TECHNICAL MEMORANDUM

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Contract No:	W9128F-18-D-0020, DO F0041
Subject:	CHAAP OU1 2018 Groundwater Monitoring Results and Program Recommendations
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Attachments:	1: Figures | 2: Tables

Introduction

Brice Engineering, LLC (Brice) and AECOM Technical Services, Inc. (AECOM) have prepared this Technical Memorandum (Memo) for the United States Army Corps of Engineers (USACE) under Contract W9128F-18-D-0020, Delivery Order (DO) F0041 for Remedial Action - Operation (RA-O) at the Cornhusker Army Ammunition Plant (CHAAP) located in Grand Island, Nebraska (**Figure 1**).

The RA-O at CHAAP includes long-term operation of the Groundwater Treatment Facility (GWTF) (shown on **Figure 2**) at Operable Unit (OU) 1 and long-term groundwater monitoring at OU1 and OU3. OU1 consists of explosives-contaminated groundwater plumes (on-site and formerly off-post) at CHAAP, and OU3 consists of the Shop Area 1,1,2-Trichloroethane (TCA) plume.

Groundwater monitoring results presented in the *2016 Annual Groundwater Monitoring and Subsurface Injection Report* (BW-URS 2017) and the *Draft Final 2017 Annual Groundwater Monitoring Report* (Trevet 2018) indicate that concentrations of 2,4,6-trinitrotoluene (TNT) and cyclotrimethylenetrinitramine (RDX), also known as cyclonite, between extraction well (EW) 6 and EW7 are declining based on comparison to historical concentrations over the past 22 years. Additionally, numerical groundwater modeling predictions with EW7 not pumping show no off-post plume migration. Therefore, temporary discontinuation of EW7 operations is being considered as early as spring of 2019 to accelerate OU1 remediation through subsurface injections focused in those isolated source areas that remain.

This Memo reviews the CHAAP OU1 remedial action objectives, goals, and operations; discusses the status of explosives concentrations in groundwater (including presentation of the 2018 groundwater analytical results and statistical trend analysis); and reviews the updated groundwater modeling predictions. Based on the current results and modeling predictions, this Memo also presents proposed RA-O program modifications through the completion of a rebound study to include ‘temporary’ discontinuation of EW7 and GWTF and initiation of a series of on-site subsurface injection events to expedite OU1 remediation and reduce cleanup timeframes while continuing to meet cleanup objectives and goals.

This Memo focuses on the status of plume concentrations in the area affected by the ‘temporary’ shutdown of EW7 and those actions proposed during the rebound study for OU1. OU3 is not discussed in this Memo.

CHAAP OU1 Remedial Action Objectives and Cleanup Goals

The remedial action objectives for CHAAP groundwater which apply to OU1 are:

- Protecting human health and the environment,
- Cleaning up groundwater to below established health advisory levels (HALs), and
- Containing high concentrations of explosives in groundwater on-post.

HALs are established cleanup goals for explosives at CHAAP per the *OU1 Record of Decision* (ROD) (USACE 1994) and the subsequent *OU1 ROD Amendment* (URSGWCFS 2001a). Per the *CHAAP OU1 ROD and OU1 ROD Amendment*, RDX, TNT, and octahydro-1,3,5,7-tetranitro-1,3,5,7-tetrazocine (HMX) were selected for the OU1 chemicals of concern because of their historical use, frequency of occurrence, and magnitude of detected concentrations. The nature and extent discussions generally focus on contaminant concentrations above the OU1 HALs, listed as follows:

- 2 micrograms per liter (µg/L) for RDX and TNT, and
- 400 µg/L for HMX.

The explosives compound HMX has not been detected above 400 µg/L in any groundwater monitoring sampling event; therefore, RDX and TNT are the focus of discussion.

OU1 RA-O Background Information

The RA-O of OU1 as established in the *CHAAP OU1 ROD* and the *OU1 ROD Amendment* include monitored natural attenuation (MNA) for the off-post plume, institutional controls (ICs) to limit public exposure to contaminated groundwater both on-site (in the form of deed restrictions) and off-post (in the form of a city ordinance), and groundwater extraction and treatment for the on-site plume. A long-term monitoring (LTM) program was established in 1996 to annually monitor and identify explosives plume migration trends in both off- and on-post monitoring well locations, and also to identify natural attenuation trends for the off-post explosives plume.

Since its beginning, the OU1 LTM program has evolved from well coverages of explosives plumes originating on-site (at primary source areas at Load Line (LL)1 and LL2) and expanding nearly 5 miles downgradient to off-post locations located in the City of Grand Island (plume distal end). Based on historic data presented in the *Remedial Investigation Report* (ICFKE 1996), OU1 maximum explosives concentrations on-site/off-post were: 860 µg/L / 28 µg/L RDX, 5,700 µg/L / 23 µg/L TNT, and 215 µg/L / 9.5 µg/L HMX, respectively.

Hydraulic containment of the on-post plume from EW7 operation and natural attenuation of the plume off-post has resulted in declining RDX concentrations (with only nominal fluctuation) at OU1 off-post monitoring wells from 1994 to present. Since EW7 operation, the once continuous OU1 explosives plume spanning off-post has reduced in size and has formed discontinuities along its axis due to natural attenuation. Since 2014, all off-post wells have been identified as being below HALs.

The most recent OU1 LTM sampling data (March 2018), indicated OU1 maximum explosives concentrations on-site/off-post were: 19 µg/L / 0.86 µg/L RDX, 20 µg/L / 0.34 µg/L TNT, and 34 µg/L / 0.79 µg/L HMX, respectively. MNA has proven effective as attenuation processes are occurring at a rate sufficient to protect human health and the environment.

ICs are also in effect at OU1 for both off-post and on-post areas to protect human health and the environment until contaminant concentrations throughout the plume areas are at or below the cleanup levels.

OU1 off-post groundwater ICs include:

- City ordinance to prevent drilling of drinking water supply wells in the explosive plume;
- Water supply established for residents in the plume area; and
- Hazard communication to the media to present updated annual results.

OU1 on-post groundwater ICs include:

- Deed restrictions, including prohibiting drilling of a drinking water supply well, restrictive covenants that prohibit residential use of the property, and right-of-entry restrictions;
- Hall County Zoning Plan which designates the property for agricultural, recreational, and industrial zoning; and
- Prohibiting the drilling of any well within 2,500 feet of the plume area.

The groundwater extraction and treatment system implemented as a remedial action for OU1 has evolved over its lifecycle. The GWTF was constructed in 1998 and initially included extraction wells EW1 through EW6, each pumping approximately 750 gallons per minute (gpm). In 2000, EW7 was installed and pumping of EW1, EW2, and EW3 was discontinued due to non-detection of explosive compounds and reduction in plume area.

The OU1 RA-O subsurface injection program began in the spring of 2007 with the most recent injections occurring in 2016. The injections were voluntarily implemented to expedite the remediation process by enhancing anaerobic in situ bioremediation processes and co-metabolically degrading TNT and RDX at the primary source areas near EW1, EW4, EW5, and EW6. The injections were added to decrease the overall site remediation timeframe by supplementing the current groundwater pump and treat system at the LL1 and LL2 primary source areas, near extraction wells EW5 and EW6. LL1 and LL2 are located at previous melt/pour facilities (Building 10) and previously excavated explosives wastewater cesspools (PEEWCs). Historic subsurface injection activities at LL1 and LL2 focused on the source areas with high explosives concentrations (greater than [>] 200 µg/L RDX and/or TNT), found in the shallow water table northeast of Building 10 and at the PEEWCs. Several primary source areas have been remediated or their effects on shallow groundwater significantly reduced as a result of the program (2007 to 2016).

Some source areas where injections occurred have shown some rebound of concentrations due to recent increases in the water level elevations (2007 to present) which have resulted in residual sources previously in the vadose zone encountering groundwater, causing dissolution and desorption of explosives (BW-URS 2015). This interpretation is further supported by information presented in the *Final Remedial Investigation/Feasibility Study* (ICF KE 1996), which indicates that former cesspools were excavated in these areas but that, many excavations were terminated at the water table (10 to 15 feet below ground surface [bgs]), and remediation action levels for soil were not achieved at the vertical limits of the excavations.

Due to the success of the injections, pumping was reduced and eventually discontinued at EW4, EW5, and EW6 to allow additional source treatment via subsurface injection. Although pumping at EW1 through EW6 was discontinued, pumping has continued in EW7. The extraction wells are shown on **Figure 2**.

EW7 has continued to operate and successfully maintain hydraulic control, preventing migration of the remaining groundwater explosives plume beyond the CHAAP former facility boundary. EW7 pumping originally operated at 500 gpm from July 2007 until November 2015, when it was reduced to 450 gpm. EW7 pumping was further reduced to 300 gpm in November 2017, based on groundwater modeling results that demonstrated hydraulic control of explosives plume around EW7 would still be maintained at the 300 gpm pumping rate. These groundwater modeling results and recommendations were included in the *Final 2016 Annual Groundwater Monitoring and Subsurface Injection Report* (BW-URS 2017).

For the OU1 RA-O at the GWTF, the groundwater collection/extraction/treatment system is operated and maintained in accordance with the *Groundwater Recovery and Treatment System Operation and Maintenance Manual, Revision 00* (Bay West 2017). GWTF samples have been historically collected from operational extraction wells, granular activated carbon (GAC) treatment system influent, lead GAC vessel effluent, lag GAC vessel effluent, and GWTF effluent. Sampling is performed to assess overall GWTF performance and verify that concentrations of explosives compounds in GWTF effluent were in conformance with State of Nebraska requirements for discharge into Silver Creek. Per these requirements, EW7 is currently sampled quarterly for various compounds in accordance with the *2014 Final UFP-QAPP* (BW-URS 2015). Historic EW7 effluent explosives sample results have shown a steady decrease in both RDX and TNT concentrations since EW7s operation began in early 2000. Maximum historic EW7 influent explosives concentrations detected for EW7 are RDX = 58 µg/L and TNT = 156 µg/L, in August 2000 and June 2001, respectively. Most recent EW7 influent RDX and TNT concentrations are RDX = 0.54 µg/L and TNT = 7 µg/L, collected in April 2018. RDX concentrations at EW7 effluent fell below its HAL in March 2013 and has remained so since that time.

OU1 Groundwater Monitoring

OU1 Groundwater Levels

OU1 water level elevations have continued to increase as observed in 2017. Water level elevations increased approximately 1 to 2 feet at on-post and off-post wells from March 2017 to March 2018; with exception to select wells proximal to EW7 (i.e., G0024, G0077, G0078, PZ017R, and the three observation wells surrounding EW7). These wells showed over a 2-foot increase in water level elevations, likely due to EW7 pumping rate being reduced in November 2017 (from 450 gpm to 300 gpm).

Trends in groundwater elevations are presented on **Figure 3**, which show groundwater elevations of two groups of monitoring wells from March 2000 to March 2018. The first group of monitoring wells was selected from shallow on-post G00 wells and on-post piezometers that are in line with the groundwater flow direction spanning the on-post area (from G0044 to G0024). The second group of monitoring wells selected is from the off-post area and include shallow NW monitoring wells (except well cluster NW080) and shallow CA monitoring wells (except well cluster CA210). Annual water level measurements have shown decreasing water level elevations from March 2000 through March 2005 followed by increasing water levels from March 2006 to March 2011 during higher seasonal precipitation. Water levels from March 2012 to August 2014 decreased due to a period of lower precipitation. Since 2014, groundwater levels at wells have either stabilized or slightly increased (**Figure 3**).

Direct Push Groundwater Investigation (March 2018)

Direct Push Groundwater Investigation Sampling Activities (March 2018)

As recommended during the 2017 Stakeholders meeting, 14 direct push locations were completed between March 5 and March 7, 2018. The purpose of the direct push groundwater investigation sampling was to collect screening data from select OU1 on-post locations with existing 'data gaps'. Data gaps included areas where 2016 pre-injection groundwater investigation sampling was completed (February 2016) and were addressed during subsurface injection activities (April 2016); however, no post-injection groundwater sampling was completed to evaluate injection performance in these areas (BW-URS 2017). Additionally, several areas between EW6 and EW7 have existing data gaps (older/limited direct push sampling locations) where updated interpretation of explosives concentrations will benefit and further direct future CHAAP activities (i.e., improved contaminant fate and transport modeling accuracy, monitoring well installation recommendations, subsurface injection recommendations, etc.).

In accordance with standard operating procedures provided in the *Draft Final Addendum 2, UFP-QAPP* (BNG-AECOM 2018) and *Final UFP-QAPP* (BW-URS 2014), 20 direct push samples were collected from 14 locations within LL1, LL2, and between EW6 and EW7 (see **Figure 4**). Samples were collected from one depth at sample locations LL1-DP147 and LL1-DP148, LL2-DP118 through LL2-DP121, and EW7-DP49 through EW7-DP53; and were collected at multiple depths at sample locations EW7-DP46 through EW7-DP48.

Direct Push Groundwater Investigation Sampling Results (March 2018)

Table 1 summarizes the explosives compounds detected in groundwater at the 2018 OU1 direct push groundwater investigation locations. The primary explosives compounds detected in groundwater collected from sample collection were RDX, HMX, and TNT (all with established HALs). Additionally, the explosives breakdown products 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), and MNX were detected.

The 2018 groundwater explosives plumes between EW6 and EW7 consisted primarily of RDX and TNT. The 2018 direct push groundwater investigation sampling results for RDX and/or TNT concentrations between EW6 and EW7 (8 sample locations), LL1 (2 sample locations), and LL2 (4 sample locations) were used to interpret the nature and extent of the RDX and TNT plumes (see **Figure 4**). Based on the 2018 OU1 direct push groundwater investigation sample results, 'data gaps' were addressed and the OU1 explosives plume extents between EW6 and EW7, at LL1, and at LL2 were refined.

Between EW6 and EW7, sample results from locations EW7-DP46 through EW7-DP49 (near EW7 and slightly upgradient) showed TNT concentrations >2 µg/L at shallow (approximately 25 feet bgs) and shallow-intermediate (approximately 35 feet bgs) depths. The maximum TNT concentration of 87 µg/L was detected at EW7-DP48-25. This maximum concentration was an increase to previously completed direct push groundwater investigation sample result collected at same location in February 2016 (TNT = 25 µg/L at EW7-DP40-35). RDX concentrations >2 µg/L were only detected at shallow depths (RDX maximum concentration of 2.2 µg/L at EW7-DP48-25). Farther upgradient between EW6 and EW7, direct push groundwater investigation locations EW7-DP50 through EW7-DP53 verified concentrations were below HALs at these locations. Overall, the 2018 TNT plume extent (>2 µg/L and >20 µg/L) and 2018 RDX plume extent (>2 µg/L) were similar to previous years plume interpretations based on direct push investigations between EW6 and EW7. However, minor changes were made to the TNT plume upgradient from EW7 to include a higher concentration than interpreted in 2016/2017, and the interpreted horizontal extent of RDX increased upgradient of the EW7, compared to interpretations in 2016/2017.

At LL1, 2018 sample results from locations LL1-DP147 and LL1-DP148 (eastern plume at LL1) verified the TNT plume (which was addressed with injections in 2016) is no longer present. This TNT plume interpreted in 2016 will be removed as all 2018 direct push groundwater investigation sample results were below all HALs.

At LL2, 2018 sample results from locations LL2-DP118 and LL2-DP119 (northern plume at LL2) verified the TNT plume (which was addressed with injections in 2016) is below its HAL and no longer present; however, the interpreted 2016 RDX plume (also addressed with injections in 2016) still remains (>2 µg/L) and has increased in concentration (RDX maximum concentration of 76 µg/L at LL2-DP119-25). This RDX maximum concentration was an increase to a previously completed direct push groundwater investigation sample result collected at the same location in February 2016 (RDX = 17 µg/L at LL2-DP114-25). At LL2-DP120 (central portion of plume at LL2) sample results verified RDX and TNT plumes (which were addressed with injections in 2016) are below HALs and are no longer present at this location. At LL2-DP121 (south portion of plume at LL2), the interpreted 2016 RDX plume remains (>2 µg/L) but has increased in concentration (2018 RDX concentration of 41 µg/L). This concentration was an increase to previously completed direct push groundwater investigation sample result collected at same location in February 2016 (RDX = 23 µg/L at LL2-DP117-25).

Direct Push Groundwater Sampling Summary

Between EW6 and EW7, the 2018 direct push groundwater investigation sample results have refined data gaps both horizontally and vertically at specific locations. Select areas had increases in concentrations near EW7 and areas farther upgradient continue to be less than the HALs. At LL1, the direct push sample results confirmed successful 2016 surface injection activities and verified none of the direct push samples at LL1 detected TNT above its HAL.

At LL2, the TNT plume (>2 µg/L) is no longer present based on results of the 2018 direct push sampling. The extent of the 2018 RDX plume (>2 µg/L) was similar to previous years plume extent based on direct push investigation sampling in 2016. RDX plumes remain at locations LL2-DP118, LL2-DP119, and LL2-DP121 with slightly increased RDX concentrations. It should be noted that direct push locations showing RDX increases in 2018 previously had limited injections prior to the 2016 injection event. These areas where limited injections have occurred are showing higher concentrations due to amendment consumption and diminished reducing conditions.

OU1 Annual Groundwater Sampling Event (March 2018)

OU1 Annual Groundwater Sampling Activities (March 2018)

As part of the CHAAP OU1/OU3 Long-term Monitoring (LTM) Program, the OU1 annual groundwater sampling event was conducted between March 12 and March 24, 2018 and included completion of a site-wide water level measurement round and sampling of 58 on-post monitoring wells, 16 on-post piezometers, and 19 off-post monitoring wells.

OU1 groundwater samples were analyzed for explosives at on- and off-post wells and laboratory MNA parameters at on-post wells only. MNA parameters included: alkalinity (Method 2320B), ammonia (Method 350.1), nitrate/nitrite (Method 353.2), sulfate (Method 300.1), sulfide (Method 4500S-2F), total Kjeldahl nitrogen (TKN) (Method 351.2), dissolved organic carbon (DOC) (Method 5310B), carbon dioxide (back calculated Method 2320B), and methane (Method RSK 175). Beginning in 2016, MNA parameters were not collected at off-post monitoring wells due to explosives concentrations being below HALs since 2014 at all off-post wells.

