR Part 261	Defines characteristics of hazardous wastes and provides lists of hazardous wastes. Identifies Solid wastes which are subject to regulations as hazardous wastes under 40 CFR Parts 124, 262-265, 268, 270, 271.	Applicable to wastes generated by remedial activities, including investigation-derived wastes, excavated soil, or solid wastes generated by treatment of soil, groundwater, or hazardous wastes.
Releases from Solid Waste Management Units	40 CFR Part 264.94	Subpart F (264.94) gives concentration limits in groundwater for hazardous constituents from a regulated unit.	Applicable if listed hazardous constituents are found in groundwater.
State			
Nebraska Environmental Protection Act	Neb. Rev. Stat. Chapter 81	State's policy on environmental control.	
Ground Water Quality Standards and Use Classification	Neb. Adm. Rules & Regs., Title 118	Establishes groundwater quality standards and use classifications for groundwater sources. Used to determine priorities for groundwater remedial actions.	State MCLs are ARARs for contaminated groundwater if the state MCL is more stringent than federal requirements. The antidegradation clause (Chapter 3) provides that if the existing quality of any groundwater is better than the MCLs, that the quality will be maintained and protected.
Rules and Regulations Pertaining to the Issuance of Permits under the NPDES	Neb. Adm. Rules & Regs., Titles 119 and 121	Establishes effluent limitations and procedures for determining effluent limitations.	Applicable if state standards are more stringent than federal requirements.
Effluent Guidelines and Standards	Neb. ADM. Rules & Regs., Title 170	Establishes MCLs for public water supply systems.	Relevant and appropriate for contaminated groundwater if the state MCL is more stringent than federal requirements.
Regulations Governing Public Water Supply Systems	Neb. ADM. Rules & Regs., Title 129, Chapter 32	Prohibits visible emissions of fugitive particulate matter beyond the premises where it originates.	Applicable if remedial activities, such as drilling, or soil excavation or grading, generate fugitive dust.
Location-Specific ARARs			
Federal			
Floodplain Management	Executive Order 11988 40 CFR Part 6, Appendix A and 40 CFR Part 6.302	Limits activities in a floodplain, which is defined as "the lowland and relatively flat areas adjoining inland and coastal waters including at a minimum that area subject to a 1 percent or greater chance of flooding in any given year" (the 100-year floodplain).	Applicable if remedial actions occur in the 100-year floodplain.
100-Year Floodplain Management	40 CFR 264.18(b)	RCRA treatment, storage, or disposal facility must be designed, constructed, operated, and maintained to avoid washout within 100-year floodplain.	Applicable if remedial actions occur in the 100-year floodplain.
Solid Waste Disposal Act, as amended	42 USCA Section 6901-6992K		

Table A-1 Applicable or Relevant and Appropriate Requirements

Standard, Requirement, Criteria, or Limitation	Citation	Description	Rationale
Floodplains	40 CFR Part 264.18(b)	RCRA treatment, storage, or disposal facility must be designed, constructed, operated, and maintained to avoid washout within 100-year floodplain.	Applicable if remedial actions occur in the 100-year floodplain.
Farmland Protection Policy Act	7 USC 420 *et seq.*	Establishes requirements for federal agencies for acquiring, managing, and disposing of lands and facilities; or provide criteria that identify and take into account the adverse effects of actions on the preservation of farmland.	Relevant and appropriate if project related activities affect farmland.
Fish and Wildlife Coordination Act	16 USCA Section 661 et seq. 33 CFR Parts 320-330 40 CFR Part 6.302	Establishes requirements for action taken to prevent, mitigate, or compensate for project-related damages or losses to fish and wildlife resources.	Applicable to effluent structures in or near a stream or river.
Archaeological and Historic Preservation Act of 1974	16 USCA Section 469; 36 CFR Part 65	Must recover and preserve artifacts in area where alteration of terrain threatens significant scientific, prehistorical, or archaeological data.	Applicable if artifacts are found during remedial activities.
National Historic Preservation Act of 1966, as amended	16 USCA Section 470 et seq. 36 CFR Part 800 40 CFR Section 6.301	Must preserve property in or eligible for National Register of Historic Places; actions should minimize harm to National Historic Landmarks.	Applicable if eligible property are potentially impacted during remedial activities.
National American Graves Protection and Repatriation Act	PL 101-601	Requires that if Native American remains or cultural items are found on federal lands, the appropriate tribe must be notified, and all activity in the area of discovery must cease for at least 30 days.	Applicable if Native American remains or cultural items are found during remedial activities.
Antiquities Act of 1906	16 USCA 431-433 43 CFR Part 3	Provides for protection of historic and prehistoric ruins and objects on Federal lands.	Applicable if historical ruins or objects are found during remedial activities.
State			
Nebraska Human Burial Sites Act	Neb. Rev. Stat. , Article 12, Sections 12-1201 to 1212	Provides protection for unmarked human burial sites on private and public lands.	Applicable if human burial sites are discovered during remedial activities.
Floodplains	Neb. Rev. Stat., Chapter 31, Article 10, Neb. Adm. Rules & Regs., Title 455, Chapters 1 through 7.	Regulates and requires permits for certain activities proposed to take place in a floodplain.	Applicable if remedial activities occur in the 100-year floodplain.
Action-Specific ARARs/TBCs			
Clean Water Act	**33 USCA Section 1251-1376**		
National Pollutant Discharge Elimination System	40 CFR Parts 122, 125	Requires permits for the discharge of pollutants from any point source into waters of the United States.	Substantive requirements applicable for remedial actions that involve point source discharges to surface waters. May be applicable to surface discharges.
	40 CFR Section 122.26(b)(14)(x)	Requires that stormwater runoff be monitored and controlled on construction sites greater than 5 acres.	Applicable if remediation site is greater than five acres, relevant and appropriate for smaller sites.
Wetland Protection	CWA 404 40 CFR 230.3(1) 33 CFR 328 (b)	Established requirements to avoid degradation of wetland due to construction activities.	Applicable to construction activities near wetlands which may be present along pipeline or well locations.
Hazardous Materials Transportation Act	40 USCA Section 1801-1813		
Hazardous Materials Transportation Regulations	49 CFR Parts 107, 171-177	Regulates transportation of hazardous materials.	Applicable for remedial actions that involve off-site transportation of hazardous materials. (e.g., spent carbon or sludge disposal).
Occupational Safety and Health Act of 1970	PL 91-596 29 USCA Section 651-678		
Safety and Health Regulations for Construction	20 CFR Part 1926	Establishes protection standards (e.g., hazard communication, excavation and trenching requirements) for workers involved in hazardous waste operations.	Applicable to onsite remedial activities.
State			
Nebraska Environmental Protection Act	Neb. Rev. Stat. Chapter 81 Article 15		
Nebraska Surface Water Quality Standards	Neb. Adm. Rules & Regs., Title 117	Establishes water quality standards and criteria for the surface waters of the state.	Applicable because groundwater is discharged into surface waters.
Ground Water Quality Standards and Use Classification	Neb. Adm. Rules & Regs., Title 118	Provides groundwater remedial actions protocol for point source groundwater pollution; defines Remedial Action Classes with basic requirements for remedial action.	Relevant and appropriate for remedial actions addressing groundwater pollution at this site.
Rules and Regulations Pertaining to the Issuance of Permits under the NPDES	Nebr. Adm. Rules & Regs., Title 119	Requires permit for discharging pollutants from a point source into the waters of the State.	Substantive requirements are applicable to point source discharge to surface waters.

Table A-1 Applicable or Relevant and Appropriate Requirements

Standard, Requirement, Criteria, or Limitation	Citation	Description	Rationale
Regulations for Underground Injections and Mineral Production Wells	Neb. Adm. Rules & Regs., Title 122	Contains rules and regulations governing injection wells and mineral production wells.	Applicable to subsurface injection of substances.
Rules and Regulations Pertaining to the Management of Wastes	Neb. Adm. Rules & Regs., Title 126	Requires permits for licenses for various waste management activities and establishes policy for releases of oil or hazardous substances and remediation of such releases.	Substantive requirements for spills/releases and remediation of spills/releases are given in Title 118 and Title 128.
Rules and Regulations Governing Hazardous Waste Management in Nebraska	Neb. Adm. Rules & Regs., Title 128	Establishes procedures for notification of hazardous waste activity, identification and listing of hazardous wastes, generators, and operators of treatment, storage, and disposal facilities.	Substantive requirements that are the same or more stringent than 40 CFR 261, 262, 263, 264, 268, 270 are applicable.
Air Pollution Control Rules and Regulations	Neb. Adm. Rules & Regs., Title 129, Chapter 2	Defines "major source" of hazardous air pollutants and major stationary sources of other pollutants, including fugitive dust and other particulate emissions.	Applicable to remedial activities generating fugitive dust, and potentially applicable to remedial alternatives involving volatilization or incineration.
	Neb. Adm. Rules & Regs., Title 129, Chapter 20	Prohibits visible dust beyond the limits of the property line where handling transportation, or construction is taking place.	Applicable to remedial activities generating fugitive dust.
	Neb. Adm. Rules & Regs., Title 129, Chapter 39	Limits visible emissions from diesel-powered vehicles on public streets or highways.	Applicable only when diesel-powered vehicles used during remedial activities are on public streets or highways.
Regulations Governing Licensure of Water Well Driller and Pump Installation Contractors and Certified of Water Well Drilling, Pump Installation, and Water Well Monitoring Supervisors or Water Well Monitoring Technician/Natural Resources Groundwater Technician	Neb. Adm. Rules & Regs., Title 178, Chapter 10	Contains rules governing the qualifications of contractors opening water well seal and installing water wells and pumps.	Applicable for opening of water well seal, installation of monitoring wells, extraction of recovery wells, and the installation of pumps.
Regulations Governing Water Well Construction, Pump Installation, and Water Well Abandonment Standards	Neb. Adm. Rules & Regs., Title 178, Chapter 12	Contains rules governing water well construction and abandonment and pump installation.	Applicable for installation of monitoring wells, extraction of recovery wells, and the installation of pumps.

Notes:

ARAR – applicable or relevant and appropriate requirement
CFR – Code of Federal Regulations
MCL – maximum contaminant level
Neb. Adm. – Nebraska Administrative
NPDES – National Pollutant Distribution Elimination System
RAO – remedial action objective
TBC – to be considered
USC - United States Code

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APPENDIX B
COST ESTIMATES

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ALTERNATIVE 1: NO ACTION

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Cornhusker Army Ammunition Plant - OU1 Alternative 1: No Action							
Task	**Description**	**Quantity**	**Unit**	**Unit Price**	**Amount**	**Year Performed**	**Net Present Worth (2022)**
BASE TASKS							
Task 1	No Action	1	Job	$ -	$ -	2023	$ -
				TOTAL COST	**$0**	**TOTAL NET PRESENT WORTH COST**	**$ -**

TASK 1 - No Action			Task 1.1			
			No Action		Total Units	Subtotal
Cornhusker Army Ammunition Plant - OU1 **Alternative 1: No Action**	**2023 Rate**	**Unit**	**Units**	**Cost**		
Professional Labor						
Program Manager	$ 200.67	hour		$ -	0	$ -
Project Manager	$ 146.18	hour		$ -	0	$ -
Contracts Manager	$ 119.01	hour		$ -	0	$ -
Mid-level Engineer	$ 103.25	hour		$ -	0	$ -
Professional Labor Subtotal			**0**	**$ -**	**0**	**$ -**
Craft Labor						
Craft Labor Subtotal			**0**	**$ -**	**0**	**$ -**
Materials						
Materials Subtotal			**0**	**$ -**	**0**	**$ -**
Supplies						
Supplies Subtotal			**0**	**$ -**	**0**	**$ -**
Equipment						
Equipment Subtotal			**0**	**$ -**	**0**	**$ -**
Other Direct Costs						
Other Direct Costs Subtotal			**0**	**$ -**	**0**	**$ -**
Subcontractor(s)/Vendors						
Subcontractors/Vendors Subtotal			**0**	**$ -**	**0**	**$ -**
Travel						
Travel Subtotal			**0**	**$ -**	**0**	**$ -**
Task Totals				$ -	$ -	$ -
Running Total by Task				$ -	**GRAND TOTAL**	**$ -**

