Five-Year Review Report

1st Five-Year Review Report
For
Former Nebraska Ordnance Plant
Operable Unit No. 2 (Groundwater)
Mead, Nebraska

May 2009

Prepared For:

U.S. Army Corps of Engineers – Kansas City District
Kansas City, Missouri

Prepared By:

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UNITED STATES ENVIRONMENTAL PROTECTION AGENCY

REGION VII
901 NORTH 5TH STREET
KANSAS CITY, KANSAS 66101

MEMORANDUM SEP 16 2009

SUBJECT: Recommendation for Division Director Approval
Five-Year Review Report, Operable Unit 2 (Groundwater)
Former Nebraska Ordnance Plant Site, Mead, Nebraska

FROM: Ken Rapplean, Remedial Project Manager
Missouri/Kansas Remedial Branch

THRU: Audrey Asher, Senior Regional Attorney
Regional Counsel

FVR Diane Easley, Chief
Missouri/Kansas Remedial Branch

TO: Cecilia Tapia, Director
Superfund Division

The attached subject document is complete and follows the *Comprehensive Five-Year Review Guidance* dated June 2001.

This review was a policy review and recognizes that the remedy was not functioning as intended by the decision document because the construction of the remedy has not been completed at the time of the review. The results at this time indicate that the remedy as designed is protective of human health and the environment.

The following recommendations for Operable Unit 2 of the Former Nebraska Ordnance Plant site include:

- Continue groundwater monitoring and analysis of chemical data to evaluate the changes in distribution of the contaminants of concern (COCs) as a means of determining the protectiveness of the system.
- Continue to evaluate the need to install additional containment and/or focused extraction wells as required within the confines of the Record of Decision (ROD).
- Continue groundwater treatment and remedy optimization modeling to evaluate focused extraction alternatives as provided in the ROD.
- Continue groundwater treatment and remedy optimization modeling to evaluate alternatives for maintaining hydraulic containment of the COCs.

This report is provided for your consideration and approval. If you have any questions, please call me at x7769.

Attachments

Approve Tapia 9/16/09 Disapprove _____

30057118
Superfund 8.0

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DEPARTMENT OF THE ARMY
KANSAS CITY DISTRICT, CORPS OF ENGINEERS
700 FEDERAL BUILDING
KANSAS CITY, MISSOURI 64106-2896

REPLY TO
ATTENTION OF:

May 14, 2009

Environmental Programs Branch
Planning, Programs and Project Management Division

Mr. Ken Rapplean, Remedial Project Manager
U.S. Environmental Protection Agency, Region VII
Superfund Division, Missouri/Kansas Remedial Branch
901 N. 5th Street
Kansas City, Kansas 66101

Mr. Ed Southwick
Nebraska Department of Environmental Quality
P.O. Box 98922
Lincoln, Nebraska 68509-8922

Dear Mr. Rapplean and Mr. Southwick:

Enclosed is the final *Five-Year Review for Nebraska Ordnance Plant, Operable Unit No. 2*. In addition, an electronic version of the document is provided. Please contact me at 816-389-3172 or by e-mail at kristine.m.stein@usace.army.mil with any questions on this matter.

Sincerely,

Kristine M. Stein
Project Manager

Enclosure

TABLE OF CONTENTS

Executive Summary ES-1

Section 1 Introduction 1-1

Section 2 Site Chronology 2-1

Section 3 Site Background 3-1

3.1 Site Description 3-1
3.2 Site History 3-1
3.3 Physical Characteristics 3-2
3.3.1 Physiography and Topography 3-3
3.3.2 Geology 3-3
3.3.3 Hydrostatigraphy 3-5
3.4 Land and Resource Use 3-6
3.5 History of Contamination 3-6
3.6 OU2 Actions 3-7
3.6.1 Remedial Investigation Results 3-7
3.6.2 Removal Actions 3-8
3.7 Basis for Taking Action (Summary of Site Risks) 3-9

Section 4 Remedial Action 4-1

4.1 Remedy Selection 4-1
4.2 Remedy Implementation 4-3
4.3 System Operations/Operations and Maintenance (O&M) 4-9
4.3.1 General Overview 4-9
4.3.2 Sampling and Monitoring 4-10
4.3.2.1 Main Groundwater Treatment Plant 4-10
4.3.2.2 Load Line 1 Groundwater Treatment Plant 4-11
4.3.2.3 Groundwater Circulation Well Operation 4-12
4.3.3 Reporting 4-13
4.3.4 Cost Summary 4-13
4.3.5 O&M Summary 4-14

Section 5 Progress Since the Last Five-Year Review 5-1

Section 6 Five-Year Review Process 6-1

6.1 Administrative Components 6-1
6.2 Community Notification and Involvement 6-1
6.3 Document Review 6-1
6.4 Data Review 6-2

6.4.1 2002 GMP 6-2
6.4.2 2003 GMP 6-3
6.4.3 2004 GMP 6-4
6.4.4 2005 GMP 6-5
6.4.5 2006 GMP 6-6
6.4.6 Evaluation of Newly Installed 2006 Monitoring Wells 6-7
6.4.7 Evaluation of Historical COC Concentration Trends 6-8
6.4.8 Chemical Results – Extraction Wells 6-12
6.4.9 Current Extent of Contamination 6-12
6.5 Site Inspection 6-12
6.6 Interviews 6-13

Section 7 Technical Assessment 7-1

7.1 Question A: Is the Remedy Functioning as Intended by the Decision Documents? 7-1
7.2 Question B: Are the Exposure Assumptions, Toxicity Data, Cleanup Levels, and Remedial Action Objectives Used at the Time of the Remedy Still Valid? 7-6
7.3 Question C: Has Any Other Information Come to Light That Could Call into Question the Protectiveness of the Remedy? 7-9
7.4 Summary of Technical Assessment 7-9

Section 8 Issues 8-1

Section 9 Recommendations and Follow-Up Actions 9-1

Section 10 Concluding Protectiveness Statement 10-1

Section 11 Next Review 11-1

Tables

Table 2-1 Chronology of Site Events
Table 3-1 Range of COC Concentrations Detected in Monitoring Well Samples During the OU2 Remedial Investigation
Table 3-2 Chemicals of Potential Concern in Groundwater
Table 3-3 Calculated Cancer Risk
Table 3-4 Calculated Hazard Index
Table 4-1 Final Target Groundwater Cleanup Goals
Table 4-2 Extraction Well Design Flow Rates

Table 4-3 Final Effluent Limitations Monitoring Requirements

Table 4-4 Annual System Operations/O&M Costs

Table 6-1 2002 GMP Groundwater Monitoring Well Sampling Summary

Table 6-2 2002 GMP Groundwater Monitoring Well Analytical Results for COCs Above Target Cleanup Goals

Table 6-3 2002 GMP Water Supply Well Sampling Summary

Table 6-4 2003 GMP Groundwater Monitoring Well Sampling Summary

Table 6-5 2003 GMP Groundwater Monitoring Well Analytical Results for COCs Above Target Cleanup Goals

Table 6-6 2003 GMP Water Supply Well Sampling Summary

Table 6-7 2004 GMP Groundwater Monitoring Well Sampling Summary

Table 6-8 2004 GMP Groundwater Monitoring Well Analytical Results for COCs Above Target Cleanup Goals

Table 6-9 2004 GMP Water Supply Well Sampling Summary

Table 6-10 2005 GMP Groundwater Monitoring Well Sampling Summary

Table 6-11 2005 GMP Groundwater Monitoring Well Analytical Results for COCs Above Target Cleanup Goals

Table 6-12 2005 GMP Water Supply Well Sampling Summary

Table 6-13 2006 GMP Groundwater Monitoring Well Sampling Summary

Table 6-14 2006 GMP Groundwater Monitoring Well Analytical Results for COCs Above Target Cleanup Goals

Table 6-15 2006 GMP Water Supply Well Sampling Summary

Table 6-16 Newly Installed Eastern and Southern Perimeter Groundwater Monitoring Well Sampling Summary

Table 6-17 TCE and RDX in Southern and Eastern Perimeter Monitoring Wells

Table 6-18 Extraction Well Sampling – TCE Results

Table 6-19 Extraction Well Sampling – RDX Results

Figures

Figure 1-1 General Site Location Map

Figure 3-1 Detailed Site Location Map

Figure 4-1 Overall Site Map

Figure 6-1 TCE in Shallow Monitoring Wells and Direct-Push Samples

Figure 6-2 TCE in Intermediate Monitoring Wells and Direct-Push Samples

Figure 6-3 RDX in Shallow Monitoring Wells and Direct-Push Samples

Figure 6-4 RDX in Intermediate Monitoring Wells and Direct-Push Samples

Attachments

Attachment 1 Load Line 1 and Main Groundwater Treatment Plant Layouts

Attachment 2 Typical Screen Displays of Automated System at the Main Treatment Plant

Attachment 3 Public Notice

Attachment 4 List of Documents Reviewed

Attachment 5 Site Inspection Checklist

Attachment 6 Photos Documenting Site Conditions

LIST OF ACRONYMS

2-AM-DNT	2-amino-4,6-dinitrotoluene
4-AM-DNT	4-amino-2,6-dinitrotoluene
AFBMD	Air Force Ballistic Missile Division
AMA	Atlas Missile Area
AOP	Advanced Oxidation Process
ARAR	Applicable or Relevant and Appropriate Requirement
ARDC	Agricultural Research and Development Center
ARPR	Annual Remedy Performance Report
ASTSWMO	Association of State and Territorial Solid Waste Management Officials
ATSDR	Agency for Toxic Substances and Disease Registry
AWSS	alternative water supply support
bgs	below ground surface
BLRA	Baseline Risk Assessment
Cal/EPA	California Environmental Protection Agency
CENWK	U.S. Army Corps of Engineers, Kansas City District
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
CF	calibration factor
CFR	Code of Federal Regulations
COC	chemical of concern
COPC	chemical of potential concern
CRA	Containment Removal Action
CSF	cancer slope factor
CV	calibration variation
%D	percent difference
1,1-DCA	1,1-dichloroethane
cis 1,2-DCE	*cis* 1,2-dichloroethene
1,2-DCP	1,2-dichloropropane
2,4-DNT	2,4-dinitrotoluene
DOD	Department of Defense
ECC	Environmental Chemical Corporation
EIS	Environmental Impact Statement
EO	Executive Order
EPA	U.S. Environmental Protection Agency
ERT	Environmental Response Team
EW	extraction well
FDS	field duplicate sample
FFA	Federal Facilities Agreement
FFRRO	Federal Facilities Restoration & Reuse Office
FNOP	former Nebraska Ordnance Plant
FS	Feasibility Study
FYR	Five-Year Review
feet/day	feet per day
GAC	granular activated carbon
GC/MS	gas chromatography/mass spectrometry
GCW	groundwater circulation well
GMP	groundwater monitoring program

GP	Geoprobe® point (direct-push location identifier)
gpm	gallons per minute
GSA	General Services Administration
HA	Health Advisory
HI	hazard index
HMX	octahydro-1,3,5,7-tetranitro-1,3,5,7-tetrazocine
HQ	hazard quotient
IAG	Interagency Agreement
ICAL	initial calibration
IRIS	Integrated Risk Information System
J	estimated concentration (below quantitation limit)
LAP	load, assemble, and pack
LCS	laboratory control samples
LCSD	laboratory control sample duplicate
LL	load line
LWS	Lincoln Water Supply
MCL	Maximum Contaminant Level
MGD	million gallons per day
mg/kg	milligram per kilogram
MS	matrix spike
MSD	matrix spike duplicate
MUD	Metropolitan Utilities District
MUDGM	Metropolitan Utilities District Groundwater Model
MW	monitoring well
NAVD	North American Vertical Datum
NCP	National Contingency Plan
NDEQ	Nebraska Department of Environmental Quality
NOP	Nebraska Ordnance Plant
NPL	National Priorities List
NYSDOH	New York State Department of Health
O&M	operations and maintenance
OERR	Office of Emergency and Remedial Response
OSWER	Office of Solid Waste and Emergency Response
OU	operable unit
ppbv	parts per billion by volume
PPRTV	Provisional Peer-Reviewed Toxicity Value
PRAP	Proposed Remedial Action Plan
QAPP	Quality Assurance Project Plan
QC	quality control
R	rejected (unusable) data
RA	remedial action
RAGS	Risk Assessment Guidance for Superfund
RAO	remedial action objective
RAB	Restoration Advisory Board
RD	remedial design
RDGM	Remedial Design Groundwater Model

RDX	hexahydro-1,3,5-trinitro-1,3,5-triazine
REL	Reference Exposure Level
RF	response factor
RI	Remedial Investigation
ROD	Record of Decision
RPD	relative percent difference
%RSD	percent relative standard deviation
SAP	Sampling and Analysis Plan
SDG	sample delivery group
SMP	Site Management Plan
SVOC	semi-volatile organic compound
TAGA	Trace Atmospheric Gas Analyzer
TCE	trichloroethene
TNB	1,3,5-trinitrobenzene
TNT	trinitrotoluene
TO	task order
trans 1,2-DCE	trans 1,2-dichloroethene
U	non-detected
URS	URS Group, Inc.
USACE	U.S. Army Corps of Engineers
UV	ultraviolet
UXO	unexploded ordnance
VOC	volatile organic compound
WSW	water supply well
µg/L	microgram per liter
$\mu g/m^3$	microgram per cubic meter

This document presents the first Five Year Review (FYR) report for Operable Unit (OU) 2 at the former Nebraska Ordnance Plant (FNOP), Mead, Nebraska and covers the period from February 2002 through February 2007. The purpose of this FYR is to provide a determination as to whether the implemented remedy is or will be protective of human health and the environment.

FNOP was a load, assemble, and pack (LAP) facility which produced bombs, boosters, and shells. It included four bomb load lines (the first of which began operation in October 1942), a bomb booster assembly plant, an ammonium nitrate plant, two explosives burning areas, a proving range, a landfill, a wastewater treatment plant, analytical laboratories, and storage and administration facilities. Most of the raw materials used to manufacture the weapons were produced at other locations and shipped to the FNOP facility for assembly.

OU2 (groundwater) sampling was initiated by the U. S. Army Corps of Engineers (USACE) during the 1989 Confirmation Sampling when samples were collected from monitoring wells and water supply wells. Hexahydro-1,3,5-trinitro-1,3,5-triazine (RDX), trinitrotoluene (TNT), and trichloroethene (TCE) were identified in the groundwater samples. Some of the TCE concentrations exceeded the Maximum Contaminant Level (MCL) of 5 micrograms per liter (µg/L). As a result of the Confirmation Study, carbon filtration systems were installed at two residences southeast of FNOP, a carbon filtration system was installed at the University of Nebraska-Lincoln, Agricultural Research and Development Center (ARDC) Agronomy Building, and two ARDC water supply wells were removed from service. Subsequently, the water supply well sampling was continued on a periodic basis. Additional residences were identified where the TCE concentrations exceeded the MCL or the RDX concentrations exceeded the Lifetime Health Advisory (HA) of 2 µg/L. Currently, water is being treated and/or bottled water is being supplied at four private residences and one commercial space which are all southeast of FNOP.

In late 1989 and early 1990, a soil gas survey was conducted by USACE to evaluate areas of soil that may be contributing TCE contamination to groundwater. TCE and other volatile organic compound (VOCs) were detected in some samples; however, source areas were not definitively identified. USACE subsequently installed and sampled additional monitoring wells prior to the OU2 Remedial Investigation (RI).

The FNOP site was listed on the National Priorities List (NPL) under Section 105 of CERCLA on August 30, 1990. In September 1991, USACE, the U.S. Environmental Protection Agency (EPA), and the Nebraska Department of Environmental Quality (NDEQ) (formerly the Nebraska Department of Environmental Control) entered into a Federal Facilities Agreement (FFA), formerly known as an Interagency Agreement (IAG)) under Section 120 of the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) to investigate and control environmental contamination at the FNOP site.

As part of the RI/Feasibility Study (FS) process, a Baseline Risk Assessment (BLRA) was completed which concluded that exposure to site groundwater may result in unacceptable risks to human health (Woodward-Clyde, 1994a). As a result, an FS was completed which led to the preparation of a Proposed Remedial Action Plan (PRAP) and subsequently the Record of Decision (ROD) in October 1996.

As a part of the remedy development process, remedial action objectives (RAOs) were developed to address the contaminated groundwater and explosives-contaminated soil which could act as a source of explosives contamination of groundwater while considering the long-term goals of protecting human health and the environment and meeting Applicable or Relevant and Appropriate Requirements (ARARs) of federal and state laws and regulations.

The OU2 RAOs stated:

- Minimize the potential for ingestion of contaminated groundwater, or reduce concentrations to acceptable health-based levels
- Minimize the potential for dermal exposure to contaminated groundwater, or reduce concentrations to acceptable health-based levels
- Minimize the potential for inhalation of chemicals released during the use of contaminated groundwater, or reduce concentrations to acceptable health-based levels

The remedial action for explosives-contaminated leaching soils is to remediate those soils to the degree that the groundwater remediation potentially benefits by saving time and money, and/or increasing protectiveness.

The remedy that has been implemented to date includes the following components:

- Thirteen extraction wells (EW) have been installed to hydraulically contain contaminated groundwater.
  - Currently, the operation of EW-13 is not necessary because the capture zone of EW-12, as represented by transport simulations, demonstrates that TCE will not migrate beyond the immediate vicinity of EW-12 in the next five years.
  - Extraction well EW-11, originally designed to serve as a containment well, has been redefined to meet the criteria for a focused extraction well to remediate groundwater containing high concentrations of TCE associated with the Load Line (LL) 1 TCE plume. EW-8 will cease operation when EW-11 begins operation in the first quarter of 2008.
- Focused extraction of groundwater in areas with relatively high concentrations of TCE and explosives. Groundwater circulation well (GCW)-1 (TCE) and GCW-2 (RDX) (Figure 4-1), originally installed as a pilot study wells in response to public concern over groundwater extraction at high rates, continue to operate as designed meeting the criteria for focused extraction
- Treatment all extracted groundwater with disposal of the treated groundwater through beneficial reuse or through surface discharge
- Potable water supply to local groundwater users whose water supply contains RDX exceeding the HA and/or TCE exceeding the MCL has been provided
- Active groundwater monitoring (including quality and groundwater elevations)
- Explosives-contaminated soil which could act as a source of explosives contamination of groundwater and which does not meet the OU1 excavation criteria has been excavated and treated

The period covered by this FYR goes from construction completion of the main groundwater treatment plant in February 2002 through February 2007. This policy FYR is required because hazardous substances, pollutants, or contaminants remain at the site related to OU2 above levels that allow for unlimited or unrestricted site use. This document was prepared in general accordance with the *Comprehensive Five-Year Review Guidance*, dated June 2001, Office of Solid Waste and Emergency Response (OSWER) Directive 9355.7-03B-P.

Completion of this FYR determined that the remedy is currently functioning effectively and is protective of human health and the environment. Exposure pathways identified in the ROD that could result in unacceptable risks are being controlled. In addition, exposure pathways identified subsequent to signature of the ROD for OU2 that could potentially result in unacceptable risks (i.e., vapor intrusion and pivot irrigation) were evaluated to determine their potential long-term impact(s) on remedy protectiveness. USACE, EPA, and NDEQ will be conducting further studies to better characterize vapor intrusion risks. An evaluation conducted in 2007 (URS, 2007f) concluded that current irrigation practices should not pose an unacceptable risk or hazard.

In the long term, protectiveness will continue to be evaluated and verified through the collection of groundwater samples in accordance with the approved groundwater monitoring program (GMP) work plan(s), routine maintenance, upkeep, and reporting related to the containment system; and routine maintenance, upkeep, and reporting related to the focused extraction system. As long as the elements required by the ROD remain in place and functioning, the chemicals of concern (COCs) in the sentry wells remain below the Final Target Groundwater Cleanup Goals, the treatment system including the focused extraction wells are functioning, groundwater is routinely monitored, and water is provided to users with impacted private wells, the remedy is judged to be protective and functioning in accordance with the ROD.