OU1 Annual Groundwater Sampling Results (March 2018)

Table 2 summarizes the explosives compounds detected in groundwater at the OU1 on-post and off-post wells from the 2018 annual sampling event, respectively. All OU1 off-post wells sampled during the 2018 OU1 annual sampling event continued to have explosive concentrations below HALs (from 2014 through 2018), therefore, only the on-post wells are further included and discussed.

The primary explosives compounds detected in groundwater at OU1 on-post wells in 2018 were RDX, HMX, and TNT (all with established HALs). Additionally, the explosives breakdown products 1,3,5-trinitrobenzene, 2,4-dinitrotoluene, 2,6-dinitrotoluene, 2-Am-DNT, 4-Am-DNT, and MNX were detected.

At OU1 on-post locations, declining explosives concentration trends and RDX and TNT breakdown products being present indicate that explosives degradation is occurring. OU1 on-post explosives concentrations show a continued declining trend due to previous on-post actions (i.e., soil removal, groundwater extraction, and subsurface injection) accounting for a majority of the overall mass reduction in groundwater. On-post, only at LL1 and LL2 residual source areas, and the area between EW6 and EW7 have explosives concentrations in groundwater above HALs; therefore, this section describes the 2018 nature and extent for those areas.

Between EW6 and EW7 (March 2018)

The 2018 groundwater explosives plumes between EW6 and EW7 consist primarily of RDX and TNT. The March 2018 groundwater sampling results for RDX and/or TNT concentrations between EW6 and EW7 were used to interpret the nature and extent of the RDX and TNT plumes and are shown on **Figure 4**.

Eighteen monitoring wells and four piezometers were sampled in March 2018 at the area between EW6 and EW7. Of the 18 wells and four piezometers, only three wells and three piezometers had explosives concentrations above the HALs for RDX and/or TNT. Decreases in explosives concentrations (RDX and/or TNT) were observed in most monitoring wells and piezometers sampled in March 2018 between EW6 and EW7 (17 of 18 wells and 3 of 4 piezometers showed declines in RDX and/or TNT concentrations, of which, four total declined to below HALs). Monitoring wells G0075 and G0080 had increases in RDX concentrations but remained below HALs (from 0.16 µg/L and 0.23 µg/L in March 2017 to 0.25 µg/L and 0.28 µg/L in March 2018, respectively). At piezometer PZ020, TNT increased slightly from March 2017 to March 2018 (5.0 µg/L to 5.9 µg/L, respectively).

During the March 2018 annual sampling event, the highest concentrations of RDX and TNT detected between EW6 and EW7 was 2.1 µg/L for RDX at G0089 (located approximately 2,300 feet upgradient of EW7) and 20 µg/L for TNT at PZ017R (adjacent to EW7). These 2018 maximum concentrations were lower than the 2017 maximum concentrations of 5.6 µg/L for RDX at G0090 (approximately 2,600 feet upgradient of EW7) and 24 µg/L for TNT at PZ017R (adjacent to EW7).

Load Line 1 (March 2018)

The 2018 groundwater explosives plumes at LL1 (including residual source areas) consisted primarily of RDX and TNT. The March 2018 groundwater sampling results for RDX and/or TNT concentrations at LL1 were used to interpret the nature and extent of the RDX and TNT plumes and are shown on **Figure 4**.

Eighteen monitoring wells and two piezometers were sampled in March 2018 at LL1. Of the 18 wells and two piezometers, only three wells had explosives concentrations above the HALs for RDX and/or TNT. Decreases in explosives concentrations (RDX and/or TNT) were observed in most monitoring wells and piezometers sampled in March 2018 at LL1 (17 of 18 wells and 1 of 2 piezometers showed declines in RDX and/or TNT concentrations or remained nondetect, of which, three total declined to below HALs). Monitoring well G0099 had a slight increase in RDX concentration but remained below HALs (from 1.3 J µg/L in March 2017 to 1.7 µg/L in March 2018, respectively). At piezometer PZ016, RDX increased slightly from March 2017 to March 2018, but also remained below its HAL (0.84 µg/L to 0.85 µg/L, respectively).

During the March 2018 annual sampling event, the highest concentrations of RDX and TNT detected at LL1 were 19 µg/L for RDX at G0096 and 5.5 µg/L for TNT at G0093. The 2018 maximum concentration for RDX was lower than the 2017 maximum concentration of 59 µg/L for RDX at G0094; however, the 2018 maximum concentration for TNT was slightly higher than the 2017 maximum concentration of 4.8 µg/L for TNT at G0093.

Rebounding Effects at LL1

Overall at LL1, explosives concentrations have been significantly reduced due to the subsurface injection program (2007 to 2016). However, select wells located in the residual source areas of LL1 and treated with injections prior to 2014 (i.e., wells G0094, and G0096) showed rebounding RDX concentrations during the annual sampling events of August 2016 and March 2017. These rebounding RDX concentrations were a result of rising water levels (2014 to 2016) in areas of limited/older subsurface injection activities, which have caused dissolution and desorption of explosives trapped in the vadose zone during periods of lower water levels (2012 to 2014).

Although RDX concentrations increased above the HAL in 2016 and 2017 at wells G0094 and G0096, RDX concentrations at these wells decreased significantly in 2018, even during the continued trend of increasing water levels (2014 to 2018). Additionally, the 2018 RDX concentrations at these wells are significantly lower compared to RDX concentrations prior to subsurface injection treatments (2014 and prior). RDX concentrations at these wells prior to injection treatments were as follows: G0094 – 2,300 µg/L, G0096 – 230 µg/L; and RDX concentrations in 2018 were as follows: G0094 – 16 µg/L, G0096 – 19 µg/L.

Load Line 2 (March 2018)

The 2018 groundwater explosives plumes at LL2 (including residual source areas) consisted primarily of RDX and TNT. The March 2018 groundwater sampling results for RDX and TNT concentrations at LL2 were used to interpret the nature and extent of the RDX and TNT plumes and are shown on **Figure 4**.

Twelve monitoring wells and six piezometers were sampled in March 2018 at LL2. None of the 12 wells and 6 piezometers had explosives concentrations above the HALs for RDX and/or TNT. Decreases in explosives concentrations (RDX and/or TNT) were observed in most monitoring wells and piezometers sampled in March 2018 at LL2 (11 of 12 wells and 5 of 6 piezometers showed declines in RDX and/or TNT concentrations or remained nondetect, of which, one well declined to below HALs). Monitoring well G0111 had a slight increase in RDX and TNT concentrations but remained below both HALs (from 0.093 J µg/L and nondetect in March 2017 to 0.48 J µg/L and 0.063 J µg/L in March 2018, respectively). At piezometer PZ013, RDX increased slightly from March 2017 to March 2018, but also remained below its HAL (0.045 J µg/L to 0.28 µg/L, respectively).

During the March 2018 annual sampling event, the highest concentrations of RDX and TNT detected at LL2 were 1.7 µg/L for RDX at G0121 and 0.77 µg/L for TNT at PZ009. These 2018 maximum concentrations for RDX were lower than the 2017 maximum concentrations of 5.7 J µg/L for RDX and 2.8 J µg/L for TNT, both at G0121 in LL2.

Rebounding Effects at LL2

At LL2 (similar to LL1), explosives concentrations have been significantly reduced due to the completion of the subsurface injection program (from 2007 to 2016). Following the 2016 subsurface injection event, no monitoring wells or piezometers (located in the residual source areas of LL2 or downgradient) have shown rebound due to rising water levels (2014 to 2018). However, in contrast and as discussed above (Direct Push Groundwater Investigation Sampling Results [March 2018]), select LL2 locations where 2016 direct push groundwater investigation sampling and subsurface injection events occurred have shown increases in RDX concentrations in 2018. At these areas in LL2, it is interpreted that due to recent rising water levels (2014 to 2018), dissolution and desorption of explosives trapped in the vadose zone during periods of lower water levels (i.e., 2012 to 2014) has occurred.

2018 Statistical Trends

Following the March 2018 sampling events, evaluations of explosives concentration trends were completed for select on- and off-post monitoring wells and piezometers. Historical OU1 LTM Program explosives data (from approximately the beginning of OU1 LTM program to present, dependent upon wells construction dates) were utilized for the trend evaluation. The purpose of this Memo is to provide data to substantiate the temporary shutdown of EW7, so the focus of the statistical trend evaluation included OU1 LTM wells proximal to EW7 near former facility boundary, and OU1 LTM wells upgradient (between EW6 and EW7).

RDX and TNT results for two sets of wells (Former Facility Boundary shown on **Figure 5** and Upgradient Wells shown on **Figure 6**) were evaluated using Mann-Kendall to assess the potential for future concentration increases. The Mann-Kendall statistic measures the trend in the data over time and is utilized in the analysis of groundwater plume stability.

Data for the Mann-Kendall analysis for wells at the former facility boundary (near operating EW7) were collected from nine monitoring wells and piezometers, including EW7. The Mann-Kendall analysis yielded the following results for TNT and RDX:

- TNT – decreasing (D) at all wells
- RDX – decreasing (D) at all wells except G0091 (stable [S])

Data for the Mann-Kendal analysis for upgradient wells were collected from seven monitoring wells. The Mann-Kendall analysis yielded the following results for TNT and RDX:

- TNT – decreasing (D) or not detected (ND) at all wells
- RDX – decreasing (D) or probably decreasing (PD) at all wells except G0087 (no trend [NT])

The trend analysis results for these two sets of wells indicate that no statistically-significant increases in TNT or RDX concentrations are expected.

2018 Numerical Groundwater Modeling

Historic use of numerical groundwater modeling has been utilized at CHAAP for simulating contaminant transport under remediation systems in place. Based on the *2001 Final Groundwater Flow and Contaminant Fate and Transport Modeling Report* (URSGWCFS 2001b) and presented in the *OU1 ROD Amendment*, model-predicted remediation timeframes for the off-post area (including feedlot adjacent to former facility boundary) was to occur between 11 to 19 years. The remediation timeframe is based on the selected alternative that is currently in place (i.e., utilizing an optimized on-post extraction including EW7 and off-post MNA). As previously mentioned, off-post explosives concentrations have been below HALs since 2014, approximately 14 years following the initial predicted timeframe.

Groundwater flow and contaminant fate and transport modeling is conducted annually and optimized based on updates to current conditions (i.e., input of current water level measurements, extraction well pumping rates, current sampling data, injection treatment effects, contaminant degradation half-life evaluations, etc.). The historic accuracy and continual optimization of model process verifies a high level of confidence for the groundwater flow and contaminant fate and transport modeling and its predicted remediation timeframes.

The initial groundwater flow model was developed using MODFLOW and utilized MODPATH, the USGS advective particle tracking model, to predict extraction well capture zones. The current remedial system was optimized for maximum containment of the on-post explosives plume using the groundwater flow model. The groundwater flow model was also used in conjunction with MT3DMS, a numerical contaminant fate and transport model (Zheng and Wang 1999), to simulate baseline contaminant (e.g., RDX and TNT) transport and transport under remedial injection conditions.

Despite there being no subsurface injections during 2017 and 2018, the remains of 2016 injections were left in the 2018 model to show their continued (but reduced) degradation effects. For the purposes of the groundwater flow model calibration, LL1 and LL2 are grouped with the area between EW6 and EW7 and are collectively referred to as the OU1 RA-O on-post area. However, in the contaminant fate and transport section, the load lines are evaluated separately from the rest of the on-post area to determine the amount of mass reduction in the OU1 RA-O Load Line Treatment Areas as a result of previous subsurface injection activities.

The groundwater flow model was recalibrated using the March 2018 site-wide water level measurements. The recalibrated flow model was used to predict the extraction well 25-year time-of-travel capture zones and to verify that EW7 was maintaining hydraulic containment and plume capture. In 2017, the CHAAP recalibrated groundwater flow model was used to prepare multiple capture zones using various pumping rates at EW7. A comparison between these capture zones and the March 2017 horizontal extent of RDX and TNT >2 µg/L verified that a pumping rate minimum of 300 gpm would provide adequate capture of plumes at LL1 and the near EW7, while allowing upgradient explosives concentrations at LL2 (addressed during 2016 subsurface injection activities) to naturally attenuate. In November 2017, the EW7 flow rate was reduced to 300 gpm. The reduction in the EW7 pumping rate from 450 gpm to 300 gpm was based on groundwater modeling results that demonstrated hydraulic control of plumes east of LL2. While 2018 modeling results suggest a RDX plume associated with LL2 is unlikely to be captured at the 300 gpm pumping rate, modeling results also show that RDX concentrations at LL2 will be reduced to below its HAL (2 µg/L) via natural attenuation processes long before the groundwater reaches the off-post boundary.

Following the groundwater flow model recalibration, the model was used in conjunction with MT3DMS to estimate RDX and TNT mass in the OU1 RA-O Load Line Treatment Area and in the on-post explosives plume between EW6 and EW7. Performance of the remaining effects from subsurface injection activities and reduction of explosives concentrations between EW6 and EW7 was evaluated by calculating percent RDX and TNT mass reduction between the 2017 and 2018 groundwater monitoring events.

2017 and 2018 Mass Comparisons

The March 2017 to March 2018 explosives mass estimations and percent reduction for the OU1 RA-O Load Line Treatment Areas, the area between EW6 and EW7, and the total area are provided in **Table 3**. Representative estimates of the explosives mass in the OU1 RA-O Load Line Treatment Area at the time of March 2017 monitoring event were 1.21 pounds of RDX and 0.98 pounds of TNT. Representative estimates of the explosives mass at the time of the March 2018 monitoring event were 1.09 pounds of RDX and 0.20 pounds of TNT. This is approximately a 9.9-percent mass decrease of RDX, a 79.9-percent mass decrease of TNT and a 41.2-percent mass decrease of RDX+TNT. This percent decrease (relative to those reported in 2017) is due to the further refinement of the explosives plumes using data gathered during the March 2018 direct push groundwater investigation and annual sampling events.

By comparison, representative estimates of the March 2017 explosives mass in the on-post explosives plume between EW6 and EW7 were 0.92 pounds for RDX and 29.18 pounds for TNT. Representative estimates of the explosives mass at the time of the March 2018 sampling event in the same area were 0.69 pounds for RDX and 39.87 pounds for TNT. This is approximately a 24.6-percent mass decrease for RDX, a 36.6-percent mass increase for TNT, and a 34.8-percent mass increase for RDX+TNT. This percent increase (relative to those reported in 2017) is due to the further refinement of the explosives plumes using data gathered during the March 2018 direct push groundwater investigation and annual sampling events. Concentrations of TNT were detected at higher levels (at select direct push sample locations) than assumed before 2018. Due to the 2018 refinement of areas with data gaps between EW6 and EW7, the current estimated mass calculated is considered more accurate.

Although a portion of the mass reduction in the injection zone treatment areas (from 2016) can be attributed to natural degradation and extraction well pumping, a majority of the reduction was a result of subsurface injection and bioremediation completed between 2007 and 2016.

Long-Term Modeling Results / Mass Estimations

Following model recalibration and completion of mass estimations, contaminant transport modeling was used to simulate the performance of the subsurface injection treatment zones installed in 2016 and to predict long-term contaminant transport conditions. This modeling evaluation was completed with the MT3DMS contaminant fate and transport model. The contaminant fate and transport model was initially set to run for 1 year (throughout 2018) with treatment zones active and continuous pumping of EW7 at the current pumping rate of 300 gpm. In year 2 (2019), EW7 was set to inactive in the model (pumping set to 0 gpm), the injection treatment zone effects were set to natural attenuation values, and the model was run from year 2 to year 17.

Under the above scenario, the model-predicted results indicated that there is no further off-post migration of RDX or TNT, and the on-post RDX and TNT concentrations are reduced to below the HALs in

17 and 12 years, respectively. These remediation timeframes take into consideration no additional years of injections in the interpreted explosives plumes and/or residual source areas at LL1, LL2, and between EW6 and EW7. Based on March 2018 sampling results, the load line source area concentrations have significantly decreased as the result of historic subsurface injections and concentration near the plume boundary have steadily declined.

These model-predicted results indicate that RDX and TNT will not further migrate off-post; therefore, the pump and treatment system may be discontinued around the start of year 2 (2019). **Table 4** provides a summary of the above modeling scenario (Scenario 1 – No Additional Injections). Based on the model-predicted results described above, a recommendation for initiating a ‘temporary’ shutdown of EW7, completing subsurface injections at existing explosives plumes, and completing a rebound study is proposed.

Proposed Rebound Study

Based on the significant decrease of explosives concentrations in groundwater and the numerical groundwater modeling results indicating the plume is reducing in size and does not migrate farther downgradient once EW7 pumping is set to “0” gpm, it is recommended, with regulatory concurrence, to ‘temporarily’ shut down the pumping at EW7 and the GWTF by late spring 2019. The GWTF would be winterized and maintained in a ‘stand-by’ condition. Routine operation and maintenance facilities (such as lawn mowing, snow removal, pest control, and security) would be maintained. Along with the continuation of annual OU1/OU3 LTM sampling and reporting activities, this ‘temporary’ shut down of the RA-O would be followed by a rebound study (comprised of quarterly sampling of select OU1 wells and direct push groundwater sampling) that would include two years of groundwater monitoring and MNA in localized areas where explosives concentrations still exceed the HALs. This generalized scenario coincides with the current CHAAP remediation exit strategy.

Monitoring Program

Following the proposed ‘temporary’ shutdown of the GWTF, the LTM sampling program would include:

- Monitoring of select wells (upgradient, side-gradient, and downgradient) at a quarterly frequency, including reincorporating 15 existing off-post wells downgradient of EW7 (formerly part of the LTM program);
- A direct push investigation in the rebound study area; and
- Continued OU1/OU3 LTM program sampling at an annual frequency.

Quarterly monitoring would include analytes currently in the OU1 LTM program and would occur in wells selected to detect and observe indications of plume rebound and/or migration. These proposed wells selected for quarterly monitoring are presented in **Figure 7**. In addition, 15 off-post wells downgradient of EW7 would be reincorporated into the OU1 LTM program (**Figure 7**), and a location- and depth-specific direct push groundwater sampling investigation would be conducted in the rebound study area.

The 15 off-post wells are existing monitoring wells once part of the OU1 LTM program (last sampled in 2013) were recommended and approved for removal once annual explosives concentrations fell below HALs for 5 years or longer. Although removed from the OU1 LTM, the wells (along with other on- and off-post wells meeting criteria and removed from OU1 LTM program) were not abandoned and have been accessed annually as part of the site-wide water level measurement activities.