ALTERNATIVE 2: MONITORED NATURAL ATTENUATION WITH LAND USE CONTROLS

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Cornhusker Army Ammunition Plant - OU1 Alternative 2: MNA with LUCs								
Task	**Description**	**Quantity**	**Unit**	**Unit Price**	**Amount**	**Year Performed**	**Net Present Worth (2022)**	**Notes**
BASE TASKS								
Task 1	Project Management	1	Job	$ 21,192	$ 21,192	2023	$ 20,615	
Task 2	Planning Documents	1	Job	$ 23,645	$ 23,645	2023	$ 23,001	
Task 3	LUC Field Activities	1	Job	$ 6,001	$ 6,001	2023	$ 5,838	
Task 4	MNA Field Activities	1	Job	$ 347,261	$ 347,261	2023	$ 337,802	
Task 5	Annual Reporting	1	Job	$ 138,568	$ 138,568	2024	$ 131,122	
Option 1	Direct Push Investigation	1	Job	$ 77,119	$ 77,119	2023	$ 75,019	
Option 2	Monitoring Well Abandonments	1	Job	$ 57,083	$ 57,083	2023	$ 55,528	Nine wells abandoned.
Option 3	GWTF O&M	1	Job	$ 28,982	$ 28,982	2023	$ 28,192	
Annual Sampling for 18 years								
2nd Year	Annual Sampling Event	1	Job	$ 373,547	$ 373,547	2024	$ 353,476	Cost of MNA field activities (Task 4) reduced by 10% to account for nine well abandonments.
2nd Year	Monitoring Well Abandonments	1	Job	$ 58,681	$ 58,681	2024	$ 55,528	Nine wells abandoned.
2nd Year	Annual Reporting	1	Job	$ 142,448	$ 142,448	2025	$ 131,122	
3rd Year	Annual Sampling Event	1	Job	$ 347,309	$ 347,309	2025	$ 319,695	Cost of MNA field activities (Task 4) reduced by 10% to account for nine well abandonments.
3rd Year	Monitoring Well Abandonments	1	Job	$ 60,324	$ 60,324	2025	$ 55,528	Nine wells abandoned.
3rd Year	Annual Reporting	1	Job	$ 146,437	$ 146,437	2026	$ 131,122	
4th Year	Annual Sampling Event	1	Job	$ 357,033	$ 357,033	2026	$ 319,695	
4th Year	Annual Reporting	1	Job	$ 150,537	$ 150,537	2027	$ 131,122	
5th Year	Annual Sampling Event	1	Job	$ 328,249	$ 328,249	2027	$ 285,915	Cost of MNA field activities (Task 4) reduced by 10% to account for five well abandonments.
5th Year	Monitoring Well Abandonments	1	Job	$ 38,250	$ 38,250	2027	$ 33,317	Five wells abandoned hereafter - Option 2 costs reduced by 40%.
5th Year	Annual Reporting	1	Job	$ 154,752	$ 154,752	2028	$ 131,122	
6th Year	Annual Sampling Event	1	Job	$ 337,439	$ 337,439	2028	$ 285,915	
6th Year	Annual Reporting	1	Job	$ 159,085	$ 159,085	2029	$ 131,122	
7th Year	Annual Sampling Event	1	Job	$ 305,904	$ 305,904	2029	$ 252,135	Cost of MNA field activities (Task 4) reduced by 10% to account for five well abandonments.
7th Year	Monitoring Well Abandonments	1	Job	$ 40,422	$ 40,422	2029	$ 33,317	Five wells abandoned.
7th Year	Annual Reporting	1	Job	$ 163,539	$ 163,539	2030	$ 131,122	
8th Year	Annual Sampling Event	1	Job	$ 314,469	$ 314,469	2030	$ 252,135	
8th Year	Annual Reporting	1	Job	$ 168,118	$ 168,118	2031	$ 131,122	
9th Year	Annual Sampling Event	1	Job	$ 279,963	$ 279,963	2031	$ 218,355	Cost of MNA field activities (Task 4) reduced by 10% to account for five well abandonments.
9th Year	Monitoring Well Abandonments	1	Job	$ 42,717	$ 42,717	2031	$ 33,317	Five wells abandoned.
9th Year	Annual Reporting	1	Job	$ 172,826	$ 172,826	2032	$ 131,122	
10th Year	Annual Sampling Event	1	Job	$ 243,278	$ 243,278	2032	$ 184,575	Cost of MNA field activities (Task 4) reduced by 10% to account for five well abandonments.
10th Year	Monitoring Well Abandonments	1	Job	$ 43,913	$ 43,913	2032	$ 33,317	Five wells abandoned.
10th Year	Annual Reporting	1	Job	$ 177,665	$ 177,665	2033	$ 131,122	
11th Year	Annual Sampling Event	1	Job	$ 225,081	$ 225,081	2033	$ 166,117	Overall cost reduced by 10%.
11th Year	Annual Reporting	1	Job	$ 182,639	$ 182,639	2034	$ 131,122	
12th Year	Annual Sampling Event	1	Job	$ 208,245	$ 208,245	2034	$ 149,505	Overall cost reduced by 10%.
12th Year	Annual Reporting	1	Job	$ 187,753	$ 187,753	2035	$ 131,122	
13th Year	Annual Sampling Event	1	Job	$ 192,668	$ 192,668	2035	$ 134,555	Overall cost reduced by 10%.
13th Year	Annual Reporting	1	Job	$ 193,010	$ 193,010	2036	$ 131,122	
14th Year	Annual Sampling Event	1	Job	$ 178,257	$ 178,257	2036	$ 121,099	Overall cost reduced by 10%.
14th Year	Annual Reporting	1	Job	$ 198,415	$ 198,415	2037	$ 131,122	
15th Year	Annual Sampling Event	1	Job	$ 164,923	$ 164,923	2037	$ 108,989	Overall cost reduced by 10%.
15th Year	Annual Reporting	1	Job	$ 203,970	$ 203,970	2038	$ 131,122	
16th Year	Annual Sampling Event	1	Job	$ 152,587	$ 152,587	2038	$ 98,090	Overall cost reduced by 10%.
16th Year	Annual Reporting	1	Job	$ 209,682	$ 209,682	2039	$ 131,122	
17th Year	Annual Sampling Event	1	Job	$ 141,173	$ 141,173	2039	$ 88,281	Overall cost reduced by 10%.

Cornhusker Army Ammunition Plant - OU1 Alternative 2: MNA with LUCs								
Task	**Description**	**Quantity**	**Unit**	**Unit Price**	**Amount**	**Year Performed**	**Net Present Worth (2022)**	**Notes**
17th Year	Annual Reporting	1	Job	$ 215,553	$ 215,553	2040	$ 131,122	
18th Year	Annual Sampling Event	1	Job	$ 130,613	$ 130,613	2040	$ 79,453	Overall cost reduced by 10%.
18th Year	Monitoring Well Abandonments	1	Job	$ 422,273	$ 422,273	2040	$ 256,872	Abandonment of remaining 40 wells. Site closeout.
18th Year	Annual Reporting	1	Job	$ 221,588	$ 221,588	2041	$ 131,122	
				TOTAL COST	**$ 8,735,185**	**TOTAL NET PRESENT WORTH COST**	**$ 6,825,382**	

Basis of Estimate:

-Assumes full level of effort for LTM until 2032. Reduce effort by 10% each year (2033 to 2041).

-Assumes 9 abandonments in 2023, 2024, and 2025, and 5 abandonments in 2027, 2029, 2031, and 2032. Field effort cost reduces by 10% after each well abandonment event.

-Assumes 21 investigation DP samples in 2023 and 9 reoccurring DP samples from 2023 to 2041.

-Assumes no O&M at GWTF after 2023.

-Line item “Annual Sampling Event” for years 2 through 18 includes the cost of Project Management, Planning Documents, LUC Field Activities, and MNA Field Activities (Tasks 1 through 4).

TASK 1 - Project Management			Task 1.1 Coordination and Communication		Task 1.2 Monthly Status Reports		Total Units	Subtotal
Cornhusker Army Ammunition Plant - OU1 Alternative 2: MNA with LUCs	**2023 Rate**	**Unit**	**Units**	**Cost**	**Units**	**Cost**		
Professional Labor								
Program Manager	$ 206.49	hour	6	$ 1,238.95	6	$ 1,238.95	12	$ 2,477.91
Project Manager	$ 150.42	hour	40	$ 6,016.66	12	$ 1,805.00	52	$ 7,821.66
Contracts Manager	$ 122.46	hour		$ -	36	$ 4,408.56	36	$ 4,408.56
Clerical	$ 55.40	hour		$ -	48	$ 2,659.12	48	$ 2,659.12
Mid-level Engineer	$ 106.24	hour	36	$ 3,824.63		$ -	36	$ 3,824.63
Professional Labor Subtotal			**82**	**$ 11,080.24**	**102**	**$ 10,111.62**	**184**	**$ 21,191.87**
Craft Labor								
Craft Labor Subtotal			**0**	**$ -**	**0**	**$ -**	**0**	**$ -**
Materials								
Materials Subtotal			**0**	**$ -**	**0**	**$ -**	**0**	**$ -**
Supplies								
Supplies Subtotal			**0**	**$ -**	**0**	**$ -**	**0**	**$ -**
Equipment								
Equipment Subtotal			**0**	**$ -**	**0**	**$ -**	**0**	**$ -**
Other Direct Costs								
Other Direct Costs Subtotal			**0**	**$ -**	**0**	**$ -**	**0**	**$ -**
Subcontractor(s)/Vendors								
Subcontractors/Vendors Subtotal			**0**	**$ -**	**0**	**$ -**	**0**	**$ -**
Travel								
Travel Subtotal			**0**	**$ -**	**0**	**$ -**	**0**	**$ -**
Task Totals				$ 11,080.24		$ 10,111.62	$ 21,191.87	$ 21,191.87
Running Total by Task				$ 11,080.24		$ 21,191.87	**GRAND TOTAL**	**$ 21,191.87**

Basis of Estimate:

1 Task 1.1: PgM=0.5 hr/mo, PM=2 hr/mo, Eng Mid=1 hr/mo; 8 hours for PM and 24 hours for Eng Mid for Quality Management Plan preparation; 8 hours for annual PM meeting
2 Task 1.2: PgM=0.5 hr/mo, PM=1 hr/mo, PC=2 hr/mo, CM=3 hr/mo, Clerical=4 hr/mo
3 Contractor manpower reporting will not be required
4 PoP = 12 months

TASK 2 - Planning Documents			Task 2.1		Task 2.2		Task 2.3		Task 2.4		Task 2.5		Task 2.6			
			Project Schedule		Work Plan (Draft)		Work Plan (Draft RTCs)		Work Plan (Draft Final)		Work Plan (Draft Final RTCs)		Work Plan (Final)		Total Units	Subtotal
Cornhusker Army Ammunition Plant - OU1 Alternative 2: MNA with LUCs	**2023 Rate**	**Unit**	**Units**	**Cost**	**Units**	**Cost**	**Units**	**Cost**	**Units**	**Cost**	**Units**	**Cost**	**Units**	**Cost**		
Professional Labor																
Project Manager	$ 150.42	hour	4	$ 601.67	10	$ 1,504.16	2	$ 300.83	3	$ 451.25	2	$ 300.83	2	$ 300.83	23	$ 3,459.58
Contracts Manager	$ 122.46	hour	12	$ 1,469.52		$ -		$ -		$ -		$ -		$ -	12	$ 1,469.52
CADD/GIS	$ 81.26	hour		$ -	20	$ 1,625.26	4	$ 325.05	5	$ 406.31	3	$ 243.79	3	$ 243.79	35	$ 2,844.20
Mid-level Engineer	$ 106.24	hour		$ -	50	$ 5,311.99	10	$ 1,062.40	13	$ 1,381.12	7	$ 743.68	7	$ 743.68	87	$ 9,242.85
Mid-level Scientist	$ 89.13	hour		$ -	30	$ 2,674.00	6	$ 534.80	8	$ 713.07	4	$ 356.53	4	$ 356.53	52	$ 4,634.94
Clerical	$ 55.40	hour		$ -	20	$ 1,107.97		$ -	4	$ 221.59		$ -	4	$ 221.59	28	$ 1,551.15
Site Safety and Health Officer (FIELD)	$ 95.72	hour		$ -	4	$ 382.89		$ -		$ -		$ -		$ -	4	$ 382.89
Professional Labor Subtotal			**16**	**$ 2,071.18**	**146**	**$ 12,606.27**	**25**	**$ 2,223.08**	**36**	**$ 3,173.34**	**18**	**$ 1,644.83**	**22**	**$ 1,866.43**	**263**	**$ 23,585.13**
Craft Labor																
Craft Labor Subtotal			**0**	**$ -**	**0**	**$ -**	**0**	**$ -**	**0**	**$ -**	**0**	**$ -**	**0**	**$ -**	**0**	**$ -**
Materials																
Materials Subtotal			**0**	**$ -**	**0**	**$ -**	**0**	**$ -**	**0**	**$ -**	**0**	**$ -**	**0**	**$ -**	**0**	**$ -**
Supplies																
Supplies Subtotal			**0**	**$ -**	**0**	**$ -**	**0**	**$ -**	**0**	**$ -**	**0**	**$ -**	**0**	**$ -**	**0**	**$ -**
Equipment																
Equipment Subtotal			**0**	**$ -**	**0**	**$ -**	**0**	**$ -**	**0**	**$ -**	**0**	**$ -**	**0**	**$ -**	**0**	**$ -**
Other Direct Costs																
Hard copies	$ 20.00	each		$ -		$ -		$ -		$ -		$ -	3	$ 60.00	3	$ 60.00
Other Direct Costs Subtotal			**0**	**$ -**	**0**	**$ -**	**0**	**$ -**	**0**	**$ -**	**0**	**$ -**	**3**	**$ 60.00**	**3**	**$ 60.00**
Subcontractor(s)/Vendors																
Subcontractor/Vendor Subtotal			**0**	**$ -**	**0**	**$ -**	**0**	**$ -**	**0**	**$ -**	**0**	**$ -**	**0**	**$ -**	**0**	**$ -**
Travel																
Travel Subtotal			**0**	**$ -**	**0**	**$ -**	**0**	**$ -**	**0**	**$ -**	**0**	**$ -**	**0**	**$ -**	**0**	**$ -**
Task Totals				$ 2,071.18		$ 12,606.27		$ 2,223.08		$ 3,173.34		$ 1,644.83		$ 1,926.43	$ 23,645.13	$ 23,645.13
Running Total by Task				$ 2,071.18		$ 14,677.45		$ 16,900.53		$ 20,073.87		$ 21,718.71		$ 23,645.13	**GRAND TOTAL**	**$ 23,645.13**

Basis of Estimate:

1 Level of effort based on previous experience with USACE.
2 Includes WP and APP/SSHP.
3 Pre-Draft RTC effort is 20% of the Pre-Draft WP development effort.
4 Draft WP effort is 25% of the Pre-Draft WP effort.
5 Draft RTC effort is 50% of the Draft WP development effort.
6 Final WP effort is 50% of the Draft WP.