Five-Year Review Summary Form

SITE IDENTIFICATION		
Site name ***(from WasteLAN)*****: Former Nebraska Ordnance Plant-Operable Unit 2 (Groundwater)**		
EPA ID ***(from WasteLAN)*****: NE6211890011**		
Region: VII	**State: NE**	**City/County: Mead/Saunders**
SITE STATUS		
NPL status: Final		
Remediation status: Under Construction, Operating		
Multiple Operable Units? YES	**Construction completion date: NA**	
Has site been put into reuse? YES		
REVIEW STATUS		
Lead agency: : U.S. Army Corps of Engineers		
Author name: various		
Author title: various	**Author affiliation: USACE, Kansas City District**	
Review period: February 2002 to February 2007		
Date(s) of site inspection: April 18, 2007		
Type of review: Post SARA		
Review number: 1		
Triggering action: Not given		
Triggering action date ***(from WasteLAN)*****: Not given**		
Due date ***(five years after triggering action date)*****: Not given**		

Five-Year Review Summary Form (cont'd)

Issues:

1) An evaluation of all operational, hydraulic, and chemical data collected in 2006 indicates the remedy is not meeting all the requirements of the ROD and fully achieving the desired results, specifically as it relates to hydraulic containment. The capture zone analysis identified the following three areas of concern requiring further evaluation:

- The middle of the LL3 RDX plume north of EW-4 and EW-5
- A small portion of the east side of the LL1 TCE plume approximately 1 mile north of EW-12
- A small portion of the east side of the Atlas Missile Area (AMA) TCE plume near MW-45, approximately 1 mile north of EW-1

2) The potential exposure pathway resulting from vapor intrusion into buildings overlying the TCE plume(s) was not previously evaluated for the site, but has been identified as a potentially complete exposure pathway. Vapor intrusion into buildings may result when TCE in contaminated groundwater volatilizes and impacts buildings overlying or in close proximity to the TCE plume.

3) The potential exposure pathway resulting from pivot irrigation utilizing potentially TCE-contaminated groundwater was not previously evaluated for the site, but has been identified as a potentially complete exposure pathway.

4) Concentrations of TCE and RDX in Johnson/Clear Creeks have increased subsequent to the initial risk evaluation completed in 2000. A re-evaluation of the potential risks from TCE and RDX in the creek may be required.

Recommendations and Follow-up Actions:

1) Steps are being implemented to reach full hydraulic containment. These steps include additional investigations regarding the extent of contamination, and groundwater treatment and remedy optimization modeling to better predict plume behavior. These activities, combined with adjustments to the system currently in place and operational, will be used to evaluate the impacts of placing additional groundwater extraction wells to address containment and minimize restoration time.

Groundwater treatment and remedy optimization modeling will include a detailed analysis of focused extraction alternatives designed to rapidly remove contamination and to shorten remediation time when compared to hydraulic containment pumping alone. It will also be used to evaluate the affects of TCE-contaminated groundwater discharges to surface water and the migration of groundwater beneath Clear Creek due to irrigation pumping. During the first quarter of 2008, EW-11, originally installed as containment well, will begin functioning as a focused extraction well.

July 31, 2011, has been established as the date when USACE will demonstrate hydraulic containment through submission of the 2010 Containment Evaluation (CE). The 2010 CE will provide a comprehensive assessment of hydraulic containment at the site.

Five-Year Review Summary Form (cont'd)

2) Vapor intrusion as a potential exposure pathway is currently under evaluation by USACE and EPA. EPA is scheduled to perform an assessment in fall 2007 using a Trace Atmospheric Gas Analyzer or TAGA mobile laboratory. EPA will evaluate the potential exposure pathway from vapor intrusion into buildings overlying the TCE plume(s) and whether vapor intrusion at any such buildings poses an unacceptable risk to human health. Resulting data will be provided to USACE during the first quarter of 2008.

3) The document entitled "Draft Technical Memorandum, Evaluation of Potential Risks Associated with Inhalation of TCE Released During Irrigation, Former Nebraska Ordnance Plant, Mead, Nebraska, In Support of the Five Year Review" evaluated potential risks to farm workers who practice field irrigation. The analysis concluded that the cancer risks and non-cancer hazard quotient (HQ) associated with inhalation of TCE released from current irrigation wells was very low and that the current irrigation practices should not pose an unacceptable risk or hazard (URS, 2007e).

4) Groundwater treatment and remedy optimization modeling will be used to evaluate the affects of TCE-contaminated groundwater discharges to surface water and the migration of groundwater beneath Clear Creek due to irrigation pumping.

Protectiveness Statement(s):

Although some remedy components have not been fully implemented and/or constructed, the portions of the remedy that have been implemented and/or constructed have achieved the goal for protection of human health. The OU2 remedy is expected to be protective of human health and the environment upon completion. July 31, 2011, has been established as the date when USACE will demonstrate hydraulic containment through submission of the 2010 CE. In the interim, exposure pathways that could result in unacceptable risks are being controlled, including the ingestion of contaminated groundwater.

Long-term protectiveness of the remedial action will be verified through the GMP and the collection of water quality data to fully evaluate potential migration of the contaminant plumes. Current data indicate that the plumes remain on site and that the remedy is functioning, as required, to achieve Final Target Groundwater Cleanup Goals. This protectiveness statement is based on the following:

- The hydraulic containment remedy component is not fully constructed. However, implementation of this component is proceeding in accordance with the ROD and the FFA. Ongoing evaluation of this remedy component has identified three areas that require additional work before full operational status of hydraulic containment is achieved. Short-term protectiveness is afforded by construction activities, to date, and support from other remedy components.

  The focused extraction remedy component is not fully constructed. However, in an effort to rapidly remove contamination and shorten restoration time in areas with relatively high TCE and/or RDX concentrations, EW-11 will begin functioning as a focused extraction well starting in the first quarter of 2008. Also, two pilot study GCWs continue to provide limited focused extraction, though not formally adopted under the FFA. Groundwater treatment and remedy optimization modeling is being used to evaluate detailed focused

Five-Year Review Summary Form (cont'd)

extraction alternatives. This remedy component does not impact short-term protectiveness.

- The groundwater treatment remedy component is operating. All extracted groundwater is being effectively treated using GAC adsorption, AOP, or air stripping. All discharge criteria were met during the FYR period.
- The disposal and beneficial reuse remedy component is operating. Treated groundwater is being properly disposed of by providing it to local users for beneficial reuse or through surface discharge.
- The alternative water supply support component of the remedy is operating. Potable water is being supplied to local groundwater users whose water supply contains RDX exceeding the HA and/or TCE exceeding the MCL. Based on chemical sampling results and visual inspection of the local area, no residents were known to be consuming drinking water that contained contaminants exceeding the OU2 Final Target Groundwater Cleanup Goals.
- The monitoring and water quality remedy component is operating. Groundwater elevations and water quality are monitoring on a quarterly, semi-annual, or annual basis to ensure the plumes are not expanding and that currently un-impacted water users are not impacted. Groundwater elevations and water quality information are used to support the hydraulic containment evaluation, with its associated groundwater modeling, placement of focused extraction wells, and the alternative water supply support program. The primary use of this information is to determine protectiveness. It also provides valuable information used to support decisions on several other remedy components.
- The excavation remedy component has been completed. Soils, which could have acted as a source of explosives contamination of groundwater and which did not meet the OU1 excavation criteria, were excavated and treated via incineration during implementation of the OU1 remedy.

In addition, exposure pathways identified subsequent to ROD signature (i.e., vapor intrusion and pivot irrigation) are being further evaluated to determine long-term impact(s).

In the short term, protectiveness has been achieved by those remedy components that are fully constructed and operational. In the long term, protectiveness will continue to be evaluated and verified through the collection of groundwater samples in accordance with the approved GMP work plan(s), routine maintenance, upkeep, and reporting related to the containment system; and routine maintenance, upkeep, and reporting related to the focused extraction system. The remedy is expected to be protective of human health and the environment upon completion.

Other Comments:

None

This document presents the First Five-Year Review (FYR) report for OU2 (Groundwater) at the former Nebraska Ordnance Plant (FNOP) near Mead, Nebraska (**Figure 1-1**). The purpose of this FYR is to provide a determination as to whether the implemented remedy is or will be protective of human health and the environment. The methods, findings, issues, recommendations and conclusions of the FYR are documented in this FYR report.

This is the first FYR conducted for OU2. The FYR was initiated by the U.S. Army Corps of Engineers, Kansas City District in April 2007 and completed in July 2008 following input and review by EPA. This policy review covers a time interval from startup of operation of the groundwater treatment system as a remedial action in February 2002 through February 2007. This FYR is required because hazardous substances, pollutants, or contaminants, related to OU2, remain at the site above levels that allow for unlimited or unrestricted site use.

This FYR is based on site-specific considerations for OU2 as the OU2 remedy is the only operable unit with a selected remedy that requires a FYR. The ROD for OU1 was signed in November 1995. Soils, which could potentially act as a source of explosives contamination to groundwater, were excavated and incinerated on site during implementation of the OU1 remedial action, completed in 1997 (OHM, 1998). No FYR is required for OU1 because no hazardous substances remained on site above health-based levels following remediation. OU3 has not reached the ROD phase, therefore, no FYR is required.

Background information collected and reviewed for the FYR included, but was not limited to, site investigation reports, remedial investigation reports, feasibility study reports, the ROD, design reports, long-term monitoring reports and other site-related documentation. Other information used in the FYR resulted from the receipt of public input interviews and the site inspection completed during the site visit on April 18, 2007. The document was prepared in general accordance with the *Comprehensive Five-Year Review Guidance*, dated June 2001 (Office of Solid Waste and Emergency Response (OSWER) Directive 9355.7-03B-P.

FNOP was a LAP facility which produced bombs, boosters, and shells. FNOP included four bomb load lines (the first of which began operation in October 1942), a bomb booster assembly plant, an ammonium nitrate plant, two explosives burning areas, a proving range, a landfill, a wastewater treatment plant, analytical laboratories, and storage and administration facilities. Most of the raw materials used to manufacture the weapons were produced at other locations and shipped to the FNOP facility for assembly. However, ammonium nitrate was produced at the Ammonium Nitrate Plant during the first months of operation. Finished munitions, bulk explosives, and related ordnance materials and components were stored and demilitarized at the site.

Significant site events and/or milestones in the operational and regulatory history of FNOP are presented in **Table 2-1**. Additional remedial design work may be necessary in the future to complete the remedy. Many of these events are discussed in greater detail elsewhere in the FYR report.

Table 2-1
Chronology of Site Events

Event	Date
Industrial operations are initiated at NOP	October 1942
Bomb production in support of World War II mission	1942-1945
Ammonium Nitrate Plant operations begin	Early 1943
World War II operations terminated, NOP placed on inactive status	1945
Explosive storage without production	1946-1949
NOP reactivated for Korean Conflict	1952
NOP placed on standby status	1956
NOP declared excess, transferred to the General Services Administration (GSA)	1959
U.S. Air Force constructs Atlas Missile Launch Facility (Atlas Missile Area) at NOP	1959-1960
University of Nebraska purchases initial 9,600 acres of NOP	1962
Atlas Missile Area abandoned	1964
University of Nebraska purchases 600 additional acres	1964
Archive Records Search, USATHAMA (now AEC)	1983
Polychlorinated Biphenyl (PCB) Investigation, University of Nebraska	1984-1985
PCB Investigation, EPA	1988
Initial environmental investigation of soil, sediment, surface water, and groundwater by USACE (Confirmation Study)	1989
NOP added to NPL	30 August 1990
Additional soil gas, soil, and UXO investigations by USACE	1990 - 1991
Preliminary Health Assessment by ATSDR	1991

Event	Date
Supplemental Soil RI by USACE	1991
Interagency Agreement (now Federal Facilities Agreement) signed	17 January 1992
OU2 RI	1992
Quarterly groundwater sampling initiated	August 1992
OU2 Proposed Plan released	October 1995
OU1 Record of Decision signed	November 1995
OU2 Record of Decision released	October 1996
Initiation of the Restoration Advisory Board	October 1996
OU2 Record of Decision signed	April 1997
Construction of Containment Removal Action (Main Groundwater Treatment Plant)	October 1997
Containment Removal Action	October 1998
Draft Final Remedial Design Phase I approved	May 1999
Construction of expanded Main Groundwater Treatment Plant initiated	November 1999
Groundwater Circulation Well pilot systems installed	April 2000
Groundwater Circulation Pilot studies completed	March 2001
Phase II Remedial Design Report (GCWs)	August 2001
Contamination in extraction well (EW) 11 determined	August 2001
Expansion of Main Groundwater Treatment Plant operational	February 2002
EW-11 Phase I Field Investigation initiated	April 2002
Main Groundwater Treatment Plant dedication	17 May 2002
EW-11 Phase II Field Investigation initiated	February 2003
Load Line 1 Remedial Design completed	September 2005
Load Line 1 Groundwater Treatment Plant operational	January 2006

This section provides a general overview of the site including the history, physical characteristics, land use and resources. The section also provides a brief description of the initial response action including the basis for taking action based on the site risks.

3.1 SITE DESCRIPTION

The FNOP site is located one-half mile south of the town of Mead, Saunders County, Nebraska (**Figure 1-1**) and occupies approximately 17,250 acres as shown on **Figure 3-1**. The site included four load lines, where bombs, shells, and rockets were assembled; the Burning/Proving Grounds, where fuses were tested and materials were destroyed by burning; the Bomb Booster Assembly Area, where boosters that amplify the effect of the detonators and assure the complete detonation of the main explosive were assembled; Administrative Area, which included offices, residences, and a laundry; Air Force Ballistic Missile Division (AFBMD) Tech Area, where historical information suggests that parts were cleaned; and the AMA. The locations of these features are shown on **Figure 3-1**.

3.2 SITE HISTORY

FNOP was a LAP facility which produced bombs, boosters, and shells during World War II and the Korean Conflict. Most of the raw materials used to manufacture the weapons were produced at other locations and shipped to the FNOP facility for assembly. However, ammonium nitrate was produced at the Ammonium Nitrate Plant during the first months of operation. Finished munitions, bulk explosives, and related ordnance materials and components were stored and demilitarized at the site.

Routine plant operations included washout of explosive materials prior to bomb loading and assembly, and bomb washing following assembly. Wash water was discharged to sumps and in open ditches.

The production facilities were active during both World War II and the Korean Conflict. The Nebraska Defense Corporation operated FNOP for the Army from 1942 until 1945 and produced munitions which were loaded with trinitrotoluene (TNT), amatol (TNT and ammonium nitrate), tritonal (TNT and aluminum), and Composition B (hexahydro-1,3,5-trinitro-1,3,5-triazine (RDX) and TNT). Tetryl boosters were assembled for bombs in the Bomb Booster Assembly Area. In 1945, ordnance production operations were terminated, and the facilities were placed on inactive status.

During the interim period (1945 through 1949), FNOP was decontaminated and used primarily for storage and disposal of bulk explosives and munitions, and production of ammonium nitrate for use as fertilizer. Decontamination consisted of flushing and sweeping buildings that were not being used for storage. After decontamination operations were completed, explosives residues in the sumps, settling basins, pipelines leading to the drainage ditches, and an unspecified quantity of contaminated soil and sludge from the drainage ditches were removed and reportedly taken to the Burning/Proving Grounds. In some instances, portions of the tile pipe composing the drainage system from the sump to the open ditches were removed and disposed.

In 1950, the plant was temporarily reactivated and produced an assortment of weapons for use in the Korean Conflict. NOP was placed on standby status in 1956 and declared excess to Army needs in 1959.

After NOP was declared excess in 1959, it was transferred to the General Services Administration (GSA) for disposition. Approximately 1,000 acres were retained by the Army for National Guard and Army Reserve training, 12 acres were retained by the Army for use as a Nike Missile Maintenance Area, 2,000 acres were transferred to the U.S. Air Force to build the Offutt Air Force Base Atlas Missile Site, and 40 acres were transferred to the Department of Commerce. From 1959 to 1960, the Offutt Air Force Base Missile Site S-1 launch area (AMA) was built on 1,185 acres north of LL4. TCE was used during construction to degrease and clean pipelines used to carry liquid oxygen fuel for missiles. Historical information suggests that TCE was released as ground spills and/or discharged into surface drainage features during the construction activities. The exact locations, quantities, and dates of TCE disposal are not known. The missile facilities were abandoned in 1964, and the AMA and Nike Area were transferred to the Nebraska National Guard. The U.S. Air Force also occupied 34 acres of the northern portion of LL1 for use as the AFBMD Technical Area. The purpose of the AFBMD Technical Area is unclear, but historical site information suggests that parts were cleaned with TCE in a laboratory, and the spent TCE was discharged into the sewer. The potential TCE soil contamination is not located in the areas contaminated with explosives. In 1962, approximately 9,600 acres of the FNOP site were purchased by the University of Nebraska for use as an agricultural research farm which is now the ARDC, and an additional 600 acres were obtained in 1964. The remaining 5,250 acres were eventually purchased by private individuals and corporations.

Since NOP closure, the property has been used primarily for agricultural production and research. In addition to these land uses, several commercial operations were conducted on FNOP property. Until 1989, Apollo Fireworks operated for a period of approximately 20 years in the former Bomb Booster Assembly Area. At the former administration buildings, various commercial enterprises are in operation including insulation board manufacturing and expanded styrene foam packing material processing. Property was leased for these and other purposes by private individuals.

3.3 PHYSICAL CHARACTERISTICS

The FNOP site is located in the Todd Valley, an abandoned stream terrace of the ancestral Platte River. The Todd Valley is bounded by till uplands to the northeast, the Wahoo Valley to the west and south, and the Platte Valley to the southeast. The thickness of unconsolidated material above bedrock in the Todd Valley at the site ranges from approximately 81 feet to 157 feet. The unconsolidated material consists of topsoil, loess, sand, and gravel. The uppermost bedrock unit is the Omadi Shale in the northwest and the Omadi Sandstone in the southeast portions of the site.

The site consists of three major alluvial aquifers: The Todd Valley aquifer, the Platte Valley aquifer, and the Wahoo Valley aquifer; and one minor aquifer, the Uplands aquifer. All four aquifers are underlain by the Omadi Formation except where the Omadi is absent and the subcrop consists of Pennsylvanian strata near the Lincoln Water System (LWS) Ashland well field. The bedrock aquifer at the site is the Omadi Sandstone aquifer.

According to the draft National Wetlands Inventory Map for the Mead Quadrangle, a number of wetland types occur in the vicinity of the site, however, these areas will not be influenced by the activities addressed in OU2.

3.3.1 Physiography and Topography

The physiography of eastern Saunders County can be divided into three regions: flood plain, terrace plain, and uplands Souders (1967).

The flood plain primarily consists of the flood plains of the Platte River and Wahoo Creek. Elevations range from 1,050 feet (North American Vertical Datum [NAVD] 88) near the LWS well field in the southeast, to 1,130 feet near Ithaca in the Wahoo Valley, and 1,120 feet near Leshara in the Platte Valley. The topography is flat, sloping 4 feet per mile in the Platte Valley and 6 feet per mile in the Wahoo Valley.

The terrace plain is known as Todd Valley, and is a stream terrace abandoned when the ancestral Platte pirated a tributary of the Elkhorn River. The terrace is generally 50 feet higher in elevation than the Wahoo Creek and Platte River flood plains. Elevations range from 1,220 feet near Colon in the northwest corner of the model area to 1,100 feet in the southeast, with a slope of approximately 9 feet per mile.

There are two areas of till uplands in the model area. One area is between the Todd Valley and the Platte Valley, and the other is southwest of Wahoo Creek. In contrast to the relatively flat Todd Valley terrace plain, the uplands are hilly with elevations ranging between 50 and 200 feet higher than Todd Valley.

3.3.2 Geology

Bedrock

The Cretaceous Omadi Formation, approximately equivalent to and often called the Dakota Formation, underlies all but the southeastern portion of Saunders County (Souders, 1967). The formation consists of sandstone, siltstone, and shale. About half of the unit is poorly cemented sandstone. In general, the uppermost unit in the Omadi is shale in the northwestern portion of FNOP, and sandstone in the southeastern portion. Cores of the upper portion of bedrock, however, often contain interbedded sandstone and shale.