The direct push groundwater sampling investigation would include up to 20 direct push samples collected from three sampling locations over eight quarterly periods. The direct push sample locations and depths would be targeted to identify any downgradient migration of the existing plume, as shown on **Figure 7**. Prior to initiating shut down of the GWTF, an initial (baseline) round of samples would be collected from the select wells and direct push locations as part of the proposed rebound study. The results of the study would be presented in quarterly Data Reports and summarized with annual program recommendations in the annual groundwater monitoring report.

Proposed Injection Program

Concurrent with the proposed rebound study, a proposed additional injection event (2 years of 600 injection points each [2019, 2020]) will be completed to remediate the remainder of the OU1 plume. The proposed subsurface injection events, with similar design and methodology as completed in past years (i.e., 2007 through 2016), is presented on **Figure 8.** Furthermore, as completed during past injection events, it is assumed up to 20 direct push sampling locations total (per injection event) will be sampled quarterly to assess injection performance. Previous injections at OU1 have proven to enhance anaerobic in-situ bioremediation and co-metabolic biodegradation processes of the RDX and TNT plumes.

Based on March 2018 current conditions (explosives concentrations, water level conditions) and recommended 'temporary' shut down of EW7 in 2019, the proposed subsurface injection design and locations were input into contaminant and fate modeling (as displayed on **Figure 8**). Using similar Contaminant Fate and Transport Model Setup, Input Parameters, and Assumptions as completed in past injection events; along with the proposed 2019/2020 subsurface injection design (600 injection point locations each year), methodology, and location placements, the model output and timeframe estimations are shown on **Table 5** (Scenario 2 - Subsurface Injections in 2019 and 2020). The proposed injections are expected to reduce the concentrations at EW7 to below HALs (at former facility boundary) in 6 years and reduce the overall site remediation timeframe down to 10 years.

Subsurface injection design locations for 2019 (600 locations as shown on **Figure 8**), were selected to establish an anaerobic-reducing environment in the subsurface groundwater that is conducive to biodegradation of explosives. The proposed injection program cannot be implemented while well EW7 and the GWTF are in operation due to potential fouling issues. Once EW7 'temporary' shutdown is implemented, water level conditions and groundwater flow will return to static conditions without influence of pumping actions. These subsurface conditions will help in creating the anaerobic/reducing subsurface environment for explosives degradation that have been successful in the past injection program. Initially addressing the explosives plumes near the former facility boundary, and reducing explosives concentrations potential for off-post migration, favors the successful results of the proposed rebound study. Additionally, near the former facility boundary, during the proposed 2020 injection event, an additional 168 of 600 injection point locations will be utilized to additionally address areas between EW6 and EW7 where the 2019 performance monitoring results indicate additional maintenance injections may be necessary, if needed.

In 2020, 432 of 600 injection point locations are proposed to treat explosives concentrations remaining at residual source areas located at LL1 and LL2 with an amendment substrate (Wesblend custom blend) at each point. These areas have been identified in March 2018 annual and direct push groundwater investigation sampling events with concentrations >20 µg/L RDX and TNT >2 µg/L.

Conclusions

Current conditions and data show reductions in explosive plume concentrations, and groundwater modeling forecasts indicate that the cleanup timeframe may be reduced by 'temporarily' shutting down the GWTF, conducting the proposed rebound study, and completing subsurface injections between EW6 near EW7, and at residual source areas located in LL1 and LL2. The proposed rebound study will demonstrate the current remediation in place (current pump and treat system) may no longer be necessary or beneficial for site remediation.

Following the conclusion of the proposed rebound study activities, two likely outcomes are anticipated. 1-downgradient migration of explosives concentrations above HALs are not identified at off-post sampling locations (i.e., direct push locations and monitoring wells), or 2- explosives concentrations above HALs are identified downgradient of former facility boundary at off-post sampling locations. Based on outcome 1, further evaluation and discussion with Stakeholders concerning a termination to the GWTF and pumping system remediation in place may be warranted. Prior to any operational change to the pump and treatment system, a formal document (i.e., ROD Amendment, ESD) with details of the proposed pump and treatment system changes, and associated field sampling program, would be prepared for Stakeholders approval. Shutdown of the RA-O would be followed by several years of groundwater monitoring and MNA for localized areas where explosives concentrations may still exceed the HALs. This generalized scenario coincides with the current CHAAP remediation exit strategy.

Based on outcome 2, additional evaluation and discussion with Stakeholders may be warranted concerning GWTF operation options (i.e., turning EW7 back on to regain capture of on-post explosives, leaving EW7 off and allowing remaining on- and off-post concentrations to remediate via MNA, and other options that may be considered). The likelihood of outcome 2 further evaluation would be dependent upon subsurface injection performance sampling data analysis, rebound study sampling analysis, and the interpreted migration trends and forecasted modeling outcomes.

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FIGURES

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TABLES

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FIGURES

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FACILITY LOCATION MAP
CORNHUSKER ARMY AMMUNITION PLANT

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CHK'D. BY: CSA	DATE: 09/02/16	16170837	1

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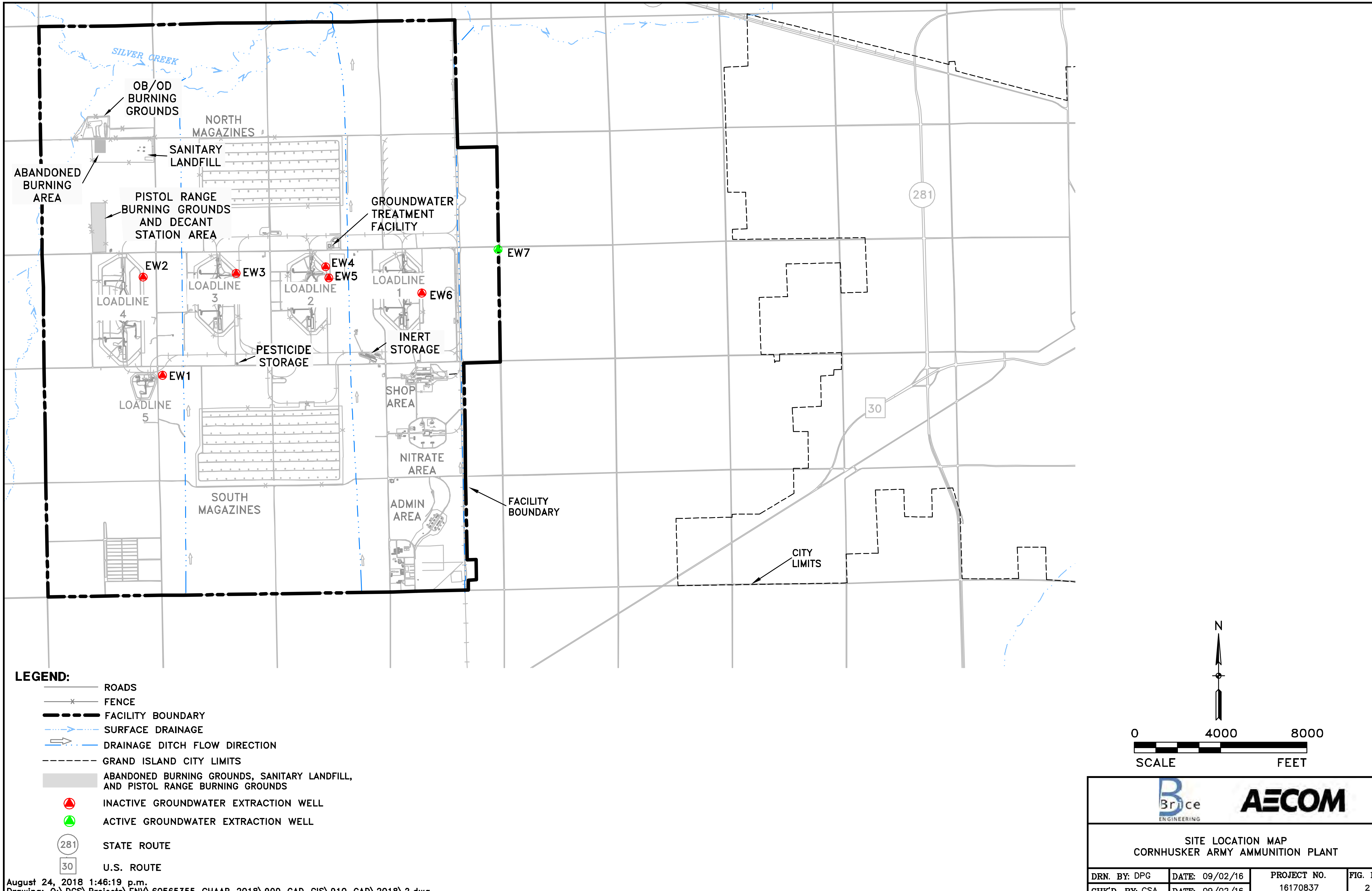

SILVER CREEK
OB/OD BURNING GROUNDS
NORTH MAGAZINES
SANITARY LANDFILL
ABANDONED BURNING AREA
PISTOL RANGE BURNING GROUNDS AND DECANT STATION AREA
GROUNDWATER TREATMENT FACILITY
EW2
EW3
EW4
EW5
EW6
EW7
LOADLINE 4
LOADLINE 3
LOADLINE 2
LOADLINE 1
INERT STORAGE
PESTICIDE STORAGE
EW1
LOADLINE 5
SHOP AREA
NITRATE AREA
SOUTH MAGAZINES
ADMIN AREA
FACILITY BOUNDARY
CITY LIMITS
281
30
N
0
4000
8000
SCALE
FEET
LEGEND:
ROADS
FENCE
FACILITY BOUNDARY
SURFACE DRAINAGE
DRAINAGE DITCH FLOW DIRECTION
GRAND ISLAND CITY LIMITS
ABANDONED BURNING GROUNDS, SANITARY LANDFILL, AND PISTOL RANGE BURNING GROUNDS
INACTIVE GROUNDWATER EXTRACTION WELL
ACTIVE GROUNDWATER EXTRACTION WELL
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SITE LOCATION MAP
CORNHUSKER ARMY AMMUNITION PLANT
DRN. BY: DPG
DATE: 09/02/16
CHK'D. BY: CSA
DATE: 09/02/16
PROJECT NO. 16170837
FIG. NO. 2

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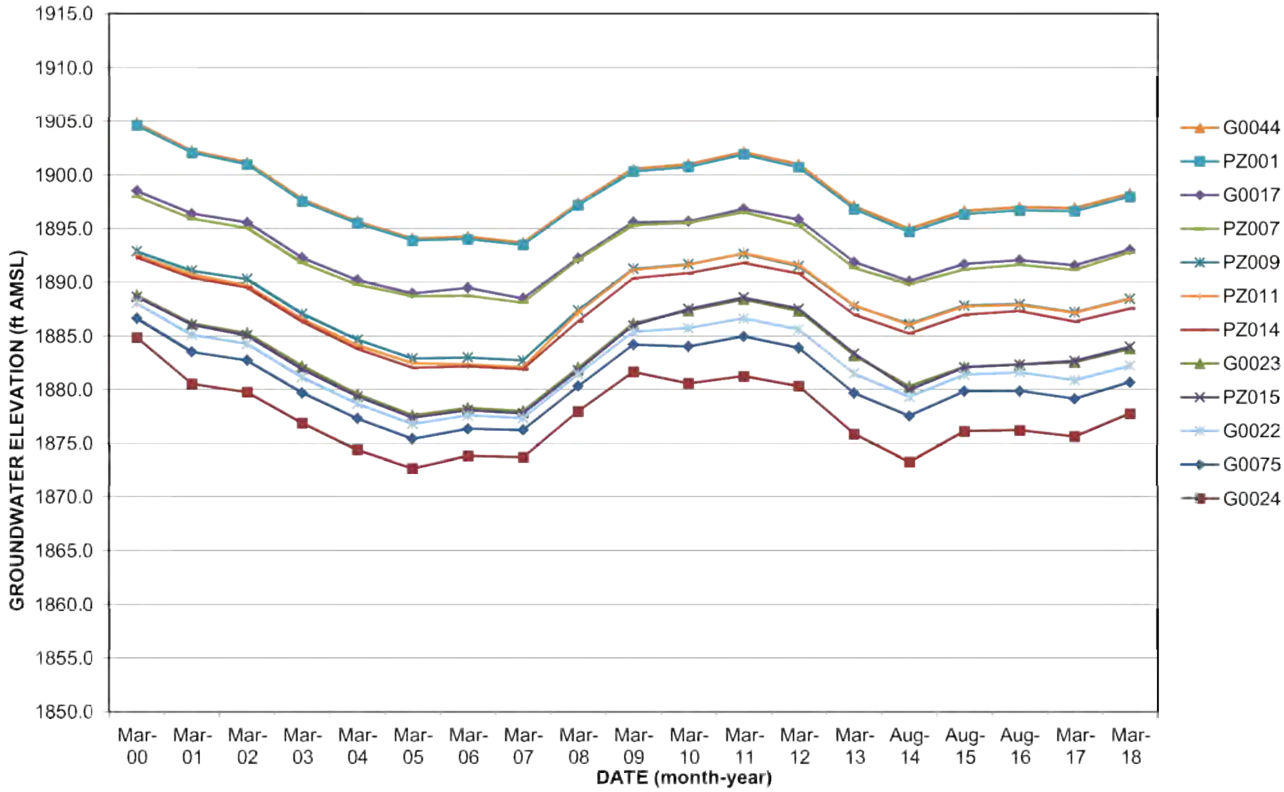
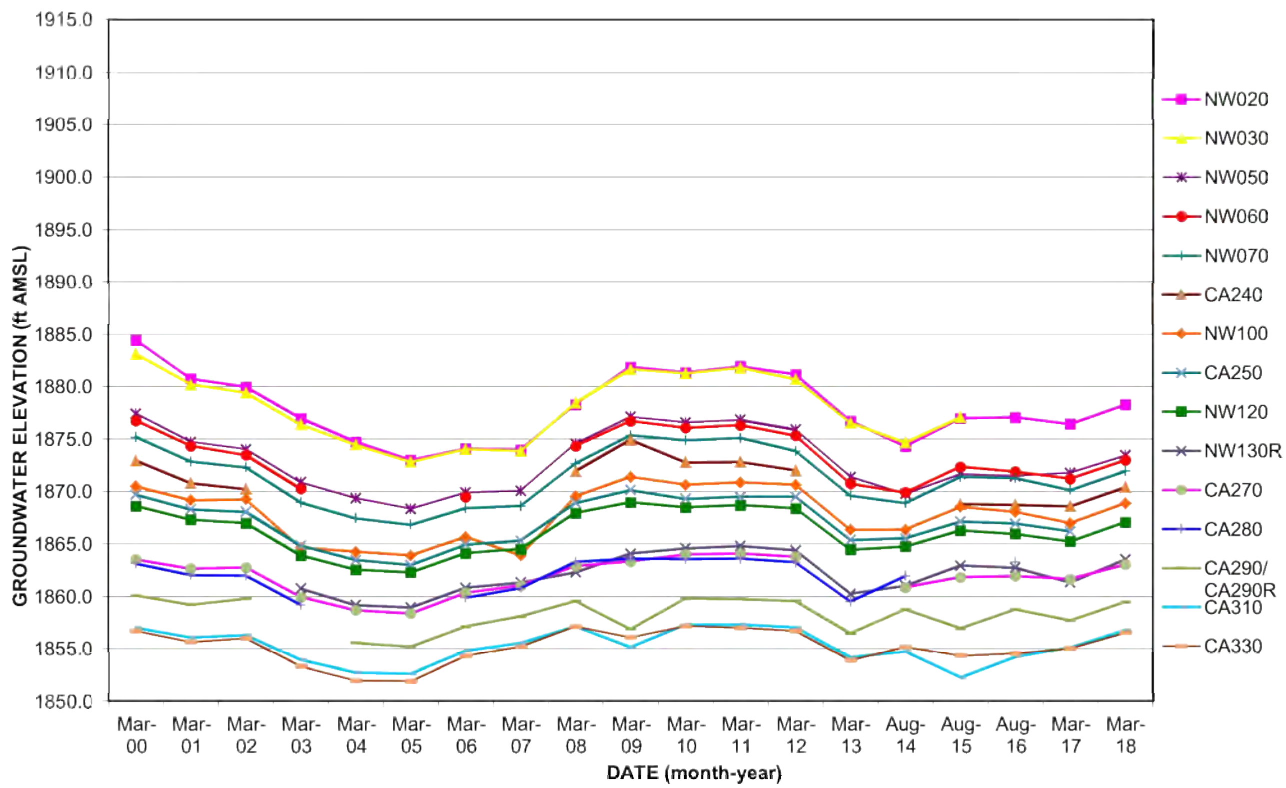
SELECTED SHALLOW ON-POST WELLS



SELECTED SHALLOW OFF-POST WELLS



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GROUNDWATER ELEVATION TRENDS IN SELECTED SHALLOW MONITORING WELLS
MARCH 2000 TO MARCH 2018
CORNHUSKER ARMY AMMUNITION PLANT