TASK 3 - LUC Field Activities			Task 3.1		Task 3.2		Task 3.3		Task 3.4		Task 3.5			
			Pre-Mobilizations / Procurements		Mobilization		Site Activities		Demobilization		Post-Demobilization Activities		Total Units	Subtotal
Cornhusker Army Ammunition Plant - OU1 Alternative 2: MNA with LUCs	**2023 Rate**	**Unit**	**Units**	**Cost**	**Units**	**Cost**	**Units**	**Cost**	**Units**	**Cost**	**Units**	**Cost**		
Professional Labor														
Project Manager	$ 150.42	hour	4	$ 601.67		$ -		$ -		$ -	2	$ 300.83	6	$ 902.50
Senior Scientist	$ 126.90	hour	4	$ 507.61		$ -		$ -		$ -	2	$ 253.81	6	$ 761.42
Mid-level Engineer	$ 106.24	hour	8	$ 849.92		$ -	8	$ 849.92		$ -	4	$ 424.96	20	$ 2,124.79
Mid-level Scientist	$ 89.13	hour	8	$ 713.07		$ -	8	$ 713.07		$ -	4	$ 356.53	20	$ 1,782.67
Professional Labor Subtotal			**24**	**$ 2,672.26**	**0**	**$ -**	**16**	**$ 1,562.98**	**0**	**$ -**	**12**	**$ 1,336.13**	**52**	**$ 5,571.38**
Craft Labor														
Craft Labor Subtotal			**0**	**$ -**	**0**	**$ -**	**0**	**$ -**	**0**	**$ -**			**0**	**$ -**
Materials														
Signage	$ 40.00	each	10	$ 400.00		$ -		$ -		$ -			10	$ 400.00
Materials Subtotal			**10**	**$ 400.00**	**0**	**$ -**	**0**	**$ -**	**0**	**$ -**			**10**	**$ 400.00**
Supplies														
PPE	$ 15.00	person/day		$ -		$ -	2	$ 30.00		$ -			2	$ 30.00
Supplies Subtotal			**0**	**$ -**	**0**	**$ -**	**4**	**$ 30.00**	**0**	**$ -**			**4**	**$ 30.00**
Equipment														
Equipment Subtotal			**0**	**$ -**	**0**	**$ -**	**0**	**$ -**	**0**	**$ -**			**0**	**$ -**
Other Direct Costs														
Other Direct Costs Subtotal			**0**	**$ -**	**0**	**$ -**	**0**	**$ -**	**0**	**$ -**			**0**	**$ -**
Subcontractor(s)/Vendors														
Subcontractor/Vendor Subtotal			**0**	**$ -**	**0**	**$ -**	**0**	**$ -**	**0**	**$ -**			**0**	**$ -**
Travel														
Travel Subtotal			**0**	**$ -**	**0**	**$ -**	**0**	**$ -**	**0**	**$ -**			**0**	**$ -**
Task Totals				$ 3,072.26		$ -		$ 1,592.98		$ -		$ 1,336.13	$ 6,001.38	$ 6,001.38
Running Total by Task				$ 3,072.26		$ 3,072.26		$ 4,665.25		$ 4,665.25		$ 6,001.38	**GRAND TOTAL**	**$ 6,001.38**

Basis of Estimate:

1 Assumes an annual site visit for review of LUCS and ICs will be performed to identify any visible new groundwater wells that appear to be located over the plume.
2 Assumes LUC inspection will be conducted during annual sampling event (mobilization, supplies, and travel costs included in Task 4).
3 Costs associated with updating the GIS overlay of the plume are included in Task 5.
4 Pre-mobilization tasks include verification of compliance or groundwater ordinance with the City of Grand Island and checking for new construction wells within proximity of the plume.

TASK 4 - MNA Field Activities			Task 4.1		Task 4.2		Task 4.3		Task 4.4		Task 4.5			
			Pre-Mobilizations / Procurements		Mobilization		Site Activities		Demobilization		Post-Demobilization Activities		Total Units	Subtotal
Cornhusker Army Ammunition Plant - OU1 Alternative 2: MNA with LUCs	**2023 Rate**	**Unit**	**Units**	**Cost**	**Units**	**Cost**	**Units**	**Cost**	**Units**	**Cost**	**Units**	**Cost**		
Professional Labor														
Project Manager	$ 150.42	hour	20	$ 3,008.33	6	$ 902.50	40	$ 6,016.66	6	$ 902.50	20	$ 3,008.33	92	$ 13,838.31
Senior Scientist	$ 126.90	hour	40	$ 5,076.11	12	$ 1,522.83	240	$ 30,456.66	12	$ 1,522.83	40	$ 5,076.11	344	$ 43,654.54
Mid-level Engineer	$ 106.24	hour	80	$ 8,499.18	24	$ 2,549.75	480	$ 50,995.06	24	$ 2,549.75	80	$ 8,499.18	688	$ 73,092.92
Mid-level Scientist	$ 89.13	hour	80	$ 7,130.67	24	$ 2,139.20	480	$ 42,784.04	24	$ 2,139.20	80	$ 7,130.67	688	$ 61,323.79
Senior Scientist (Chemist)	$ 126.90	hour	80	$ 10,152.22		$ -	300	$ 38,070.82		$ -	40	$ 5,076.11	420	$ 53,299.15
Professional Labor Subtotal			**300**	**$ 33,866.51**	**66**	**$ 7,114.29**	**1540**	**$ 168,323.24**	**66**	**$ 7,114.29**	**260**	**$ 28,790.40**	**2232**	**$ 245,208.71**
Craft Labor														
Craft Labor Subtotal			**0**	**$ -**	**0**	**$ -**	**0**	**$ -**	**0**	**$ -**			**0**	**$ -**
Services														
Shipping (sample coolers and misc.)	$ 4,011.96	LS		$ -		$ -	1	$ 4,011.96		$ -			1	$ 4,011.96
Materials Subtotal			**0**	**$ -**	**0**	**$ -**	**1**	**$ 4,011.96**	**0**	**$ -**	**0**	**$ -**	**1**	**$ 4,011.96**
Supplies														
Field Supplies	$ 6,833.82	LS		$ -		$ -	1	$ 6,833.82		$ -			1	$ 6,833.82
Supplies Subtotal			**0**	**$ -**	**0**	**$ -**	**1**	**$ 6,833.82**	**0**	**$ -**	**0**	**$ -**	**1**	**$ 6,833.82**
Equipment														
Rentals	$ 11,362.57	LS		$ -		$ -	1	$ 11,362.57		$ -		$ -	1	$ 11,362.57
Equipment Subtotal			**0**	**$ -**	**0**	**$ -**	**1**	**$ 11,362.57**	**0**	**$ -**	**0**	**$ -**	**1**	**$ 11,362.57**
Subcontractor(s)/Vendors														
Laboratory Analysis - 87 Wells	$ 31,383.87	LS		$ -		$ -	1	$ 31,383.87		$ -		$ -	1	$ 31,383.87
Laboratory Analysis - 9 Direct Push Samples	$ 1,136.09	LS		$ -		$ -	1	$ 1,136.09		$ -		$ -	1	$ 1,136.09
Laboratory Analysis - IDW (Purge Water)	$ 1,066.53	LS		$ -		$ -	2	$ 2,133.06		$ -		$ -	2	$ 2,133.06
Drilling	$ 3,970.51	LS		$ -		$ -	1	$ 3,970.51		$ -		$ -	1	$ 3,970.51
55-Gallon Drum	$ 150.00	Each		$ -		$ -	20	$ 3,000.00		$ -		$ -	20	$ 3,000.00
Waste T&D	$ 75.00	Ton		$ -		$ -	5	$ 375.00		$ -		$ -	5	$ 375.00
Profile Fee	$ 75.00	LS		$ -		$ -	1	$ 75.00		$ -		$ -	1	$ 75.00
Subcontractor/Vendor Subtotal			**0**	**$ -**	**0**	**$ -**	**31**	**$ 42,073.53**	**0**	**$ -**	**0**	**$ -**	**31**	**$ 42,073.53**
Travel														
Airfare R/T to Grand Island, NE	$ 800.00	Each		$ -	5	$ 4,000.00		$ -		$ -			5	$ 4,000.00
Per Diem	$ 157.00	person/day		$ -	5	$ 785.00	100	$ 15,700.00	5	$ 785.00			110	$ 17,270.00
Hotel/Lodging	$ 150.00	person/day		$ -	5	$ 750.00	100	$ 15,000.00	5	$ 750.00			110	$ 16,500.00
Travel Subtotal			**0**	**$ -**	**15**	**$ 5,535.00**	**200**	**$ 30,700.00**	**10**	**$ 1,535.00**	**0**	**$ -**	**225**	**$ 37,770.00**
Task Totals				$ 33,866.51		$ 12,649.29		$ 263,305.11		$ 8,649.29		$ 28,790.40	$ 347,260.59	$ 347,260.59
Running Total by Task				$ 33,866.51		$ 46,515.79		$ 309,820.91		$ 318,470.19		$ 347,260.59	**GRAND TOTAL**	**$ 347,260.59**

Basis of Estimate:

1 All tasks require 2 hr/day for PM. Field days are 12 hours for personnel, with equipment run 10 hours.
2 Assumes 5 person field crew.
3 Assumes field crew can complete field activities in 15 days at a rate of 6 wells sampled per day.
4 Assume 9 recurring direct push wells can be completed in 3 days at a rate of 4 per day.
4 Assume two field trucks are needed for field transportation.
5 Costs shown are for CY2023. Costs are escalated on the summary page for activities completed in subsequent years.

TASK 5 - Annual Reporting			Task 5.1 Periodic Review (Draft)		Task 5.2 Periodic Review (Draft RTCs)		Task 5.3 Periodic Review (Draft Final)		Task 5.4 Periodic Review (Draft Final RTCs)		Task 5.5 Periodic Review (Final)		Total Units	Subtotal
Cornhusker Army Ammunition Plant - OU1 Alternative 2: MNA with LUCs	**2024 Rate**	**Unit**	**Units**	**Cost**	**Units**	**Cost**	**Units**	**Cost**	**Units**	**Cost**	**Units**	**Cost**		
Professional Labor														
Project Manager	$ 150.42	hour	60	$ 9,024.99	12	$ 1,805.00	15	$ 2,256.25	8	$ 1,203.33	8	$ 1,203.33	103	$ 15,492.89
CADD/GIS	$ 81.26	hour	120	$ 9,751.55	24	$ 1,950.31	50	$ 4,063.15	25	$ 2,031.57	25	$ 2,031.57	244	$ 19,828.15
Mid-level Engineer	$ 106.24	hour	320	$ 33,996.71	40	$ 4,249.59	50	$ 5,311.99	25	$ 2,655.99	25	$ 2,655.99	460	$ 48,870.27
Senior Scientist	$ 126.90	hour	240	$ 30,456.66	40	$ 5,076.11	50	$ 6,345.14	25	$ 3,172.57	25	$ 3,172.57	380	$ 48,223.04
Clerical	$ 55.40	hour	50	$ 2,769.91		$ -	30	$ 1,661.95		$ -	30	$ 1,661.95	110	$ 6,093.81
Professional Labor Subtotal			**790**	**$ 85,999.81**	**116**	**$ 13,081.01**	**195**	**$ 19,638.46**	**83**	**$ 9,063.47**	**113**	**$ 10,725.41**	**1297**	**$ 138,508.16**
Craft Labor														
Craft Labor Subtotal			**0**	**$ -**	**0**	**$ -**	**0**	**$ -**	**0**	**$ -**	**0**	**$ -**	**0**	**$ -**
Materials														
Materials Subtotal			**0**	**$ -**	**0**	**$ -**	**0**	**$ -**	**0**	**$ -**	**0**	**$ -**	**0**	**$ -**
Supplies														
Supplies Subtotal			**0**	**$ -**	**0**	**$ -**	**0**	**$ -**	**0**	**$ -**	**0**	**$ -**	**0**	**$ -**
Equipment														
Equipment Subtotal			**0**	**$ -**	**0**	**$ -**	**0**	**$ -**	**0**	**$ -**	**0**	**$ -**	**0**	**$ -**
Other Direct Costs														
Hard copies	$ 20.00	each		$ -		$ -		$ -		$ -	3	$ 60.00	3	$ 60.00
Other Direct Costs Subtotal			**0**	**$ -**	**0**	**$ -**	**0**	**$ -**	**0**	**$ -**	**3**	**$ 60.00**	**3**	**$ 60.00**
Subcontractor(s)/Vendors														
Subcontractor/Vendor Subtotal			**0**	**$ -**	**0**	**$ -**	**0**	**$ -**	**0**	**$ -**	**0**	**$ -**	**0**	**$ -**
Travel														
Travel Subtotal			**0**	**$ -**	**0**	**$ -**	**0**	**$ -**	**0**	**$ -**	**0**	**$ -**	**0**	**$ -**
Task Totals				$ 85,999.81		$ 13,081.01		$ 19,638.46		$ 9,063.47		$ 10,785.41	$ 138,568.16	$ 138,568.16
Running Total by Task				$ 85,999.81		$ 99,080.82		$ 118,719.28		$ 127,782.75		$ 138,568.16	**GRAND TOTAL**	**$ 138,568.16**

Basis of Estimate:

1 Assumes reporting includes Annual Groundwater Monitoring Reports and Monitoring Well Abandonment Letter Reports.

2 Annual report will summarize GWTF activities, monitoring well sampling, direct push sampling, well abandonment, analytical results, modeling results, a groundwater quality assessment of the current monitoring year, historical data, conclusions, and recommendations for subsequent years.