In southeastern Saunders County, including the area of the LWS Ashland well field, the uppermost bedrock consists of Pennsylvanian limestones and shales.

Till and Fluvio-Glacial Deposits

Souders (1967) used the configuration of the bedrock surface and data on the ease or difficulty in obtaining water supplies to infer the presence of buried Quaternary channels beneath the till uplands. These sand and gravel channels might possibly correlate to the David City Formation of Nebraskan age, which is a pro-glacial fluvial deposit. The David City Formation is overlain by Nebraskan and Kansan tills, which are composed of a heterogeneous mixture of clay and silt (Reed and Dreeszen, 1965). Souders indicates some sands, silts, and clays in between layers of till, which may correspond to younger fluvio-glacial deposits, possibly of Kansan age.

The ancestral Platte River eroded most of the till, and fluvio-glacial deposits in the Todd Valley were mostly eroded before late Kansan time. Clays, silts, and sands near the margins of Todd Valley, such as those near the landfill in the northeastern portion of FNOP, may be remnant Early or Medial-Pleistocene fluvio-glacial deposits.

Todd Valley Deposits

During the middle and late Pleistocene, the Todd Valley was filled by coarse alluviation ahead of advancing ice. Deposition was interrupted by erosion during inter-glacial stages. The deposits in Todd Valley might include the Kansan-age sands and gravels of the Grand Island Member, and the Illinoian-age Crete Member, which may be re-worked sediments of the Grand Island Member. Intense erosion preceded the deposition of the finer grained Todd Valley Sand during retreat of the Wisconsinan ice sheet (Reed, 1948).

The unconsolidated sediments in the Todd Valley range from 81 feet near the landfill to 157 feet in the paleochannel near EW-8 (Woodward-Clyde, 1993b).

Due to the difficulty in differentiating the ages of the alluvium in the Todd Valley, Piskin (1971) attempted to divide the alluvium into two informal units. Piskin chose the top of the lower unit based on the uppermost occurrence of a trace of medium gravel (on the Wentworth scale, roughly equivalent to fine gravel on the American Standards for Testing and Materials (ASTM) scale) or 20 percent fine gravel (on the Wentworth scale, roughly equivalent to coarse sand on the ASTM scale). As more stratigraphic data was collected during the RI (Woodward-Clyde, 1993b), the greater complexity of the Todd Valley sediments became evident, and the gradual transition in grain size between the upper and lower alluvium made Piskin's classification impractical. For site characterization purposes, the Todd Valley aquifer is divided into two layers to correspond to the depths of the shallow and intermediate monitoring wells, allowing vertical distribution of concentration data.

Loess

During Wisconsinan time the Todd Valley and the surrounding uplands were covered by the light brown and light gray mottled Peoria Loess. The loess typically ranges between 10 and 20 feet in thickness in the Todd Valley. The loess is absent in the Platte River valley and the Wahoo Creek valley.

Wahoo Valley Alluvium

A cross-section presented by Souders (1967) indicates that the sediments in the Wahoo Valley are stratigraphically distinct from the Todd Valley sediments, and were deposited by Wahoo Creek. The similarity of elevation of the Wahoo and Platte valleys suggests that the Wahoo Valley may lie in the abandoned channel of the ancestral Platte River.

The sediments in the Wahoo Valley are generally 30 to 80 feet thick. The upper silts and clays in Wahoo Valley are alluvial overbank fines and are unrelated to the Peoria Loess. They are typically less than 15 feet thick. In the vicinity of EW-12, Wahoo Valley alluvium tends to be finer with less gravel than the alluvium in the Todd Valley. Souders (1967) indicates that glacio-fluvial silts correlative with Early Pleistocene units in the till uplands southwest of Wahoo Creek may be present at the base of unconsolidated sediments in the Wahoo Valley.

Platte River Alluvial Gravels, Sands and Fines

Most of the sands and gravels of the Platte River alluvium are probably Wisconsinan or Recent and not correlative to the Todd Valley sediments. However, remnants of older sediments may be present in the Platte Valley. The Platte River alluvium is typically less than 50 feet thick in the western and eastern portions of the valley, including the area near Johnson Creek and EW-1,

but a channel in the bedrock surface up to 100 feet deep is oriented north-south through the center of the valley and the Metropolitan Utilities District (MUD) well field.

The silts and clays overlying the Platte River sands and gravels are alluvial overbank deposits, which are unrelated to the Peoria Loess. The thickness of the overbank fines typically ranges from 0 to 20 feet.

3.3.3 Hydrostatigraphy

The hydrogeology of the modeled area consists of three major alluvial aquifers: the Todd Valley aquifer, the Platte Valley aquifer, and the Wahoo Valley aquifer; and one minor aquifer, the Uplands aquifer. All four aquifers are underlain by the Omadi Formation, except where the Omadi is absent and the subcrop consists of Pennsylvanian strata near the LWS Ashland well field. It was assumed that there is a sufficient vertical permeability contrast between the Omadi Formation and the unconsolidated alluvial aquifers so that the Omadi Formation forms an impermeable base to the alluvial aquifer system. This assumption was made for the following reasons:

- Flow in the aquifer as measured at the Site is near horizontal with little to no vertical gradients measured in the wells screened in the unconsolidated aquifer.
- A two-order of magnitude difference in the vertical hydraulic conductivity exists between the unconsolidated aquifers and the Omadi Formation. Generally, a two-order of magnitude difference in hydraulic conductivity is sufficient to justify the placement of an impermeable boundary (Anderson and Woessner, 1992).

Platte Valley Aquifer

The hydrostratigraphy of the Platte Valley consists of two principal layers:

1. Silt and clay overbank deposits approximately 5 to 15 feet thick
2. Coarse grained sand and gravel alluvium

The low permeability overbank deposits act as an upper semi-confining unit to the Platte Valley aquifer, which impedes but does not prevent upflow between the aquifer and the ground surface (Woodward-Clyde, 1996a).

Todd Valley Aquifer

The hydrostratigraphy of the Todd Valley consists of two principal sedimentary units:

1. The Peoria Loess, which is typically 10 to 20 feet thick but ranges from 2 to 23 feet thick at the Site (Woodward-Clyde, 1996a), and is unsaturated
2. The Todd Valley sands and gravels, which are partially saturated, are typically between 80 and 110 feet thick, but can be as thick as 157 feet (near LL1), and as thin as 48 feet (southwest of the Landfill)

The Todd Valley aquifer is unconfined in nearly all of the model area; however, it may be confined in the northwest corner of the model. The saturated thickness of the aquifer is controlled by the erosional bedrock surface at its base and the elevation of the potentiometric surface, except where it is confined, and the loess forms the upper confining unit. Throughout

the modeled area the saturated thickness of the aquifer ranges from approximately 30 feet in the southeast to over 100 feet near LL1 and near Mead.

Wahoo Valley Aquifer

The hydrostratigraphy of the Wahoo Valley consists of two principal sedimentary units:

1. Silt and clay overbank deposits typically 2 to 15 feet thick
2. Sand and gravel alluvium, typically 30 to 80 feet thick

Where present, the low permeability overbank deposits act as an aquitard to the Wahoo Valley aquifer that impedes but does not prevent upward flow.

Uplands Aquifer

The transmissivities in the till uplands (CSD, 2005) are generally lower than those in the Todd Valley, despite the greater saturated thickness (CSD, 1996). Souders (1967) used the configuration of the bedrock surface and data on the ease or difficulty in obtaining water supplies to infer the presence of buried Quaternary channels beneath the till uplands. Clays, silts, and sands near the margins of Todd Valley, such as those near the landfill in the northeastern portion of FNOP, may be remnant early or medial-Pleistocene fluvio-glacial deposits.

Souders (1967) infers a southeast trending channel along the Todd Valley side of the till uplands, but this is based on very little data. The bedrock surface contour shows a buried channel trending east-west under the southern end of the till uplands, east of the AMA and terminating under the stream terrace between Johnson Creek and Clear Creek that is an extension of the Todd Valley surface. According to "Transmissivity of the Principal Aquifer, 2005" (CSD, 2005), however, the sediments composing this terrace have a lower transmissivity than the surrounding material, despite the greater thickness.

Souders (1967) inferred an area of low transmissivity near the village of Yutan based on specific capacities of Yutan's two municipal wells. The Yutan wells present in 1967 are no longer registered, and the three Yutan wells currently registered have higher specific capacities (based on registration information) than the original wells, suggesting that Souders' tentative mapping of an area without fluvio-glacial deposits beneath the till near Yutan may not be correct.

3.4 LAND AND RESOURCE USE

Currently, most of the site is owned by the University of Nebraska, which operates an agricultural experiment station called the ARDC on the premises. Crop, hog, dairy, and cattle research take place on site. Other portions are owned by the Nebraska National Guard, United States Air Force, and Army Reserves. Some private pasture and crop production also takes place on site, and some private light industry exists near the northern end of the site. Adjacent land use is primarily agricultural, except for the Village of Mead which is located north of the site.

3.5 HISTORY OF CONTAMINATION

Previous investigations include an archives search for the U.S. Army Toxic and Hazardous Materials Agency (USATHAMA, now called Army Environmental Center) in 1983; PCB investigations by the University of Nebraska in 1984 and 1985, USEPA in 1988, and USACE in 1993; a soil, sediment, surface water, and groundwater investigation by USACE in 1989; a

shallow soil gas investigation in 1990; a soil investigation by the USACE in 1991; an unexploded ordnance (UXO) survey and soil investigation by USACE in 1991; a preliminary health assessment by the Agency of Toxic Substances and Disease Registry (ATSDR) in 1991; and a Supplemental Soil RI for OU1 by USACE in 1991.

OU2 (Groundwater) sampling was initiated by USACE during the 1989 Confirmation Sampling when samples were collected from monitoring wells and water supply wells. RDX, TNT, and TCE were identified in the groundwater samples. Some of the TCE concentrations exceeded the MCL of 5 micrograms per liter (µg/L). As a result of the Confirmation Study, carbon filtration systems were installed at two residences southeast of the FNOP, a carbon filtration system was installed at the ARDC Agronomy Building, and two ARDC water supply wells were removed from service. Subsequently, the water supply well sampling was continued on a periodic basis. Additional residences were identified where the TCE concentrations exceeded the MCL or the RDX concentrations exceeded the Lifetime Health Advisory (HA) of 2 µg/L. Currently, water is being treated and/or bottled water is being supplied at four private residences and one commercial space which are all southeast of FNOP.

In late 1989 and early 1990, a soil gas survey was conducted by USACE to evaluate areas of soil that may be contributing TCE contamination to groundwater. TCE and other VOCs were detected in some samples; however, source areas were not definitively identified. USACE subsequently installed and sampled additional monitoring wells prior to the OU2 RI.

The FNOP site was listed on the National Priorities List (NPL) under Section 105 of CERCLA on August 30, 1990. In September 1991, USACE, USEPA, and NDEQ entered into an FFA (formerly known as Interagency Agreement (IAG)) under Section 120 of CERCLA to investigate and control environmental contamination at the FNOP site.

3.6 OU2 ACTIONS

3.6.1 Remedial Investigation Results

USACE conducted the OU2 RI in 1992 to evaluate the nature and extent of potential COCs in the groundwater at the FNOP site attributable to past DoD activities. The secondary objective was to evaluate the potential nature and extent of VOC contamination in soils at three areas (Administration Area, AMA, and the AFBMD Technical Area) to assess whether or not these contaminated areas are possible continuing sources of VOCs in the groundwater. Groundwater samples were also collected from 136 monitoring wells and were analyzed for VOCs, explosives compounds, and general water quality parameters. Selected monitoring wells were also analyzed for semi-volatile organic compounds (SVOCs) and metals. Soil and soil gas samples were collected and analyzed for VOCs. Field data were also collected to characterize the geology at the FNOP site, and to estimate the direction and rate of groundwater flow. Groundwater samples were collected from every monitoring well on a quarterly basis beginning during the OU2 RI (August 1992) and continuing for one year. Subsequent sampling has been performed periodically at selected monitoring wells, and the site-wide GMP is ongoing.

The OU2 RI identified four groundwater contamination plumes with a separate source location identified for each plume. Two of the plumes consist of explosives-contaminated groundwater (primarily RDX) and two of the plumes consist of primarily TCE-contaminated groundwater. The plumes overlap in two areas where both TCE and RDX are in the groundwater in the same

location. Both the TCE plume with its source at the AMA and the explosives plume with its source at LL2, LL3, and LL4 extend past the eastern boundary of FNOP.

Higher groundwater contamination was found in the upper fine sand units than in the sand and gravel units below. Generally, lower contamination was found in the deepest of the three aquifers which is the Omadi Sandstone aquifer. **Table 3-1** lists the chemicals subsequently identified as COCs in groundwater and their ranges of detection during the RI. Six of the seven COCs are classified as possible or probable human carcinogens, and all seven may cause noncancer health effects.

The OU2 RI data indicated that the Administration Area was not a continuing source of groundwater contamination. However, data did not conclusively indicate whether the AMA or the AFBMD Tech Area are, or are not, continuing sources of TCE to groundwater. The RI data do indicate TCE groundwater contamination did originate in those areas.

Table 3-1
Range of COC Concentrations Detected in Monitoring Well Samples During the OU2 Remedial Investigation

Chemical of Concern	Frequency of Detections	Range of Detected Concentrations in MWs	
		Minimum (µg/L)	Maximum (µg/L)
Methylene chloride	117 of 128	0.5	43
1,2-dichloropropane	1 of 128	25	25
TCE	28 of 128	0.9	1800
TNB	5 of 128	0.32	2.2
TNT	3 of 128	6.5	20
RDX	44 of 128	0.16	98
2,4-DNT	1 of 128	0.97	0.97

3.6.2 Removal Actions

Subsequent to the OU2 RI several removal actions were completed to address potential risk from COC contamination in existing drinking water on the FNOP site. Four of those removal actions consisted of installing point-of-entry or point-of-use granular activated carbon adsorption treatment systems in private residences or University of Nebraska ARDC facilities. The fifth action consisted of supplying bottled water to a private residence.

A Groundwater Containment Removal Action (CRA) was developed for the site to allow an early start for the TCE containment, which would have otherwise taken place following signature of the ROD. The specific objectives for the Groundwater CRA were as follows:

- Hydraulic containment of groundwater contamination to minimize expansion of the two TCE contamination plumes and stop the downgradient movement of the TCE plumes
- Protection of unimpacted downgradient groundwater users
- Treatment and discharge of extracted groundwater to meet applicable standards

- Periodic monitoring of the effectiveness of the containment system

Because all of the proposed alternatives for the OU2 remedy at the site, except for the no action alternative, included the element of hydraulic containment, the Groundwater Containment Removal Action was consistent with the final remedy.

3.7 BASIS FOR TAKING ACTION (SUMMARY OF SITE RISKS)

CERCLA requires protection of human health and the environment from risks due to current and potential future exposure to releases of hazardous substances at or from a site. As part of the OU2 RI/FS, a BLRA was prepared to evaluate potential human health risks associated with exposure to contaminated groundwater and subsurface soils in the absence of any remedial action. Potential risks were estimated based on a number of assumptions, including the populations that could be exposed to site contaminants and the likely magnitude of such exposures.

An evaluation of subsurface soils identified TCE and acetone as the chemicals of potential concern (COPCs) in AMA soils. The COPCs identified in LL1 soils were TCE, benzene, and acetone.

An evaluation of site groundwater data identified COPCs, including several VOCs, SVOCs, explosives, and one metal that appeared to be contaminants related to the FNOP site. As a result, it was concluded that actual or threatened releases of contaminants from this site, if not addressed, may present a current or potential threat to public health, welfare, or the environment.

Table 3-2 presents the COPCs identified in the BLRA in site-wide groundwater:

Table 3-2
Chemicals of Potential Concern in Groundwater

Parameter Group	Parameter
VOCs	1,1,1-trichlorethane
	1,2-dichoroethene
	1,2-dichloropropane
	acetone
	chloroform
	methylene chloride
	tetrachloroethene
	TCE
SVOCs	diethyl phthalate
	di-n-butyl- phthalate
	n-nitrosodiphenylamine
	phenol
Explosives	1,3,5-trinitrobenzene (TNB)
	2,4,6-trinitrotoluene (TNT)
	2,4-dinitrotoluene (2,4-DNT)
	hexahydro-1,3,5-trinitro-1,3,5-triazine (RDX)
	octahydro-1,3,5,7-tetranitro-1,3,5,7-tetrazocine (HMX)
Metals	aluminum
	lead
	nickel
	vanadium

A detailed BLRA was performed to characterize risks to both current and hypothetical future populations. The key components of the risk assessment included a chemical analysis section that identified the site-related chemicals, an exposure assessment that identified potentially exposed populations and intake assumptions, a toxicity assessment that identified chemical specific toxicity values, a risk characterization that quantified potential risks, and an uncertainty

section that identified the primary sources of uncertainty associated with the risk assessment and the likely impacts of these uncertainties on the results.

An evaluation of local populations and land use was used to identify exposure scenarios for quantitative evaluation in the BLRA. Potential exposure pathways evaluated in the OU2 BLRA were ingestion of well water, dermal exposure to groundwater, and inhalation of volatile chemicals in groundwater. Potential risks were estimated for both current and future use scenarios. Site workers, and child and adult residents were evaluated for potential exposure to groundwater from the two most-contaminated monitoring wells found on-site (MW-5B and MW-40B), while construction workers were evaluated for potential exposure to subsurface soils during excavation activities and subsequent showering in water from the two most-contaminated wells. These populations were believed to have the greatest potential for exposure at the site.

Potential excess cancer risks (i.e., risks above the normal expected cancer rate) were calculated as part of the BLRA. The cancer risks represent estimates of the probability that an individual might develop cancer as a result of exposure to a chemical over a lifetime. For example, a 3 in 10,000 (also expressed as $3x10^{-4}$) risk estimate means that not more than an additional 3 out of 10,000 people exposed would be expected to develop cancer. When the calculated cancer risk from lifetime exposure to site-related chemicals is estimated to be more than one additional (excess) cancer case in 10,000 ($1x10^{-4}$), some kind of remedial action is generally required under CERCLA. When the cancer risk is between one additional cancer case in 10,000 and one in 1,000,000 (1×10^{-6}) people, action may be necessary depending on such site-specific factors as location, environmental impact, and non-cancer health effects. If the risk is less than one additional cancer case in 1,000,000 people, action is generally not required unless there are also environmental risks or non-cancer health effects.

Non-cancer health hazards are addressed by comparing average (chronic) daily intakes to reference doses. A reference dose is the amount of a chemical that a person can take in over a long term without suffering adverse health effects. The ratio of chronic daily intake to the reference dose is known as the hazard index (HI). An HI value of 1 is considered an upper "threshold" for possible adverse health effects. Remedial action is generally warranted when the HI exceeds 1.

The following tables summarize the cancer risks **(Table 3-3)** and the non-cancer hazards **(Table 3-4)** associated with OU2 groundwater and subsurface soil at the Site. (Note: risks falling outside the acceptable risk ranges are highlighted with bold type.)

Table 3-3
Calculated Cancer Risk

Summary of Cancer Risks					
	Adult Resident	Child Resident	On-Site Worker	Construction Worker in Load Line 1 Area	Construction Worker in Atlas Missile Area
Monitoring Well MW-5B	3×10^{-4}	7×10^{-5}	4×10^{-5}	3×10^{-8}	3×10^{-8}
Monitoring Well MW-40B	2×10^{-3}	6×10^{-4}	2×10^{-4}	4×10^{-6}	4×10^{-6}

Table 3-4
Calculated Hazard Index

Summary of Non-Cancer HIs (Acceptable HI range is less than 1)					
	Adult Resident	Child Resident	On-Site Worker	Construction Worker in Load Line 1 Area	Construction Worker in Atlas Missile Area
Monitoring Well MW-5B	3	7	1	0.02	0.02
Monitoring Well MW-40B	3	13	0.9	1	1

The cancer and non-cancer risks identified above, which fall outside of the acceptable risk ranges, represent the basis for taking action at OU2.