DRN. BY: DPG	DATE: 08/06/18	PROJECT NO.	FIG. NO.
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EW7-DP48
Depth TnT RDX
21'-25' 87 2.2
31'-35' 5 0.73
41'-45' 0.5 0.76
EW7-DP47
Depth TnT RDX
21'-25' 0.14 2.1
31'-35' 6.1 0.76
41'-45' 1.1 0.7
EW7-DP46
Depth TnT RDX
21'-25' 9.4 2.1
31'-35' 5.7 1.9
41'-45' 0.34 0.24
EW7-DP49
Depth TnT RDX
31'-35' 2.9 0.55
EW7-DP50
Depth TnT RDX
31'-35' 0.63 1.7
EW7-DP51
Depth TnT RDX
31'-35' 0.26 ND
EW7-DP52
Depth TnT RDX
31'-35' ND ND
EW7-DP53
Depth TnT RDX
21'-25' 0.32 ND
LL1-DP147
Depth TnT RDX
18'-22' 0.55 ND
LL1-DP148
Depth TnT RDX
18'-22' ND ND
LL2-DP118
Depth TnT RDX
21'-25' 1.3 4.8
LL2-DP119
Depth TnT RDX
21'-25' 0.32 76
LL2-DP120
Depth TnT RDX
21'-25' ND 0.89
LL2-DP121
Depth TnT RDX
21'-25' ND 41
13th STREET
COUNTY ROAD
ALDA ROAD
3rd AVENUE
NORTH BOHL ROAD
EW7 (ACTIVE)
(INACTIVE) EW5
(INACTIVE) EW6
EW4 (INACTIVE)
G-130593
G-123999
LEGEND
G0121 2018 OU1 GROUNDWATER SAMPLING LOCATIONS (MARCH)
(ND) TNT CONCENTRATION (µg/L)
(ND) RDX CONCENTRATION (µg/L)
ND NON DETECT
NS NOT SAMPLED
2016 WESBLEND 66-10 TREATMENT WALL LOCATION (9.8% BY VOLUME)
BLDG 14 FORMER SITE FEATURES
ADVECTIVE PARTICLE TRANSPORT FLOWPATH (EW7 AT 300 GPM)
FENCE
SURFACE DRAINAGE
EW3 (INACTIVE) EXTRACTION WELL
NW020 OFF-POST GROUNDWATER MONITORING WELL
G0015 ON-POST GROUNDWATER MONITORING WELL
PZ007 ON-POST PIEZOMETER
LL1-DP148 2018 DIRECT PUSH GROUNDWATER SAMPLING LOCATION (MARCH)
2016 DIRECT PUSH GROUNDWATER SAMPLING LOCATION (FEBRUARY)
2015 DIRECT PUSH GROUNDWATER SAMPLING LOCATION (MARCH)
ACTIVE IRRIGATION WELL
2 INTERPRETED HORIZONTAL EXTENT OF EXPLOSIVES (TNT CONCENTRATIONS >2µg/L) MARCH 2018
20 INTERPRETED HORIZONTAL EXTENT OF EXPLOSIVES (TNT CONCENTRATIONS >20µg/L) MARCH 2018
2 INTERPRETED HORIZONTAL EXTENT OF EXPLOSIVES (RDX CONCENTRATIONS >2µg/L) MARCH 2018
20 INTERPRETED HORIZONTAL EXTENT OF EXPLOSIVES (RDX CONCENTRATIONS >20µg/L) MARCH 2018
300 150 0 300
SCALE IN FEET
N
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OU1 2018 EXTENT OF EXPLOSIVES PLUME LOAD LINE 1, LOAD LINE 2, AND BETWEEN EW6 AND EW7 (OU1)
CORNHUSKER ARMY AMMUNITION PLANT
DRN. BY: DPG
DATE: 05/24/18
PROJECT NO. 60565366
FIG. NO. 4
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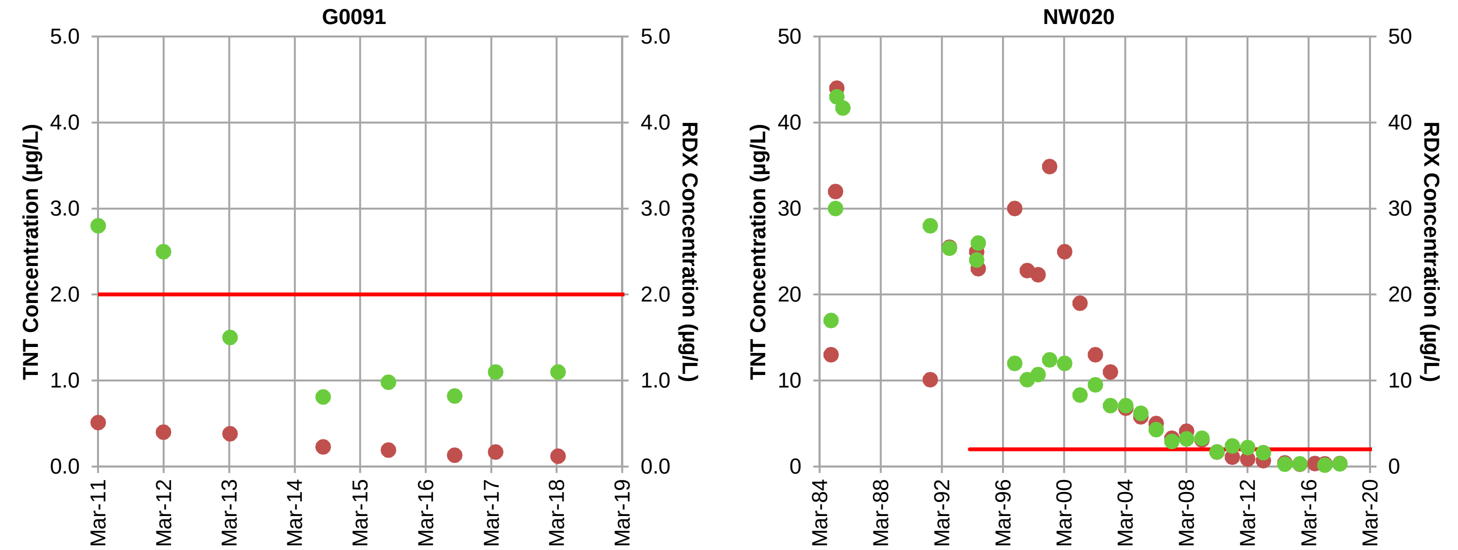


Nonparametric Trend Analysis for TNT and RDX

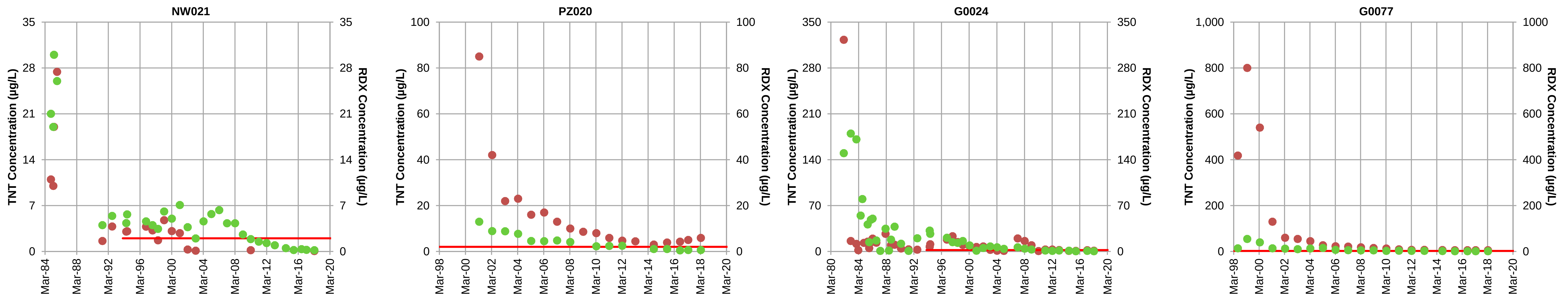
Well	Detect	Non-detect	Total Samples	Detection Frequency	Min (µg/L)	Max (µg/L)	Mean (µg/L)	Median (µg/L)	MK Result	Trend
G0091	8 / 8	0 / 0	8 / 8	100% / 100%	0.12 / 0.81	0.51 / 2.8	0.30 / 1.5	0.20 / 1.1	100% / 89%	D / S
NW020	31 / 30	0 / 1	31 / 31	100% / 97%	0.29 / 0.17	53.0 / 43.0	14.1 / 11.8	10.1 / 7.7	100% / 100%	D / D
NW021	18 / 31	13 / 0	31 / 31	58% / 100%	0.08 / 0.21	27.4 / 30.0	5.5 / 6.0	3.1 / 4.3	100% / 100%	D / D
PZ020	18 / 16	0 / 2	18 / 18	100% / 89%	3.0 / 0.52	85.0 / 13.0	15.7 / 4.2	8.3 / 3.3	100% / 100%	D / D
G0024	39 / 40	7 / 6	46 / 46	85% / 87%	0.59 / 0.40	323 / 180	17.0 / 27.8	8.0 / 12.6	100% / 100%	D / D
G0077	21 / 21	0 / 0	21 / 21	100% / 100%	5.3 / 1.3	800 / 55.0	105 / 10.2	18.0 / 4.8	100% / 100%	D / D
EW7	19 / 19	0 / 0	19 / 19	100% / 100%	6.4 / 0.33	137 / 39.0	43.0 / 11.8	31.0 / 7.0	100% / 100%	D / D
PZ017R	17 / 17	0 / 0	17 / 17	100% / 100%	20.0 / 1.8	100 / 120	57.0 / 42.2	41.0 / 10.0	100% / 100%	D / D
PZ018	18 / 18	0 / 0	18 / 18	100% / 100%	0.47 / 0.10	100 / 69.0	36.5 / 27.8	28.5 / 19.5	100% / 100%	D / D

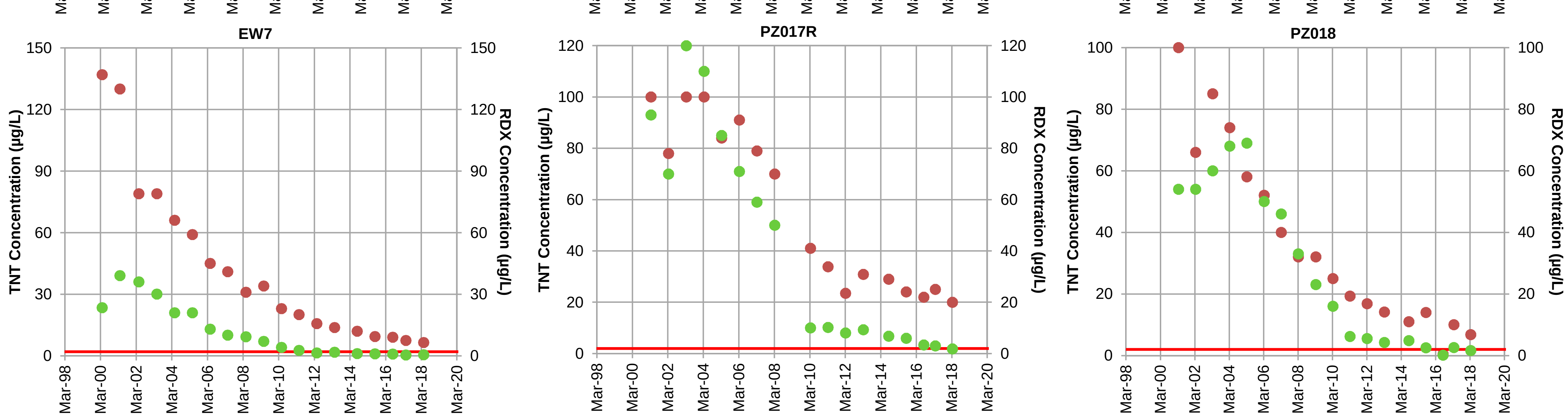
Notes:

Trend analysis performed using Mann-Kendall test at 0.05 significance level.

µg/L = micrograms per liter — MK = Mann-Kendall — S = stable — (red line) = HAL (1994) TNT/RDX

D = decreasing — RDX = hexahydro-1,3,5-trinitro-1,3,5-triazine — TNT = 2,4,6-trinitrotoluene





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Mann-Kendall Analysis for TNT and RDX
Former Facility Boundary Wells (OU1)
Cornhusker Army Ammunition Plant

Drawn By: RPF	Date: 7/26/2018	Figure 5
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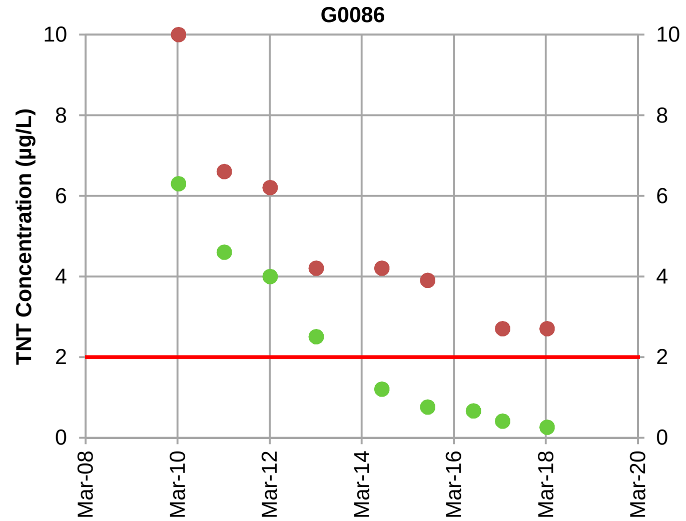
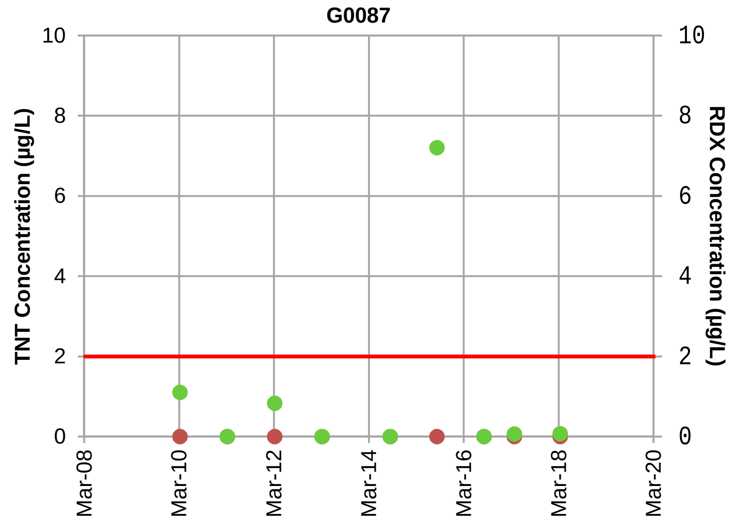




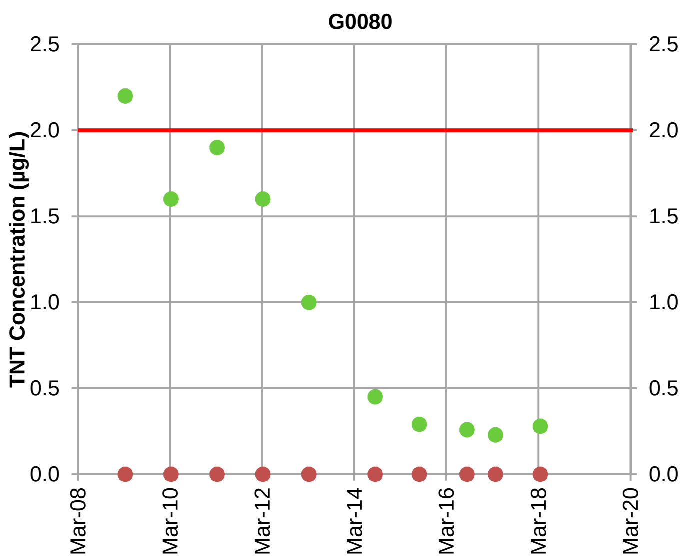
Nonparametric Trend Analysis for TNT and RDX

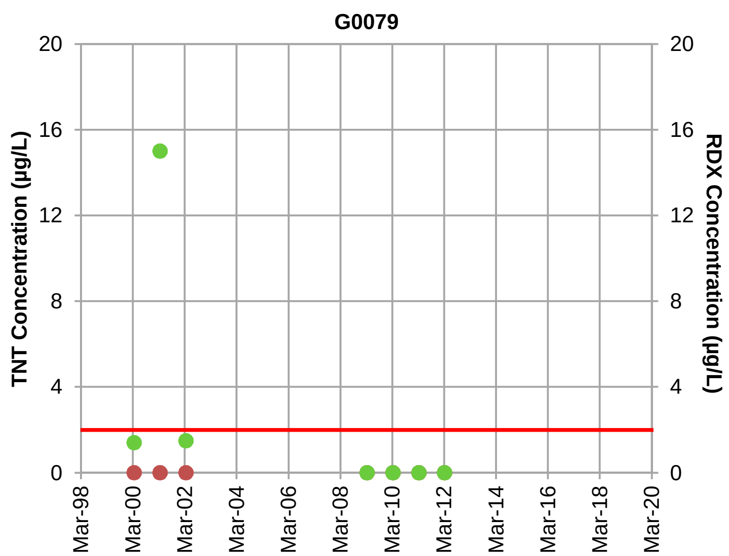
Well	Detect	Non-detect	Total Samples	Detection Frequency	Min (µg/L)	Max (µg/L)	Mean (µg/L)	Median (µg/L)	MK Result	Trend
G0086	8 / 9	1 / 0	9 / 9	89% / 100%	2.7 / 0.26	10.0 / 6.3	5.1 / 2.3	4.2 / 1.2	100% / 100%	D / D
G0087	0 / 5	9 / 4	9 / 9	0% / 56%	ND / 0.06	ND / 7.2	ND / 1.9	ND / 0.83	46% / 46%	ND / NT
G0080	0 / 10	10 / 0	10 / 10	0% / 100%	ND / 0.23	ND / 2.2	ND / 0.98	ND / 0.73	46% / 100%	ND / D
G0079	0 / 3	7 / 4	7 / 7	0% / 43%	ND / 1.4	ND / 15.0	ND / 6.0	ND / 1.5	44% / 93%	ND / PD
G0075	10 / 20	11 / 1	21 / 21	48% / 95%	1.2 / 0.06	12.0 / 14.0	4.7 / 5.6	1.7 / 5.5	100% / 100%	D / D
G0081	9 / 10	1 / 0	10 / 10	90% / 100%	1.0 / 0.29	43.0 / 3.3	16.5 / 1.1	12.7 / 1.1	100% / 100%	D / D
G0082	8 / 10	2 / 0	10 / 10	80% / 100%	0.11 / 1.7	1.4 / 16.0	0.74 / 5.5	0.61 / 4.5	100% / 93%	D / PD

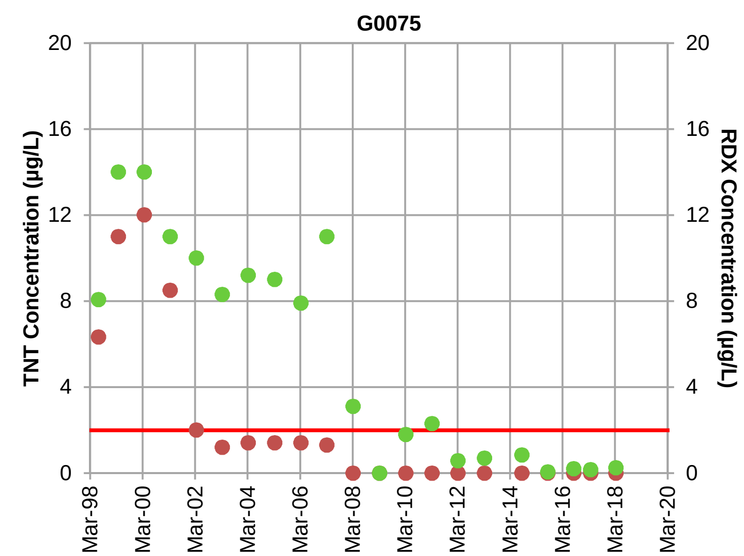
Notes:

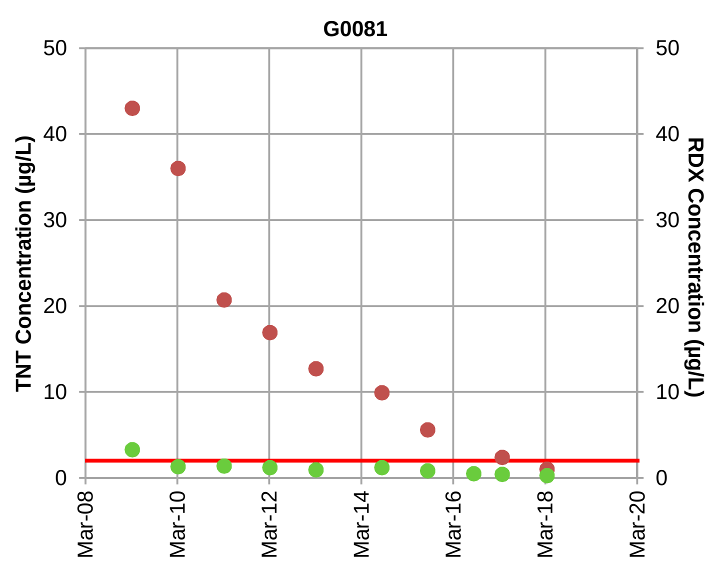
Trend analysis performed using Mann-Kendall test at 0.05 significance level.