3 Annual report will include a recalibration of the CHAAP numerical flow model and contaminant fate and transport model to current conditions.

Option 1 - Direct Push Investigation			Option 1.1		Option 1.2		Option 1.3		Option 1.4		Option 1.5			
			Pre-Mobilizations / Procurements		Mobilization		Site Activities		Demobilization		Post-Demobilization Activities		Total Units	Subtotal
Cornhusker Army Ammunition Plant - OU1 Alternative 2: MNA with LUCs	**2023 Rate**	**Unit**	**Units**	**Cost**	**Units**	**Cost**	**Units**	**Cost**	**Units**	**Cost**	**Units**	**Cost**		
Professional Labor														
Project Manager	$ 150.42	hour	4	$ 601.67		$ -	22	$ 3,309.16		$ -	2	$ 300.83	28	$ 4,211.66
Senior Scientist	$ 126.90	hour	8	$ 1,015.22		$ -	72	$ 9,137.00		$ -	8	$ 1,015.22	88	$ 11,167.44
Mid-level Engineer	$ 106.24	hour	16	$ 1,699.84		$ -	144	$ 15,298.52		$ -	16	$ 1,699.84	176	$ 18,698.19
Mid-level Scientist	$ 89.13	hour	16	$ 1,426.13		$ -	144	$ 12,835.21		$ -	16	$ 1,426.13	176	$ 15,687.48
Professional Labor Subtotal			**44**	**$ 4,742.86**	**0**	**$ -**	**382**	**$ 40,579.89**	**0**	**$ -**	**42**	**$ 4,442.02**	**468**	**$ 49,764.77**
Services														
Shipping (sample coolers and misc.)	$ 1,085.37	LS		$ -		$ -	1	$ 1,085.37		$ -			1	$ 1,085.37
Materials Subtotal			**0**	**$ -**	**0**	**$ -**	**1**	**$ 1,085.37**	**0**	**$ -**	**0**	**$ -**	**1**	**$ 1,085.37**
Supplies														
Field Supplies	$ 1,412.55	LS		$ -		$ -	1	$ 1,412.55		$ -			1	$ 1,412.55
Supplies Subtotal			**0**	**$ -**	**0**	**$ -**	**1**	**$ 1,412.55**	**0**	**$ -**	**0**	**$ -**	**1**	**$ 1,412.55**
Equipment														
Rentals	$ 3,846.33	LS		$ -		$ -	1	$ 3,846.33		$ -		$ -	1	$ 3,846.33
Equipment Subtotal			**0**	**$ -**	**0**	**$ -**	**1**	**$ 3,846.33**	**0**	**$ -**	**0**	**$ -**	**1**	**$ 3,846.33**
Subcontractor(s)/Vendors														
Laboratory Analysis - 21 DP Samples	$ 2,726.61	LS		$ -		$ -	1	$ 2,726.61		$ -		$ -	1	$ 2,726.61
Laboratory Analysis - IDW (Purge Water)	$ 1,066.53	LS		$ -		$ -	1	$ 1,066.53		$ -		$ -	1	$ 1,066.53
Drilling	$ 6,057.21	LS		$ -		$ -	1	$ 6,057.21		$ -		$ -	1	$ 6,057.21
55-Gallon Drum	$ 150.00	Each		$ -		$ -	10	$ 1,500.00		$ -		$ -	10	$ 1,500.00
Waste T&D	$ 75.00	Ton		$ -		$ -	5	$ 375.00		$ -		$ -	5	$ 375.00
Profile Fee	$ 75.00	LS		$ -		$ -	1	$ 75.00		$ -		$ -	1	$ 75.00
Subcontractor/Vendor Subtotal			**0**	**$ -**	**0**	**$ -**	**19**	**$ 11,800.35**	**0**	**$ -**	**0**	**$ -**	**19**	**$ 11,800.35**
Travel														
Airfare R/T to Grand Island, NE	$ 800.00	Each		$ -		$ -		$ -		$ -			0	$ -
Per Diem	$ 157.00	person/day		$ -		$ -	30	$ 4,710.00		$ -			30	$ 4,710.00
Hotel/Lodging	$ 150.00	person/day		$ -		$ -	30	$ 4,500.00		$ -			30	$ 4,500.00
Travel Subtotal			**0**	**$ -**	**0**	**$ -**	**60**	**$ 9,210.00**	**0**	**$ -**	**0**	**$ -**	**60**	**$ 9,210.00**
Task Totals				$ 4,742.86		$ -		$ 67,934.49		$ -		$ 4,442.02	$ 77,119.38	$ 77,119.38
Running Total by Task				$ 4,742.86		$ 4,742.86		$ 72,677.35		$ 72,677.35		$ 77,119.38	**GRAND TOTAL**	**$ 77,119.38**

Basis of Estimate:

1 All tasks require 2 hr/day for PM. Field days are 12 hours for personnel, with equipment run 10 hours.
2 Assumes 5 person field crew.
3 Assumes field crew can complete field activities in 6 days at a rate of 4 per day.
4 Assume direct push investigation would be conducted during annual sampling event.
5 Mobilization/demobilization, and airfare costs are included in Task 4.
6 Assume two field trucks are needed for field transportation.
7 Costs shown are for CY2023. Costs are escalated on the summary page for activities completed in subsequent years.

Option 2 - Monitoring Well Abandonments			Option 2.1		Option 2.2		Option 2.3		Option 2.4		Option 2.5			
			Pre-Mobilizations / Procurements		Mobilization		Site Activities		Demobilization		Post-Demobilization Activities		Total Units	Subtotal
Cornhusker Army Ammunition Plant - OU1 Alternative 2: MNA with LUCs	**2023 Rate**	**Unit**	**Units**	**Cost**	**Units**	**Cost**	**Units**	**Cost**	**Units**	**Cost**	**Units**	**Cost**		
Professional Labor														
Project Manager	$ 150.42	hour	4	$ 601.67		$ -	9	$ 1,353.75		$ -	2	$ 300.83	15	$ 2,256.25
Senior Scientist	$ 126.90	hour	8	$ 1,015.22		$ -	54	$ 6,852.75		$ -	4	$ 507.61	66	$ 8,375.58
Mid-level Engineer	$ 106.24	hour	16	$ 1,699.84		$ -	108	$ 11,473.89		$ -	8	$ 849.92	132	$ 14,023.64
Mid-level Scientist	$ 89.13	hour	16	$ 1,426.13		$ -	108	$ 9,626.41		$ -	8	$ 713.07	132	$ 11,765.61
Site Safety and Health Officer (FIELD)	$ 95.72	hour		$ -		$ -		$ -		$ -		$ -	0	$ -
Professional Labor Subtotal			**44**	**$ 4,742.86**	**0**	**$ -**	**279**	**$ 29,306.79**	**0**	**$ -**	**22**	**$ 2,371.43**	**345**	**$ 36,421.08**
Services														
Shipping (sample coolers and misc.)	$ 154.18	LS		$ -		$ -	1	$ 154.18		$ -			1	$ 154.18
Materials Subtotal			**0**	**$ -**	**0**	**$ -**	**1**	**$ 154.18**	**0**	**$ -**	**0**	**$ -**	**1**	**$ 154.18**
Supplies														
Field Supplies	$ 950.00	LS		$ -		$ -	1	$ 950.00		$ -			1	$ 950.00
Supplies Subtotal			**0**	**$ -**	**0**	**$ -**	**1**	**$ 950.00**	**0**	**$ -**	**0**	**$ -**	**1**	**$ 950.00**
Equipment														
Rentals	$ 3,846.33	LS		$ -		$ -	1	$ 3,846.33		$ -		$ -	1	$ 3,846.33
Equipment Subtotal			**0**	**$ -**	**0**	**$ -**	**1**	**$ 3,846.33**	**0**	**$ -**	**0**	**$ -**	**1**	**$ 3,846.33**
Subcontractor(s)/Vendors														
Laboratory Analysis - IDW	$ 1,066.53	LS		$ -		$ -	2	$ 2,133.06		$ -		$ -	2	$ 2,133.06
Drilling	$ 3,970.51	LS		$ -		$ -	1	$ 3,970.51		$ -		$ -	1	$ 3,970.51
55-Gallon Drum	$ 150.00	Each		$ -		$ -	15	$ 2,250.00		$ -		$ -	15	$ 2,250.00
Waste T&D	$ 75.00	Ton		$ -		$ -	5	$ 375.00		$ -		$ -	5	$ 375.00
Profile Fee	$ 75.00	LS		$ -		$ -	1	$ 75.00		$ -		$ -	1	$ 75.00
Subcontractor/Vendor Subtotal			**0**	**$ -**	**0**	**$ -**	**24**	**$ 8,803.58**	**0**	**$ -**	**0**	**$ -**	**25**	**$ 8,803.58**
Travel														
Airfare R/T to Grand Island, NE	$ 800.00	Each		$ -		$ -		$ -		$ -			0	$ -
Per Diem	$ 157.00	person/day		$ -		$ -	22.5	$ 3,532.50		$ -			22.5	$ 3,532.50
Hotel/Lodging	$ 150.00	person/day		$ -		$ -	22.5	$ 3,375.00		$ -			22.5	$ 3,375.00
Travel Subtotal			**0**	**$ -**	**0**	**$ -**	**45**	**$ 6,907.50**	**0**	**$ -**	**0**	**$ -**	**45**	**$ 6,907.50**
Task Totals				$ 4,742.86		$ -		$ 49,968.39		$ -		$ 2,371.43	$ 57,082.67	$ 57,082.67
Running Total by Task				$ 4,742.86		$ 4,742.86		$ 54,711.24		$ 54,711.24		$ 57,082.67	**GRAND TOTAL**	**$ 57,082.67**

Basis of Estimate:

1 All tasks require 2 hr/day for PM. Field days are 12 hours for personnel, with equipment run 10 hours.
2 Assumes 5 person field crew.
3 Assumes field crew can complete field activities in 5 days at a rate of 2 wells abandoned per day.
4 Assume wells would be abandoned during annual sampling event.
5 Mobilization/demobilization, and airfare costs are included in Task 4.
6 Assume two field trucks are needed for field transportation.
7 Costs shown are for CY2023. Costs are escalated on the summary page for activities completed in subsequent years.

Option 3 - GWTF O&M			Option 3.1		Option 3.2		Option 3.3		Option 3.4		Option 3.5			
			Pre-Mobilizations / Procurements		Mobilization		Site Activities		Demobilization		Post-Demobilization Activities		Total Units	Subtotal
Cornhusker Army Ammunition Plant - OU1 Alternative 2: MNA with LUCs	**2023 Rate**	**Unit**	**Units**	**Cost**	**Units**	**Cost**	**Units**	**Cost**	**Units**	**Cost**	**Units**	**Cost**		
Professional Labor														
Project Manager	$ 150.42	hour		$ -		$ -		$ -		$ -		$ -	0	$ -
Mid-level Engineer	$ 106.24	hour		$ -		$ -		$ -		$ -		$ -	0	$ -
Mid-level Scientist	$ 89.13	hour		$ -		$ -		$ -		$ -		$ -	0	$ -
Site Safety and Health Officer (FIELD)	$ 95.72	hour		$ -		$ -		$ -		$ -		$ -	0	$ -
Professional Labor Subtotal			**0**	**$ -**	**0**	**$ -**	**0**	**$ -**	**0**	**$ -**	**0**	**$ -**	**0**	**$ -**
Services														
Shipping (sample coolers and misc.)	$ 4,011.96	LS		$ -		$ -		$ -		$ -			0	$ -
Materials Subtotal			**0**	**$ -**	**0**	**$ -**		**$ -**	**0**	**$ -**	**0**	**$ -**	**0**	**$ -**
Supplies														
Field Supplies	$ 6,833.82	LS		$ -		$ -		$ -		$ -			0	$ -
Supplies Subtotal			**0**	**$ -**	**0**	**$ -**	**0**	**$ -**	**0**	**$ -**	**0**	**$ -**	**0**	**$ -**
Equipment														
Rentals	$ 11,362.57	LS		$ -		$ -		$ -		$ -		$ -	0	$ -
Equipment Subtotal			**0**	**$ -**	**0**	**$ -**	**0**	**$ -**	**0**	**$ -**	**0**	**$ -**	**0**	**$ -**
Subcontractor(s)/Vendors														
GWTF Annual O&M (misc.)	$ 28,981.85	LS		$ -		$ -	1	$ 28,981.85		$ -		$ -	1	$ 28,981.85
Subcontractor/Vendor Subtotal			**0**	**$ -**	**0**	**$ -**	**1**	**$ 28,981.85**	**0**	**$ -**	**0**	**$ -**	**1**	**$ 28,981.85**
Travel														
Travel Subtotal			**0**	**$ -**	**0**	**$ -**	**0**	**$ -**	**0**	**$ -**	**0**	**$ -**	**0**	**$ -**
Task Totals				$ -		$ -		$ 28,981.85		$ -		$ -	$ 28,981.85	$ 28,981.85
Running Total by Task				$ -		$ -		$ 28,981.85		$ 28,981.85		$ 28,981.85	**GRAND TOTAL**	**$ 28,981.85**

Basis of Estimate:

1 Includes costs associated with GWTF operation and maintenance including, but not limited to: all labor and ODCs for monthly electricity bill; monthly inspection of pumps,motors, air compressor, air dryer, fire extinguisher, ladder and eye wash; pest management; office cleaning; water delivery; herbicides for weed control; mowing; small tools & supplies; and various building repairs.