The following sections discuss remedy selection, planning, implementation, and current status of the remedy (performance and O&M) selected in the OU2 ROD. It details and summarizes the relevant site activities reviewed as a portion of this FYR. The dates of this FYR are February 2002 (system start) through February 2007.

4.1 REMEDY SELECTION

As discussed in Section 3.7, the risk assessment concluded that exposure to site groundwater may result in unacceptable risks to human health. As a result, a Feasibility Study (FS) was completed followed by the preparation of a PRAP, and subsequently the ROD in October 1996.

As a part of the remedy development process, remedial action objectives (RAOs) were developed to address the contaminated groundwater and explosives-contaminated soil which could act as a source of explosives contamination of groundwater while considering the long-term goals of protecting human health and the environment and meeting ARARs of federal and state laws and regulations.

The OU2 RAOs stated:

- Minimize the potential for ingestion of contaminated groundwater, or reduce concentrations to acceptable health-based levels
- Minimize the potential for dermal exposure to contaminated groundwater, or reduce concentrations to acceptable health-based levels
- Minimize the potential for inhalation of chemicals released during the use of contaminated groundwater, or reduce concentrations to acceptable health-based levels

The remedial action for explosives-contaminated leaching soils is to remediate those soils to the degree that the groundwater remediation potentially benefits by saving time and money, and/or increasing protectiveness.

Based on the results of the BLRA, USACE, USEPA, and NDEQ selected the Final Target Groundwater Cleanup Goals below for OU2.

Table 4-1
Final Target Groundwater Cleanup Goals

Chemical of Concern	Total Concentration (µg/L)	Basis for Value
Methylene chloride	5	MCL
1,2-dichloropropane	5	MCL
TCE	5	MCL
TNB	0.778	Non-cancer effect (HI)
TNT	2	Health Advisory
2,4-DNT	1.24	10^{-5} Carcinogenic risk
RDX	2	Health Advisory

The basis for the remedy selection was the nine evaluation criteria established in the National Oil and Hazardous Substances Pollution Contingency Plan (NCP) Part 300.430(e)(9)(iii). The following rationale was used to develop the Final Target Groundwater Cleanup Goals:

- For those chemicals with MCLs established, the MCL was the established cleanup goal.
- For those chemicals that do not have MCLs, but have carcinogenic effects, non-carcinogenic effects, or HAs, the cleanup goal is the lowest of any of the following: the value from the carcinogenic risk of $1x10^{-5}$; the value calculated from the (non-carcinogenic) HI of 1.0; or the HAs.

The FS evaluated eight alternatives in detail. The ROD selected the alternative that best satisfied the RAOs; that was best able to be protective of human health and the environment; complied with ARARs; utilized permanent solutions to the maximum extent practicable; would significantly reduce the toxicity, mobility, and volume of contaminants through treatment; and was implementable.

The selected alternative (Alternative 4) provided the best balance of tradeoffs among the alternatives with respect to the evaluation criteria, especially the five balancing criteria. The selected alternative was distinguished from the other alternatives by including both excavation and treatment for leaching soils, and focused extraction of groundwater. The soils excavation and treatment removed a potential source of groundwater contamination. The intent of the focused extraction was to shorten the restoration time with the least adverse impact on groundwater availability.

The major components of the selected remedial action for OU2 include:

- Hydraulically contain contaminated groundwater exceeding the Final Target Groundwater Cleanup Goals
- Focused extraction of groundwater in areas with relatively high concentrations of TCE and explosives
- Treat all extracted groundwater using GAC adsorption, AOP, and air stripping, any of which may be applied individually or in combination
- Dispose of the treated groundwater by beneficially reusing it or through surface discharge
- Provide a potable water supply to local groundwater users whose water supply contains RDX exceeding the HA and/or TCE exceeding the MCL
- Monitor the groundwater elevations and water quality
- Excavate and treat explosives-contaminated soil which could act as a source of explosives contamination of groundwater and which does not meet the OU1 excavation criteria

4.2 REMEDY IMPLEMENTATION

The BLRA concluded that exposure to site groundwater may result in unacceptable risks to human health. As a result, an FS was completed which led to the preparation of a PRAP and the subsequent signing of the OU2 ROD in April 1997. The OU2 ROD defined a remedy that included two different applications of aquifer restoration; containment and focused extraction. The goal of the hydraulic containment, as defined by the ROD, is to prevent groundwater from becoming contaminated in excess of the Final Target Groundwater Cleanup Goals in the future. The goal of the focused extraction, as defined by the ROD, is to rapidly remove contamination and shorten remediation time in areas with relatively high TCE and/or RDX concentrations, when compared to hydraulic containment pumping alone.

The remedy that has been implemented, to date, was designed and constructed in phases. The final Phase I design called for contaminated groundwater to be intercepted by 11 extraction wells near the southern boundary of FNOP, piping to transport the extracted contaminated groundwater to a central treatment facility, and piping to transport the treated water to discharge or reuse locations(s) (URSGWCFS, 1999). The central treatment facility (main groundwater treatment plant) was constructed in 1997. Design and initial operating parameters for the groundwater extraction system were developed using the results of groundwater flow and contaminant transport modeling.

The individual remedy components for OU2 are presented below.

- **Hydraulically contain contaminated groundwater exceeding the Final Target Groundwater Cleanup Goals.**

  In October 1998, as a part of the CRA, two extraction wells, EW-1 and EW-8, were initially installed and began extracting contaminated groundwater to the main groundwater treatment plant at rates of 200 gpm and 400 gpm, respectively. Nine additional Phase I design containment extraction wells were installed in 2001 and connected to new pipelines which delivered the groundwater to the main groundwater treatment plant. Ten of the 11 extraction wells (with the exception of EW-11) began pumping in February 2002 at an initial pumping rate of 2,629 gpm. EW-11 was not put into operation due to high TCE concentrations detected during initial testing following well development in 2001. Currently, EW-11 is not operational and will be converted to a focused extraction well in the first quarter of 2008.

  The initial understanding of the extent of the LL1 TCE plume was that it ended at or in the vicinity of EW-8 and EW-11. Further direct-push groundwater investigations in 2002 and 2003 indicated that the TCE plume, exceeding the 5 µg/L Final Target Groundwater Cleanup Goal, extended downgradient of EW-8 and EW-11, to the vicinity of Silver Creek. This additional data indicated that the plume extends approximately one mile further south than was portrayed in the Final ROD for OU2, requiring the design of two additional hydraulic containment wells, EW-12 and EW-13, upgradient of Silver Creek. A direct–push groundwater investigation was conducted in 2004 to aid in determining the locations of EW-12 and EW-13 and associated groundwater monitoring wells. EW-12 and EW-13 were subsequently installed in 2006.

  The remedial design for the LL1 groundwater treatment plant was completed in September 2005 and is capable of treating a total influent flow of 550 gpm. In January and February

2006 a direct-push groundwater investigation was conducted to delineate the extent of VOC contamination south of EW-12 and EW-13, prior to their initial operation.

The LL1 hydraulic containment system was designed to contain the downgradient extent of the plume in the vicinity of Silver Creek. The system consists of groundwater extraction wells EW-12 and EW-13, piping for transport of the groundwater to the new LL1 groundwater treatment plant, treatment by air stripping, off gas treatment with vapor phase granular activated carbon, and piping for the discharge of treated groundwater to a existing outfall (from the main groundwater treatment plant) on Wahoo Creek.

The original design for capturing the LL1 plume south of EW-11 was based on an assumed hydraulic conductivity of 130 ft/day, the value used for the Todd Valley in the Remedial Design Groundwater Model (RDGM) IV. EW-13 was installed at the same time as EW-12. Following installation and development of EW-12 and EW-13, EW-13 yielded less than 50 gpm.

Groundwater is currently being extracted by extraction wells EW-1 through EW-10 and EW-12. EW-11 is not currently operational and will be converted to a focused extraction well in the first quarter of 2008. EW-13 is not currently operational because transport simulations suggest that TCE will not migrate beyond the immediate vicinity of EW-12 within the next five years. However, the utility of EW-13 is being further evaluated. To date, 13 extraction wells have been installed to contain contaminated groundwater. All of the extraction wells were completed in the unconfined aquifer overlying bedrock to account for the distribution of contamination at the well locations. The containment well locations are shown on **Figure 4-1**.

The following table summarizes the designed pumping rate for each extraction well. The rates summarized below are documented in RDGMIII (URS, 2002a). Pumping rates for EW-12 and EW-13 are from the Load Line 1 Remedial Design (URS, 2005a). The actual pumping rates of the extraction wells are provided in Table 2-2 of the 2006 CE (URS, 2007b).

Table 4-2
Extraction Well Flow Rates

Extraction Well	Target Pumping Rate (gpm)
EW-1	200
EW-2	150
EW-3	200
EW-4	150
EW-5	175
EW-6	275
EW-7	300
EW-8	250
EW-9	275
EW-10	400
EW-11[1]	350
EW-12	325
EW-13	225

Note:

[1]Due to high TCE concentrations detected during construction and subsequent sampling, EW-11 was operational only briefly during 2001 and was placed off-line on February 8, 2002. EW-11 will remain off-line until a pretreatment system is installed. The target completion date for the AOP treatment system is the first quarter of 2008. The AOP treatment system will pretreat groundwater extracted by EW-11 before the groundwater is conveyed to the main groundwater treatment plant for polishing.

An evaluation of all operational, hydraulic, and chemical data collected in 2006 indicates the remedy is not meeting all the requirements of the ROD and fully achieving the desired results, specifically as it relates to hydraulic containment. The capture zone analysis identified the following three areas of concern requiring further evaluation:

- The middle of the LL3 RDX plume north of EW-4 and EW-5
- A small portion of the east side of the LL1 TCE plume approximately 1 mile north of EW-12
- A small portion of the east side of the AMA TCE plume near MW-45, approximately 1 mile north of EW-1

Steps are currently being implemented to evaluate each of these three areas to ensure that the remedy will function according to the requirements of the OU2 ROD (Woodward-Clyde, 1996c). Activities to remedy these areas of concern may consist of additional monitoring, additional investigations regarding the extent of contamination in the areas of concern, or additional modeling simulations to better predict plume behavior. Adjustments to the system currently in place and operational, to hydraulically contain the plume, will also be required. These adjustments will include, but are not limited to, changes to design flow rates and/or supplemental extraction well locations.

Perimeter monitoring wells and residential wells within a 1-mile radius of the plume boundary are regularly sampled as part of the yearly GMP. Groundwater chemical analyses from eastern and southern perimeter groundwater monitoring wells installed in 2006 demonstrate that there is no RDX above 2 µg/L or TCE above 5 µg/L downgradient of the extraction wells. Furthermore, there was no evidence of unacceptable risk to human health, resulting from exposure to contaminated groundwater. Aside from the residences that already receive alternative water supply or in-home carbon treatment units, there have been no detections of site-related contaminants in any of the residential water supply wells located within a 1-mile radius of the contaminant plume boundaries.

- **Focused extraction of groundwater in areas with relatively high concentrations of TCE and explosives.**

  The focused extraction portion of the remedy received substantial public input, prior to and during development of the Phase I Remedial Design, concerning the impact of focused remedial groundwater extraction on the available groundwater supply. As a result, a formal plan was developed to limit aquifer drawdown and to provide a protocol to address groundwater shortages that could develop due to remedial action pumping. The plan included a pilot study to characterize a zero-discharge GCW technology to remediate relatively high concentrations of RDX and TCE without further depleting the areas groundwater resources. Two systems were successfully pilot tested: GCW-1 (**Figure 4-1**) was designed to operate at approximately 50 gpm, and treat TCE-contaminated water using a shallow tray air stripper; and GCW-2 (**Figure 4-1**) was designed to operate at approximately 20 gpm, and treat RDX-contaminated groundwater using a medium pressure UV light system. As a result of the pilot study findings, a Phase II design was completed that identified 12 additional GCWs as a replacement for the previously identified focused extraction wells. The Phase II design, completed in August 2001, will not be implemented. However, steps have been taken to perform limited focused extraction by continuing to operate the two pilot study GCWs in areas of high concentration, though they have not been formally adopted under the FFA. Starting in the first quarter of 2008, EW-11, originally installed as a containment well, will begin functioning as a focused extraction well and extracted water will be pretreated through an AOP treatment system before releasing the AOP-treated water to the main groundwater treatment plant for polishing. Also, current groundwater treatment and remedy optimization modeling includes a detailed analysis of other focused extraction alternatives being considered. These elements are consistent with the ROD requirements and the Site Management Plan (SMP). Once these alternatives have been evaluated and consensus is achieved, the selected remedy will be implemented.

- **Treat all extracted groundwater using granular activated carbon (GAC) adsorption, advanced oxidation processes (AOP), and air stripping. GAC adsorption and AOP may be applied individually or in combination, while air stripping must be applied in combination with one of the other technologies to effectively treat explosives.**

  Groundwater treatment is being successfully accomplished by all three of the treatment technologies prescribed in the ROD. The main groundwater treatment plant, operational since 1997, treats influent groundwater from EW-1 through EW-10 (EW-11 is not currently operational and will be converted to a focused extraction well in the first quarter of 2008) using GAC to remove a combination of TCE and RDX. The LL1 groundwater treatment plant, operational since February 2006, is successfully treating groundwater from EW-12 (EW-13 is

not currently operational and its utility is being further evaluated) using air stripping because the influent stream contains only TCE.

GCW-1 is treating TCE-contaminated groundwater in an area containing relatively high concentrations of TCE using air stripping. GCW-2 is treating RDX-contaminated groundwater in an area containing relatively high concentrations of RDX using ultraviolet (UV) light, an advanced oxidation process.

Influent concentrations of VOCs to the main groundwater treatment plant increased during the FYR period with a high concentration of 16.9 µg/L (TCE only) detected in December 2006. Explosives concentrations remained constant during the FYR period, averaging 1.83 µg/L. Total VOCs and explosives were non-detect in the effluent with the following exceptions: methylene chloride was detected at 16 µg/L (August 2005), 27 µg/L (September 2005), and 3 µg/L (October 2005); TCE was detected at 1.2 µg/L (January 2005); *cis* 1,2-DCE was detected at 0.12 µg/L (January 2005); and RDX was detected at 0.275 µg/L (June 2006).

Influent concentrations of VOCs at the LL1 groundwater treatment plant averaged 16.6 µg/L (TCE only) and explosives concentrations were non-detect over the 10-month reporting period in 2006. Effluent concentrations were non-detect for total VOCs and explosives during the reporting period.

- **Dispose of the treated groundwater by beneficially reusing it or through surface discharge.**

  This portion of the remedy is in place and functioning effectively. Two surface water outfalls are available for discharge of treated groundwater. Treated groundwater discharges into Wahoo Creek at an average monthly flow rate of approximately 1,800 gpm and the outfall located on Clear Creek discharges at an average monthly flow rate of approximately 400 gpm. Water is also being beneficially reused by the University of Nebraska-Lincoln, ARDC for irrigation purposes and by two local residents, one to maintain the level in a privately-owned pond and one for irrigation. Provisions have also been established to facilitate the beneficial reuse of treated groundwater for fire-fighting purposes. The effluent discharge limitations issued by the state of Nebraska (NDEQ, 1998) are presented in Section 4.3.2.1. All discharge requirements were met during the FYR period.

- **Provide a potable water supply to local groundwater users whose water supply contains RDX exceeding the HA and/or TCE exceeding the MCL.**

  This portion of the remedy is in place and functioning effectively. There are a total of five residences associated with Wells 50B, 52A, 52C, 53, and 54 that were part of the alternative water supply support (AWSS) program during the FYR period. Residential wells 52A, 52C, 53, and 54 have GAC units. Residential wells 50B, 52A, and 52C receive bottled water. The residential wells were included in the program based on current and/or historic detections of RDX greater than 2 µg/L and TCE greater than 5 µg/L in residential water supply wells.

  Based on the residential well sampling completed at the site during this FYR period, data indicate that no one is drinking water contaminated above the Final Target Cleanup Goals established in the OU2 ROD.

  In an effort to determine whether any new residences or water users are present in the area which may be impacted by contamination, the following activities are performed semi-annually:

- A survey of the state of Nebraska Well Registry Database for any new potable water wells in the vicinity of the site
- A review of real estate transactions in the area
- Visual inspections of the local area to determine if any new potable water wells have been installed

In addition to the state of Nebraska Well Registry Database surveys, a physical inspection of the site is routinely performed by the operators of the main groundwater treatment and by USACE contractor personnel during routine monitoring well and water supply well sampling events. The physical inspection is intended to identify new construction sites or activities that may indicate the installation of new potable water wells within or downgradient of the groundwater plumes. Based on chemical sampling results and visual inspection of the local area, no residents were known to be consuming drinking water that contained contaminants exceeding the OU2 Final Target Groundwater Cleanup Goals.

The GMP began in August 1992 during the OU2 RI and continued through 2000 and from 2003 through 2006. No monitoring wells were sampled between June 1993 and September 1994 and between December 2000 and January 2003. However, site-wide monitoring of water supply wells has generally been performed quarterly since December 1993. Currently, 68 residential/supply wells and 234 groundwater monitoring wells are sampled quarterly, semi-annually, or annually as part of the GMP. This includes perimeter monitoring wells, as well as residential wells, within a 1-mile radius of the plume boundary.

- **Monitor the groundwater elevations and water quality.**

  This portion of the remedy is in place and functioning effectively. Groundwater level information and groundwater quality information is collected as part of the remedial system(s) operation and maintenance under the site-wide GMP. Between 2002 and 2005 there were 71 residential/water supply wells sampled; three University of Nebraska wells were taken off line in 2006. There are currently 68 residential/water supply wells and 234 groundwater monitoring wells that are sampled either quarterly, semi-annually, or annually as part of the GMP. This includes perimeter monitoring wells, as well as residential wells, within a 1-mile radius of the plume boundary. Groundwater chemical analyses from eastern and southern perimeter groundwater monitoring wells, installed in 2006, demonstrate that RDX levels are below 2 µg/L and TCE levels are below 5 µg/L downgradient of the extraction wells.

- **Excavate and treat explosives-contaminated soil which could act as a source of explosives contamination of groundwater and which does not meet the Operable Unit 1 (OU1) excavation criteria.**

  This portion of the remedy is in place and complete. Soils which could potentially act as a source of explosives contamination to groundwater were excavated and incinerated on-site during implementation of the OU1 remedial action completed in 1997 (OHM, 1998). No Five-Year Review is required for OU1 because no hazardous substances remained on site above health-based levels following remediation. No further action for explosives-contaminated soil is required for OU1 and OU2.

4.3 SYSTEM OPERATIONS/OPERATIONS AND MAINTENANCE (O&M)

O&M activities for the OU2 remedial system(s) include the on-going operation, maintenance and general upkeep of the main treatment plant, the LL1 treatment plant, the GCW systems and the associated ancillary equipment including groundwater extraction wells, monitoring wells, and effluent discharge areas. Activities also include groundwater monitoring and sampling of the treatment plant(s) effluent, as well as upkeep, maintenance and sampling of the AWSS wells.

O&M activities are conducted by fulltime on-site personnel. Routine maintenance and monitoring are conducted on a daily basis, whereas other preventative maintenance activities are conducted on an as-needed basis. A preventative maintenance schedule is maintained for the equipment and records are readily available for review. The treatment plant(s) are equipped with alarm systems which are capable of notifying the treatment plant operators on a 24-hour basis if maintenance issues or emergencies arise. As a result, an operator is on call at all times.