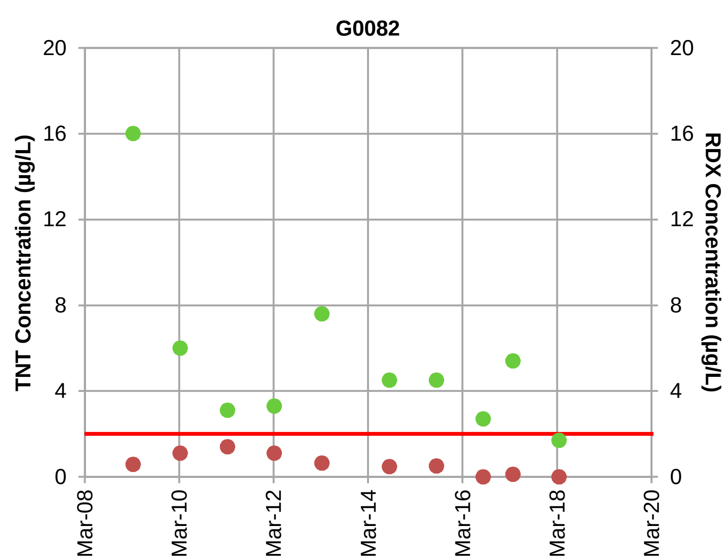
µg/L = micrograms per liter
ND = not detected
RDX = hexahydro-1,3,5-trinitro-1,3,5-triazine
D = decreasing
NT = no trend
TNT = 2,4,6-trinitrotoluene
MK = Mann-Kendall
PD = probably decreasing
= HAL (1994) TNT/RDX











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Mann-Kendall Analysis for TNT and RDX
Upgradient Wells (OU1)
Cornhusker Army Ammunition Plant

Drawn By: RPF	Date: 7/30/2018	**Figure 6**
Checked By: DC	Project No.: 60565355	

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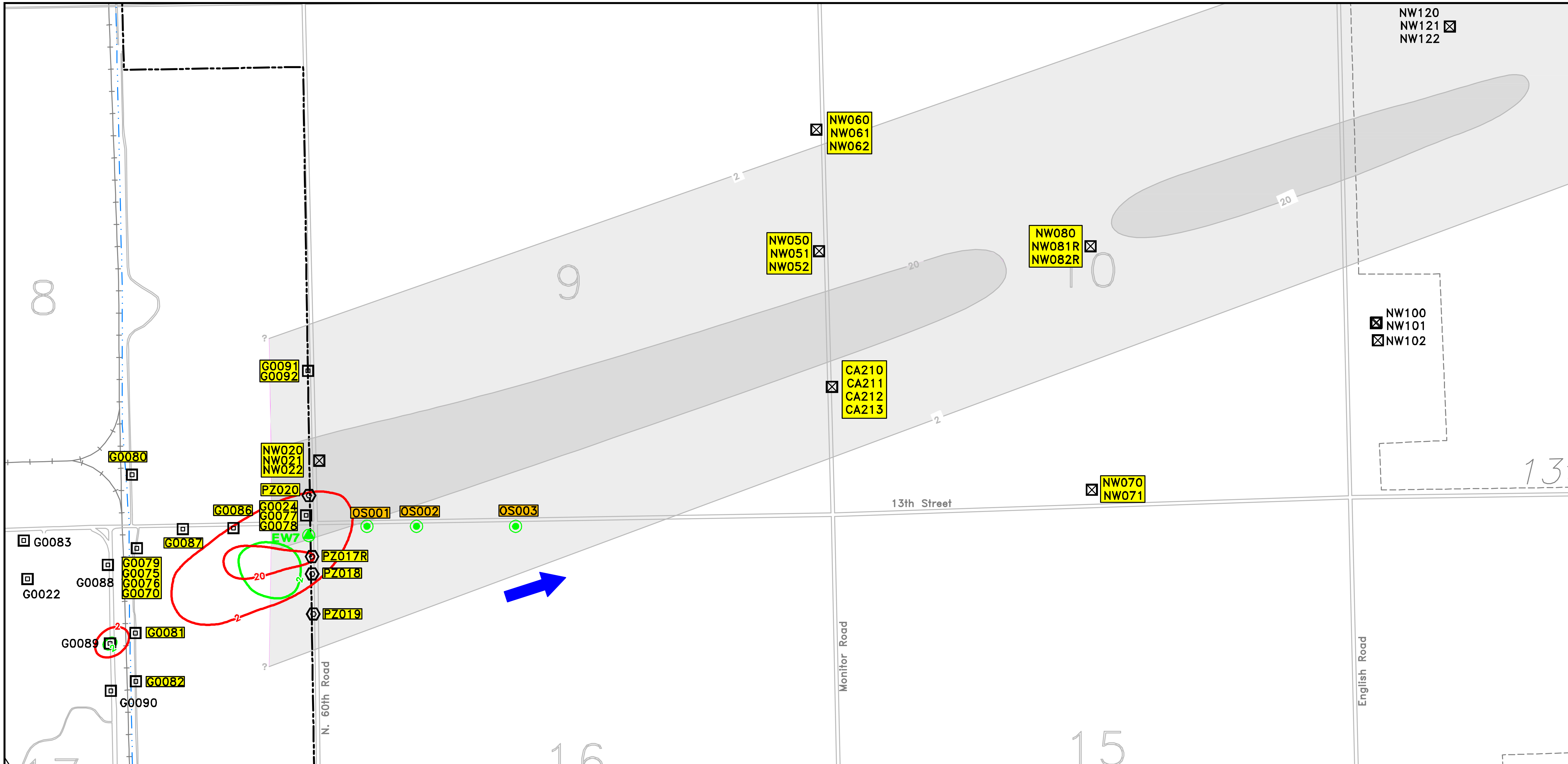

LEGEND:

- ON–POST GROUNDWATER MONITORING WELL
- OFF–POST GROUNDWATER MONITORING WELL
- ON–POST PIEZOMETER
- INACTIVE GROUNDWATER EXTRACTION WELL
- ACTIVE GROUNDWATER EXTRACTION WELL
- G0029 — 2019 GROUNDWATER SAMPLING LOCATIONS – OU1 REBOUND STUDY (QUARTERLY)
- OS001 — 2019 OU1 DIRECT PUSH SAMPLING LOCATIONS – REBOUND STUDY (QUARTERLY)
- 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) MARCH 2018
- 20 — INTERPRETED HORIZONTAL EXTENT OF EXPLOSIVES (TNT CONCENTRATIONS >20µg/L) MARCH 2018
- 2 — INTERPRETED HORIZONTAL EXTENT OF EXPLOSIVES (RDX CONCENTRATIONS >2µg/L) MARCH 2018
- 2 — INTERPRETED HORIZONTAL EXTENT OF EXPLOSIVES (RDX CONCENTRATIONS >2µg/L) JULY 1994
- 20 — INTERPRETED HORIZONTAL EXTENT OF EXPLOSIVES (RDX CONCENTRATIONS >20µg/L) JULY 1994

N

SCALE 0 — 1000 — 2000 FEET

Bristol Engineering — AECOM

PROPOSED 2019 REBOUND STUDY SAMPLING LOCATIONS MAP
OFF–POST/ON–POST (OU1)
CORNHUSKER ARMY AMMUNITION PLANT

DRN. BY: DPG	DATE: 05/30/18	PROJECT NO.	FIG. NO.
CHK'D. BY: DC	DATE: 05/30/18	60536870	7

December 19, 2018 4:03:56 p.m.
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EW7-DP47		
Depth	TnT	RDX
21'-25'	0.14	2.1
31'-35'	6.1	0.76
41'-45'	1.1	0.2

EW7-DP48		
Depth	TnT	RDX
21'-25'	87	2.2
31'-35'	5	0.73
41'-45'	0.5	0.76

EW7-DP52		
Depth	TnT	RDX
31'-35'	ND	ND

EW7-DP53		
Depth	TnT	RDX
21'-25'	0.32	ND

EW7-DP49		
Depth	TnT	RDX
31'-35'	2.9	0.55

EW7-DP51		
Depth	TnT	RDX
31'-35'	0.26	ND

EW7-DP46		
Depth	TnT	RDX
21'-25'	9.4	2.1
31'-35'	5.7	1.9
41'-45'	0.34	0.24

EW7-DP50		
Depth	TnT	RDX
31'-35'	0.63	1.7

LL1-DP147		
Depth	TnT	RDX
18'-22'	0.55	ND

LL1-DP148		
Depth	TnT	RDX
18'-22'	ND	ND

LL2-DP118		
Depth	TnT	RDX
21'-25'	1.3	4.8

LL2-DP119		
Depth	TnT	RDX
21'-25'	0.32	76

LL2-DP120		
Depth	TnT	RDX
21'-25'	ND	0.89

LL2-DP121		
Depth	TnT	RDX
21'-25'	ND	41

2020 LL2 INJECTION WALL	LENGTH (FEET)	NUMBER OF POINTS	SPACING (FEET)	AMENDMENT
LL2-T125	165	12	15	WB66-10 9.8%
LL2-T126	165	12	15	WB66-10 9.8%
LL2-T127	165	12	15	WB66-10 9.8%
LL2-T128	165	12	15	WB66-10 9.8%
LL2-T129	165	12	15	WB66-10 9.8%
LL2-T130	165	12	15	WB66-10 9.8%
LL2-T131	165	12	15	WB66-10 9.8%
LL2-T132	165	12	15	WB66-10 9.8%
LL2-T133	165	12	15	WB66-10 9.8%
LL2-T134	165	12	15	WB66-10 9.8%
LL2-T135	165	12	15	WB66-10 9.8%
LL2-T136	165	12	15	WB66-10 9.8%
LL2-T137	165	12	15	WB66-10 9.8%
LL2-T138	165	12	15	WB66-10 9.8%
LL2-T139	165	12	15	WB66-10 9.8%
2020 LL2 TOTAL	2475	180		

2020 LL1 INJECTION WALL	LENGTH (FEET)	NUMBER OF POINTS	SPACING (FEET)	AMENDMENT
LL1-T129	165	12	15	WB66-10 9.8%
LL1-T130	165	12	15	WB66-10 9.8%
LL1-T131	165	12	15	WB66-10 9.8%
LL1-T132	165	12	15	WB66-10 9.8%
LL1-T133	165	12	15	WB66-10 9.8%
LL1-T134	165	12	15	WB66-10 9.8%
LL1-T135	255	18	15	WB66-10 9.8%
LL1-T136	255	18	15	WB66-10 9.8%
LL1-T137	255	18	15	WB66-10 9.8%
LL1-T138	255	18	15	WB66-10 9.8%
LL1-T139	255	18	15	WB66-10 9.8%
LL1-T140	255	18	15	WB66-10 9.8%
LL1-T141	165	12	15	WB66-10 9.8%
LL1-T142	165	12	15	WB66-10 9.8%
LL1-T143	165	12	15	WB66-10 9.8%
LL1-T144	165	12	15	WB66-10 9.8%
LL1-T145	165	12	15	WB66-10 9.8%
LL1-T146	165	12	15	WB66-10 9.8%
2020 LL1 TOTAL	3510	252		

2019 EW7 INJECTION WALL	LENGTH (FEET)	NUMBER OF POINTS	SPACING (FEET)	AMENDMENT
EW7-T1	255	18	15	WB66-10 9.8%
EW7-T2	345	24	15	WB66-10 9.8%
EW7-T3	615	42	15	WB66-10 9.8%
EW7-T4	615	42	15	WB66-10 9.8%
EW7-T5	615	42	15	WB66-10 9.8%
EW7-T6	615	42	15	WB66-10 9.8%
EW7-T7	615	42	15	WB66-10 9.8%
EW7-T8	705	48	15	WB66-10 9.8%
EW7-T9	705	48	15	WB66-10 9.8%
EW7-T10	705	48	15	WB66-10 9.8%
EW7-T11	705	48	15	WB66-10 9.8%
EW7-T12	705	48	15	WB66-10 9.8%
EW7-T13	615	48	15	WB66-10 9.8%
EW7-T14	615	48	15	WB66-10 9.8%
EW7-T15	165	12	15	WB66-10 9.8%
EW7-T16	165	12	15	WB66-10 9.8%
2019 EW7 TOTAL	8760	600		
2020 EW7 INJECTION WALL	LENGTH (FEET)	NUMBER OF POINTS	SPACING (FEET)	AMENDMENT
EW7-T17	345	24	15	WB66-10 9.8%
EW7-T18	525	36	15	WB66-10 9.8%
EW7-T19	615	42	15	WB66-10 9.8%
EW7-T20	615	42	15	WB66-10 9.8%
EW7-T21	345	24	15	WB66-10 9.8%
2020 EW7 TOTAL	19965	168		
2019-2020 EW7 TOTAL	28725	768		

LEGEND

- G0121 — 2018 OU1 GROUNDWATER SAMPLING LOCATIONS (MARCH)
- (ND) — TNT CONCENTRATION (µg/L)
- (ND) — RDX CONCENTRATION (µg/L)
- ND — NON DETECT
- NS — NOT SAMPLED
- 2019 PROPOSED WESBLEND 66-10 TREATMENT WALL LOCATION (9.8% BY VOLUME)
- 2020 PROPOSED WESBLEND 66-10 TREATMENT WALL LOCATION (9.8% BY VOLUME)
- 2016 WESBLEND 66-10 TREATMENT WALL LOCATION (9.8% BY VOLUME)
- BLDG 14 — FORMER SITE FEATURES
- ADVECTIVE PARTICLE TRANSPORT FLOWPATH (EW7 AT 300 GPM)
- FENCE
- SURFACE DRAINAGE
- EW3 (INACTIVE) — EXTRACTION WELL
- NW020 — OFF-POST GROUNDWATER MONITORING WELL
- G0015 — ON-POST GROUNDWATER MONITORING WELL
- PZ007 — ON-POST PIEZOMETER
- 2018 DIRECT PUSH GROUNDWATER SAMPLING LOCATION (MARCH)
- 2016 DIRECT PUSH GROUNDWATER SAMPLING LOCATION (FEBRUARY)
- 2015 DIRECT PUSH GROUNDWATER SAMPLING LOCATION (MARCH)
- ACTIVE IRRIGATION WELL
- 2 — INTERPRETED HORIZONTAL EXTENT OF EXPLOSIVES (TNT CONCENTRATIONS >2µg/L) MARCH 2018
- 20 — INTERPRETED HORIZONTAL EXTENT OF EXPLOSIVES (TNT CONCENTRATIONS >20µg/L) MARCH 2018
- 2 — INTERPRETED HORIZONTAL EXTENT OF EXPLOSIVES (RDX CONCENTRATIONS >2µg/L) MARCH 2018
- 20 — INTERPRETED HORIZONTAL EXTENT OF EXPLOSIVES (RDX CONCENTRATIONS >20µg/L) MARCH 2018

300 150 0 300
SCALE IN FEET

Brice ENGINEERING — AECOM

PROPOSED 2019/2020 SUBSURFACE INJECTION
LOAD LINE 1, LOAD LINE 2, AND BETWEEN EW6
AND EW7 (OU1)
CORNHUSKER ARMY AMMUNITION PLANT

DRN. BY: DPG	DATE: 07/25/18	PROJECT NO.	FIG. NO.
CHK'D. BY: CSA	REVISION: 0	60565366	8

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TABLES

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TABLE 1
SUMMARY OF EXPLOSIVES DETECTED, DIRECT PUSH GROUNDWATER INVESTIGATION LOCATIONS
2018 ANNUAL REPORT