ALTERNATIVE 3: MONITORED NATURAL ATTENUATION WITH LAND USE CONTROLS AND SUBSURFACE INJECTIONS

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Cornhusker Army Ammunition Plant - OU1
Alternative 3: MNA with LUCs and Subsurface Injections

Task	Description	Quantity	Unit	Unit Price	Amount	Year Performed	Net Present Worth (2022)	Notes
BASE TASKS								
Task 1	Project Management	1	Job	$ 21,192	$ 21,192	2023	$ 20,615	
Task 2	Planning Documents	1	Job	$ 23,645	$ 23,645	2023	$ 23,001	
Task 3	LUC Field Activities	1	Job	$ 6,001	$ 6,001	2023	$ 5,838	
Task 4	MNA Field Activities	1	Job	$ 347,261	$ 347,261	2023	$ 337,802	
Task 5	Annual Reporting	1	Job	$ 138,568	$ 138,568	2024	$ 131,122	
Option 1	Direct Push Investigation	1	Job	$ 77,119	$ 77,119	2023	$ 75,019	
Option 2	Monitoring Well Abandonments	1	Job	$ 57,083	$ 57,083	2023	$ 55,528	Nine wells abandoned.
Option 3	GWTF O&M	1	Job	$ 28,982	$ 28,982	2023	$ 28,192	
Annual Sampling for 18 years								
2nd Year	Annual Sampling Event	1	Job	$ 373,547	$ 373,547	2024	$ 353,476	Cost of MNA field activities (Task 4) reduced by 10% to account for nine well abandonments.
2nd Year	Monitoring Well Abandonments	1	Job	$ 58,681	$ 58,681	2024	$ 55,528	Nine wells abandoned.
2nd Year	Subsurface Injections	1	Job	$ 892,923	$ 892,923	2024	$ 844,944	
2nd Year	Performance Monitoring	1	Job	$ 409,979	$ 409,979	2024	$ 387,950	
2nd Year	Annual Reporting	1	Job	$ 142,448	$ 142,448	2025	$ 131,122	
3rd Year	Annual Sampling Event	1	Job	$ 347,309	$ 347,309	2025	$ 319,695	Cost of MNA field activities (Task 4) reduced by 10% to account for nine well abandonments.
3rd Year	Monitoring Well Abandonments	1	Job	$ 60,324	$ 60,324	2025	$ 55,528	Nine wells abandoned.
3rd Year	Subsurface Injections	1	Job	$ 917,925	$ 917,925	2025	$ 844,944	
3rd Year	Performance Monitoring	1	Job	$ 421,459	$ 421,459	2025	$ 387,950	
3rd Year	Annual Reporting	1	Job	$ 146,437	$ 146,437	2026	$ 131,122	
4th Year	Annual Sampling Event	1	Job	$ 357,033	$ 357,033	2026	$ 319,695	
4th Year	Annual Reporting	1	Job	$ 150,537	$ 150,537	2027	$ 131,122	
5th Year	Annual Sampling Event	1	Job	$ 328,249	$ 328,249	2027	$ 285,915	Cost of MNA field activities (Task 4) reduced by 10% to account for five well abandonments.
5th Year	Monitoring Well Abandonments	1	Job	$ 38,250	$ 38,250	2027	$ 33,317	Five wells abandoned hereafter - Option 2 costs reduced by 40%.
5th Year	Annual Reporting	1	Job	$ 154,752	$ 154,752	2028	$ 131,122	
6th Year	Annual Sampling Event	1	Job	$ 337,439	$ 337,439	2028	$ 285,915	
6th Year	Annual Reporting	1	Job	$ 159,085	$ 159,085	2029	$ 131,122	
7th Year	Annual Sampling Event	1	Job	$ 305,904	$ 305,904	2029	$ 252,135	Cost of MNA field activities (Task 4) reduced by 10% to account for five well abandonments.
7th Year	Monitoring Well Abandonments	1	Job	$ 40,422	$ 40,422	2029	$ 33,317	Five wells abandoned.
7th Year	Annual Reporting	1	Job	$ 163,539	$ 163,539	2030	$ 131,122	
8th Year	Annual Sampling Event	1	Job	$ 314,469	$ 314,469	2030	$ 252,135	
8th Year	Annual Reporting	1	Job	$ 168,118	$ 168,118	2031	$ 131,122	
9th Year	Annual Sampling Event	1	Job	$ 279,963	$ 279,963	2031	$ 218,355	Cost of MNA field activities (Task 4) reduced by 10% to account for five well abandonments.
9th Year	Monitoring Well Abandonments	1	Job	$ 42,717	$ 42,717	2031	$ 33,317	Five wells abandoned.
9th Year	Annual Reporting	1	Job	$ 172,826	$ 172,826	2032	$ 131,122	
10th Year	Annual Sampling Event	1	Job	$ 243,278	$ 243,278	2032	$ 184,575	Cost of MNA field activities (Task 4) reduced by 10% to account for five well abandonments.
10th Year	Monitoring Well Abandonments	1	Job	$ 43,913	$ 43,913	2032	$ 33,317	Five wells abandoned.
10th Year	Annual Reporting	1	Job	$ 177,665	$ 177,665	2033	$ 131,122	
11th Year	Annual Sampling Event	1	Job	$ 225,081	$ 225,081	2033	$ 166,117	Overall cost reduced by 10%.
11th Year	Annual Reporting	1	Job	$ 182,639	$ 182,639	2034	$ 131,122	
12th Year	Annual Sampling Event	1	Job	$ 208,245	$ 208,245	2034	$ 149,505	Overall cost reduced by 10%.
12th Year	Annual Reporting	1	Job	$ 187,753	$ 187,753	2035	$ 131,122	
13th Year	Annual Sampling Event	1	Job	$ 192,668	$ 192,668	2035	$ 134,555	Overall cost reduced by 10%.
13th Year	Annual Reporting	1	Job	$ 193,010	$ 193,010	2036	$ 131,122	
14th Year	Annual Sampling Event	1	Job	$ 178,257	$ 178,257	2036	$ 121,099	Overall cost reduced by 10%.
14th Year	Annual Reporting	1	Job	$ 198,415	$ 198,415	2037	$ 131,122	
15th Year	Annual Sampling Event	1	Job	$ 164,923	$ 164,923	2037	$ 108,989	Overall cost reduced by 10%.

Cornhusker Army Ammunition Plant - OU1 Alternative 3: MNA with LUCs and Subsurface Injections								
Task	**Description**	**Quantity**	**Unit**	**Unit Price**	**Amount**	**Year Performed**	**Net Present Worth (2022)**	**Notes**
15th Year	Annual Reporting	1	Job	$ 203,970	$ 203,970	2038	$ 131,122	
16th Year	Annual Sampling Event	1	Job	$ 152,587	$ 152,587	2038	$ 98,090	Overall cost reduced by 10%.
16th Year	Monitoring Well Abandonments	1	Job	$ 422,273	$ 422,273	2038	$ 271,458	Abandonment of remaining 40 wells. Site closeout.
16th Year	Annual Reporting	1	Job	$ 209,682	$ 209,682	2039	$ 131,122	
				TOTAL COST	**$ 10,668,544**	**TOTAL NET PRESENT WORTH COST**	**$ 8,875,776**	

Basis of Estimate:

-Assumes full level of effort for LTM until 2032. Reduce effort by 10% each year (2033 to 2039).

-Assumes 9 abandonments in 2023, 2024, and 2025, and 5 abandonments in 2027, 2029, 2031, and 2032. Field effort cost reduces by 10% after each well abandonment event.

-Assumes 21 investigation DP samples in 2023 and 9 reoccurring DP samples from 2023 to 2039.

-Assumes no O&M at GWTF after 2023.

-Line item “Annual Sampling Event” for years 2 through 16 includes the cost of Project Management, Planning Documents, LUC Field Activities, and MNA Field Activities (Tasks 1 through 4).

TASK 1 - Project Management			Task 1.1 Coordination and Communication		Task 1.2 Monthly Status Reports		Total Units	Subtotal
Cornhusker Army Ammunition Plant - OU1 Alternative 3: MNA with LUCs and Subsurface Injections	**2023 Rate**	**Unit**	**Units**	**Cost**	**Units**	**Cost**		
Professional Labor								
Program Manager	$ 206.49	hour	6	$ 1,238.95	6	$ 1,238.95	12	$ 2,477.91
Project Manager	$ 150.42	hour	40	$ 6,016.66	12	$ 1,805.00	52	$ 7,821.66
Contracts Manager	$ 122.46	hour		$ -	36	$ 4,408.56	36	$ 4,408.56
Clerical	$ 55.40	hour		$ -	48	$ 2,659.12	48	$ 2,659.12
Mid-level Engineer	$ 106.24	hour	36	$ 3,824.63		$ -	36	$ 3,824.63
Professional Labor Subtotal			**82**	**$ 11,080.24**	**102**	**$ 10,111.62**	**184**	**$ 21,191.87**
Craft Labor								
Craft Labor Subtotal			**0**	**$ -**	**0**	**$ -**	**0**	**$ -**
Materials								
Materials Subtotal			**0**	**$ -**	**0**	**$ -**	**0**	**$ -**
Supplies								
Supplies Subtotal			**0**	**$ -**	**0**	**$ -**	**0**	**$ -**
Equipment								
Equipment Subtotal			**0**	**$ -**	**0**	**$ -**	**0**	**$ -**
Other Direct Costs								
Other Direct Costs Subtotal			**0**	**$ -**	**0**	**$ -**	**0**	**$ -**
Subcontractor(s)/Vendors								
Subcontractors/Vendors Subtotal			**0**	**$ -**	**0**	**$ -**	**0**	**$ -**
Travel								
Travel Subtotal			**0**	**$ -**	**0**	**$ -**	**0**	**$ -**
Task Totals				$ 11,080.24		$ 10,111.62	$ 21,191.87	$ 21,191.87
Running Total by Task				$ 11,080.24		$ 21,191.87	**GRAND TOTAL**	**$ 21,191.87**

Basis of Estimate:

1 Task 1.1: PgM=0.5 hr/mo, PM=2 hr/mo, Eng Mid=1 hr/mo; 8 hours for PM and 24 hours for Eng Mid for Quality Management Plan preparation; 8 hours for annual PM meeting
2 Task 1.2: PgM=0.5 hr/mo, PM=1 hr/mo, PC=2 hr/mo, CM=3 hr/mo, Clerical=4 hr/mo
3 Contractor manpower reporting will not be required
4 PoP = 12 months

TASK 2 - Planning Documents			Task 2.1		Task 2.2		Task 2.3		Task 2.4		Task 2.5		Task 2.6			
			Project Schedule		Work Plan (Draft)		Work Plan (Draft RTCs)		Work Plan (Draft Final)		Work Plan (Draft Final RTCs)		Work Plan (Final)		Total Units	Subtotal
Cornhusker Army Ammunition Plant - OU1 Alternative 3: MNA with LUCs and Subsurface Injections	**2023 Rate**	**Unit**	**Units**	**Cost**	**Units**	**Cost**	**Units**	**Cost**	**Units**	**Cost**	**Units**	**Cost**	**Units**	**Cost**		
Professional Labor																
Project Manager	$ 150.42	hour	4	$ 601.67	10	$ 1,504.16	2	$ 300.83	3	$ 451.25	2	$ 300.83	2	$ 300.83	23	$ 3,459.58
Contracts Manager	$ 122.46	hour	12	$ 1,469.52		$ -		$ -		$ -		$ -		$ -	12	$ 1,469.52
CADD/GIS	$ 81.26	hour		$ -	20	$ 1,625.26	4	$ 325.05	5	$ 406.31	3	$ 243.79	3	$ 243.79	35	$ 2,844.20
Mid-level Engineer	$ 106.24	hour		$ -	50	$ 5,311.99	10	$ 1,062.40	13	$ 1,381.12	7	$ 743.68	7	$ 743.68	87	$ 9,242.85
Mid-level Scientist	$ 89.13	hour		$ -	30	$ 2,674.00	6	$ 534.80	8	$ 713.07	4	$ 356.53	4	$ 356.53	52	$ 4,634.94
Clerical	$ 55.40	hour		$ -	20	$ 1,107.97		$ -	4	$ 221.59		$ -	4	$ 221.59	28	$ 1,551.15
Site Safety and Health Officer (FIELD)	$ 95.72	hour		$ -	4	$ 382.89		$ -		$ -		$ -		$ -	4	$ 382.89
Professional Labor Subtotal			**16**	**$ 2,071.18**	**146**	**$ 12,606.27**	**25**	**$ 2,223.08**	**36**	**$ 3,173.34**	**18**	**$ 1,644.83**	**22**	**$ 1,866.43**	**263**	**$ 23,585.13**
Craft Labor																
Craft Labor Subtotal			**0**	**$ -**	**0**	**$ -**	**0**	**$ -**	**0**	**$ -**	**0**	**$ -**	**0**	**$ -**	**0**	**$ -**
Materials																
Materials Subtotal			**0**	**$ -**	**0**	**$ -**	**0**	**$ -**	**0**	**$ -**	**0**	**$ -**	**0**	**$ -**	**0**	**$ -**
Supplies																
Supplies Subtotal			**0**	**$ -**	**0**	**$ -**	**0**	**$ -**	**0**	**$ -**	**0**	**$ -**	**0**	**$ -**	**0**	**$ -**
Equipment																
Equipment Subtotal			**0**	**$ -**	**0**	**$ -**	**0**	**$ -**	**0**	**$ -**	**0**	**$ -**	**0**	**$ -**	**0**	**$ -**
Other Direct Costs																
Hard copies	$ 20.00	each		$ -		$ -		$ -		$ -		$ -	3	$ 60.00	3	$ 60.00
Other Direct Costs Subtotal			**0**	**$ -**	**0**	**$ -**	**0**	**$ -**	**0**	**$ -**	**0**	**$ -**	**3**	**$ 60.00**	**3**	**$ 60.00**
Subcontractor(s)/Vendors																
Subcontractor/Vendor Subtotal			**0**	**$ -**	**0**	**$ -**	**0**	**$ -**	**0**	**$ -**	**0**	**$ -**	**0**	**$ -**	**0**	**$ -**
Travel																
Travel Subtotal			**0**	**$ -**	**0**	**$ -**	**0**	**$ -**	**0**	**$ -**	**0**	**$ -**	**0**	**$ -**	**0**	**$ -**
Task Totals				$ 2,071.18		$ 12,606.27		$ 2,223.08		$ 3,173.34		$ 1,644.83		$ 1,926.43	$ 23,645.13	$ 23,645.13
Running Total by Task				$ 2,071.18		$ 14,677.45		$ 16,900.53		$ 20,073.87		$ 21,718.71		$ 23,645.13	**GRAND TOTAL**	**$ 23,645.13**

Basis of Estimate:

1 Level of effort based on previous experience with USACE.
2 Includes WP and APP/SSHP.
3 Pre-Draft RTC effort is 20% of the Pre-Draft WP development effort.
4 Draft WP effort is 25% of the Pre-Draft WP effort.
5 Draft RTC effort is 50% of the Draft WP development effort.
6 Final WP effort is 50% of the Draft WP.