4.3.1 General Overview

The general operational requirements applicable to the OU2 remedial system(s) are summarized below:

- Operate all equipment, systems, processes, and appurtenances in accordance with the contract, equipment manufacturer's specifications, and the approved O&M Manual.
- Extract groundwater on a continuous basis to achieve hydraulic control, focused extraction, and remediation of groundwater.
- Treat off-gas vapor emissions at the LL1 treatment plant using vapor phase granular activated carbon.
- Discharge treated groundwater to surface water (at Wahoo Creek and Clear Creek) in accordance with discharge limits, as well as re-inject treated water from GCW-1 and GCW-2.
- Beneficially re-use treated groundwater (i.e., for irrigation, fire prevention).
- Containerize, characterize, transport, and dispose of all process and sampling waste residuals at an approved waste disposal facility.
- Procure all equipment, spare parts, supplies, and services required for operation, maintenance, monitoring, and management of the treatment systems.
- Manage and maintain an inventory of equipment, spare parts, supplies, and tools required for continuous operation with minimal downtime.
- Monitor treatment system performance, compliance, and remedial progress by collecting specified samples and field measurements in accordance with the project-specific SAP.
- Prepare operational records and maintain project files. Prepare and submit operational reports, as required.
- Abide by all operational requirements and report any non-compliant conditions to USACE.
- Optimize the use of process equipment to minimize operational costs.
- Notify the Project Manager immediately of any system downtime greater than 24 hours or any non compliance with discharge requirements.

- Provide routine, preventative, and corrective maintenance, including all processes, equipment, controls, facilities, and appurtenances.
- Perform routine, preventative, and corrective maintenance in accordance with the equipment manufacturer's specifications and the O&M Manual.
- Store all tools, spare parts, equipment, and supplies in an appropriate storage area. Manage the inventory and maintenance of such items to minimize downtime for maintenance.
- Maintain good housekeeping practices. Keep facilities neat, organized, and litter free. Clean and remove accidental spills.
- Routinely inspect and maintain the physical condition of exterior facilities, equipment, and grounds.

4.3.2 Sampling and Monitoring

Part of the overall O&M of the system is sampling and monitoring activities to evaluate treatment system performance and compliance. All sampling and monitoring activities are performed in accordance with the approved project Sampling and Analysis Plan and related documents.

Water level measurements and samples are collected from the extraction wells and their associated observation/monitoring wells (quarterly), the influent and effluent pipelines (monthly) and air samples are collected from the exhaust stack at the LL1 treatment plant (monthly). The samples are used to assess whether the remedial system is meeting the project objectives. Effluent water sample results are reviewed to determine if concentrations of RDX and TCE in the effluent meet the discharge limits of 2 µg/L and 5 µg/L, respectively, and effluent air samples from the carbon vessels are meeting the 200 $\mu g/m^3$ (ppm by weight) discharge limit.

4.3.2.1 Main Groundwater Treatment Plant

There are eight vessels at the main groundwater treatment plant. During the FYR period, a total of 30 carbon change outs, at 20,000 pounds per vessel, were required. Change outs were performed when breakthrough (detectable concentrations between 1 and 4 µg/L) were seen in these vessels.

Sampling was performed every month at the main groundwater treatment plant at the influent, effluent, and GACs. Influent concentrations of VOCs to the main groundwater treatment plant increased during the FYR period with a high concentration of 16.9 µg/L (TCE only) detected in December 2006. Explosives concentrations remained constant during the FYR period, averaging 1.83 µg/L. Total VOCs and explosives were non-detect in the effluent, with the following exceptions: methylene chloride was detected at 16 µg/L (August 2005), 27 µg/L (September 2005), and 3 µg/L (October 2005); TCE was detected at 1.2 µg/L (January 2005); *cis* 1,2-DCE was detected at 0.12 µg/L (January 2005); and RDX was detected at 0.275 µg/L (June 2006).

During the FYR period, the main groundwater treatment plant treated and discharged 5,399,599,000 gallons of water. All discharge criteria were met during this FYR period.

The detection limits for the COCs in water (influent and effluent) at the main groundwater treatment plant for the FYR period are presented below. The range of detection limits was dependent upon the laboratory used and any dilutions made.

- TNB - 0.075 - 0.67 µg/L
- TNT - 0.075 - 1.0 µg/L
- 2,4-DNT - 0.075 - 0.62 µg/L
- RDX - 0.075 - 0.77 µg/L
- 1,2-DCP - 0.119 - 5.0 µg/L
- TCE - 0.12 - 5.0 µg/L
- Methylene chloride - 0.398 - 7.0 µg/L

The table below presents the OU2 ROD COCs and associated discharge criteria for the main groundwater treatment plant and the LL1 groundwater treatment plant (discussed in the next section). The enforceable discharge criteria are based on the Final Effluent Limitations Monitoring Requirements for this site provided by the state of Nebraska on October 5, 1998.

Table 4-3
Final Effluent Limitations Monitoring Requirements[1]

OU2 ROD COCs	30-day Average (µg/L)[2]	Daily Maximum (µg/L)[2]
Combined Explosives (TNT, RDX, tetryl)	100	200
Total HMX	200	400
Total RDX	50	100
TCE	5	5
TNT	10	20

Note:
[1] Final Effluent Limitations Monitoring Requirements (October 5, 1998)
[2] Units presented as mg/L in the October 5, 1998, letter (1 mg/L = 1,000 µg/L)

4.3.2.2 Load Line 1 Groundwater Treatment Plant

The LL1 groundwater treatment plant was not operational during the entire FYR period. The official O&M of the LL1 groundwater treatment plant began on February 13, 2006.

Influent, effluent water and air discharge points were sampled at the LL1 groundwater treatment plant each week for the first month of operation (February 2006) and every month thereafter. The purpose of the sampling was to monitor plant efficiency, to determine if contaminant breakthrough had occurred (in the vapor phase carbon unit), and to verify that contract specific discharge parameters (in accordance with the Final Effluent Limitations Monitoring Requirements issued by the state of Nebraska) were met. No vapor phase carbon change outs were performed during 2006 or in January or February 2007. Air effluent samples were non-detect for TCE during this period. Influent groundwater samples showed TCE concentrations increasing slowly with 11.4 µg/L recorded as of February 2006 compared to 16.3 µg/L in January 2007. Effluent samples were nondetect during this period. Detection limits vary each time the laboratory updates their detection limits (at least yearly). The detection limits for the COCs in water (influent and effluent) at the LL1 groundwater treatment plant were as follows:

- Explosives (TNB, TNT, 2,4-DNT, and RDX) - 0.075 µg/L - 0.094 µg/L
- 1,2-DCP - 0.119 µg/L
- TCE - 0.151 µg/L
- Methylene chloride - 0.398 µg/L

The LL1 groundwater treatment plant treated 177,545,000 gallons of water during the 12-month period of February 2006 through February 2007. All discharge criteria were met during this period.

The air emissions design for the LL1 groundwater treatment plant air effluent was based on the Region 9 Preliminary Remediation Goal (PRG) of 0.017 µg/m^3 for TCE. The sampling results for the LL1 groundwater treatment plant air effluent are compared to a limit of 200 µg/m^3 (ppm by weight) for TCE, representing the modeled concentration necessary to assure that the Region 9 PRG for TCE is not exceeded at the FNOP property boundary (County Road F). The treated effluent air emissions data for the LL1 groundwater treatment plant are not reproduced here, but are presented in the 2006 Annual O&M Report (Appendix A to the 2006 Draft Final ARPR) (URS, 2007c).

Detection limits for the COCs (TCE) in air (effluent) are presented below. Analyses performed for methylene chloride and 1,2-DCP were nondetect.

- TCE – 50 µg/m^3 – 1,900 µg/m^3. The higher detection limit (1,900 µg/m^3) was used during the first quarter of 2006. Detection limits of 50 µg/m^3 and 100 µg/m^3, used starting with the second quarter of 2006, were obtained from a different analytical laboratory. Detection limits as low as 1.1 µg/m^3 were used in 2007. Detection limits change for each analysis and are dependent upon the volume of air sampled.

4.3.2.3 Groundwater Circulation Well Operation

Influent and effluent samples were collected from GCW-1 and GCW-2 in March, June, September and December 2006. The associated MWs for each of the GCWs were sampled most recently in June 2006. The average treatment efficiencies exceeded 97% for GCW-1 (TCE) and 89% for GCW-2 (RDX) for the review period. Maintenance on the GCWs included inflating packers and cleaning the UV bulb for the GCW-2 system. Both GCWs were impacted by frequent weather related power interruptions that required re-starts and lowering of flow rates due to low groundwater levels. The following provides an operational summary for GCW-1 and GCW-2:

GCW-1 (TCE)

- Influent concentrations from November 4, 2003, through June 11, 2007, ranged between 510 µg/L (March 8, 2005) and 4,575 µg/L (November 4, 2003).
- Effluent concentrations from November 4, 2003, through June 11, 2007, ranged between 0.65 µg/L (June 11, 2007) and 298 µg/L (November 4, 2003).
- Sampling results from MW-72B, upgradient of GCW-1, indicate a decreasing trend since 2004.
- Analytical results indicate that the effective aquifer treatment area extends at least 100 feet downgradient of GCW-1 to MW-73A/B.

GCW-2 (RDX)

- Influent concentrations from November 4, 2003, through June 11, 2007, ranged between 3.09 µg/L (March 7, 2007) and 24.60 µg/L (November 4, 2003).
- Effluent concentrations from November 4, 2003, through June 11, 2007, ranged between ND (December 14, 2005) and 14.9 µg/L (November 4, 2003).
- Sampling results from MW-65B (shallow zone), upgradient of GCW-2, indicate that RDX levels have been consistently and significantly above the cleanup goal since 2004. There were no RDX detections in the intermediate zone (MW-65A), upgradient of GCW-2, during the period of 2004 through 2006.
- Analytical results indicate that the effective aquifer treatment area extends at least 60 feet downgradient of GCW-2 to MW-67A/B in intermediate and shallow groundwater, respectively.

4.3.3 Reporting

Operational reports are prepared and submitted to USACE on a routine basis, either weekly, monthly, or annually depending on the reporting requirement. In general, the reports summarize the O&M data and system monitoring information collected during the reporting period. If any effluent discharge result were to exceed the established limits, USACE would be notified in writing within 48 hours of discovering the exceedance.

Typical report contents include:

- Overall system up time and hours of operation
- Measured values of all standard operating parameters
- Description of adjustments performed
- Analytical results
- Field measurements
- Summary of maintenance performed
- Description and corrective action related to system shutdown
- Operational problems and associated remedies
- Utility usage
- Labor requirements
- Health and safety issues
- Other general observations as appropriate

4.3.4 Cost Summary

O&M costs for the OU2 remedial system(s) include groundwater treatment plant component and structure maintenance, sampling and analysis efforts, monitoring well installation (as needed) and maintenance, general site management, and labor. To date, no unexpected issues or

problems have arisen which resulted in a significant increase in the estimated O&M costs. Treatment plant operators indicate that their current operating budget is sufficient to keep the remedial system(s) operating in a safe and effective manner. However, the treatment plant operators expect that maintenance costs will rise as the equipment ages and becomes more maintenance intensive. These increases in maintenance are generally anticipated with a system of this type and necessary to keep the plant functioning and operating over the long term.

The O&M costs as reported by the operating contractor are presented below.

Table 4-4
Annual System Operations/O&M Costs

Year	O&M System Costs
2002	$901,000
2003	$990,500
2004	$848,200
2005	$1,100,000
2006	$1,503,000

4.3.5 O&M Summary

During this FYR the annual O&M reports as prepared and submitted by the operating contractor were reviewed. Weekly and/or monthly reports were not specifically reviewed as the data contained therein was generally summarized in the annual report. All reports were consistent with the requirements for O&M reporting as established in the applicable planning documents.

The reports reviewed included:

- Annual Summary Operations and Maintenance Report Year 2002 (dated January 2003)
- Annual Summary Operations and Maintenance Report Year 2003 (dated January 2004)
- Annual Summary Operations and Maintenance Report Year 2004 (dated February 2005)
- Annual Summary Operations and Maintenance Report Year 2005 (dated February 2006)
- Annual Summary Operations and Maintenance Report Year 2006 (dated February 2007)

The reports indicated that no major alarms occurred during any of the reporting periods. The reports also indicate that the plant(s) required periodic shut down for a variety of reasons which primarily related to general maintenance, replacement of faulty parts and/or equipment, weather, and/or well rehabilitation. During these periods the plants were generally offline for a few hours rather than days.

Carbon change outs were reported to have occurred in all years with the exception of Year 2004.

No safety incidents have been reported.

Effluent discharge levels were met throughout the period of operation.

Although not specifically stated in the individual reports, the plant(s) are reported to maintain a greater than 97 percent run time, which indicates the plants are operating as intended and the prescribed O&M is adequate.

This is the first FYR for OU2 at FNOP.

The following sections describe the activities conducted in preparation for, and completion of, the FYR. The activities are briefly described in the following sections and include: project administration, community notification and involvement, document review, data review and evaluation, site inspection, and interviews.

6.1 ADMINISTRATIVE COMPONENTS

USACE has the responsibility for planning, coordinating, funding, and conducting five-year reviews. USACE is responsible for making protectiveness determinations upon conclusion of each FYR. However, EPA retains final authority over whether the FYR adequately addresses the protectiveness of the remedies. While not part of the FYR Team, EPA and NDEQ are included as part of the review and comment process on the Draft FYR. This FYR has been revised based on comments received from EPA and NDEQ. EPA will either concur with the FYR, as revised, or will issue independent findings.

The FYR Team consists of personnel from USACE, Kansas City District (supported by URS Group, Inc.). Planning for the FYR process began in November 2006. The Draft FYR was completed in July 2007. The period of evaluation associated with this FYR is February 2002 through February 2007.

The FYR process included notification to the regulatory agencies, the community, and other interested parties upon initiation of the FYR. Public input was received, relevant documents and data were reviewed, and a site inspection was performed. Each of these elements is detailed in the following subsections.

6.2 COMMUNITY NOTIFICATION AND INVOLVEMENT

Initial community notification was accomplished by providing a FYR overview presentation at the January 25, 2007, Restoration Advisory Board (RAB) meeting held in Mead, Nebraska. In addition, a public notice was placed in the local papers including: the Omaha World Herald, the Lincoln Journal Star, the Ashland Gazette, and the Wahoo Newspaper on April 12, 2007. A copy of the public notices is provided in **Attachment 3**.

Upon approval of this FYR, a public notice will be printed in the Omaha World-Herald, the Lincoln Journal Star, the Wahoo Newspaper and the Ashland Gazette announcing the completion. The notice will provide information on the location of the Information Repository, where a copy of the FYR will be available for public review.

6.3 DOCUMENT REVIEW

This FYR included a review of relevant information contained in a variety of site related documents. Review of information primarily focused on documents produced after February 2002 (start of the FYR time frame) but also included information presented in the OU2 RI, FS, PRAP, and ROD. A list of site related documents reviewed in total or in part during preparation of this FYR is contained in **Attachment 4**.

6.4 DATA REVIEW

This section presents a summary of the field sample collection activities and the analytical results for the GMP for the last five years. Analytical results were evaluated against the Final Target Groundwater Cleanup Goals as summarized in Section 3.6, Table 3-1.

6.4.1 2002 GMP

Monitoring Wells

One groundwater monitoring well sampling event was completed in January 2003 during the 2002 GMP. Semi-annual sampling was planned for 2002; however, only one sampling event was completed. A list of the monitoring wells sampled and the analysis performed is contained in **Table 6-1**. The analytical results of COCs reported above the Final Target Groundwater Cleanup Goals are presented in **Table 6-2**.

Water Supply Wells

Three water supply well sampling events (March, June, and December) were completed during the 2002 GMP. A list of the water supply wells and the analysis performed is contained in **Table 6-3**.

TCE exceeded the Final Target Groundwater Cleanup Goal in two water supply wells during the 2002 GMP. TCE was detected in the sample taken before the GAC unit from WSW-54 in the 2nd quarter at a concentration of 26.4 µg/L. TCE was not detected in the sample taken after the GAC unit from WSW-54. TCE was detected in WSW-52C in the 2nd quarter at a concentration of 360 µg/L. WSW-52C was sampled again in July 2002 due to the high detection reported in June; the results for TCE from this sampling was a concentration of 477 µg/L.

In 2002 the owners of WSW-52C were supplied with bottled water. In April 2003 a GAC unit was installed for WSW-52C.

RDX exceeded the Final Target Groundwater Cleanup Goal in three water supply wells during the 2002 GMP. RDX was detected in the duplicated sample from WSW-50B in the 1st quarter at a concentration of 1.95 µg/L (2.31 µg/L in the field duplicate sample (FDS)). RDX was detected in the sample taken before the GAC unit from WSW-54 in the 2nd quarter at a concentration of 7.68 µg/L. RDX was detected in the sample taken before the GAC unit from WSW-52A in the 2nd quarter at a concentration of 5.2 µg/L. RDX was not detected in the samples taken after the GAC unit from WSW-54 or WSW 52A.

TCE and RDX were the only COCs detected above the Final Target Groundwater Cleanup Goals in the water supply wells during the 2002 GMP.

As a part of the water supply support, residential groundwater is routinely monitored in the vicinity of the site, which includes all currently and potentially impacted water supply wells. In addition to sampling, monitoring also includes a review of real estate transactions for the area, a survey of the state of Nebraska Well Registry Database, and visual inspections of the local area to determine whether any new potable water wells have been installed in the vicinity of the site.

Additionally, a physical inspection of the site is routinely performed by the operators of the main groundwater treatment and by USACE contractor personnel during routine monitoring well and water supply well sampling events. The physical inspection is intended to identify new

construction sites or activities that may indicate the installation of new potable water wells within or downgradient of the groundwater plumes. Based on chemical sampling results and visual inspection of the local area, no residents were known to be consuming drinking water that contained contaminants exceeding the OU2 Final Target Groundwater Cleanup Goals.

Groundwater Flow

Water levels were collected during the GMP and the groundwater flow direction was found to be generally to the southeast, consistent with historical data.

6.4.2 2003 GMP

Monitoring Wells

Two groundwater monitoring well sampling events were completed (March and October) during the 2003 GMP. A list of the monitoring wells sampled and the analysis performed is contained in **Table 6-4**. The analytical results of COCs reported above the Final Target Groundwater Cleanup Goals are presented in **Table 6-5**.

Water Supply Wells

Four water supply well sampling events (March, June, September, and December) were completed during the 2003 GMP. A list of the water supply wells and the analysis performed is contained in **Table 6-6**.

TCE exceeded the Final Target Groundwater Cleanup Goal in two water supply wells during the 2003 GMP. TCE was detected in the sample taken from a sampling port prior to treatment by the GAC unit from WSW-52C in the 2nd and 4th quarters at concentrations of 2,484 µg/L and 717 µg/L (660 µg/L in the FDS), respectively. TCE was detected in the sample taken from a sampling port prior to treatment by the GAC unit from WSW-54 in the 2nd quarter at a concentration of 21.4 µg/L (20.6 µg/L in the FDS). TCE was not detected in either of these wells in samples taken after treatment by the GAC units.

RDX exceeded the Final Target Groundwater Cleanup Goal in one water supply well during the 2003 GMP. RDX was detected in the sample taken from a sampling port prior to treatment by the GAC unit from WSW-54 in the 2nd quarter at a concentration of 7.5 J µg/L (10.1 µg/L in the FDS). RDX was detected in the sample taken after the GAC unit from WSW-54 in the 2nd quarter at a concentration of 0.9 J µg/L.

TCE and RDX were the only COCs detected above the Final Target Groundwater Cleanup Goals in the water supply wells during the 2003 GMP.

As a part of the water supply support, residential groundwater is routinely monitored in the vicinity of the site, which includes all currently and potentially impacted water supply wells. In addition to sampling, monitoring also includes a review of real estate transactions for the area, a survey of the state of Nebraska Well Registry Database, and visual inspections of the local area to determine whether any new potable water wells have been installed in the vicinity of the site.

Additionally, a physical inspection of the site is routinely performed by the operators of the main groundwater treatment and by USACE contractor personnel during routine monitoring well and water supply well sampling events. The physical inspection is intended to identify new

construction sites or activities that may indicate the installation of new potable water wells within or downgradient of the groundwater plumes. Based on chemical sampling results and visual inspection of the local area, no residents were known to be consuming drinking water that contained contaminants exceeding the OU2 Final Target Groundwater Cleanup Goals.

Groundwater Flow

Water levels were collected during the GMP and the groundwater flow direction was found to be generally to the southeast, consistent with historical data.