FIELD ID	CHAAP	EW7-DP46-25					EW7-DP46-35					EW7-DP46-45					EW7-DP47-25					EW7-DP47-35					EW7-DP47-45				
METHOD	HALs	SW846 8330A					SW846 8330A					SW846 8330A					SW846 8330A					SW846 8330A					SW846 8330A				
SAMPLE DATE	(µg/L)	3/5/2018					3/5/2018					3/5/2018					3/5/2018					3/5/2018					3/5/2018				
		Result	Qual	DL	LOD	LOQ	Result	Qual	DL	LOD	LOQ	Result	Qual	DL	LOD	LOQ	Result	Qual	DL	LOD	LOQ	Result	Qual	DL	LOD	LOQ	Result	Qual	DL	LOD	LOQ
EXPLOSIVES (USEPA Method 8330A) (µg/L)																															
1,3,5-TRINITROBENZENE	NA	6.9		0.031	0.1	0.15	18		0.16	0.51	0.77	0.97		0.032	0.1	0.15	29		0.16	0.51	0.76	34		0.16	0.51	0.76	3.6		0.032	0.1	0.15
1,3-DINITROBENZENE	NA	<	U	0.051	0.1	0.15	<	U	0.051	0.1	0.15	<	U	0.051	0.1	0.15	11		0.051	0.51	0.76	0.18		0.051	0.1	0.15	<	U	0.051	0.1	0.15
2,4,6-TRINITROTOLUENE	2	9.4		0.051	0.1	0.15	5.7		0.051	0.1	0.15	0.34		0.051	0.1	0.15	0.14	J	0.25	0.1	0.15	6.1		0.051	0.1	0.15	1.1		0.051	0.1	0.15
2,4-DINITROTOLUENE	NA	<	U	0.051	0.1	0.13	0.097	J	0.051	0.1	0.13	<	U	0.051	0.1	0.13	0.37	J	0.051	0.1	0.13	0.21	J	0.051	0.1	0.13	<	U	0.051	0.1	0.13
2-AMINO-4,6-DINITROTOLUENE	NA	2		0.03	0.1	0.15	1.8		0.031	0.1	0.15	0.39		0.031	0.1	0.15	2.8		0.03	0.1	0.15	1.9		0.03	0.1	0.15	1.6		0.031	0.1	0.15
4-AMINO-2,6-DINITROTOLUENE	NA	2.2		0.051	0.1	0.15	1.6		0.051	0.1	0.15	0.22		0.051	0.1	0.15	2.8		0.051	0.1	0.15	2		0.051	0.1	0.15	1.1		0.051	0.1	0.15
MNX	400	<	U	0.037	0.1	0.51	<	U	0.037	0.1	0.51	<	U	0.037	0.1	0.51	0.085	J	0.036	0.1	0.51	<	U	0.037	0.1	0.51	<	U	0.037	0.1	0.51
HMX	NA	1.2		0.028	0.1	0.15	1.2		0.029	0.1	0.15	0.27		0.029	0.1	0.15	1.8		0.028	0.1	0.15	0.75		0.028	0.1	0.15	0.21		0.029	0.1	0.15
RDX	2	2.1		0.037	0.1	0.15	1.9		0.037	0.1	0.15	0.24	J	0.037	0.1	0.15	2.1		0.036	0.1	0.15	0.76		0.037	0.1	0.15	0.2	J	0.037	0.1	0.15

FIELD ID	CHAAP	EW7-DP48-25					EW7-DP48-35					EW7-DP48-45					EW7-DP49-35					EW7-DP549-35 (DP49-35 duplicate)					EW7-DP50-35				
METHOD	HALs	SW846 8330A					SW846 8330A					SW846 8330A					SW846 8330A					SW846 8330A					SW846 8330A				
SAMPLE DATE	(µg/L)	3/6/2018					3/6/2018					3/6/2018					3/6/2018					3/6/2018					3/6/2018				
		Result	Qual	DL	LOD	LOQ	Result	Qual	DL	LOD	LOQ	Result	Qual	DL	LOD	LOQ	Result	Qual	DL	LOD	LOQ	Result	Qual	DL	LOD	LOQ	Result	Qual	DL	LOD	LOQ
EXPLOSIVES (USEPA Method 8330A) (µg/L)																															
1,3,5-TRINITROBENZENE	NA	80	J	0.63	2	3	21		0.16	0.51	0.77	2.5		0.032	0.1	0.15	11		0.063	0.2	0.3	9.2		0.031	0.2	0.3	1.4		0.032	0.1	0.15
1,3-DINITROBENZENE	NA	<	U	0.051	0.1	0.15	<	U	0.051	0.1	0.15	<	U	0.051	0.1	0.15	<	U	0.051	0.1	0.15	0.051	J	0.051	0.1	0.15	<	U	0.051	0.1	0.15
2,4,6-TRINITROTOLUENE	2	87	J	1	2	3	5		0.051	0.1	0.15	0.5		0.051	0.1	0.15	2.9		0.051	0.1	0.15	2.3		0.051	0.1	0.15	0.63		0.051	0.1	0.15
2,4-DINITROTOLUENE	NA	0.17	J	0.051	0.1	0.13	0.41	J	0.051	0.1	0.13	0.1	J	0.051	0.1	0.13	0.23	J	0.051	0.1	0.13	0.23	J	0.051	0.1	0.13	<	U	0.051	0.1	0.13
2-AMINO-4,6-DINITROTOLUENE	NA	5.6		0.03	0.1	0.15	1.3		0.031	0.1	0.15	0.42		0.031	0.1	0.15	1.6		0.03	0.1	0.15	1.2		0.03	0.1	0.15	0.7		0.031	0.1	0.15
4-AMINO-2,6-DINITROTOLUENE	NA	4.7		0.051	0.1	0.15	1.2		0.051	0.1	0.15	0.26		0.051	0.1	0.15	1.3		0.051	0.1	0.15	0.98		0.051	0.1	0.15	0.69		0.051	0.1	0.15
MNX	400	<	U	0.037	0.1	0.51	<	U	0.037	0.1	0.51	0.038	J	0.037	0.1	0.51	<	U	0.037	0.1	0.51	0.044	J	0.037	0.1	0.51	0.16	J	0.037	0.1	0.51
HMX	NA	1.9		0.028	0.1	0.15	0.62		0.029	0.1	0.15	0.27		0.029	0.1	0.15	0.57		0.028	0.1	0.15	0.52		0.028	0.1	0.15	1.2		0.029	0.1	0.15
RDX	2	2.2		0.037	0.1	0.15	0.73		0.037	0.1	0.15	0.26		0.037	0.1	0.15	0.55		0.037	0.1	0.15	0.5		0.037	0.1	0.15	1.7		0.037	0.1	0.15

Notes:
(shaded box) Concentrations exceed CHAAP HALs
< = less than LOQ
µg/L = micrograms per liter
CHAAP = Cornhusker Army Ammunition Plant
DL = detection limit
HAL = health advisory level
HMX = octahydro-1,3,5,7-tetranitro-1,3,5,7-tetrazocine
ID = identification number
J = estimated
LOD = limit of detection
LOQ = limit of quantification
MNX = mono-nitroso-RDX
NA = not available
Qual = qualifier
RDX = hexahydro-1,3,5-trinitro-1,3,5-triazine
U = nondetect
USEPA = United States Environmental Protection Agency

TABLE 1 (CONTINUED)
SUMMARY OF EXPLOSIVES DETECTED, DIRECT PUSH GROUNDWATER INVESTIGATION LOCATIONS
2018 ANNUAL REPORT

FIELD ID	CHAAP	EW7-DP51-35					EW7-DP52-35					EW7-DP53-25					LL1-DP147-22					LL1-DP148-22					LL2-DP118-25				
METHOD	HALs	SW846 8330A					SW846 8330A					SW846 8330A					SW846 8330A					SW846 8330A					SW846 8330A				
SAMPLE DATE	(µg/L)	3/6/2018					3/6/2018					3/6/2018					3/7/2018					3/7/2018					3/7/2018				
		Result	Qual	DL	LOD	LOQ	Result	Qual	DL	LOD	LOQ	Result	Qual	DL	LOD	LOQ	Result	Qual	DL	LOD	LOQ	Result	Qual	DL	LOD	LOQ	Result	Qual	DL	LOD	LOQ
EXPLOSIVES (USEPA Method 8330A) (µg/L)																															
1,3,5-TRINITROBENZENE	NA	0.72		0.032	0.1	0.15	0.1	J	0.032	0.1	0.15	0.95		0.031	0.1	0.15	0.84		0.031	0.099	0.15	<	U	0.031	0.098	0.15	5.3		0.031	0.099	0.15
1,3-DINITROBENZENE	NA	<	U	0.051	0.1	0.15	<	U	0.051	0.1	0.15	<	U	0.051	0.1	0.15	<	U	0.049	0.099	0.15	<	U	0.049	0.098	0.15	<	U	0.049	0.099	0.15
2,4,6-TRINITROTOLUENE	2	0.26		0.051	0.1	0.15	<	U	0.051	0.1	0.15	0.32		0.051	0.1	0.15	0.55		0.049	0.099	0.15	<	U	0.049	0.098	0.15	1.3		0.049	0.099	0.15
2,4-DINITROTOLUENE	NA	<	U	0.051	0.1	0.13	<	U	0.051	0.1	0.13	<	U	0.051	0.1	0.13	<	U	0.049	0.099	0.13	<	U	0.049	0.098	0.13	0.08	J	0.049	0.099	0.13
2-AMINO-4,6-DINITROTOLUENE	NA	0.47		0.031	0.1	0.15	0.14	J	0.031	0.1	0.15	0.21		0.03	0.1	0.15	0.57		0.03	0.099	0.15	<	U	0.03	0.098	0.15	3.8		0.03	0.099	0.15
4-AMINO-2,6-DINITROTOLUENE	NA	0.39		0.051	0.1	0.15	0.11	J	0.051	0.1	0.15	0.24		0.051	0.1	0.15	0.53		0.049	0.099	0.15	<	U	0.049	0.098	0.15	4.5		0.049	0.099	0.15
MNX	400	<	U	0.037	0.1	0.51	<	U	0.037	0.1	0.51	<	U	0.036	0.1	0.51	<	U	0.035	0.099	0.49	<	U	0.035	0.098	0.49	0.57	J	0.035	0.099	0.49
HMX	NA	0.31		0.029	0.1	0.15	0.16		0.029	0.1	0.15	0.25		0.028	0.1	0.15	<	U	0.028	0.099	0.15	<	U	0.028	0.098	0.15	2.6		0.028	0.099	0.15
RDX	2	<	U	0.037	0.1	0.15	<	U	0.037	0.1	0.15	<	U	0.036	0.1	0.15	<	U	0.035	0.099	0.15	<	U	0.035	0.098	0.15	4.8		0.035	0.099	0.15

FIELD ID	CHAAP	LL2-DP119-25					LL2-DP120-25					LL2-DP121-25				
METHOD	HALs	SW846 8330A					SW846 8330A					SW846 8330A				
SAMPLE DATE	(µg/L)	3/7/2018					3/7/2018					3/7/2018				
		Result	Qual	DL	LOD	LOQ	Result	Qual	DL	LOD	LOQ	Result	Qual	DL	LOD	LOQ
EXPLOSIVES (USEPA Method 8330A) (µg/L)																
1,3,5-TRINITROBENZENE	NA	2.7	J	0.033	0.11	0.16	<	U	0.03	0.098	0.15	<	U	0.03	0.097	0.15
1,3-DINITROBENZENE	NA	<	U	0.053	0.11	0.16	<	U	0.049	0.098	0.15	<	U	0.049	0.097	0.15
2,4,6-TRINITROTOLUENE	2	0.32	J	0.053	0.11	0.16	<	U	0.049	0.098	0.15	<	U	0.049	0.097	0.15
2,4-DINITROTOLUENE	NA	0.086	J	0.053	0.11	0.14	<	U	0.049	0.098	0.13	<	U	0.049	0.097	0.13
2-AMINO-4,6-DINITROTOLUENE	NA	0.65	J	0.032	0.11	0.16	0.38		0.03	0.098	0.15	0.99	J	0.029	0.097	0.15
4-AMINO-2,6-DINITROTOLUENE	NA	0.52	J	0.053	0.11	0.16	0.6		0.049	0.098	0.15	1.2	J	0.049	0.097	0.15
MNX	400	6.8	J	0.038	0.11	0.53	<	U	0.035	0.098	0.49	3.8	J	0.35	0.097	0.49
HMX	NA	9.5	J	0.03	0.11	0.16	2.9	J	0.028	0.098	0.15	41	J	0.027	0.97	1.5
RDX	2	76	J	0.77	2.1	3.2	0.89		0.035	0.098	0.15	41	J	0.35	0.97	1.5

Notes:

[shaded box] Concentrations exceed CHAAP HALs
< = less than LOQ
µg/L = micrograms per liter
CHAAP = Cornhusker Army Ammunition Plant
DL = detection limit
HAL = health advisory level
HMX = octahydro-1,3,5,7-tetranitro-1,3,5,7-tetrazocine
ID = identification number
J = estimated
LOD = limit of detection
LOQ = limit of quantification
MNX = mono-nitroso-RDX
NA = not available
Qual = qualifier
RDX = hexahydro-1,3,5-trinitro-1,3,5-triazine
U = nondetect
USEPA = United States Environmental Protection Agency

TABLE 2
SUMMARY OF EXPLOSIVES DETECTED, OU1 ON-POST MONITORING WELLS AND PIEZOMETERS
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FIELD ID	CHAAP	G0022-18A					G0024-18A					G0048-18A					G0066R-18A					G0067-18A					G0075-18A					G0077-18A				
METHOD	HALs	SW846 8330A					SW846 8330A					SW846 8330A					SW846 8330A					SW846 8330A					SW846 8330A					SW846 8330A				
SAMPLE DATE	(µg/L)	3/22/2018					3/20/2018					3/20/2018					3/22/2018					3/22/2018					3/21/2018					3/20/2018				
		Result	Qual	DL	LOD	LOQ	Result	Qual	DL	LOD	LOQ	Result	Qual	DL	LOD	LOQ	Result	Qual	DL	LOD	LOQ	Result	Qual	DL	LOD	LOQ	Result	Qual	DL	LOD	LOQ	Result	Qual	DL	LOD	LOQ
EXPLOSIVES (USEPA Method 8330A) (µg/L)																																				
1,3,5-TRINITROBENZENE	NA	0.61		0.032	0.1	0.15	<	U	0.032	0.1	0.15	<	U	0.033	0.1	0.16	0.48	J	0.032	0.1	0.15	<	U	0.033	0.11	0.16	<	U	0.032	0.1	0.15	2.7		0.033	0.11	0.16
1,3-DINITROBENZENE	NA	<	U	0.052	0.1	0.15	<	U	0.052	0.1	0.15	<	U	0.052	0.1	0.16	<	U	0.051	0.1	0.15	<	U	0.053	0.11	0.16	<	U	0.051	0.1	0.15	<	U	0.053	0.11	0.16
2,4,6-TRINITROTOLUENE	2	1.9		0.052	0.1	0.15	1.1		0.052	0.1	0.15	<	U	0.052	0.1	0.16	0.33	J	0.051	0.1	0.15	<	U	0.053	0.11	0.16	<	U	0.051	0.1	0.15	5.3		0.053	0.11	0.16
2,4-DINITROTOLUENE	NA	<	U	0.052	0.1	0.13	<	U	0.052	0.1	0.13	<	U	0.052	0.1	0.14	<	U	0.051	0.1	0.13	<	U	0.053	0.11	0.14	<	U	0.051	0.1	0.13	0.063	J	0.053	0.11	0.14
2,6-DINITROTOLUENE	NA	<	U	0.052	0.1	0.13	<	U	0.052	0.1	0.13	<	U	0.052	0.1	0.14	<	U	0.051	0.1	0.13	<	U	0.053	0.11	0.14	<	U	0.051	0.1	0.13	<	U	0.053	0.11	0.14
2-AMINO-4,6-DINITROTOLUENE	NA	3.1		0.031	0.1	0.15	1.8		0.031	0.1	0.15	<	U	0.031	0.1	0.16	0.87	J	0.031	0.1	0.15	<	U	0.032	0.11	0.16	0.45		0.031	0.1	0.15	3.9		0.032	0.11	0.16
3-NITROTOLUENE	NA	<	U	0.059	0.21	0.52	<	U	0.059	0.21	0.52	<	U	0.06	0.21	0.52	<	U	0.058	0.2	0.51	<	U	0.06	0.21	0.53	<	U	0.058	0.2	0.51	<	U	0.06	0.21	0.53
4-AMINO-2,6-DINITROTOLUENE	NA	4		0.052	0.1	0.15	1.9		0.052	0.1	0.15	<	U	0.052	0.1	0.16	0.76	J	0.051	0.1	0.15	<	U	0.053	0.11	0.16	0.37		0.051	0.1	0.15	4.5		0.053	0.11	0.16
MNX	NA	<	U	0.037	0.1	0.52	<	U	0.037	0.1	0.52	<	U	0.038	0.1	0.52	<	U	0.037	0.1	0.51	<	U	0.038	0.11	0.53	<	U	0.037	0.1	0.51	<	U	0.038	0.11	0.53
HMX	400	0.89		0.029	0.1	0.15	0.41		0.029	0.1	0.15	1		0.029	0.1	0.16	0.2	J	0.029	0.1	0.15	0.44		0.029	0.11	0.16	0.37		0.029	0.1	0.15	0.91		0.03	0.11	0.16
NITROBENZENE	NA	<	U	0.052	0.1	0.15	<	U	0.052	0.1	0.15	<	U	0.052	0.1	0.16	<	U	0.051	0.1	0.15	<	U	0.053	0.11	0.16	<	U	0.051	0.1	0.15	<	U	0.053	0.11	0.16
RDX	2	0.82		0.037	0.1	0.15	0.53		0.037	0.1	0.15	0.49		0.038	0.1	0.16	<	U	0.037	0.1	0.15	1.9		0.038	0.11	0.16	0.25		0.037	0.1	0.15	1.3		0.038	0.11	0.16