TASK 3 - LUC Field Activities			Task 3.1		Task 3.2		Task 3.3		Task 3.4		Task 3.5			
			Pre-Mobilizations / Procurements		Mobilization		Site Activities		Demobilization		Post-Demobilization Activities		Total Units	Subtotal
Cornhusker Army Ammunition Plant - OU1 Alternative 3: MNA with LUCs and Subsurface Injections	**2023 Rate**	**Unit**	**Units**	**Cost**	**Units**	**Cost**	**Units**	**Cost**	**Units**	**Cost**	**Units**	**Cost**		
Professional Labor														
Project Manager	$ 150.42	hour	4	$ 601.67		$ -		$ -		$ -	2	$ 300.83	6	$ 902.50
Senior Scientist	$ 126.90	hour	4	$ 507.61		$ -		$ -		$ -	2	$ 253.81	6	$ 761.42
Mid-level Engineer	$ 106.24	hour	8	$ 849.92		$ -	8	$ 849.92		$ -	4	$ 424.96	20	$ 2,124.79
Mid-level Scientist	$ 89.13	hour	8	$ 713.07		$ -	8	$ 713.07		$ -	4	$ 356.53	20	$ 1,782.67
Professional Labor Subtotal			**24**	**$ 2,672.26**	**0**	**$ -**	**16**	**$ 1,562.98**	**0**	**$ -**	**12**	**$ 1,336.13**	**52**	**$ 5,571.38**
Craft Labor														
Craft Labor Subtotal			**0**	**$ -**	**0**	**$ -**	**0**	**$ -**	**0**	**$ -**			**0**	**$ -**
Materials														
Signage	$ 40.00	each	10	$ 400.00		$ -		$ -		$ -			10	$ 400.00
Materials Subtotal			**10**	**$ 400.00**	**0**	**$ -**	**0**	**$ -**	**0**	**$ -**			**10**	**$ 400.00**
Supplies														
PPE	$ 15.00	person/day		$ -		$ -	2	$ 30.00		$ -			2	$ 30.00
Supplies Subtotal			**0**	**$ -**	**0**	**$ -**	**4**	**$ 30.00**	**0**	**$ -**			**4**	**$ 30.00**
Equipment														
Equipment Subtotal			**0**	**$ -**	**0**	**$ -**	**0**	**$ -**	**0**	**$ -**			**0**	**$ -**
Other Direct Costs														
Other Direct Costs Subtotal			**0**	**$ -**	**0**	**$ -**	**0**	**$ -**	**0**	**$ -**			**0**	**$ -**
Subcontractor(s)/Vendors														
Subcontractor/Vendor Subtotal			**0**	**$ -**	**0**	**$ -**	**0**	**$ -**	**0**	**$ -**			**0**	**$ -**
Travel														
Travel Subtotal			**0**	**$ -**	**0**	**$ -**	**0**	**$ -**	**0**	**$ -**			**0**	**$ -**
Task Totals				$ 3,072.26		$ -		$ 1,592.98		$ -		$ 1,336.13	$ 6,001.38	$ 6,001.38
Running Total by Task				$ 3,072.26		$ 3,072.26		$ 4,665.25		$ 4,665.25		$ 6,001.38	**GRAND TOTAL**	**$ 6,001.38**

Basis of Estimate:

1 Assumes an annual site visit for review of LUCS and ICs will be performed to identify any visible new groundwater wells that appear to be located over the plume.
2 Assumes LUC inspection will be conducted during annual sampling event (mobilization, supplies, and travel costs included in Task 4).
3 Costs associated with updating the GIS overlay of the plume are included in Task 5.
4 Pre-mobilization tasks include verification of compliance or groundwater ordinance with the City of Grand Island and checking for new construction wells within proximity of the plume.

TASK 4 - MNA Field Activities			Task 4.1		Task 4.2		Task 4.3		Task 4.4		Task 4.5			
			Pre-Mobilizations / Procurements		Mobilization		Site Activities		Demobilization		Post-Demobilization Activities		Total Units	Subtotal
Cornhusker Army Ammunition Plant - OU1 Alternative 3: MNA with LUCs and Subsurface Injections	**2023 Rate**	**Unit**	**Units**	**Cost**	**Units**	**Cost**	**Units**	**Cost**	**Units**	**Cost**	**Units**	**Cost**		
Professional Labor														
Project Manager	$ 150.42	hour	20	$ 3,008.33	6	$ 902.50	40	$ 6,016.66	6	$ 902.50	20	$ 3,008.33	92	$ 13,838.31
Senior Scientist	$ 126.90	hour	40	$ 5,076.11	12	$ 1,522.83	240	$ 30,456.66	12	$ 1,522.83	40	$ 5,076.11	344	$ 43,654.54
Mid-level Engineer	$ 106.24	hour	80	$ 8,499.18	24	$ 2,549.75	480	$ 50,995.06	24	$ 2,549.75	80	$ 8,499.18	688	$ 73,092.92
Mid-level Scientist	$ 89.13	hour	80	$ 7,130.67	24	$ 2,139.20	480	$ 42,784.04	24	$ 2,139.20	80	$ 7,130.67	688	$ 61,323.79
Senior Scientist (Chemist)	$ 126.90	hour	80	$ 10,152.22		$ -	300	$ 38,070.82		$ -	40	$ 5,076.11	420	$ 53,299.15
Professional Labor Subtotal			**300**	**$ 33,866.51**	**66**	**$ 7,114.29**	**1540**	**$ 168,323.24**	**66**	**$ 7,114.29**	**260**	**$ 28,790.40**	**2232**	**$ 245,208.71**
Craft Labor														
Craft Labor Subtotal			**0**	**$ -**	**0**	**$ -**	**0**	**$ -**	**0**	**$ -**			**0**	**$ -**
Services														
Shipping (sample coolers and misc.)	$ 4,011.96	LS		$ -		$ -	1	$ 4,011.96		$ -			1	$ 4,011.96
Materials Subtotal			**0**	**$ -**	**0**	**$ -**	**1**	**$ 4,011.96**	**0**	**$ -**	**0**	**$ -**	**1**	**$ 4,011.96**
Supplies														
Field Supplies	$ 6,833.82	LS		$ -		$ -	1	$ 6,833.82		$ -			1	$ 6,833.82
Supplies Subtotal			**0**	**$ -**	**0**	**$ -**	**1**	**$ 6,833.82**	**0**	**$ -**	**0**	**$ -**	**1**	**$ 6,833.82**
Equipment														
Rentals	$ 11,362.57	LS		$ -		$ -	1	$ 11,362.57		$ -		$ -	1	$ 11,362.57
Equipment Subtotal			**0**	**$ -**	**0**	**$ -**	**1**	**$ 11,362.57**	**0**	**$ -**	**0**	**$ -**	**1**	**$ 11,362.57**
Subcontractor(s)/Vendors														
Laboratory Analysis - 87 Wells	$ 31,383.87	LS		$ -		$ -	1	$ 31,383.87		$ -		$ -	1	$ 31,383.87
Laboratory Analysis - 9 Direct Push Samples	$ 1,136.09	LS		$ -		$ -	1	$ 1,136.09		$ -		$ -	1	$ 1,136.09
Laboratory Analysis - IDW (Purge Water)	$ 1,066.53	LS		$ -		$ -	2	$ 2,133.06		$ -		$ -	2	$ 2,133.06
Drilling	$ 3,970.51	LS		$ -		$ -	1	$ 3,970.51		$ -		$ -	1	$ 3,970.51
55-Gallon Drum	$ 150.00	Each		$ -		$ -	20	$ 3,000.00		$ -		$ -	20	$ 3,000.00
Waste T&D	$ 75.00	Ton		$ -		$ -	5	$ 375.00		$ -		$ -	5	$ 375.00
Profile Fee	$ 75.00	LS		$ -		$ -	1	$ 75.00		$ -		$ -	1	$ 75.00
Subcontractor/Vendor Subtotal			**0**	**$ -**	**0**	**$ -**	**31**	**$ 42,073.53**	**0**	**$ -**	**0**	**$ -**	**31**	**$ 42,073.53**
Travel														
Airfare R/T to Grand Island, NE	$ 800.00	Each		$ -	5	$ 4,000.00		$ -		$ -			5	$ 4,000.00
Per Diem	$ 157.00	person/day		$ -	5	$ 785.00	100	$ 15,700.00	5	$ 785.00			110	$ 17,270.00
Hotel/Lodging	$ 150.00	person/day		$ -	5	$ 750.00	100	$ 15,000.00	5	$ 750.00			110	$ 16,500.00
Travel Subtotal			**0**	**$ -**	**15**	**$ 5,535.00**	**200**	**$ 30,700.00**	**10**	**$ 1,535.00**	**0**	**$ -**	**225**	**$ 37,770.00**
Task Totals				$ 33,866.51		$ 12,649.29		$ 263,305.11		$ 8,649.29		$ 28,790.40	$ 347,260.59	$ 347,260.59
Running Total by Task				$ 33,866.51		$ 46,515.79		$ 309,820.91		$ 318,470.19		$ 347,260.59	**GRAND TOTAL**	**$ 347,260.59**

Basis of Estimate:

1 All tasks require 2 hr/day for PM. Field days are 12 hours for personnel, with equipment run 10 hours.
2 Assumes 5 person field crew.
3 Assumes field crew can complete field activities in 15 days at a rate of 6 wells sampled per day.
4 Assume 9 recurring direct push wells can be completed in 3 days at a rate of 4 per day.
4 Assume two field trucks are needed for field transportation.
5 Costs shown are for CY2023. Costs are escalated on the summary page for activities completed in subsequent years.

TASK 5 - Annual Reporting			Task 5.1 Periodic Review (Draft)		Task 5.2 Periodic Review (Draft RTCs)		Task 5.3 Periodic Review (Draft Final)		Task 5.4 Periodic Review (Draft Final RTCs)		Task 5.5 Periodic Review (Final)		Total Units	Subtotal
Cornhusker Army Ammunition Plant - OU1 Alternative 3: MNA with LUCs and Subsurface Injections	**2024 Rate**	**Unit**	**Units**	**Cost**	**Units**	**Cost**	**Units**	**Cost**	**Units**	**Cost**	**Units**	**Cost**		
Professional Labor														
Project Manager	$ 150.42	hour	60	$ 9,024.99	12	$ 1,805.00	15	$ 2,256.25	8	$ 1,203.33	8	$ 1,203.33	103	$ 15,492.89
CADD/GIS	$ 81.26	hour	120	$ 9,751.55	24	$ 1,950.31	50	$ 4,063.15	25	$ 2,031.57	25	$ 2,031.57	244	$ 19,828.15
Mid-level Engineer	$ 106.24	hour	320	$ 33,996.71	40	$ 4,249.59	50	$ 5,311.99	25	$ 2,655.99	25	$ 2,655.99	460	$ 48,870.27
Senior Scientist	$ 126.90	hour	240	$ 30,456.66	40	$ 5,076.11	50	$ 6,345.14	25	$ 3,172.57	25	$ 3,172.57	380	$ 48,223.04
Clerical	$ 55.40	hour	50	$ 2,769.91		$ -	30	$ 1,661.95		$ -	30	$ 1,661.95	110	$ 6,093.81
Professional Labor Subtotal			**790**	**$ 85,999.81**	**116**	**$ 13,081.01**	**195**	**$ 19,638.46**	**83**	**$ 9,063.47**	**113**	**$ 10,725.41**	**1297**	**$ 138,508.16**
Craft Labor														
Craft Labor Subtotal			**0**	**$ -**	**0**	**$ -**	**0**	**$ -**	**0**	**$ -**	**0**	**$ -**	**0**	**$ -**
Materials														
Materials Subtotal			**0**	**$ -**	**0**	**$ -**	**0**	**$ -**	**0**	**$ -**	**0**	**$ -**	**0**	**$ -**
Supplies														
Supplies Subtotal			**0**	**$ -**	**0**	**$ -**	**0**	**$ -**	**0**	**$ -**	**0**	**$ -**	**0**	**$ -**
Equipment														
Equipment Subtotal			**0**	**$ -**	**0**	**$ -**	**0**	**$ -**	**0**	**$ -**	**0**	**$ -**	**0**	**$ -**
Other Direct Costs														
Hard copies	$ 20.00	each		$ -		$ -		$ -		$ -	3	$ 60.00	3	$ 60.00
Other Direct Costs Subtotal			**0**	**$ -**	**0**	**$ -**	**0**	**$ -**	**0**	**$ -**	**3**	**$ 60.00**	**3**	**$ 60.00**
Subcontractor(s)/Vendors														
Subcontractor/Vendor Subtotal			**0**	**$ -**	**0**	**$ -**	**0**	**$ -**	**0**	**$ -**	**0**	**$ -**	**0**	**$ -**
Travel														
Travel Subtotal			**0**	**$ -**	**0**	**$ -**	**0**	**$ -**	**0**	**$ -**	**0**	**$ -**	**0**	**$ -**
Task Totals				$ 85,999.81		$ 13,081.01		$ 19,638.46		$ 9,063.47		$ 10,785.41	$ 138,568.16	$ 138,568.16
Running Total by Task				$ 85,999.81		$ 99,080.82		$ 118,719.28		$ 127,782.75		$ 138,568.16	**GRAND TOTAL**	**$ 138,568.16**

Basis of Estimate:

1 Assumes reporting includes Annual Groundwater Monitoring Reports and Monitoring Well Abandonment Letter Reports.

2 Annual report will summarize GWTF activities, monitoring well sampling, direct push sampling, well abandonment, analytical results, modeling results, a groundwater quality assessment of the current monitoring year, historical data, conclusions, and recommendations for subsequent years.