6.4.3 2004 GMP

Monitoring Wells

Two groundwater monitoring well sampling events were completed (March and September) during the 2004 GMP. In addition, sentinel wells were sampled in November/December and Operation and Maintenance (O&M) monitoring well sampling was completed in May. A list of the monitoring wells sampled and the analysis performed is contained in **Table 6-7**. The analytical results of COCs reported above the Final Target Groundwater Cleanup Goals are presented in **Table 6-8**.

Water Supply Wells

Four water supply well sampling events (March, June, September, and October/November) were completed during the 2004 GMP. In addition to the scheduled sampling events, a one-mile buffer zone water supply well sampling event was completed. A list of the water supply wells and the analysis performed is contained in **Table 6-9**.

TCE exceeded the Final Target Groundwater Cleanup Goal in two water supply wells during the 2004 GMP. TCE was detected in the samples taken from a sampling port prior to treatment by the GAC unit from WSW-52C in the 1st, 3rd, and 4th quarters at concentrations of 450 µg/L, 540 µg/L, and 550 µg/L (560 µg/L in the FDS), respectively. TCE was detected in the sample taken from a sampling port prior to treatment by the GAC unit from WSW-54 in the 2nd quarter at a concentration of 14 µg/L. TCE was not detected in either of these wells in samples taken after treatment by the GAC units.

RDX exceeded the Final Target Groundwater Cleanup Goal in two water supply wells during the 2004 GMP. RDX was detected in the Artesian well in the 4th quarter at a concentration of 2.2 µg/L. RDX was detected in the sample taken from a sampling port prior to treatment by the before GAC unit from WSW-54 in the 2nd quarter at a concentration of 5.9 µg/L. RDX was not detected in samples taken after treatment by the GAC unit from WSW-54. The Artesian well is not used as a potable water source.

TCE and RDX were the only COCs detected above the Final Target Groundwater Cleanup Goals in the water supply wells during the 2004 GMP.

As a part of the water supply support, residential groundwater is routinely monitored in the vicinity of the site, which includes all currently and potentially impacted water supply wells. In addition to sampling, monitoring also includes a review of real estate transactions for the area, a survey of the state of Nebraska Well Registry Database, and visual inspections of the local area to determine whether any new potable water wells have been installed in the vicinity of the site.

Additionally, a physical inspection of the site is routinely performed by the operators of the main groundwater treatment and by USACE contractor personnel during routine monitoring well and water supply well sampling events. The physical inspection is intended to identify new construction sites or activities that may indicate the installation of new potable water wells within or downgradient of the groundwater plumes. Based on chemical sampling results and visual inspection of the local area, no residents were known to be consuming drinking water that contained contaminants exceeding the OU2 Final Target Groundwater Cleanup Goals.

Groundwater Flow

Water levels were collected during the GMP and the groundwater flow direction was found to be generally to the southeast, consistent with historical data.

6.4.4 2005 GMP

Monitoring Wells

Four groundwater monitoring well sampling events were completed (March, June, September/October, and December) during the 2005 GMP. In addition, O&M monitoring well sampling was completed in June and August. A list of the monitoring wells sampled and the analysis performed is contained in **Table 6-10**. The analytical results of COCs reported above Final Target Groundwater Cleanup Goals are presented in **Table 6-11**.

Water Supply Wells

Four water supply well sampling events (March, June, September/October, and December) were completed during the 2005 GMP. Seventy-two water supply wells were sampled during the 2005 GMP. A list of the water supply wells and the analysis performed is contained in **Table 6-12**.

TCE exceeded the Final Target Groundwater Cleanup Goal in three water supply wells during the 2005 GMP. TCE was detected in the Artesian well in the 1st, 2nd, 3rd, and 4th quarters at concentrations of 5 µg/L, 6.4 µg/L (6.4 µg/L in the FDS), 9.8 µg/L (9.2 µg/L in the FDS), and 13.7 µg/L (13.6 µg/L in the FDS), respectively. TCE was detected in the sample collected from a sampling port prior to treatment by the GAC unit from WSW-52C in the 1st and 3rd quarters at concentrations of 610 J µg/L (540 µg/L in the FDS) and 900 µg/L (930 µg/L in the FDS), respectively. TCE was detected in the sample collected from a sampling port prior to treatment by the GAC unit WSW-54 in the 1st and 3rd quarters at concentrations of 15 µg/L (16 µg/L in the FDS) and 17 µg/L (17 µg/L in the FDS), respectively. Both of the wells with GAC units had no detections of TCE in the samples collected after treatment by the GAC unit. The Artesian well is not used as a potable water source.

Methylene chloride exceeded the Final Target Groundwater Cleanup Goal in two water supply wells during the 2005 GMP. Methylene chloride was detected in the sample collected from a sampling port prior to treatment by the GAC unit from WSW-52A in the 3rd quarter at a concentration of 6.2 µg/L in the FDS and was not detected in the original sample. Methylene chloride was detected in the sample taken before the GAC unit from WSW-52C in the 3rd quarter at a concentration of 6.7 µg/L in the FDS and was not detected in the original sample.

Methylene chloride was not detected in samples collected after treatment by the GAC unit from these wells.

RDX exceeded the Final Target Groundwater Cleanup Goal in two water supply wells during the 2005 GMP. RDX was detected in the Artesian well in the 1st, 2nd, 3rd, and 4th quarters at concentrations of 3.27 µg/L, 2.63 µg/L (2.78 µg/L in the FDS), 3.75 µg/L (3.14 µg/L in the FDS), and 3.43 µg/L (3.45 µg/L in the FDS), respectively. RDX was detected in the samples collected from a sampling port prior to treatment by the GAC unit from WSW-54 in the 1st and 3rd quarters at concentrations of 5.53 µg/L (5.74 µg/L in the FDS) and 5.5 µg/L, respectively. RDX was not detected in samples collected after treatment by the GAC unit from WSW-54.

TCE and RDX were the only COCs detected above the Final Target Groundwater Cleanup Goals in the water supply wells during the 2006 GMP.

As a part of the water supply support, residential groundwater is routinely monitored in the vicinity of the site, which includes all currently and potentially impacted water supply wells. In addition to sampling, monitoring also includes a review of real estate transactions for the area, a survey of the state of Nebraska Well Registry Database, and visual inspections of the local area to determine whether any new potable water wells have been installed in the vicinity of the site.

Additionally, a physical inspection of the site is routinely performed by the operators of the main groundwater treatment and by USACE contractor personnel during routine monitoring well and water supply well sampling events. The physical inspection is intended to identify new construction sites or activities that may indicate the installation of new potable water wells within or downgradient of the groundwater plumes. Based on chemical sampling results and visual inspection of the local area, no residents were known to be consuming drinking water that contained contaminants exceeding the OU2 Final Target Groundwater Cleanup Goals.

Groundwater Flow

Water levels were collected during the GMP and the groundwater flow direction was found to be generally to the southeast, consistent with historical data.

6.4.5 2006 GMP

Monitoring Wells

Four groundwater monitoring well sampling events were completed (March, April, September, and December) during the 2006 GMP. In addition, O&M monitoring well sampling was completed in June. A list of the monitoring wells sampled and the analysis performed is contained in **Table 6-13**. The analytical results of COCs reported above the Final Target Groundwater Cleanup Goals are presented in **Table 6-14**.

Water Supply Wells

Two water supply well sampling events (March and September) were completed during the 2006 GMP. A list of the water supply wells and the analysis performed is contained in **Table 6-15**.

TCE exceeded the Final Target Groundwater Cleanup Goal in two water supply wells during the 2006 GMP. TCE was detected in the Artesian well in the 1st, 3rd, and 4th quarters at concentrations of 18.3 µg/L, 39.8 µg/L, and 41.3 µg/L, respectively. TCE was detected in the

samples taken before the GAC unit from WSW-52C in the 1st and 3rd quarters at concentrations of 578 µg/L (532 µg/L in the FDS) and 568 µg/L (559 µg/L in the FDS), respectively. TCE was detected in the samples taken from a sampling port prior to treatment by the GAC unit from WSW-54 in the 1st and 3rd quarters at concentrations of 11.7 µg/L (11.5 µg/L in the FDS) and 13.3 J µg/L (13.7 J µg/L in the FDS), respectively. Both of the wells with GAC units had no detections of TCE in samples after treatment by the GAC unit. The Artesian well is not used as a potable water source.

RDX exceeded the Final Target Groundwater Cleanup Goal in two water supply wells during the 2006 GMP. RDX was detected in the Artesian well in the 1st, 3rd, and 4th quarters at concentrations of 3.82 µg/L, 4.08 µg/L, and 3.85 µg/L, respectively. RDX was detected in the samples taken before the GAC unit from WSW-54 in the 1st and 3rd quarters at concentrations of 4.67 µg/L (4.55 µg/L in the FDS) and 4.92 µg/L (5.03 µg/L in the FDS), respectively. RDX was not detected in samples taken after the GAC unit from WSW-54.

TCE and RDX were the only COCs detected above the Final Target Groundwater Cleanup Goals in the water supply wells during the 2006 GMP.

As a part of the water supply support, residential groundwater is routinely monitored in the vicinity of the site, which includes all currently and potentially impacted water supply wells. In addition to sampling, monitoring also includes a review of real estate transactions for the area, a survey of the state of Nebraska Well Registry Database, and visual inspections of the local area to determine whether any new potable water wells have been installed in the vicinity of the site.

Additionally, a physical inspection of the site is routinely performed by the operators of the main groundwater treatment and by USACE contractor personnel during routine monitoring well and water supply well sampling events. The physical inspection is intended to identify new construction sites or activities that may indicate the installation of new potable water wells within or downgradient of the groundwater plumes. Based on chemical sampling results and visual inspection of the local area, no residents were known to be consuming drinking water that contained contaminants exceeding the OU2 Final Target Groundwater Cleanup Goals.

Groundwater Flow

Water levels were collected during the GMP and the groundwater flow direction was found to be generally to the southeast, consistent with historical data.

6.4.6 Evaluation of Newly Installed 2006 Monitoring Wells

Monitoring wells were installed in the southern and eastern portions of the site in 2006. With the exception of monitoring well clusters MW-94 and MW-99, which were placed within plumes, the new wells were placed in areas outside of the capture zone for use in the containment evaluation. The following monitoring wells were installed in 2006:

MW-86A,B,D	MW-97A,B,D	MW-103A,B,D	MW-113A,B,D
MW-87A,B,D	MW-98A,B,D	MW-106A,B,D	MW-114A,B,D
MW-88A,B,D	MW-99A,B,D	MW-107A,B,D	MW-115A,B,D

MW-94A,B,D	MW-100A,B,D	MW-108A,B,D	MW-116A,B,D
MW-95A,B,D	MW-101A,B,D	MW-110A,B,D	MW-117A,B,D
MW-96A,B,D	MW-102A,B,D	MW-112A,B	MW-118A,B

Shallow (B) monitoring wells were installed at the base of the top half of the saturated thickness of the unconsolidated aquifer. Intermediate (A) monitoring wells were installed at the base of the unconsolidated aquifer. When sandstone was encountered at the top of bedrock, deep (D) monitoring wells were installed in the bedrock. The monitoring well locations are presented on **Figures 6-1** through **6-4**.

The following section describes the analytical results of the initial sampling (January-February 2007) of the newly installed southern and eastern monitoring wells. A list of the monitoring wells sampled and the analysis performed is contained in **Table 6-16**. The analytical results for TCE and RDX (the only COCs detected in these wells) are presented in **Table 6-17**.

TCE

TCE was not detected in any of the new monitoring wells during the January-February 2007 sampling event.

RDX

During the January-February 2007 sampling event, RDX was detected above the Final Target Groundwater Cleanup Goal (2 µg/L) at the following new monitoring well locations:

- MW-99A (3.16 µg/L) (3.72 µg/L in the FDS), MW-99B (3.78 µg/L), and MW-99D (4.08 µg/L)

It is important to note that this well cluster is located within the LL3 plume.

RDX was the only COCs detected above the Final Target Groundwater Cleanup Goals during this sampling event.

6.4.7 Evaluation of Historical COC Concentration Trends

TCE

Monitoring Wells

TCE concentrations are decreasing at monitoring wells MW-12, MW-23B, located in the north end of LL1. TCE concentrations are decreasing at monitoring wells MW-02A, and MW-02B, located on the west side of the LL1. Near the middle and west of the axis of the LL1 plume, concentrations in MW-21A and MW-24A (**Figure 6-1**) have been increasing since EW-8 began pumping in 2002. Since these wells are west of the axis of the plume, this suggests that the EW-8 pumping is drawing the axis of the plume slightly towards the west. Concentrations in the leading third of the LL1 plume are much lower than the upgradient portions of the plume. Concentrations at MW-90B and MW-90A, which are located upgradient of EW-12, have shown

an increasing trend. Concentrations in MW-80A and MW-80B, which are downgradient of EW-12, began declining shortly after EW-12 began pumping.

Concentrations of TCE in MW-40B downgradient of GCW-1 have declined sharply since GCW-1 became operational in June 2000. Concentrations of TCE in MW-72B, which is upgradient of GCW-1, have decreased since May 2004. Concentrations of TCE in MW-9A and MW-9B, which are located on the west side of the former AMA plume and on the southeast side of LL4, have been decreasing since 2000. Concentrations of TCE in MW-43A and MW-43B, which are located approximately one mile southeast of the NDR Reservoir, are mixed. TCE concentrations in MW-43A have been increasing since 1995, while TCE concentrations in MW-43B have been decreasing since 1992. As would be expected, concentrations in MW-44A, which is located near the downgradient end in the center of the plume, are increasing due to migration towards the FNOP containment system. Concentrations in MW-45A and MW-45B, which are located east of Johnson Creek and MW-36A and MW-36B, which are located west of and adjacent to Johnson Creek have been declining during the period of this review.

Concentrations of TCE in MW-18C (shallow well), approximately 2,000 feet downgradient of Burning Grounds, has been declining since 1993.

Charts showing TCE concentrations over time are presented on **Figures 6-1** and **6-2**.

Water Supply Wells

Concentrations of TCE in the Artesian well have steadily increased from 0.7 µg/L in June 2003 to 50.3 µg/L in February 2007. The Artesian well is not used as a potable water source.

Concentrations of TCE in the samples taken from a sampling port prior to treatment by the GAC unit from WSW-52C have been erratic, starting with a concentration of 360 µg/L in June 2002 and increasing to 2,484 µg/L in June 2003. TCE concentrations in WSW-52C then began declining until they bottomed out with a non-detect in June 2004. TCE concentrations in WSW-52C then began increasing until they reached 900 µg/L (930 µg/L in the FDS) in September 2005. In 2006 the concentrations in WSW-52C ranged from 568 µg/L (559 µg/L in the FDS) to 578 µg/L (532 µg/L in the FDS).

Concentrations of TCE in the samples taken from a sampling port prior to treatment by the GAC unit from WSW-53 increased from non-detect to 4 µg/L from June 2002 to March 2005. Since then, TCE concentrations have varied from 1.95 µg/L (2.9 µg/L in the FDS) to 3.47 µg/L (4.41 µg/L in the FDS).

Concentrations of TCE in the samples taken from a sampling port prior to treatment by the GAC unit from WSW-54 have decreased from 26.4 µg/L in June 2002 to 13.3 J µg/L (13.7 J µg/L in the FDS) in September 2006.

RDX

Monitoring Wells

Concentrations of RDX in MW-21B near the central part of the LL1 plume have decreased slightly since 1993. Concentrations of RDX in MW-24B, located in the southern portion and on the western edge of the LL1 plume, have been increasing slightly since 2004.

RDX concentrations are decreasing at monitoring well clusters near LL2. Concentrations of RDX in MW-04B have slightly decreased since 1993 and RDX concentrations in MW-05B have been decreasing significantly since 1993. RDX concentrations in MW-28B, MW-31B, and MW-29A, located near the edge of the plume, have varied from ND to about 10 µg/L. RDX in MW-29A has shown a decreasing trend since 1993. RDX concentrations in MW-32A, located approximately ¾ of a mile downgradient of the Biological Active Zone Enhancement Pilot Study Area (URS, 2003c), have shown a decreasing trend while RDX concentrations in MW-32D have shown a slight increasing trend.

RDX concentrations have remained consistent in the MW-07B well cluster location near LL3. RDX concentrations in the MW-33 well cluster have demonstrated a declining trend since 1993, possibly due to a southerly shift in the LL3 plume due to pumping of EW-4.

RDX concentrations are decreasing at the MW-08 cluster near LL4. RDX concentrations increased to about 5 µg/L in MW-42A located approximately 1.5 miles downgradient of MW-08.

The RDX concentration at MW-11 near the Burning Grounds has decreased from 35 µg/L in 1992 to ND in 2006. RDX concentrations in MW-54A, located northeast of the former Landfill Area, have decreased slightly since 1995. RDX concentrations in MW-18C (shallow), located approximately ½ mile downgradient of MW-11, have remained consistent (approximately 5 µg/L) since 1995. RDX concentration in MW-43B, located approximately one mile southeast of MW-11, shows an increasing trend until 1993 then a decreasing trend until 2000 followed by an increasing trend to 2005 when it begins a decreasing trend again. RDX concentrations in the MW-45 cluster, located east of Johnson Creek, have consistently ranged from about 2 to 8 µg/L since 1993.

Charts showing RDX concentrations over time are presented on **Figures 6-3** and **6-4**.

Water Supply Wells

Concentrations of RDX in the Artesian well have increased from 1.78 µg/L in June 2003 to 4.08 µg/L in September 2006. Since September 2006 concentrations of RDX in the Artesian well have decreased to 2.4 µg/L in February 2007. The Artesian well is not used as a potable water source.

Concentrations of RDX in WSW-50B have declined from 2.31 µg/L in March 2002 to non-detect in the next sampling round in June 2002. Since June 2002 concentrations of RDX in WSW-50B have ranged from non-detect to 1.43 µg/L.

Concentrations of RDX in the samples taken before the GAC unit from WSW-54 have decreased slightly from 7.68 µg/L in June 2002 to 4.92 µg/L (5.03 µg/L in the FDS) in September 2006.

Methylene Chloride

Monitoring Wells

Methylene chloride was detected above the Final Target Groundwater Cleanup Goal (5 µg/L) at five monitoring wells at the site at concentrations ranging from 5 J µg/L to 12 J µg/L during the period of this FYR.

Water Supply Wells

Methylene chloride was detected in two water supply wells during the period of this FYR. Methylene chloride was detected in the samples taken before the GAC unit from WSW-52A and WSW-52C during the September 2005 sampling round at concentrations of 6.2 µg/L and 6.7 µg/L, respectively.

1,2-DCP

Monitoring Wells

1,2-DCP has not been detected above the Final Target Groundwater Cleanup Goal (5 µg/L) in any monitoring well during the period of this FYR.

Water Supply Wells

1,2-DCP has not been detected in any water supply well during the period of this FYR.

TNB

Monitoring Wells

TNB was detected above the Final Target Groundwater Cleanup Goal (0.778 µg/L) at one monitoring well during the period of the FYR. TNB was detected in MW-05B in September 2003 at a concentration of 2.69 µg/L. This is an increase from the detection of 1.2 µg/L in December 2000.

Water Supply Wells

1,2-DCP has not been detected in any water supply well during the period of this FYR.

TNT

Monitoring Wells

TNT was detected above the Final Target Groundwater Cleanup Goal (2 µg/L) at two monitoring wells during the period of the FYR. TNT was detected in MW-05B in September 2003 at a concentration of 32.3 µg/L. The concentrations in this well have been relatively consistent since 1992. TNT was detected in MW-07B in March 2003 at a concentration of 4.23 µg/L. The detections in this well have decreased slightly since 1992.

Water Supply Wells

TNT has not been detected in any water supply well during the period of this FYR.

2,4-DNT

Monitoring Wells

2,4-DNT was detected above the Final Target Groundwater Cleanup Goal (1.24 µg/L) at one monitoring well during the period of the FYR. 2,4-DNT was detected in MW-05B in September

2003 at a concentration of 1.72 µg/L. Detections in this well have been relatively consistent since 1993.

Water Supply Wells

2,4-DNT has not been detected in any water supply well during the period of this FYR.