FIELD ID	CHAAP	G0080-18A					G0081-18A					G0082-18A					G0083-18A					G0084-18A					G0085-18A					G0285-18A (G0085 duplicate)				
METHOD	HALs	SW846 8330A					SW846 8330A					SW846 8330A					SW846 8330A					SW846 8330A					SW846 8330A					SW846 8330A				
SAMPLE DATE	(µg/L)	3/20/2018					3/21/2018					3/22/2018					3/22/2018					3/20/2018					3/20/2018					3/20/2018				
		Result	Qual	DL	LOD	LOQ	Result	Qual	DL	LOD	LOQ	Result	Qual	DL	LOD	LOQ	Result	Qual	DL	LOD	LOQ	Result	Qual	DL	LOD	LOQ	Result	Qual	DL	LOD	LOQ	Result	Qual	DL	LOD	LOQ
EXPLOSIVES (USEPA Method 8330A) (µg/L)																																				
1,3,5-TRINITROBENZENE	NA	<	U	0.032	0.1	0.15	<	U	0.032	0.1	0.16	0.056	J	0.032	0.1	0.16	0.051	J	0.032	0.1	0.16	<	U	0.033	0.11	0.16	<	U	0.031	0.1	0.15	<	U	0.033	0.1	0.16
1,3-DINITROBENZENE	NA	<	U	0.052	0.1	0.15	<	U	0.052	0.1	0.16	<	U	0.052	0.1	0.16	<	U	0.052	0.1	0.16	<	U	0.053	0.11	0.16	<	U	0.051	0.1	0.15	<	U	0.053	0.1	0.16
2,4,6-TRINITROTOLUENE	2	<	U	0.052	0.1	0.15	1		0.052	0.1	0.16	<	U	0.052	0.1	0.16	<	U	0.052	0.1	0.16	<	U	0.053	0.11	0.16	<	U	0.051	0.1	0.15	<	U	0.053	0.1	0.16
2,4-DINITROTOLUENE	NA	<	U	0.052	0.1	0.13	<	U	0.052	0.1	0.14	<	U	0.052	0.1	0.13	<	U	0.052	0.1	0.14	<	U	0.053	0.11	0.14	<	U	0.051	0.1	0.13	<	U	0.053	0.1	0.14
2,6-DINITROTOLUENE	NA	<	U	0.052	0.1	0.13	<	U	0.052	0.1	0.14	<	U	0.052	0.1	0.13	<	U	0.052	0.1	0.14	<	U	0.053	0.11	0.14	<	U	0.051	0.1	0.13	<	U	0.053	0.1	0.14
2-AMINO-4,6-DINITROTOLUENE	NA	0.23		0.031	0.1	0.15	0.48		0.031	0.1	0.16	0.68		0.031	0.1	0.16	<	U	0.031	0.1	0.16	<	U	0.032	0.11	0.16	<	U	0.03	0.1	0.15	<	U	0.032	0.1	0.16
3-NITROTOLUENE	NA	<	U	0.059	0.21	0.52	<	U	0.059	0.21	0.52	<	U	0.059	0.21	0.52	<	U	0.06	0.21	0.52	<	U	0.06	0.21	0.53	<	U	0.058	0.2	0.51	<	U	0.06	0.2	0.53
4-AMINO-2,6-DINITROTOLUENE	NA	0.17		0.052	0.1	0.15	0.48		0.052	0.1	0.16	0.56		0.052	0.1	0.16	<	U	0.052	0.1	0.16	<	U	0.053	0.11	0.16	<	U	0.051	0.1	0.15	<	U	0.053	0.1	0.16
MNX	NA	<	U	0.037	0.1	0.52	<	U	0.038	0.1	0.52	<	U	0.037	0.1	0.52	<	U	0.038	0.1	0.52	<	U	0.038	0.11	0.53	<	U	0.037	0.1	0.51	<	U	0.038	0.1	0.53
HMX	400	0.33		0.029	0.1	0.15	0.041	J	0.029	0.1	0.16	1.4		0.029	0.1	0.16	0.19		0.029	0.1	0.16	2.9	J	0.03	0.11	0.16	2.3	J	0.028	0.1	0.15	2.3	J	0.03	0.1	0.16
NITROBENZENE	NA	<	U	0.052	0.1	0.15	<	U	0.052	0.1	0.16	<	U	0.052	0.1	0.16	<	U	0.052	0.1	0.16	<	U	0.053	0.11	0.16	<	U	0.051	0.1	0.15	<	U	0.053	0.1	0.16
RDX	2	0.28		0.037	0.1	0.15	0.29	J	0.038	0.1	0.16	1.7		0.037	0.1	0.16	<	U	0.038	0.1	0.16	0.18	J	0.038	0.11	0.16	<	U	0.037	0.1	0.15	0.062	J	0.038	0.1	0.16

Notes:

[shaded box] Concentrations exceed CHAAP HALs

* = Sample results for piezometer PZ017R rejected based on analysis error. PZ017R-18A duplicate sample (PZ021-18A) is shown.

< = less than LOQ

µg/L = micrograms per liter

CHAAP = Cornhusker Army Ammunition Plant

DL = detection limit

HAL = health advisory level

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

ID = identification number

J = estimated

LOD = limit of detection

LOQ = limit of quantification

MNX = mono-nitroso-RDX

NA = not available

OU = Operable Unit

Qual = qualifier

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

U = nondetect

USEPA = United States Environmental Protection Agency

TABLE 2 (CONTINUED)
SUMMARY OF EXPLOSIVES DETECTED, OU1 ON-POST MONITORING WELLS AND PIEZOMETERS
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FIELD ID	CHAAP	G0086-18A					G0087-18A					G0088-18A					G0089-18A				
METHOD	HALs	SW846 8330A					SW846 8330A					SW846 8330A					SW846 8330A				
SAMPLE DATE	(µg/L)	3/19/2018					3/19/2018					3/21/2018					3/22/2018				
		Result	Qual	DL	LOD	LOQ	Result	Qual	DL	LOD	LOQ	Result	Qual	DL	LOD	LOQ	Result	Qual	DL	LOD	LOQ
EXPLOSIVES (USEPA Method 8330A) (µg/L)																					
1,3,5-TRINITROBENZENE	NA	10		0.032	0.1	0.15	<	U	0.032	0.1	0.15	7		0.033	0.11	0.16	8.2		0.031	0.1	0.15
1,3-DINITROBENZENE	NA	<	U	0.051	0.1	0.15	<	U	0.051	0.1	0.15	<	U	0.053	0.11	0.16	<	U	0.05	0.1	0.15
2,4,6-TRINITROTOLUENE	2	2.7		0.051	0.1	0.15	<	U	0.051	0.1	0.15	0.95		0.053	0.11	0.16	5.5		0.05	0.1	0.15
2,4-DINITROTOLUENE	NA	<	U	0.051	0.1	0.13	<	U	0.051	0.1	0.13	<	U	0.053	0.11	0.14	<	U	0.05	0.1	0.13
2,6-DINITROTOLUENE	NA	<	U	0.051	0.1	0.13	<	U	0.051	0.1	0.13	<	U	0.053	0.11	0.14	<	U	0.05	0.1	0.13
2-AMINO-4,6-DINITROTOLUENE	NA	1.6		0.031	0.1	0.15	<	U	0.031	0.1	0.15	0.94		0.032	0.11	0.16	2		0.03	0.1	0.15
3-NITROTOLUENE	NA	<	U	0.058	0.21	0.51	<	U	0.058	0.2	0.51	<	U	0.061	0.21	0.53	<	U	0.057	0.2	0.5
4-AMINO-2,6-DINITROTOLUENE	NA	1.1		0.051	0.1	0.15	<	U	0.051	0.1	0.15	0.71		0.053	0.11	0.16	2.4		0.05	0.1	0.15
MNX	NA	<	U	0.037	0.1	0.51	<	U	0.037	0.1	0.51	<	U	0.038	0.11	0.53	<	U	0.036	0.1	0.5
HMX	400	0.53		0.029	0.1	0.15	0.54		0.029	0.1	0.15	0.21		0.03	0.11	0.16	0.9		0.028	0.1	0.15
NITROBENZENE	NA	<	U	0.051	0.1	0.15	<	U	0.051	0.1	0.15	<	U	0.053	0.11	0.16	<	U	0.05	0.1	0.15
RDX	2	0.26		0.037	0.1	0.15	0.072	J	0.037	0.1	0.15	0.16	J	0.038	0.11	0.16	2.1		0.036	0.1	0.15

FIELD ID	G0090-18A					G0091-18A					G0092-18A				
METHOD	SW846 8330A					SW846 8330A					SW846 8330A				
SAMPLE DATE	3/22/2018					3/15/2018					3/15/2018				
	Result	Qual	DL	LOD	LOQ	Result	Qual	DL	LOD	LOQ	Result	Qual	DL	LOD	LOQ
EXPLOSIVES (USEPA Method 8330A) (µg/L)															
1,3,5-TRINITROBENZENE	1.5		0.033	0.11	0.16	<	UJ	0.031	0.1	0.15	<	U	0.033	0.11	0.16
1,3-DINITROBENZENE	<	U	0.053	0.11	0.16	<	UJ	0.051	0.1	0.15	<	U	0.053	0.11	0.16
2,4,6-TRINITROTOLUENE	0.38		0.053	0.11	0.16	0.12	J	0.051	0.1	0.15	<	U	0.053	0.11	0.16
2,4-DINITROTOLUENE	<	U	0.053	0.11	0.14	<	UJ	0.051	0.1	0.13	<	U	0.053	0.11	0.14
2,6-DINITROTOLUENE	<	U	0.053	0.11	0.14	<	UJ	0.051	0.1	0.13	<	U	0.053	0.11	0.14
2-AMINO-4,6-DINITROTOLUENE	0.49		0.032	0.11	0.16	0.32	J	0.03	0.1	0.15	<	U	0.032	0.11	0.16
3-NITROTOLUENE	<	U	0.06	0.21	0.53	<	UJ	0.058	0.2	0.51	<	U	0.06	0.21	0.53
4-AMINO-2,6-DINITROTOLUENE	0.23		0.053	0.11	0.16	0.2	J	0.051	0.1	0.15	<	U	0.053	0.11	0.16
MNX	<	U	0.038	0.11	0.53	<	UJ	0.037	0.1	0.51	<	U	0.038	0.11	0.53
HMX	1.7		0.03	0.11	0.16	0.72	J	0.028	0.1	0.15	0.18		0.03	0.11	0.16
NITROBENZENE	<	U	0.053	0.11	0.16	<	UJ	0.051	0.1	0.15	<	U	0.053	0.11	0.16
RDX	1.7		0.038	0.11	0.16	1.1	J	0.037	0.1	0.15	<	U	0.038	0.11	0.16

FIELD ID	CHAAP	G0093-18A					G0094-18A					G0095-18A					G0096-18A				
METHOD	HALs	SW846 8330A					SW846 8330A					SW846 8330A					SW846 8330A				
SAMPLE DATE	(µg/L)	3/22/2018					3/23/2018					3/15/2018					3/23/2018				
		Result	Qual	DL	LOD	LOQ	Result	Qual	DL	LOD	LOQ	Result	Qual	DL	LOD	LOQ	Result	Qual	DL	LOD	LOQ
EXPLOSIVES (USEPA Method 8330A) (µg/L)																					
1,3,5-TRINITROBENZENE	NA	20		0.15	0.5	0.75	0.25	J	0.032	0.1	0.16	<	UJ	0.034	0.11	0.16	2.7		0.032	0.1	0.15
1,3-DINITROBENZENE	NA	<	U	0.05	0.1	0.15	<	UJ	0.052	0.1	0.16	<	UJ	0.054	0.11	0.16	<	U	0.051	0.1	0.15
2,4,6-TRINITROTOLUENE	2	3.5		0.05	0.1	0.15	4.9	J	0.052	0.1	0.16	<	UJ	0.054	0.11	0.16	0.27		0.051	0.1	0.15
2,4-DINITROTOLUENE	NA	<	U	0.05	0.1	0.13	0.9	J	0.052	0.1	0.13	<	UJ	0.054	0.11	0.14	<	U	0.051	0.1	0.13
2,6-DINITROTOLUENE	NA	<	U	0.05	0.1	0.13	0.13	J	0.052	0.1	0.13	<	UJ	0.054	0.11	0.14	0.14	J	0.051	0.1	0.13
2-AMINO-4,6-DINITROTOLUENE	NA	1.9		0.03	0.1	0.15	22	J	0.31	1	1.6	0.39	J	0.032	0.11	0.16	0.71		0.031	0.1	0.15
3-NITROTOLUENE	NA	<	U	0.057	0.2	0.5	<	UJ	0.059	0.21	0.52	<	UJ	0.062	0.22	0.54	<	U	0.058	0.2	0.51
4-AMINO-2,6-DINITROTOLUENE	NA	2.5		0.05	0.1	0.15	22	J	0.52	1	1.6	0.28	J	0.054	0.11	0.16	0.8		0.051	0.1	0.15
MNX	NA	<	U	0.036	0.1	0.5	1.1	J	0.37	0.1	0.52	<	UJ	0.039	0.11	0.54	0.69		0.037	0.1	0.51
HMX	400	0.82	J	0.028	0.1	0.15	34	J	0.029	1	1.6	0.52	J	0.03	0.11	0.16	5.3		0.029	0.1	0.15
NITROBENZENE	NA	<	U	0.05	0.1	0.15	<	UJ	0.052	0.1	0.16	<	UJ	0.054	0.11	0.16	<	U	0.051	0.1	0.15
RDX	2	0.62		0.036	0.1	0.15	16	J	0.37	1	1.6	0.17	J	0.039	0.11	0.16	19		0.18	0.51	0.77

FIELD ID	G0097-18A					G0098-18A					G0099-18A				
METHOD	SW846 8330A					SW846 8330A					SW846 8330A				
SAMPLE DATE	3/21/2018					3/21/2018					3/23/2018				
	Result	Qual	DL	LOD	LOQ	Result	Qual	DL	LOD	LOQ	Result	Qual	DL	LOD	LOQ
EXPLOSIVES (USEPA Method 8330A) (µg/L)															
1,3,5-TRINITROBENZENE	<	U	0.033	0.11	0.16	<	U	0.032	0.1	0.16	0.033	J	0.031	0.1	0.15
1,3-DINITROBENZENE	<	U	0.053	0.11	0.16	<	U	0.052	0.1	0.16	<	U	0.05	0.1	0.15
2,4,6-TRINITROTOLUENE	<	U	0.053	0.11	0.16	<	U	0.052	0.1	0.16	<	U	0.05	0.1	0.15
2,4-DINITROTOLUENE	<	U	0.053	0.11	0.14	<	U	0.052	0.1	0.14	<	U	0.05	0.1	0.13
2,6-DINITROTOLUENE	<	U	0.053	0.11	0.14	0.74	J	0.052	0.1	0.14	<	U	0.05	0.1	0.13
2-AMINO-4,6-DINITROTOLUENE	0.67		0.032	0.11	0.16	<	U	0.031	0.1	0.16	<	U	0.03	0.1	0.15
3-NITROTOLUENE	<	U	0.061	0.21	0.52	<	U	0.06	0.21	0.52	<	U	0.058	0.2	0.5
4-AMINO-2,6-DINITROTOLUENE	0.61		0.053	0.11	0.16	<	U	0.052	0.1	0.16	<	U	0.05	0.1	0.15
MNX	<	U	0.038	0.11	0.52	<	U	0.038	0.1	0.52	0.48	J	0.036	0.1	0.5
HMX	1.8		0.03	0.11	0.16	0.6	J	0.029	0.1	0.16	1.2	J	0.028	0.1	0.15
NITROBENZENE	<	U	0.053	0.11	0.16	<	U	0.052	0.1	0.16	<	U	0.05	0.1	0.15
RDX	<	U	0.038	0.11	0.16	<	U	0.038	0.1	0.16	1.7		0.036	0.1	0.15

Notes:

[shaded box] Concentrations exceed CHAAP HALs

* = Sample results for piezometer PZ017R rejected based on analysis error. PZ017R-18A duplicate sample (PZ021-18A) is shown.

< = less than LOQ
µg/L = micrograms per liter
CHAAP = Cornhusker Army Ammunition Plant
DL = detection limit
HAL = health advisory level
HMX = octahydro-1,3,5,7-tetranitro-1,3,5,7-tetrazocine
ID = identification number
J = estimated
LOD = limit of detection
LOQ = limit of quantification
MNX = mono-nitroso-RDX
NA = not available
OU = Operable Unit
Qual = qualifier
RDX = hexahydro-1,3,5-trinitro-1,3,5-triazine
U = nondetect
USEPA = United States Environmental Protection Agency

TABLE 2 (CONTINUED)
SUMMARY OF EXPLOSIVES DETECTED, OU1 ON-POST MONITORING WELLS AND PIEZOMETERS
2018 ANNUAL REPORT

FIELD ID	CHAAP	G0100-18A					G0101-18A					G0108-18A					G0109-18A					G0110-18A					G0111-18A					G0112-18A				
METHOD	HALs	SW846 8330A					SW846 8330A					SW846 8330A					SW846 8330A					SW846 8330A					SW846 8330A					SW846 8330A				
SAMPLE DATE	(µg/L)	3/15/2018					3/15/2018					3/21/2018					3/21/2018					3/22/2018					3/15/2018					3/21/2018				
		Result	Qual	DL	LOD	LOQ	Result	Qual	DL	LOD	LOQ	Result	Qual	DL	LOD	LOQ	Result	Qual	DL	LOD	LOQ	Result	Qual	DL	LOD	LOQ	Result	Qual	DL	LOD	LOQ	Result	Qual	DL	LOD	LOQ
EXPLOSIVES (USEPA Method 8330A) (µg/L)																																				
1,3,5-TRINITROBENZENE	NA	0.37	J	0.032	0.1	0.15	0.24	J	0.032	0.1	0.15	<	U	0.032	0.1	0.16	0.1	J	0.032	0.1	0.16	<	U	0.032	0.1	0.15	0.034	J	0.032	0.1	0.15	0.29	J	0.033	0.11	0.16
1,3-DINITROBENZENE	NA	<	U	0.051	0.1	0.15	<	UJ	0.052	0.1	0.15	<	U	0.052	0.1	0.16	<	U	0.052	0.1	0.16	<	U	0.051	0.1	0.15	<	UJ	0.051	0.1	0.15	<	U	0.053	0.11	0.16
2,4,6-TRINITROTOLUENE	2	<	U	0.051	0.1	0.15	<	UJ	0.052	0.1	0.15	<	U	0.052	0.1	0.16	<	U	0.052	0.1	0.16	<	U	0.051	0.1	0.15	0.063	J	0.051	0.1	0.15	0.072	J	0.053	0.11	0.16
2,4-DINITROTOLUENE	NA	<	U	0.051	0.1	0.13	<	UJ	0.052	0.1	0.13	<	U	0.052	0.1	0.14	<	U	0.052	0.1	0.14	<	U	0.051	0.1	0.13	<	UJ	0.051	0.1	0.13	<	U	0.053	0.11	0.14
2,6-DINITROTOLUENE	NA	<	U	0.051	0.1	0.13	<	UJ	0.052	0.1	0.13	0.44	J	0.052	0.1	0.14	<	U	0.052	0.1	0.14	0.19	J	0.051	0.1	0.13	<	UJ	0.051	0.1	0.13	<	U	0.053	0.11	0.14
2-AMINO-4,6-DINITROTOLUENE	NA	<	U	0.031	0.1	0.15	0.4	J	0.031	0.1	0.15	<	U	0.031	0.1	0.16	<	U	0.031	0.1	0.16	<	U	0.031	0.1	0.15	0.73	J	0.031	0.1	0.15	0.26		0.032	0.11	0.16
3-NITROTOLUENE	NA	<	U	0.058	0.2	0.51	<	UJ	0.059	0.21	0.52	<	U	0.059	0.21	0.52	<	U	0.06	0.21	0.52	<	U	0.058	0.2	0.51	<	UJ	0.058	0.2	0.51	<	U	0.06	0.21	0.53
4-AMINO-2,6-DINITROTOLUENE	NA	<	U	0.051	0.1	0.15	0.81	J	0.052	0.1	0.15	<	U	0.052	0.1	0.16	<	U	0.052	0.1	0.16	<	U	0.051	0.1	0.15	2.3	J	0.051	0.1	0.15	0.36		0.053	0.11	0.16
MNX	NA	<	U	0.37	0.1	0.51	<	UJ	0.037	0.1	0.52	<	U	0.038	0.1	0.52	<	U	0.038	0.1	0.52	<	U	0.037	0.1	0.51	<	UJ	0.037	0.1	0.51	<	U	0.038	0.11	0.53
HMX	400	<	UJ	0.029	1	1.5	2.2	J	0.029	0.1	0.15	0.79	J	0.029	0.1	0.16	2.8		0.029	0.1	0.16	0.37	J	0.029	0.1	0.15	1.3	J	0.029	0.1	0.15	0.77		0.03	0.11	0.16
NITROBENZENE	NA	<	U	0.051	0.1	0.15	0.096	J	0.052	0.1	0.15	<	U	0.052	0.1	0.16	<	U	0.052	0.1	0.16	<	U	0.051	0.1	0.15	<	UJ	0.051	0.1	0.15	<	U	0.053	0.11	0.16
RDX	2	<	U	0.037	0.1	0.15	1.1	J	0.037	0.1	0.15	<	U	0.038	0.1	0.16	<	U	0.038	0.1	0.16	<	U	0.037	0.1	0.15	0.48	J	0.037	0.1	0.15	0.6		0.038	0.11	0.16