3 Annual report will include a recalibration of the CHAAP numerical flow model and contaminant fate and transport model to current conditions.

Option 1 - Direct Push Investigation			Option 1.1		Option 1.2		Option 1.3		Option 1.4		Option 1.5			
			Pre-Mobilizations / Procurements		Mobilization		Site Activities		Demobilization		Post-Demobilization Activities		Total Units	Subtotal
Cornhusker Army Ammunition Plant - OU1 Alternative 3: MNA with LUCs and Subsurface Injections	**2023 Rate**	**Unit**	**Units**	**Cost**	**Units**	**Cost**	**Units**	**Cost**	**Units**	**Cost**	**Units**	**Cost**		
Professional Labor														
Project Manager	$ 150.42	hour	4	$ 601.67		$ -	22	$ 3,309.16		$ -	2	$ 300.83	28	$ 4,211.66
Senior Scientist	$ 126.90	hour	8	$ 1,015.22		$ -	72	$ 9,137.00		$ -	8	$ 1,015.22	88	$ 11,167.44
Mid-level Engineer	$ 106.24	hour	16	$ 1,699.84		$ -	144	$ 15,298.52		$ -	16	$ 1,699.84	176	$ 18,698.19
Mid-level Scientist	$ 89.13	hour	16	$ 1,426.13		$ -	144	$ 12,835.21		$ -	16	$ 1,426.13	176	$ 15,687.48
Professional Labor Subtotal			**44**	**$ 4,742.86**	**0**	**$ -**	**382**	**$ 40,579.89**	**0**	**$ -**	**42**	**$ 4,442.02**	**468**	**$ 49,764.77**
Services														
Shipping (sample coolers and misc.)	$ 1,085.37	LS		$ -		$ -	1	$ 1,085.37		$ -			1	$ 1,085.37
Materials Subtotal			**0**	**$ -**	**0**	**$ -**	**1**	**$ 1,085.37**	**0**	**$ -**	**0**	**$ -**	**1**	**$ 1,085.37**
Supplies														
Field Supplies	$ 1,412.55	LS		$ -		$ -	1	$ 1,412.55		$ -			1	$ 1,412.55
Supplies Subtotal			**0**	**$ -**	**0**	**$ -**	**1**	**$ 1,412.55**	**0**	**$ -**	**0**	**$ -**	**1**	**$ 1,412.55**
Equipment														
Rentals	$ 3,846.33	LS		$ -		$ -	1	$ 3,846.33		$ -		$ -	1	$ 3,846.33
Equipment Subtotal			**0**	**$ -**	**0**	**$ -**	**1**	**$ 3,846.33**	**0**	**$ -**	**0**	**$ -**	**1**	**$ 3,846.33**
Subcontractor(s)/Vendors														
Laboratory Analysis - 21 DP Samples	$ 2,726.61	LS		$ -		$ -	1	$ 2,726.61		$ -		$ -	1	$ 2,726.61
Laboratory Analysis - IDW (Purge Water)	$ 1,066.53	LS		$ -		$ -	1	$ 1,066.53		$ -		$ -	1	$ 1,066.53
Drilling	$ 6,057.21	LS		$ -		$ -	1	$ 6,057.21		$ -		$ -	1	$ 6,057.21
55-Gallon Drum	$ 150.00	Each		$ -		$ -	10	$ 1,500.00		$ -		$ -	10	$ 1,500.00
Waste T&D	$ 75.00	Ton		$ -		$ -	5	$ 375.00		$ -		$ -	5	$ 375.00
Profile Fee	$ 75.00	LS		$ -		$ -	1	$ 75.00		$ -		$ -	1	$ 75.00
Subcontractor/Vendor Subtotal			**0**	**$ -**	**0**	**$ -**	**19**	**$ 11,800.35**	**0**	**$ -**	**0**	**$ -**	**19**	**$ 11,800.35**
Travel														
Airfare R/T to Grand Island, NE	$ 800.00	Each		$ -		$ -		$ -		$ -			0	$ -
Per Diem	$ 157.00	person/day		$ -		$ -	30	$ 4,710.00		$ -			30	$ 4,710.00
Hotel/Lodging	$ 150.00	person/day		$ -		$ -	30	$ 4,500.00		$ -			30	$ 4,500.00
Travel Subtotal			**0**	**$ -**	**0**	**$ -**	**60**	**$ 9,210.00**	**0**	**$ -**	**0**	**$ -**	**60**	**$ 9,210.00**
Task Totals				$ 4,742.86		$ -		$ 67,934.49		$ -		$ 4,442.02	$ 77,119.38	$ 77,119.38
Running Total by Task				$ 4,742.86		$ 4,742.86		$ 72,677.35		$ 72,677.35		$ 77,119.38	**GRAND TOTAL**	**$ 77,119.38**

Basis of Estimate:

1 All tasks require 2 hr/day for PM. Field days are 12 hours for personnel, with equipment run 10 hours.
2 Assumes 5 person field crew.
3 Assumes field crew can complete field activities in 6 days at a rate of 4 per day.
4 Assume direct push investigation would be conducted during annual sampling event.
5 Mobilization/demobilization, and airfare costs are included in Task 4.
6 Assume two field trucks are needed for field transportation.
7 Costs shown are for CY2023. Costs are escalated on the summary page for activities completed in subsequent years.

Option 2 - Monitoring Well Abandonments			Option 2.1		Option 2.2		Option 2.3		Option 2.4		Option 2.5			
			Pre-Mobilizations / Procurements		Mobilization		Site Activities		Demobilization		Post-Demobilization Activities		Total Units	Subtotal
Cornhusker Army Ammunition Plant - OU1 Alternative 3: MNA with LUCs and Subsurface Injections	**2023 Rate**	**Unit**	**Units**	**Cost**	**Units**	**Cost**	**Units**	**Cost**	**Units**	**Cost**	**Units**	**Cost**		
Professional Labor														
Project Manager	$ 150.42	hour	4	$ 601.67		$ -	9	$ 1,353.75		$ -	2	$ 300.83	15	$ 2,256.25
Senior Scientist	$ 126.90	hour	8	$ 1,015.22		$ -	54	$ 6,852.75		$ -	4	$ 507.61	66	$ 8,375.58
Mid-level Engineer	$ 106.24	hour	16	$ 1,699.84		$ -	108	$ 11,473.89		$ -	8	$ 849.92	132	$ 14,023.64
Mid-level Scientist	$ 89.13	hour	16	$ 1,426.13		$ -	108	$ 9,626.41		$ -	8	$ 713.07	132	$ 11,765.61
Site Safety and Health Officer (FIELD)	$ 95.72	hour		$ -		$ -		$ -		$ -		$ -	0	$ -
Professional Labor Subtotal			**44**	**$ 4,742.86**	**0**	**$ -**	**279**	**$ 29,306.79**	**0**	**$ -**	**22**	**$ 2,371.43**	**345**	**$ 36,421.08**
Services														
Shipping (sample coolers and misc.)	$ 154.18	LS		$ -		$ -	1	$ 154.18		$ -			1	$ 154.18
Materials Subtotal			**0**	**$ -**	**0**	**$ -**	**1**	**$ 154.18**	**0**	**$ -**	**0**	**$ -**	**1**	**$ 154.18**
Supplies														
Field Supplies	$ 950.00	LS		$ -		$ -	1	$ 950.00		$ -			1	$ 950.00
Supplies Subtotal			**0**	**$ -**	**0**	**$ -**	**1**	**$ 950.00**	**0**	**$ -**	**0**	**$ -**	**1**	**$ 950.00**
Equipment														
Rentals	$ 3,846.33	LS		$ -		$ -	1	$ 3,846.33		$ -		$ -	1	$ 3,846.33
Equipment Subtotal			**0**	**$ -**	**0**	**$ -**	**1**	**$ 3,846.33**	**0**	**$ -**	**0**	**$ -**	**1**	**$ 3,846.33**
Subcontractor(s)/Vendors														
Laboratory Analysis - IDW	$ 1,066.53	LS		$ -		$ -	2	$ 2,133.06		$ -		$ -	2	$ 2,133.06
Drilling	$ 3,970.51	LS		$ -		$ -	1	$ 3,970.51		$ -		$ -	1	$ 3,970.51
55-Gallon Drum	$ 150.00	Each		$ -		$ -	15	$ 2,250.00		$ -		$ -	15	$ 2,250.00
Waste T&D	$ 75.00	Ton		$ -		$ -	5	$ 375.00		$ -		$ -	5	$ 375.00
Profile Fee	$ 75.00	LS		$ -		$ -	1	$ 75.00		$ -		$ -	1	$ 75.00
Subcontractor/Vendor Subtotal			**0**	**$ -**	**0**	**$ -**	**24**	**$ 8,803.58**	**0**	**$ -**	**0**	**$ -**	**25**	**$ 8,803.58**
Travel														
Airfare R/T to Grand Island, NE	$ 800.00	Each		$ -		$ -		$ -		$ -			0	$ -
Per Diem	$ 157.00	person/day		$ -		$ -	22.5	$ 3,532.50		$ -			22.5	$ 3,532.50
Hotel/Lodging	$ 150.00	person/day		$ -		$ -	22.5	$ 3,375.00		$ -			22.5	$ 3,375.00
Travel Subtotal			**0**	**$ -**	**0**	**$ -**	**45**	**$ 6,907.50**	**0**	**$ -**	**0**	**$ -**	**45**	**$ 6,907.50**
Task Totals				$ 4,742.86		$ -		$ 49,968.39		$ -		$ 2,371.43	$ 57,082.67	$ 57,082.67
Running Total by Task				$ 4,742.86		$ 4,742.86		$ 54,711.24		$ 54,711.24		$ 57,082.67	**GRAND TOTAL**	**$ 57,082.67**

Basis of Estimate:

1 All tasks require 2 hr/day for PM. Field days are 12 hours for personnel, with equipment run 10 hours.
2 Assumes 5 person field crew.
3 Assumes field crew can complete field activities in 5 days at a rate of 2 wells abandoned per day.
4 Assume wells would be abandoned during annual sampling event.
5 Mobilization/demobilization, and airfare costs are included in Task 4.
6 Assume two field trucks are needed for field transportation.
7 Costs shown are for CY2023. Costs are escalated on the summary page for activities completed in subsequent years.

Option 3 - GWTF O&M			Option 3.1		Option 3.2		Option 3.3		Option 3.4		Option 3.5			
			Pre-Mobilizations / Procurements		Mobilization		Site Activities		Demobilization		Post-Demobilization Activities		Total Units	Subtotal
Cornhusker Army Ammunition Plant - OU1 Alternative 3: MNA with LUCs and Subsurface Injections	**2023 Rate**	**Unit**	**Units**	**Cost**	**Units**	**Cost**	**Units**	**Cost**	**Units**	**Cost**	**Units**	**Cost**		
Professional Labor														
Project Manager	$ 150.42	hour		$ -		$ -		$ -		$ -		$ -	0	$ -
Mid-level Engineer	$ 106.24	hour		$ -		$ -		$ -		$ -		$ -	0	$ -
Mid-level Scientist	$ 89.13	hour		$ -		$ -		$ -		$ -		$ -	0	$ -
Site Safety and Health Officer (FIELD)	$ 95.72	hour		$ -		$ -		$ -		$ -		$ -	0	$ -
Professional Labor Subtotal			**0**	**$ -**	**0**	**$ -**	**0**	**$ -**	**0**	**$ -**	**0**	**$ -**	**0**	**$ -**
Services														
Shipping (sample coolers and misc.)	$ 4,011.96	LS		$ -		$ -		$ -		$ -			0	$ -
Materials Subtotal			**0**	**$ -**	**0**	**$ -**		**$ -**	**0**	**$ -**	**0**	**$ -**	**0**	**$ -**
Supplies														
Field Supplies	$ 6,833.82	LS		$ -		$ -		$ -		$ -			0	$ -
Supplies Subtotal			**0**	**$ -**	**0**	**$ -**	**0**	**$ -**	**0**	**$ -**	**0**	**$ -**	**0**	**$ -**
Equipment														
Rentals	$ 11,362.57	LS		$ -		$ -		$ -		$ -		$ -	0	$ -
Equipment Subtotal			**0**	**$ -**	**0**	**$ -**	**0**	**$ -**	**0**	**$ -**	**0**	**$ -**	**0**	**$ -**
Subcontractor(s)/Vendors														
GWTF Annual O&M (misc.)	$ 28,981.85	LS		$ -		$ -	1	$ 28,981.85		$ -		$ -	1	$ 28,981.85
Subcontractor/Vendor Subtotal			**0**	**$ -**	**0**	**$ -**	**1**	**$ 28,981.85**	**0**	**$ -**	**0**	**$ -**	**1**	**$ 28,981.85**
Travel														
Travel Subtotal			**0**	**$ -**	**0**	**$ -**	**0**	**$ -**	**0**	**$ -**	**0**	**$ -**	**0**	**$ -**
Task Totals				$ -		$ -		$ 28,981.85		$ -		$ -	$ 28,981.85	$ 28,981.85
Running Total by Task				$ -		$ -		$ 28,981.85		$ 28,981.85		$ 28,981.85	**GRAND TOTAL**	**$ 28,981.85**

Basis of Estimate:

1 Includes costs associated with GWTF operation and maintenance including, but not limited to: all labor and ODCs for monthly electricity bill; monthly inspection of pumps, motors, air compressor, air dryer, fire extinguisher, ladder and eye wash; pest management; office cleaning; water delivery; herbicides for weed control; mowing; small tools & supplies; and various building repairs.