6.4.8 Chemical Results – Extraction Wells

This section summarizes the extraction well chemical data collected by ECC from February 2002 through February 2007. Chemical data were collected from eleven operating extraction wells at the Site. **Figure 6-3** and **Figure 6-4** show the locations of the extraction wells and the monitoring wells on-site.

TCE results in the extraction wells are summarized in **Table 6-18**. RDX results in the extraction wells are summarized in **Table 6-19**.

6.4.9 Current Extent of Contamination

The distribution of the primary COCs, RDX and TCE, has been interpreted based on groundwater data collected from multiple investigations and the GMP. The current extent of contamination is represented on **Figures 6-1** through **6-4**. In addition, graphs of TCE concentrations over time for select well clusters are provided on **Figures 6-1** and **6-2** and graphs of RDX concentrations over time for select well clusters are provided on **Figures 6-3** and **6-4**.

6.5 SITE INSPECTION

A site inspection was completed on April 18, 2007, by representatives of USACE - Kansas City District, URS, and ECC. The Site Inspection checklist and photos documenting the site conditions are included in **Attachments 5** and **6**. Personnel from EPA and NDEQ were unable to participate at the scheduled time. Participants included:

- David Nelson – USACE
- Lisa Tholl – URS
- David Convy – URS
- Tim Thares – ECC
- Vince Stallbaumer – ECC

The general purpose of the site inspection was to visually and operationally assess the protectiveness of the remedy in-place for OU2. The site inspection consisted of the following OU2 remedy in-place locations:

- Main groundwater treatment plant
- LL1 treatment plant
- The permitted discharge outfalls at Wahoo and Clear Creeks
- EW-11 area
- GCW-1

- GCW-2
- EW-5 well and pump house
- The proposed site of the future AOP treatment facility
- General overall tour of FNOP. The site inspection concluded with a review of the on-site documentation and interviews with the treatment plant operators.

In general, all treatment plant equipment at the main treatment plant, the LL1 treatment plant, and GCW-1 and GCW-2 appeared to be in good working order and functioning as designed. Carbon change out had just been completed on three of the four lead carbon vessels at the main treatment plant and the fourth was scheduled for change out the next day. No issues with the overall change out process were reported. All treatment plant buildings were well maintained and free of clutter and unnecessary obstruction. Applicable postings and warning signs were clearly visible where necessary and all fencing and gates in working order and locked as required. All applicable operations and maintenance documentation and records are up-to-date and maintained and were readily available for review at the main treatment plant as well as discharge permits and operator license requirements.

The two outfall locations (Wahoo Creek and Clear Creek) used for permitted discharge of the treated groundwater were observed to be in good working order. Both outfall locations were free of obstruction and flowing freely. The outfall locations are posted as necessary, maintained as needed, and inspected on a weekly basis by the treatment plant operators.

All groundwater extraction wells are housed in well houses. During the site inspection, personnel visited the site of EW-11 (currently not operating) and EW-5 as representative of the system as a whole. The well house areas were found to be well maintained, clean and functioning as designed. Treatment plant operators reported infrequent incidents of vandalism at some well houses located in close proximity to county roads. These incidents were typically minor in nature (damage to security lights) and did not result in system integrity or operational problems.

The groundwater monitoring system at the site includes 234 groundwater monitoring wells. During the site tour many wells within the system were observed. These wells appeared to be well maintained and in good working condition. Wells were surrounded by protective balusters and brightly painted for easy identification. It was noted at one well site that the protective casing around a monitoring well appeared to be unlocked and open. This was later discussed with the treatment plant operators who stated that the wells in question had recently been installed and the entire installation process was yet to be completed. No additional issues were observed during the general site tour.

6.6 INTERVIEWS

Interviews were conducted with the on-site O&M operators from ECC (contractors for USACE, Kansas City District), as well as the O&M Project Manager and Project Engineer. No significant issues were raised during the interviews that would affect the overall protectiveness of the remedy.

An interview conducted with Tim Thares and Vince Stallbaumer, both ECC employees and full-time operators of the treatment plants and GCWs, indicated that all operational aspects of the

main groundwater treatment plant, the LL1 treatment plant, and the two GCWs functioned as intended. They stated that only minor incidents of vandalism have occurred at one extraction well pump house and with the solar panel for the water level gauging station on Wahoo Creek. Both incidents required only minor repairs. The systems are operating with an uptime of approximately 97 percent.

USACE has maintained an ongoing commitment to community involvement during this FYR period. The community has been informed of progress at the site through fact sheets, published public notices, public meetings, a USACE-sponsored project website, yearly site tours, and incorporation of the Administrative Record in the Mead Public Library. Input from community members living or working near the site was routinely received through written correspondence and during Restoration Advisory Board Meetings and Public Availability Sessions.

As identified in Section 1.0, the type of review associated with OU2 is considered to be a policy review. According to EPA's Comprehensive Five-Year Review Guidance, a policy review is conducted when the remedial action, upon completion, will not leave hazardous substances, pollutants, or contaminants on site above levels that allow for unlimited use and unrestricted exposure, but requires five years or more to complete. The remedial action for OU2 meets these criteria. EPA guidance also identifies the trigger for a policy review as the date when construction is completed. This milestone has not been fully achieved for OU2. Accordingly, the FYR was initiated and executed at the discretion of USACE, EPA, and NDEQ, rather than as a result of a specific trigger. The period of review has been established based on the achievement of operational status of the main groundwater treatment plant.

Section 7.0 presents a technical assessment and is formulated based on the answers to Questions A, B, and C, presented below. As answers were formulated, consideration was given to the status of the remedial action. For consistency with FYR guidance, each question is summarily answered either yes or no. Supporting information is provided in the previous sections and referenced documents with additional analysis provided, as needed.

Question A: Is the remedy functioning as intended by the decision documents?

Question B: Are the exposure assumptions, toxicity data, cleanup levels, and remedial action objectives (RAOs) used at the time of the remedy selection still valid?

Question C: Has any other information come to light that could call into question the protectiveness of the remedy?

7.1 QUESTION A: IS THE REMEDY FUNCTIONING AS INTENDED BY THE DECISION DOCUMENTS?

No.

An evaluation of all operational, hydraulic, and chemical data collected through 2006 indicates that there are some areas where the OU2 remedial system is not functioning as intended by the ROD; however, the remedy is not fully constructed. The remedy is being constructed according to the requirements of the decision documents and is expected to be protective when complete. The remedy that has been implemented, to date, includes seven major components – hydraulic containment, focused extraction, groundwater treatment, disposal and beneficial reuse, alternative water supply support, water quality monitoring, and excavation and treatment of explosives-contaminated soils. Of these, hydraulic containment and focused extraction are under construction.

As previously stated the RAOs of the OU2 remediation are to:

- Minimize the potential for ingestion of contaminated groundwater, or reduce concentrations to acceptable health-based levels
- Minimize the potential for dermal exposure to contaminated groundwater, or reduce concentrations to acceptable health-based levels
- Minimize the potential for inhalation of chemicals released during the use of contaminated groundwater, or reduce concentrations to acceptable health-based levels

An analysis based on the individual components of the selected remedial action for OU2 is provided below. Each element is considered relative to Question A.

Hydraulically contain contaminated groundwater exceeding the Final Target Groundwater Cleanup Goals.

Analysis: The remedy component was initially thought to be complete. An evaluation of all operational, hydraulic, and chemical data collected in 2006 indicates the remedy is not meeting all the requirements of the ROD and fully achieving the desired results, specifically as it relates to hydraulic containment. The capture zone analysis identified the following three areas of concern requiring further evaluation:

- The middle of the LL3 RDX plume north of EW-4 and EW-5
- A small portion of the east side of the LL1 TCE plume approximately 1 mile north of EW-12
- A small portion of the east side of the AMA TCE plume near MW-45 approximately 1 mile north of EW-1

Steps are currently being implemented to evaluate each of these three areas to ensure that the remedy will function according to the requirements of the OU2 ROD (Woodward-Clyde, 1996c). Activities to remedy these areas of concern may consist of additional monitoring, additional investigations regarding the extent of contamination in the areas of concern, or additional modeling simulations to better predict plume behavior. Adjustments to the system currently in place and operational, to hydraulically contain the plume, will also be required. These adjustments will include, but are not limited to, changes to design flow rates and/or supplemental extraction well locations.

To date, 13 extraction wells have been installed to contain contaminated groundwater. The final Phase I design called for contaminated groundwater to be intercepted by 11 extraction wells near the southern boundary of the former NOP. Design and initial operating parameters for the groundwater extraction system were developed using the results of groundwater flow and contaminant transport modeling. Two extraction wells, EW-1 and EW-8, were installed in 1998 and began extracting contaminated groundwater which was delivered to the main groundwater treatment plant. The nine remaining Phase I design containment extraction wells were installed in 2001. Supplemental groundwater investigations identified the need for two additional hydraulic containment wells, EW-12 and EW-13, downgradient of EW-8 and EW-11, in the vicinity of Silver Creek. EW-11 is not currently operational and will be converted to a focused extraction well during the first quarter of 2008. EW-13 is not currently operational because testing of EW-12 revealed a much larger capture zone than expected and transport simulations suggest that TCE will not migrate beyond the immediate vicinity of EW-12 in the next five years. However, the utility of EW-13 is being further evaluated.

Activities used to evaluate the performance of the containment system include the following:

- Evaluation of water level measurements collected each year as a part of the GMP and development of potentiometric surface maps and groundwater flow-line maps to demonstrate that the containment system is maintaining an inward gradient

- Comparison of most recent specific capacities to previous measurements to evaluate the need for well maintenance
- Particle tracking simulations to estimate the width and continuity of capture zones
- Evaluation of concentration trends at all screened intervals for the groundwater monitoring well clusters identified in the Containment Evaluation Work Plan

As established in the FFA SMP, these activities, along with activities performed in support of the other remedy components, will culminate each year in development of a CE. The CE will document the performance of the containment system annually, providing both conclusions and recommendations.

The GMP is used to support this and other remedy components during construction. As a part of the GMP, groundwater samples are collected from select monitoring wells and water supply wells; and surface water samples are collected from three site creeks (Silver Creek, Clear Creek, and Johnson Creek). Samples are analyzed for COCs and the results are reported quarterly. Also, perimeter monitoring wells and residential wells within a 1-mile radius of the plume boundary are regularly sampled as part of the yearly GMP. Groundwater chemical analyses from eastern and southern perimeter groundwater monitoring wells installed in 2006 demonstrate that there is no RDX above 2 µg/L or TCE above 5 µg/L downgradient of the extraction wells. Furthermore, there was no evidence of unacceptable risk to human health resulting from exposure to contaminated groundwater. Aside from the residences that already receive alternative water supply or in-home carbon treatment units, there have been no detections of site-related contaminants in any of the residential water supply wells located within a 1-mile radius of the contaminant plume boundaries.

Focused extraction of groundwater in areas with relatively high concentrations of TCE and explosives.

Analysis: The focused extraction portion of the ROD has not been fully implemented. Steps have been taken to implement limited focused extraction by continuing to operate two pilot study groundwater circulation wells (GCWs), though they have not been formally adopted under the FFA. Starting in the first quarter of 2008, EW-11, originally installed as a containment well, will begin functioning as a focused extraction well and extracted water will be pretreated through an AOP treatment system before releasing the AOP-treated water to the main groundwater treatment plant for polishing. Also, current groundwater treatment and remedy optimization modeling includes a detailed analysis of focused extraction alternatives being considered. These elements are consistent with the ROD requirements and the SMP. The goal of the focused extraction, as defined by the ROD, is to rapidly remove contamination and shorten restoration time in areas with relatively high TCE and/or RDX concentrations, when compared to hydraulic containment pumping alone. Accordingly, this remedy component does not have a direct or immediate impact on protectiveness. Even though this remedy component must be fully implemented, it does not impact short-term protectiveness. The impact of focused extraction is long term.

Treat all extracted groundwater using GAC adsorption, AOP, and air stripping, any of which may be applied individually or in combination.

Analysis: This remedy component is operating. However, as treatment capacity increases, additional capacity will be added. Groundwater treatment is being successfully accomplished

by all three of the treatment technologies prescribed in the ROD. The main groundwater treatment plant treats influent groundwater from EW-1 through EW-10 (EW-11 is not currently operational and will be converted to a focused extraction well in the first quarter of 2008) using GAC to remove a combination of TCE and RDX. The AOP treatment system, with a targeted completion in the first quarter of 2008, will pretreat groundwater extracted by EW-11 before being conveyed to the main groundwater treatment plant for polishing. All discharge criteria for the main groundwater treatment plant were met during this FYR period.

The LL1 groundwater treatment plant is successfully treating groundwater from EW-12 (EW-13 is not currently operational and its utility is being further evaluated) using air stripping because the influent stream contains only TCE. All discharge criteria for the LL1 groundwater treatment plant were met during this period.

GCW-1 is treating TCE-contaminated groundwater in an area containing relatively high concentrations of TCE using air stripping. GCW-2 is treating RDX-contaminated groundwater in an area containing relatively high concentrations of RDX using ultraviolet light, an advanced oxidation process.

This element of the remedy is functioning as intended by the decision documents.

Dispose of the treated groundwater by beneficially reusing it or through surface discharge.

Analysis: This remedy component is operating. Two surface water outfalls are available for discharge of treated groundwater. Treated groundwater discharges into Wahoo Creek at an average monthly flow rate of approximately 1,800 gallons per minute (gpm) and the outfall located on Clear Creek discharges at an average monthly flow rate of approximately 400 gpm. Water is also being beneficially reused by the ARDC for irrigation purposes and by two local residents, one to maintain the level in a privately-owned pond and one for irrigation. The effluent discharge limitations issued by the state of Nebraska (NDEQ, 1998) are presented in the table below.

Final Effluent Limitations Monitoring Requirements[1]

OU2 ROD COCs	30-day Average (µg/L)[2]	Daily Maximum (µg/L)[2]
Combined Explosives (TNT, RDX, tetryl)	100	200
Total HMX	200	400
Total RDX	50	100
TCE	5	5
TNT	10	20

Note:
[1] Final Effluent Limitations Monitoring Requirements (October 5, 1998)
[2] Units presented as mg/L in the October 5, 1998, letter (1 mg/L = 1,000 µg/L)

This element of the remedy is functioning as intended by the decision documents.

Provide a potable water supply to local groundwater users whose water supply contains RDX exceeding the HA and/or TCE exceeding the MCL.

Analysis: This remedy component is operating. However, additional capacity will be added, if necessary. There are a total of five residences associated with Wells 50B, 52A, 52C, 53, and 54 that were part of the alternative water supply support (AWSS) program during the FYR period. Residential wells 52A, 52C, 53, and 54 have GAC units. Residential wells 50B, 52A, and 52C receive bottled water. The residential wells were included in the program based on current and/or historic detections of RDX greater than 2 µg/L and TCE greater than 5 µg/L in residential water supply wells.

Aside from the residences that already receive bottled water or have a GAC treatment unit installed, no site-related contaminants were detected above action levels from any of the residential water supply wells located within a 1-mile radius of the contaminant plume boundaries during the FYR period.

In an effort to determine whether any new residences or water users are present in the area which may be impacted by contamination, the following activities are performed semi-annually:

- A survey of the state of Nebraska Well Registry Database for any new potable water wells in the vicinity of the site
- A review of real estate transactions in the area
- Visual inspections of the local area to determine if any new potable water wells have been installed

In addition to the state of Nebraska Well Registry Database surveys, a physical inspection of the site is routinely performed by the operators of the main groundwater treatment and by USACE contractor personnel during routine monitoring well and water supply well sampling events. The physical inspection is intended to identify new construction sites or activities that may indicate the installation of new potable water wells within or downgradient of the groundwater plumes. Based on chemical sampling results and visual inspection of the local area, no residents were known to be consuming drinking water that contained contaminants exceeding the OU2 Final Target Groundwater Cleanup Goals.

The GMP began in August 1992 during the OU2 RI and continued through 2000 and from 2003 through 2006. No monitoring wells were sampled between June 1993 and September 1994 and between December 2000 and January 2003. However, site-wide monitoring of water supply wells has generally been performed quarterly since December 1993. Currently, 68 residential/supply wells and 234 groundwater monitoring wells are sampled quarterly, semi-annually, or annually as part of the GMP. This includes perimeter monitoring wells, as well as residential wells, within a 1-mile radius of the plume boundary.

This element of the remedy is functioning as intended by the decision documents.

Monitor the groundwater elevations and water quality.

Analysis: This remedy component is operating. Substantial resources are employed to support this component which provides valuable information used to support decisions on several other remedy components. Groundwater elevations and water quality information are

used to support the hydraulic containment evaluation, with its associated groundwater modeling, placement of focused extraction wells, and the alternative water supply support program. Groundwater level information and groundwater quality information is collected as part of the remedial system(s) operation and maintenance under the site-wide GMP. There are currently 68 residential/water supply wells and 234 groundwater monitoring wells that are sampled either quarterly, semi-annually, or annually as part of the GMP. This includes perimeter monitoring wells, as well as residential wells, within a 1-mile radius of the plume boundary. Groundwater chemical analyses from eastern and southern perimeter groundwater monitoring wells, installed in 2006, demonstrate that RDX levels are below 2 µg/L and TCE levels are below 5 µg/L downgradient of the extraction wells.

This element of the remedy is functioning as intended by the decision documents.

Excavate and treat explosives-contaminated soil which could act as a source of explosives contamination of groundwater and which does not meet the Operable Unit 1 (OU1) excavation criteria.

Analysis: This remedy component has been completed. Soils which could potentially act as a source of explosives contamination to groundwater were excavated and incinerated on-site during implementation of the OU1 remedial action completed in 1997 (OHM, 1998). No Five-Year Review is required for OU1 because no hazardous substances remained on site above health-based levels following remediation. No further action for explosives-contaminated soil is required for OU1 and OU2.

This element of the remedy is complete and cleanup levels have been achieved.

7.2 QUESTION B: ARE THE EXPOSURE ASSUMPTIONS, TOXICITY DATA, CLEANUP LEVELS, AND REMEDIAL ACTION OBJECTIVES USED AT THE TIME OF THE REMEDY STILL VALID?

Yes.

As part of the FYR process, it is necessary to evaluate whether previous risk assessment results remain valid for the site, and if the remedial action objectives used at the time of remedy selection are still protective. This evaluation is made by reviewing the individual components of the risk assessment, including data used in the evaluation, exposure assumptions, chemical-specific toxicity values, as well as evaluating whether risk assessment methodologies have changed since the risk assessment was originally performed.

Consistent with land use at the time of the risk assessment, land use at the site is mixed, and includes residences, agricultural use and use by employees of the University of Nebraska. The site land use has not changed since the risk assessment was performed, and is not anticipated to change for the foreseeable future. Consistent with current and likely future site use, the risk assessment evaluated resident and worker exposure to groundwater via drinking and bathing, and excavation worker exposure to subsurface soil via direct contact and inhalation of vapors in an excavation trench.

The Mead OU2 BLRA was completed in 1994 and focused on human health risks associated with site groundwater and subsurface soils. No ecological risk assessment was performed for OU2, as there is no direct contact of ecological receptors with site groundwater or subsurface soils.

During completion of the OU2 BLRA and FS, cleanup goals were developed for the most sensitive population (i.e., residents). Major exposure pathways were identified for these receptor groups and included:

- Ingestion of groundwater
- Dermal exposure to groundwater during showering
- Inhalation of volatile chemicals in groundwater during showering

Subsequent to the remedy selection for OU2, two human health exposure pathways that may have some association with groundwater contamination were identified. These were:

- Inhalation of TCE in indoor air, released as vapor from groundwater into soil, and subsequently migrating through the soil into buildings (e.g., a "vapor intrusion" pathway). (Note: This is different from the inhalation of vapors related to showering, which was evaluated in the original OU2 BLRA. This potential pathway may require an evaluation of buildings overlying or in close proximity to the TCE plume.)
- Inhalation of TCE in outdoor air, released as vapor from farm irrigation systems.