FIELD ID	CHAAP	G0113-18A					G0114-18A					G0115-18A					G0116-18A					G0118-18A					G0119-18A					G0120-18A				
METHOD	HALs	SW846 8330A					SW846 8330A					SW846 8330A					SW846 8330A					SW846 8330A					SW846 8330A					SW846 8330A				
SAMPLE DATE	(µg/L)	3/21/2018					3/23/2018					3/19/2018					3/15/2018					3/22/2018					3/15/2018					3/14/2018				
		Result	Qual	DL	LOD	LOQ	Result	Qual	DL	LOD	LOQ	Result	Qual	DL	LOD	LOQ	Result	Qual	DL	LOD	LOQ	Result	Qual	DL	LOD	LOQ	Result	Qual	DL	LOD	LOQ	Result	Qual	DL	LOD	LOQ
EXPLOSIVES (USEPA Method 8330A) (µg/L)																																				
1,3,5-TRINITROBENZENE	NA	0.13	J	0.032	0.1	0.16	<	U	0.031	0.1	0.15	<	U	0.031	0.1	0.15	<	U	0.032	0.1	0.15	<	U	0.033	0.11	0.16	<	UJ	0.032	0.1	0.15	<	U	0.032	0.1	0.16
1,3-DINITROBENZENE	NA	<	U	0.052	0.1	0.16	<	U	0.05	0.1	0.15	<	U	0.05	0.1	0.15	<	U	0.051	0.1	0.15	<	U	0.053	0.11	0.16	<	UJ	0.051	0.1	0.15	<	U	0.052	0.1	0.16
2,4,6-TRINITROTOLUENE	2	<	U	0.052	0.1	0.16	<	U	0.05	0.1	0.15	<	U	0.05	0.1	0.15	<	U	0.051	0.1	0.15	<	U	0.053	0.11	0.16	<	UJ	0.051	0.1	0.15	<	U	0.052	0.1	0.16
2,4-DINITROTOLUENE	NA	<	U	0.052	0.1	0.14	<	U	0.05	0.1	0.13	<	U	0.05	0.1	0.13	3.3		0.051	0.1	0.13	<	U	0.053	0.11	0.14	<	UJ	0.051	0.1	0.13	<	U	0.052	0.1	0.13
2,6-DINITROTOLUENE	NA	<	U	0.052	0.1	0.14	<	U	0.05	0.1	0.13	<	U	0.05	0.1	0.13	<	U	0.051	0.1	0.13	<	U	0.053	0.11	0.14	<	UJ	0.051	0.1	0.13	<	U	0.052	0.1	0.13
2-AMINO-4,6-DINITROTOLUENE	NA	<	U	0.031	0.1	0.16	<	U	0.03	0.1	0.15	<	U	0.03	0.1	0.15	<	U	0.031	0.1	0.15	<	U	0.032	0.11	0.16	<	UJ	0.031	0.1	0.15	<	U	0.031	0.1	0.16
3-NITROTOLUENE	NA	<	U	0.059	0.21	0.52	<	U	0.058	0.2	0.5	<	U	0.057	0.2	0.5	<	U	0.058	0.2	0.51	<	U	0.06	0.21	0.53	<	UJ	0.058	0.2	0.51	<	U	0.059	0.21	0.52
4-AMINO-2,6-DINITROTOLUENE	NA	0.094	J	0.052	0.1	0.16	<	U	0.05	0.1	0.15	<	U	0.05	0.1	0.15	<	U	0.051	0.1	0.15	<	U	0.053	0.11	0.16	<	UJ	0.051	0.1	0.15	<	U	0.052	0.1	0.16
MNX	NA	<	U	0.037	0.1	0.52	<	U	0.036	0.1	0.5	<	U	0.036	0.1	0.5	<	U	0.037	0.1	0.51	<	U	0.038	0.11	0.53	<	UJ	0.037	0.1	0.51	<	U	0.037	0.1	0.52
HMX	400	0.77		0.029	0.1	0.16	0.68		0.028	0.1	0.15	2.1	J	0.028	0.1	0.15	9.1	J	0.029	0.1	0.15	5	J	0.029	0.11	0.16	0.085	J	0.029	0.1	0.15	10	J	0.029	0.1	0.16
NITROBENZENE	NA	<	U	0.052	0.1	0.16	<	U	0.05	0.1	0.15	<	U	0.05	0.1	0.15	<	U	0.051	0.1	0.15	<	U	0.053	0.11	0.16	<	UJ	0.051	0.1	0.15	<	U	0.052	0.1	0.16
RDX	2	<	U	0.037	0.1	0.16	0.3		0.036	0.1	0.15	<	U	0.036	0.1	0.15	<	U	0.037	0.1	0.15	<	U	0.038	0.11	0.16	<	UJ	0.037	0.1	0.15	<	U	0.037	0.1	0.16

Notes:

[shaded box] Concentrations exceed CHAAP HALs

* = Sample results for piezometer PZ017R rejected based on analysis error. PZ017R-18A duplicate sample (PZ021-18A) is shown.

< = less than LOQ
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TABLE 2 (CONTINUED)
SUMMARY OF EXPLOSIVES DETECTED, OU1 ON-POST MONITORING WELLS AND PIEZOMETERS
2018 ANNUAL REPORT

FIELD ID	CHAAP	G0121-18A					PZ009-18A					PZ010-18A					PZ011-18A					PZ012-18A					PZ013-18A					PZ014-18A				
METHOD	HALs	SW846 8330A					SW846 8330A					SW846 8330A					SW846 8330A					SW846 8330A					SW846 8330A					SW846 8330A				
SAMPLE DATE	(µg/L)	3/22/2018					3/15/2018					3/14/2018					3/19/2018					3/19/2018					3/14/2018					3/15/2018				
		Result	Qual	DL	LOD	LOQ	Result	Qual	DL	LOD	LOQ	Result	Qual	DL	LOD	LOQ	Result	Qual	DL	LOD	LOQ	Result	Qual	DL	LOD	LOQ	Result	Qual	DL	LOD	LOQ	Result	Qual	DL	LOD	LOQ
EXPLOSIVES (USEPA Method 8330A) (µg/L)																																				
1,3,5-TRINITROBENZENE	NA	<	U	0.031	0.1	0.15	1.5	J	0.032	0.1	0.15	<	UJ	0.033	0.11	0.14	<	U	0.033	0.11	0.16	<	U	0.033	0.11	0.16	<	U	0.033	0.11	0.16	<	UJ	0.033	0.11	0.16
1,3-DINITROBENZENE	NA	<	U	0.05	0.1	0.15	<	UJ	0.051	0.1	0.15	<	UJ	0.053	0.11	0.16	0.24	J	0.053	0.11	0.16	<	U	0.053	0.11	0.16	<	U	0.053	0.11	0.16	<	UJ	0.053	0.11	0.16
2,4,6-TRINITROTOLUENE	2	<	U	0.05	0.1	0.15	0.77	J	0.051	0.1	0.15	<	UJ	0.053	0.11	0.16	<	U	0.053	0.11	0.16	<	U	0.053	0.11	0.16	<	U	0.053	0.11	0.16	<	UJ	0.053	0.11	0.16
2,4-DINITROTOLUENE	NA	<	U	0.05	0.1	0.13	<	UJ	0.051	0.1	0.13	<	UJ	0.053	0.11	0.16	<	U	0.053	0.11	0.14	<	U	0.053	0.11	0.14	<	U	0.053	0.11	0.14	<	UJ	0.053	0.11	0.14
2,6-DINITROTOLUENE	NA	<	U	0.05	0.1	0.13	<	UJ	0.051	0.1	0.13	<	UJ	0.053	0.11	0.53	<	U	0.053	0.11	0.14	<	U	0.053	0.11	0.14	<	U	0.053	0.11	0.14	<	UJ	0.053	0.11	0.14
2-AMINO-4,6-DINITROTOLUENE	NA	0.5		0.03	0.1	0.15	1.2	J	0.031	0.1	0.15	0.27	J	0.032	0.11	0.14	<	U	0.032	0.11	0.16	<	U	0.032	0.11	0.16	0.97		0.032	0.11	0.16	<	UJ	0.032	0.11	0.16
3-NITROTOLUENE	NA	<	U	0.057	0.2	0.5	<	UJ	0.058	0.2	0.51	<	UJ	0.06	0.21	0.16	<	U	0.06	0.21	0.53	<	U	0.06	0.21	0.53	<	U	0.06	0.21	0.53	<	UJ	0.06	0.21	0.53
4-AMINO-2,6-DINITROTOLUENE	NA	0.51		0.05	0.1	0.15	0.93	J	0.051	0.1	0.15	0.57	J	0.053	0.11	0.16	<	U	0.053	0.11	0.16	<	U	0.053	0.11	0.16	2.1		0.053	0.11	0.16	<	UJ	0.053	0.11	0.16
MNX	NA	<	U	0.036	0.1	0.5	<	UJ	0.037	0.1	0.51	<	UJ	0.038	0.11	0.53	<	U	0.038	0.11	0.53	<	U	0.038	0.11	0.53	<	U	0.038	0.11	0.53	<	UJ	0.038	0.11	0.53
HMX	400	6.7	J	0.028	0.1	0.15	<	UJ	0.029	0.1	0.15	<	UJ	0.03	0.11	0.53	<	U	0.03	0.11	0.16	<	U	0.03	0.11	0.16	1.6	J	0.03	0.11	0.16	0.16	J	0.03	0.11	0.16
NITROBENZENE	NA	<	U	0.05	0.1	0.15	<	UJ	0.051	0.1	0.15	<	UJ	0.053	0.11	0.16	<	U	0.053	0.11	0.16	<	U	0.053	0.11	0.16	<	U	0.053	0.11	0.16	<	UJ	0.053	0.11	0.16
RDX	2	1.7		0.036	0.1	0.15	<	UJ	0.037	0.1	0.15	<	UJ	0.038	0.11	0.16	0.31		0.038	0.11	0.16	<	U	0.038	0.11	0.16	0.28	J	0.038	0.11	0.16	<	UJ	0.038	0.11	0.16

FIELD ID	CHAAP	PZ015-18A					PZ016-18A					PZ021-18A (PZ017R duplicate)*					PZ018-18A					PZ019-18A					PZ020-18A				
METHOD	HALs	SW846 8330A					SW846 8330A					SW846 8330A					SW846 8330A					SW846 8330A					SW846 8330A				
SAMPLE DATE	(µg/L)	3/22/2018					3/22/2018					3/20/2018					3/20/2018					3/20/2018					3/20/2018				
		Result	Qual	DL	LOD	LOQ	Result	Qual	DL	LOD	LOQ	Result	Qual	DL	LOD	LOQ	Result	Qual	DL	LOD	LOQ	Result	Qual	DL	LOD	LOQ	Result	Qual	DL	LOD	LOQ
EXPLOSIVES (USEPA Method 8330A) (µg/L)																															
1,3,5-TRINITROBENZENE	NA	<	U	0.032	0.1	0.15	<	U	0.032	0.1	0.16	8	J	0.032	0.1	0.16	15		0.16	0.52	0.79	<	U	0.032	0.1	0.15	3.2		0.032	0.1	0.15
1,3-DINITROBENZENE	NA	<	U	0.051	0.1	0.15	<	U	0.052	0.1	0.16	<	UJ	0.052	0.1	0.16	<	U	0.052	0.1	0.16	<	U	0.051	0.1	0.15	<	U	0.051	0.1	0.15
2,4,6-TRINITROTOLUENE	2	<	U	0.051	0.1	0.15	<	U	0.052	0.1	0.16	20	J	0.52	0.1	1.6	6.8		0.052	0.1	0.16	<	U	0.051	0.1	0.15	5.9		0.051	0.1	0.15
2,4-DINITROTOLUENE	NA	<	U	0.051	0.1	0.13	<	U	0.052	0.1	0.14	<	UJ	0.052	0.1	0.14	<	U	0.052	0.1	0.14	<	U	0.051	0.1	0.13	<	U	0.051	0.1	0.13
2,6-DINITROTOLUENE	NA	<	U	0.051	0.1	0.13	<	U	0.052	0.1	0.14	<	UJ	0.052	0.1	0.14	<	U	0.052	0.1	0.14	<	U	0.051	0.1	0.13	<	U	0.051	0.1	0.13
2-AMINO-4,6-DINITROTOLUENE	NA	<	U	0.031	0.1	0.15	0.59		0.031	0.1	0.16	4.4	J	0.031	0.1	0.16	2		0.031	0.1	0.16	<	U	0.031	0.1	0.15	3.3		0.031	0.1	0.15
3-NITROTOLUENE	NA	<	U	0.058	0.2	0.51	<	U	0.059	0.21	0.52	<	UJ	0.06	0.21	0.52	<	U	0.06	0.21	0.52	<	U	0.058	0.2	0.51	<	U	0.059	0.21	0.51
4-AMINO-2,6-DINITROTOLUENE	NA	<	U	0.051	0.1	0.15	0.83		0.052	0.1	0.16	4.5	J	0.052	0.1	0.16	2.1		0.052	0.1	0.16	<	U	0.051	0.1	0.15	3.1		0.051	0.1	0.15
MNX	NA	<	U	0.037	0.1	0.51	<	U	0.037	0.1	0.52	<	UJ	0.038	0.1	0.52	<	U	0.038	0.1	0.52	<	U	0.037	0.1	0.51	<	U	0.037	0.1	0.51
HMX	400	0.37		0.029	0.1	0.15	1.4		0.029	0.1	0.16	1.3	J	0.029	0.1	0.16	1.2		0.029	0.1	0.16	<	U	0.028	0.1	0.15	0.59		0.029	0.1	0.15
NITROBENZENE	NA	<	U	0.051	0.1	0.15	<	U	0.052	0.1	0.16	<	UJ	0.052	0.1	0.16	<	U	0.052	0.1	0.16	<	U	0.051	0.1	0.15	<	U	0.051	0.1	0.15
RDX	2	<	U	0.037	0.1	0.15	0.85		0.037	0.1	0.16	1.8	J	0.038	0.1	0.16	1.6		0.038	0.1	0.16	<	U	0.037	0.1	0.15	0.62		0.037	0.1	0.15

Notes:

(shaded) Concentrations exceed CHAAP HALs

* = Sample results for piezometer PZ017R rejected based on analysis error. PZ017R-18A duplicate sample (PZ021-18A) is shown.

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HMX = octahydro-1,3,5,7-tetranitro-1,3,5,7-tetrazocine
ID = identification number
J = estimated
LOD = limit of detection
LOQ = limit of quantification
MNX = mono-nitroso-RDX
NA = not available
OU = Operable Unit
Qual = qualifier
RDX = hexahydro-1,3,5-trinitro-1,3,5-triazine
U = nondetect
USEPA = United States Environmental Protection Agency

TABLE 3
HISTORICAL EXPLOSIVES MASS ESTIMATIONS AND PERCENT REDUCTIONS
2018 ANNUAL REPORT

March 2017			
Explosives Parameter(s)	**Load Line Treatment Areas (mass in pounds)**	**Area Between EW6 and EW7 (mass in pounds)**	**Total Area (mass in pounds)**
RDX	1.21	0.92	2.13
TNT	0.98	29.18	30.16
RDX + TNT	2.19	30.1	32.29

March 2018					
Explosive Parameter(s)	**Load Line Treatment Areas (mass in pounds)**	**Area Between EW6 and EW7 (mass in pounds)**	**Total Area (mass in pounds)**	**Load Line Treatment Areas (percent reduction since 2017)**	**Area Between EW6 and EW7 (percent reduction since 2016)**
RDX	1.09	0.69	1.78	9.9%	24.6%
TNT	0.20	39.87	40.06	79.9%	-36.6%
RDX+TNT	1.29	40.56	41.85	41.2%	-34.8%

Notes:

The explosives mass was estimated using the CHAAP groundwater contaminant fate and transport model.

% = percent

CHAAP = Cornhusker Army Ammunition Plant

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

TNT = 2,4,6-trinitrotoluene

TABLE 4
2019 GROUNDWATER MODEL SCENARIO 1
(No Additional Injections)

EW7 Pumping @ 300 gpm (Years)	Treatment Effects (Years)	Concentrations ND at EW7	Concentrations ND Site-wide	Off-site Migration	Notes
2018					
0-1	0-1	12	17	No	EW7 active for one year (through 2018). Treatment effects for 1 year (from 2016 injections).

TABLE 5
2019 GROUNDWATER MODEL SCENARIO 2
(Subsurface Injections in 2019 and 2020)

EW7 Pumping @ 300 gpm (Years)	Treatment Effects (Years)	Concentrations ND at EW7	Concentrations ND Site-wide	Off-site Migration	Notes
2018					
0-1	0-5	6	10	No	EW7 active for one year (through 2018). Injections 2019 (600 points @ EW7) and 2020 (168 @ EW7, 432 @ LL1 and LL2). Treatment effects for next 5 years (from 2016, 2019, 2020 injections).