Option 4 - Subsurface Injections			Option 4.1		Option 4.2		Option 4.3		Option 4.4		Option 4.5			
			Pre-Mobilizations / Procurements		Mobilization		Site Activities		Demobilization		Post-Demobilization Activities		Total Units	Subtotal
Cornhusker Army Ammunition Plant - OU1 Alternative 3: MNA with LUCs and Subsurface Injections	**2023 Rate**	**Unit**	**Units**	**Cost**	**Units**	**Cost**	**Units**	**Cost**	**Units**	**Cost**	**Units**	**Cost**		
Professional Labor														
Project Manager	$ 150.42	hour	20	$ 3,008.33	2	$ 300.83	60	$ 9,024.99	2	$ 300.83	4	$ 601.67	88	$ 13,236.65
Senior Scientist	$ 126.90	hour	80	$ 10,152.22	12	$ 1,522.83	460	$ 58,375.26	12	$ 1,522.83	40	$ 5,076.11	604	$ 76,649.25
Mid-level Engineer	$ 106.24	hour	120	$ 12,748.77	36	$ 3,824.63	1180	$ 125,362.86	36	$ 3,824.63	120	$ 12,748.77	1492	$ 158,509.65
Mid-level Scientist	$ 89.13	hour	80	$ 7,130.67	36	$ 3,208.80	1080	$ 96,264.08	72	$ 6,417.61	80	$ 7,130.67	1348	$ 120,151.84
Professional Labor Subtotal			**300**	**$ 33,039.99**	**86**	**$ 8,857.10**	**2780**	**$ 289,027.19**	**122**	**$ 12,065.90**	**244**	**$ 25,557.21**	**3532**	**$ 368,547.39**
Craft Labor														
Craft Labor Subtotal			**0**	**$ -**	**0**	**$ -**	**0**	**$ -**	**0**	**$ -**			**0**	**$ -**
Services														
Shipping (sample coolers and misc.)	$ 154.18	LS		$ -		$ -	1	$ 154.18		$ -		$ -	1	$ 154.18
Materials Subtotal			**0**	**$ -**	**0**	**$ -**	**1**	**$ 154.18**	**0**	**$ -**	**0**	**$ -**	**1**	**$ 154.18**
Supplies														
Field Supplies	$ 5,797.95	LS		$ -		$ -	1	$ 5,797.95		$ -		$ -	1	$ 5,797.95
Supplies Subtotal			**0**	**$ -**	**0**	**$ -**	**1**	**$ 5,797.95**	**0**	**$ -**	**0**	**$ -**	**1**	**$ 5,797.95**
Equipment														
Rentals	$ 19,231.66	LS		$ -		$ -	1	$ 19,231.66		$ -		$ -	1	$ 19,231.66
Equipment Subtotal			**0**	**$ -**	**0**	**$ -**	**1**	**$ 19,231.66**	**0**	**$ -**	**0**	**$ -**	**1**	**$ 19,231.66**
Subcontractor(s)/Vendors														
Laboratory Analysis - IDW	$ 1,066.53	LS		$ -		$ -	2	$ 2,133.06		$ -		$ -	2	$ 2,133.06
Drilling	$ 250,577.09	LS		$ -		$ -	1	$ 250,577.09		$ -		$ -	1	$ 250,577.09
55-Gallon Drum	$ 150.00	Each		$ -		$ -	100	$ 15,000.00		$ -		$ -	100	$ 15,000.00
Waste T&D	$ 75.00	Ton		$ -		$ -	25	$ 1,875.00		$ -		$ -	25	$ 1,875.00
Profile Fee	$ 75.00	LS		$ -		$ -	1	$ 75.00		$ -		$ -	1	$ 75.00
Wesblend	$ 109,586.60	LS		$ -		$ -	1	$ 109,586.60		$ -		$ -	1	$ 109,586.60
Water Truck	$ 50,961.31	LS		$ -		$ -	1	$ 50,961.31		$ -			1	$ 50,961.31
Subcontractor/Vendor Subtotal			**0**	**$ -**	**0**	**$ -**	**131**	**$ 430,208.06**	**0**	**$ -**	**0**	**$ -**	**131**	**$ 430,208.06**
Travel														
Airfare R/T to Grand Island, NE	$ 800.00	Each		$ -	6	$ 4,800.00		$ -		$ -		$ -	6	$ 4,800.00
Per Diem	$ 157.00	person/day		$ -	6	$ 942.00	200	$ 31,400.00	6	$ 942.00		$ -	212	$ 33,284.00
Hotel/Lodging	$ 150.00	person/day		$ -	6	$ 900.00	200	$ 30,000.00		$ -		$ -	206	$ 30,900.00
Travel Subtotal			**0**	**$ -**	**18**	**$ 6,642.00**	**400**	**$ 61,400.00**	**6**	**$ 942.00**	**0**	**$ -**	**424**	**$ 68,984.00**
Task Totals				$ 33,039.99		$ 15,499.10		$ 805,819.05		$ 13,007.90		$ 25,557.21	$ 892,923.25	$ 892,923.25
Running Total by Task				$ 33,039.99		$ 48,539.08		$ 854,358.13		$ 867,366.03		$ 892,923.25	**GRAND TOTAL**	**$ 892,923.25**

Basis of Estimate:

1 All tasks require 2 hr/day for PM. Field days are 12 hours for personnel, with equipment run 10 hours.
2 Includes 1 senior scientist and 5 mid-level engineers/geologists for duration of injection event.
3 Includes 80 hours of office preparation activities for senior and mid-scientist.
4 Assumes 3 direct push drill rigs/crews and 2 water trucks for each injection event.
5 Assumes field crew can complete field activities in 30 days at a rate of 20 per day.
6 Includes 10 x 10hr field days for senior and mid-scientist to complete GPS survey of all injection point locations.
7 Assume two field trucks are needed for field transportation.
8 Costs shown are for CY2023. Costs are escalated on the summary page for activities completed in subsequent years.

Option 5 - Performance Monitoring			Option 5.1		Option 5.2		Option 5.3		Option 5.4		Option 5.5			
			Pre-Mobilizations / Procurements		Mobilization		Site Activities		Demobilization		Post-Demobilization Activities		Total Units	Subtotal
Cornhusker Army Ammunition Plant - OU1 Alternative 3: MNA with LUCs and Subsurface Injections	**2023 Rate**	**Unit**	**Units**	**Cost**	**Units**	**Cost**	**Units**	**Cost**	**Units**	**Cost**	**Units**	**Cost**		
Professional Labor														
Project Manager	$ 150.42	hour	80	$ 12,033.32	8	$ 1,203.33	40	$ 6,016.66	8	$ 1,203.33	16	$ 2,406.66	152	$ 22,863.30
Senior Scientist	$ 126.90	hour	160	$ 20,304.44	48	$ 6,091.33	240	$ 30,456.66	48	$ 6,091.33	160	$ 20,304.44	656	$ 83,248.20
Mid-level Engineer	$ 106.24	hour	160	$ 16,998.35	48	$ 5,099.51	240	$ 25,497.53	48	$ 5,099.51	160	$ 16,998.35	656	$ 69,693.25
Mid-level Scientist	$ 89.13	hour	160	$ 14,261.35	48	$ 4,278.40	240	$ 21,392.02	48	$ 4,278.40	160	$ 14,261.35	656	$ 58,471.52
Senior Scientist (Chemist)	$ 126.90	hour	32	$ 4,060.89		$ -		$ -		$ -	160	$ 20,304.44	192	$ 24,365.33
Professional Labor Subtotal			**592**	**$ 67,658.34**	**152**	**$ 16,672.57**	**760**	**$ 83,362.86**	**152**	**$ 16,672.57**	**656**	**$ 74,275.24**	**2312**	**$ 258,641.59**
Craft Labor														
Craft Labor Subtotal			**0**	**$ -**	**0**	**$ -**	**0**	**$ -**	**0**	**$ -**		**$ -**	**0**	**$ -**
Services														
Shipping (sample coolers and misc.)	$ 4,164.11	LS		$ -		$ -	1	$ 4,164.11		$ -		$ -	1	$ 4,164.11
Materials Subtotal			**0**	**$ -**	**0**	**$ -**	**1**	**$ 4,164.11**	**0**	**$ -**	**0**	**$ -**	**1**	**$ 4,164.11**
Supplies														
Field Supplies	$ 8,968.49	LS		$ -		$ -	1	$ 8,968.49		$ -		$ -	1	$ 8,968.49
Supplies Subtotal			**0**	**$ -**	**0**	**$ -**	**1**	**$ 8,968.49**	**0**	**$ -**	**0**	**$ -**	**1**	**$ 8,968.49**
Equipment														
Rentals	$ 11,954.94	LS		$ -		$ -	1	$ 11,954.94		$ -		$ -	1	$ 11,954.94
Equipment Subtotal			**0**	**$ -**	**0**	**$ -**	**1**	**$ 11,954.94**	**0**	**$ -**	**0**	**$ -**	**1**	**$ 11,954.94**
Other Direct Costs														
Other Direct Costs Subtotal			**0**	**$ -**	**0**	**$ -**	**1**	**$ -**	**0**	**$ -**	**0**		**0**	**$ -**
Subcontractor(s)/Vendors														
Laboratory Analysis	$ 7,192.14	LS		$ -		$ -	4	$ 28,768.55		$ -		$ -	4	$ 28,768.55
Laboratory Analysis - IDW	$ 2,133.06	LS		$ -		$ -	4	$ 8,532.26		$ -		$ -	4	$ 8,532.26
Drilling	$ 11,042.09	LS		$ -		$ -	4	$ 44,168.34		$ -		$ -	4	$ 44,168.34
55-Gallon Drum	$ 150.00	Each		$ -		$ -	20	$ 3,000.00		$ -		$ -	20	$ 3,000.00
Waste T&D	$ 75.00	Ton		$ -		$ -	10	$ 750.00		$ -		$ -	10	$ 750.00
Profile Fee	$ 75.00	LS		$ -		$ -	1	$ 75.00		$ -		$ -	1	$ 75.00
Subcontractor/Vendor Subtotal			**0**	**$ -**	**0**	**$ -**	**43**	**$ 85,294.14**	**0**	**$ -**	**0**	**$ -**	**43**	**$ 85,294.14**
Travel														
Airfare R/T to Grand Island, NE	$ 800.00	Each		$ -	12	$ 9,600.00		$ -		$ -		$ -	12	$ 9,600.00
Per Diem	$ 157.00	person/day		$ -	12	$ 1,884.00	84	$ 13,188.00	12	$ 1,884.00		$ -	108	$ 16,956.00
Hotel/Lodging	$ 150.00	person/day		$ -	12	$ 1,800.00	84	$ 12,600.00		$ -		$ -	96	$ 14,400.00
Travel Subtotal			**0**	**$ -**	**36**	**$ 13,284.00**	**168**	**$ 25,788.00**	**12**	**$ 1,884.00**	**0**	**$ -**	**216**	**$ 40,956.00**
Task Totals				$ 67,658.34		$ 29,956.57		$ 219,532.55		$ 18,556.57		$ 74,275.24	$ 409,979.28	$ 409,979.28
Running Total by Task				$ 67,658.34		$ 97,614.91		$ 317,147.47		$ 335,704.04		$ 409,979.28	**GRAND TOTAL**	**$ 409,979.28**

Basis of Estimate:

1 All tasks require 2 hr/day for PM. Field days are 12 hours for personnel, with equipment run 10 hours.
2 Total cost includes 4 sampling events: 1 pre-injection event and 3 quarterly post-injection events.
3 Includes 1 senior scientist and 2 mid-level engineers/geologists for duration of performance monitoring event.
5 Includes 8 hours of laboratory coordination and 40 hours for data validation for senior chemist for each event.
6 Assumes field crew can complete field activities in 5 days at a rate of 4 per day plus two days for mobilization/demobilization.
7 Assume one field truck is needed for field transportation.
8 Costs shown are for CY2023. Costs are escalated on the summary page for activities completed in subsequent years.