The best information on vapor intrusion at the site comes from the TAGA study performed by EPA. In the TAGA study, the highest level of TCE found in a residence is 0.27 ppbv or 1.45 $\mu g/m^3$ with a risk of $3x10^{-6}$ taken with the TAGA sampler. TCE levels of 0.12 and 0.13 ppbv, corresponding to $1x10^{-6}$ cancer risks, were found in samples taken using SUMMA cannisters on the first floor and basement during that study. The cancer risk level associated with the vapor intrusion pathway is, therefore, much less than 10^{-4}. The detected levels are also much less than CalEPA's 600 $\mu g/m^3$ or the New York State Department of Health's (NYSDOH) 10 $\mu g/m^3$ non-carcinogenic toxicity levels, so that the HI of 1 will not be exceeded. The subslab SUMMA sample was 0.024 ppbv, suggesting that the measured TCE levels might be due to sources in that residence rather than vapor intrusion.

Another pathway identified and evaluated subsequent to the remedy selection for OU2 is associated with potential risks resulting from inhalation of TCE from irrigation. This included an evaluation of potential TCE cancer risks and non-cancer hazards to farm workers who perform crop irrigation, and who may subsequently inhale TCE vapors released from the irrigation water. TCE concentrations from the irrigation well with the highest TCE concentration on-site (IR-7 at 64 µg/L) and a direct-push sampling location, where the highest TCE concentration in groundwater was detected (GP-11), were used as the basis for the risk calculations. Potential TCE concentrations in the air were calculated using an EPA screening model (SCREEN3), and potential risks and hazards were calculated using standard EPA risk assessment protocols and equations and Cal/EPA toxicity factors. The cancer risk associated with inhalation of TCE released from the irrigation well with the highest concentration (IR-7) was estimated to be 6×10^{-8}, while the non-cancer HI was 0.0001. The cancer risk, if an irrigation well were to be installed at the GP-11 location, was estimated to be 5×10^{-5}, with a HI of 0.09 (URS, 2007f). During the EPA/ERT study, air monitoring was performed passing an operating University of Nebraska irrigation sprinkler. TCE was detected below the detection limit of the instrumentation (at 0.022 ppbv) (Lockheed Martin, 2007). A level of 0.022 ppbv is below the 0.18 ppbv for a 10^{-6} cancer risk. Therefore, risks at existing irrigation wells are well within the acceptable risk ranges for both cancer and non-cancer health effects, although higher

risks could be experienced if new irrigation wells were to be located in areas over higher groundwater concentrations.

In February 2000, as part of the OU3 BLRA, indirect contact of groundwater entering surface water bodies by both human and ecological receptors was evaluated. Subsequent to completion of the OU3 risk assessment, concentrations of TCE and RDX in Johnson and Clear Creeks have increased. The surface water exposure pathway was evaluated again in 2006 as a result of the observed increase in surface water concentrations. These assessments concluded that the increased concentration of TCE would pose a 1×10^{-7} cancer risk, while the increased RDX would pose a cancer risk of 3×10^{-9} with an HQ of 0.00009 (URS, 2006a,b). These risks still fall within the acceptable ranges for cancer and non-cancer health effects.

Since completion of the OU2 risk assessment, no additional COCs or contaminant source areas have been identified at the site, nor have any physical characteristics at the site changed that could potentially affect the protectiveness of the remedy. EPA has re-evaluated the toxicity of one of the COCs, 1, 3, 5-trinitrobenzene, and determined that it is less toxic than previously thought (the oral reference dose has changed from 5×10^{-5} mg/kg-day to 3×10^{-2} mg/kg-day). As such, the remedy is still considered protective.

The oral cancer slope factor (CSF) of 0.011 $(mg/kg/day)^{-1}$ used to evaluate TCE in the OU2 BLRA was withdrawn by EPA in 1989. Although withdrawn, this value was most commonly used in risk assessments until relatively recently, since there were no alternative values available.

In addition to cancer risk, TCE can produce non-carcinogenic toxic effects. The OU2 BLRA did not evaluate the non-carcinogenic effects of TCE, as no reference doses were available at the time. Since completion of the risk assessment, EPA has proposed an oral reference dose of 0.0003 mg/kg/day and an inhalation reference dose of 0.01 mg/kg/day for evaluating the non-cancer effects of TCE. Although the lack of TCE reference doses in the risk assessment means that the non-cancer effects of TCE were not evaluated, the carcinogenic effects are typically the toxic endpoint of most concern.

A consensus has developed that the CalEPA slope factors and chronic inhalation Reference Exposure Level (REL) and NYSDOH's air criteria level are appropriate Tier III toxicity values for TCE. The toxicity values proposed by EPA in the 2001 draft risk assessment are in the process of review and revision by the agency and will be considered in future FYRs if new values are finalized. The current toxicity values do not cause significant changes to TCE risks.

Several risk assessment guidance documents have changed and/or been issued since completion of the OU2 risk assessment. The primary guidance used in preparation of the human health risk assessment was *Risk Assessment Guidance for Superfund: Volume 1: Human Health Evaluation Manual* (RAGS) (EPA, 1989). RAGS is still considered the primary guidance document for preparation of human health risk assessments. The primary change in risk assessment guidance relevant to this site involves evaluation of vapors released from groundwater and subsurface soils. Since the risk assessment was conducted, EPA has developed a standardized vapor intrusion model (the "Johnson and Ettinger Model") to evaluate potential risks associated with releases of vapors from groundwater into soils, and subsequent intrusion into buildings.

7.3 QUESTION C: HAS ANY OTHER INFORMATION COME TO LIGHT THAT COULD CALL INTO QUESTION THE PROTECTIVENESS OF THE REMEDY?

No.

MCLs and HAs are ARARs for this site. These values, based on the Safe Drinking Water Act, are the basis for containment of groundwater and the provision of alternative drinking water supply to address risks at the site. These values have not changed since the ROD.

Since the implementation of the remedy, there have been no changes in the physical conditions of the site that would affect the protectiveness of the remedy. The surrounding area remains rural and the land use remains primarily agricultural in nature. The site land use is not anticipated to change for the foreseeable future.

Although not currently impacting the protectiveness of the remedy, two issues worth noting have developed since the 1996 ROD:

1. Metropolitan Utilities District Well Field
2. Proposal of a CSF for TCE

In April 2002 an Environmental Impact Statement (EIS) was issued for MUD's proposed development of the Platte West Well Field to provide water to the Omaha metropolitan area. The groundwater modeling portion of the EIS stated that "pumping from the Platte West well field will have little or no impact on the Mead plume migration" (Burns & McDonnell, 2002).

In July 2002, a groundwater flow model evaluated the impact of the proposed MUD water supply well field on the remediation of contaminant plumes at FNOP (URS, 2002e). The following conclusions were developed from the MUD Groundwater Model (MUDGM):

- The gradient induced by the operation of the MUD well field is not sufficient to draw particles located around the perimeter of the AMA plume into the well field, assuming an annual average pumping rate of 50 million gallons per day (MGD)
- The model-predicted cone of depression generated by the MUD well field extends into the AMA plume, assuming an annual average pumping rate of 50 MGD
- The site hydraulic containment system is able to maintain capture of the AMA plume with the MUD well field operating, assuming an annual average pumping rate of 50 MGD
- The operation of the MUD well field causes the AMA plume to travel approximately 1,000 feet further east than the plume would travel if the MUD well field did not operate

The cancer risks due to trichloroethylene (TCE) were estimated in the 1994 OU2 BLRA using an oral CSF of 0.011 $(mg/kg/day)^{-1}$ that was withdrawn from IRIS by EPA in 1989. When the OU2 BLRA was prepared, use of the withdrawn CSF was recommended because no alternative value was available.

In 2001, EPA proposed new CSFs for TCE in an external draft risk assessment. These CSFs were subjected to significant criticism by the Department of Defense and the chemical industry. The National Academy of Sciences reviewed the 2001 draft TCE risk assessment and issued a report on issues and further work needed to develop new estimates of TCE toxicity (NAS, 2006). It should be noted that the revision process and review of revised toxicity values may take several years. If revised toxicity values are released, they will be addressed in future FYRs.

In 2003, EPA issued OSWER Directive 9285.7-53 detailing the hierarchy of sources to be used in selecting toxicity factors for Superfund risk assessments. Using that toxicity hierarchy, the CalEPA CSF of 0.013 $(mg/kg/day)^{-1}$ is an appropriate Tier III toxicity value, which meets the criteria of peer reviewed, available to the public, and transparent in methods and processes used to develop the values.

The CalEPA CSF is approximately 18 percent higher than the withdrawn CSF indicating a proportionate increase in the estimate of carcinogenic potency. Since this is an increase in toxicity, exposures considered in the BLRA that exceeded acceptable risks would still exceed acceptable risks if corrective measures were not being taken. The remedial goal set at the MCL of 5.0 μg/L TCE provides protection to a cancer risk of approximately $3x10^{-6}$ near the lower end of the acceptable risk range of 10^{-6} to 10^{-4}.

7.4 SUMMARY OF TECHNICAL ASSESSMENT

According to the data and documents reviewed, and the site inspections and the interviews, the remedy at FNOP is functioning effectively and achieving the results described in the OU2 ROD. Exposure assumptions, toxicity data and cleanup levels remain protective and the initial remedial action objectives are still valid. A few issues were identified during the completion of this FYR and are summarized in Section 8.0. The list of documents reviewed to compile this report is presented as **Attachment 4**.

Four potential issues were identified during the completion of this FYR as outlined below:

Issue 1

Based on the evaluation of all operational, hydraulic, and chemical data collected in 2006, additional attention may be required in the areas of concern identified by the capture zone analysis. The capture zone analysis indicates that the extraction wells contain the known extent of contamination with the exception of three areas requiring further evaluation and attention:

- The middle of the LL3 RDX plume north of EW-4 and EW-5
- A small portion of the east side of the LL1 TCE plume approximately 1 mile north of EW-12
- A small portion of the east side of the AMA TCE plume near MW-45 approximately 1 mile north of EW-1

Issue 2

The EPA/ERT performed a study in October 2007 using a TAGA mobile laboratory to evaluate the potential exposure pathway from vapor intrusion into buildings. In the sub-slab samples, the study found TCE concentrations ranging from 0.0083 ppbv to 0.13 ppbv in four out of the five samples collected (Lockheed Martin, 2007). While the risk levels of TCE found in buildings by the EPA/ERT were less than the *de minimus* risk of 10^{-6}, further characterization of risks due to vapor intrusion may be conducted by EPA, USACE, and/or NDEQ. Remedial activities associated with vapor intrusion, if required, would be conducted under OU3.

Issue 3

The potential exposure pathway resulting from pivot irrigation utilizing potentially TCE-contaminated groundwater was not previously evaluated in the OU2 BLRA, but subsequent to ROD signature, has been identified as a potentially complete exposure pathway.

Issue 4

The surface water exposure pathway is being evaluated under OU3. Given the nature of the increase in concentrations of TCE and RDX in Johnson and Clear Creeks since the time the initial risk evaluation was completed in 2000, a verification of the potential risks from TCE and RDX in the creek was warranted. This evaluation was completed in June of 2006.

Recommendations and potential follow-up actions as they relate to the four issues identified in Section 8.0 are summarized below.

Issue 1 – Recommendation and Follow-up Actions

The remedy for OU2 is under construction. Steps are being implemented to reach full hydraulic containment. These steps include additional investigations regarding the extent of contamination, and groundwater treatment and remedy optimization modeling to better predict plume behavior. These activities, combined with adjustments to the system currently in place and operational, will be used to evaluate the impacts of placing additional groundwater extraction wells to address containment and minimize restoration time.

Groundwater treatment and remedy optimization modeling will include a detailed analysis of focused extraction alternatives designed to rapidly remove contamination and to shorten remediation time when compared to hydraulic containment pumping alone. It will also be used to evaluate the affects of TCE-contaminated groundwater discharges to surface water and the migration of groundwater beneath Clear Creek due to irrigation pumping. During the first quarter of 2008, EW-11, originally installed as containment well, will begin functioning as a focused extraction well.

July 31, 2011, has been established as the date when USACE will demonstrate hydraulic containment through submission of the 2010 CE. The 2010 CE will provide a comprehensive assessment of hydraulic containment at the site.

Issue 2 – Recommendation and Follow-up Actions

The EPA/ERT performed a study in October 2007 using a TAGA mobile laboratory to evaluate the potential exposure pathway from vapor intrusion into buildings. Although the preliminary vapor intrusion study performed by EPA/ERT does not fall within this first FYR period, the FYR Team felt it pertinent to include the findings of the study. In the sub-slab samples, the study found TCE concentrations ranging from 0.0083 ppbv to 0.13 ppbv in four out of the five samples collected (Lockheed Martin, 2007). While the risk levels of TCE found in buildings by the EPA/ERT were less than the *de minimus* risk of 10^{-6}, further characterization of risks due to vapor intrusion may be conducted by EPA, USACE, and/or NDEQ. Remedial activities associated with vapor intrusion, if required, would be conducted under OU3. The OU3 ROD is scheduled for submission in late 2010.

Issue 3 – Recommendation and Follow-up Actions

The document entitled "Draft Technical Memorandum, Evaluation of Potential Risks Associated with Inhalation of TCE Released During Irrigation, Former Nebraska Ordnance Plant, Mead, Nebraska, In Support of the Five Year Review" (URS, 2007f) evaluated potential risks to farm workers who practice field irrigation. The analysis concluded that the cancer risks and non-cancer HQ associated with inhalation of TCE released from current irrigation wells was very low and that the current irrigation practices should not pose an unacceptable risk or hazard. No further action is required.

Issue 4 – Recommendation and Follow-up Actions

The surface water exposure pathway was evaluated as part of the OU3 BLRA and again in 2006 as a result of an observed increase in concentrations in surface water. These assessments concluded that at the current concentrations neither TCE nor RDX would pose an unacceptable risk based on the uses evaluated. Given the increase in concentrations since the OU3 BLRA, continued monitoring of surface water is recommended. Surface water is monitored quarterly as part of the site-wide GMP and according to the groundwater monitoring plan that is evaluated and updated each year based on historical data.

Based on discussions with EPA, NDEQ, and other interested parties, permission was sought from landowners in the vicinity of Johnson Creek to place signs reading "No Trespassing – Surface Water Exposure Health Hazard." The signs were placed in locations where permission from the landowners was received.

Recommended actions to complete implementation of the focused extraction component of the OU2 remedy are summarized below:

- EW-11, originally installed as a containment well, will begin functioning as a focused extraction well in the first quarter of 2008. Groundwater extracted water by EW-11 will be pretreated through an AOP treatment system before the groundwater is conveyed to the main groundwater treatment plant for polishing.
- Groundwater treatment and remedy optimization modeling to evaluate focused extraction alternatives.
- Perform limited focused extraction by continuing to operate two pilot study groundwater circulation wells in areas of high concentration.

Although some remedy components have not been fully implemented and/or constructed, the portions of the remedy that have been implemented and/or constructed have achieved the goal for protection of human health. The OU2 remedy is expected to be protective of human health and the environment upon completion. July 31, 2011, has been established as the date when USACE will demonstrate hydraulic containment through submission of the 2010 CE. In the interim, exposure pathways that could result in unacceptable risks are being controlled, including the ingestion of contaminated groundwater.

Long-term protectiveness of the remedial action will be verified through the GMP and the collection of water quality data to fully evaluate potential migration of the contaminant plumes. Current data indicate that the plumes remain on site and that the remedy is functioning, as required, to achieve Final Target Groundwater Cleanup Goals. This protectiveness statement is based on the following:

- The hydraulic containment remedy component is not fully constructed. However, implementation of this component is proceeding in accordance with the ROD and the FFA. Ongoing evaluation of this remedy component has identified three areas that require additional work before full operational status of hydraulic containment is achieved. Short-term protectiveness is afforded by construction activities, to date, and support from other remedy components.

- The focused extraction remedy component is not fully constructed. However, in an effort to rapidly remove contamination and shorten restoration time in areas with relatively high TCE and/or RDX concentrations, EW-11 will begin functioning as a focused extraction well starting in the first quarter of 2008. Also, two pilot study GCWs continue to provide limited focused extraction, though not formally adopted under the FFA. Groundwater treatment and remedy optimization modeling is being used to evaluate detailed focused extraction alternatives. This remedy component does not impact short-term protectiveness.

- The groundwater treatment remedy component is operating. All extracted groundwater is being effectively treated using GAC adsorption, AOP, or air stripping. All discharge criteria were met during the FYR period.

- The disposal and beneficial reuse remedy component is operating. Treated groundwater is being properly disposed of by providing it to local users for beneficial reuse or through surface discharge.

- The alternative water supply support component of the remedy is operating. Potable water is being supplied to local groundwater users whose water supply contains RDX exceeding the HA and/or TCE exceeding the MCL. Based on chemical sampling results and visual inspection of the local area, no residents were known to be consuming drinking water that contained contaminants exceeding the OU2 Final Target Groundwater Cleanup Goals.

- The monitoring and water quality remedy component is operating. Groundwater elevations and water quality are monitored on a quarterly, semi-annual, or annual basis to ensure the plumes are not expanding and that currently un-impacted water users are not impacted. Groundwater elevations and water quality information are used to support the hydraulic containment evaluation, with its associated groundwater modeling, placement of focused extraction wells, and the alternative water supply support program. The primary use of this information is to

determine protectiveness. It also provides valuable information used to support decisions on several other remedy components.

- The excavation remedy component has been completed. Soils, which could have acted as a source of explosives contamination of groundwater and which did not meet the OU1 excavation criteria, were excavated and treated via incineration during implementation of the OU1 remedy.

The following elements of the FFA SMP are being addressed to satisfy the requirements of the ROD:

- Groundwater monitoring and analysis of chemical data to evaluate the changes in distribution of the COCs, as a means of determining the protectiveness of the system
- Evaluating the need to install additional containment and/or focused extraction wells, as required within the confines of the ROD
- Groundwater treatment and remedy optimization modeling to evaluate focused extraction alternatives, as provided in the ROD
- Groundwater treatment and remedy optimization modeling to evaluate alternatives for bringing the current hydraulic containments system back into containment

Completion of this FYR determined that the remedy is not functioning as intended by the decision documents because the remedy is not fully constructed. However, the remedy is being constructed in accordance with the requirements of the OU2 ROD. Exposure pathways identified subsequent to signature of the OU2 ROD, which could potentially result in unacceptable risks (i.e., vapor intrusion and surface water exposure), are being further evaluated to determine their potential long-term impact(s) on remedy protectiveness.

In the short term, protectiveness has been achieved by those remedy components that are fully constructed and operational. In the long term, protectiveness will continue to be evaluated and verified through the collection of groundwater samples in accordance with the approved GMP work plan(s), routine maintenance, upkeep, and reporting related to the containment system; and routine maintenance, upkeep, and reporting related to the focused extraction system. The remedy at OU2 is expected to be protective of human health and the environment upon completion and in the interim, exposure pathways that could result in unacceptable risks are being controlled.

The second FYR will be completed within five years of EPA's signed concurrence with this initial FYR. The exact date cannot be established at this time but the second FYR is expected to be initiated prior to the end of calendar year 2012 with a completion date of 2013.

Table 6-1
2002 GMP Groundwater Monitoring Well Sampling Summary
Former Nebraska Ordnance Plant, Mead, Nebraska

Monitoring Well	Analysis Performed
MW-10A	VOCs
MW-10B	VOCs
MW-20A	VOCs and Explosives
MW-20B	VOCs and Explosives
MW-20C	VOCs and Explosives
MW-21A	VOCs and Explosives
MW-21B	VOCs and Explosives
MW-21D	VOCs and Explosives
MW-23A	VOCs
MW-24A	VOCs
MW-24B	VOCs
MW-28A	VOCs and Explosives
MW-28B	VOCs and Explosives
MW-28D	VOCs and Explosives
MW-32A	Explosives
MW-32B	Explosives
MW-32D	Explosives
MW-34A	Explosives
MW-34B	Explosives
MW-34D	Explosives
MW-35A	Explosives
MW-35B	Explosives
MW-35D	Explosives
MW-36A	VOCs and Explosives
MW-36B	VOCs and Explosives
MW-36D	VOCs and Explosives
MW-37A	VOCs and Explosives
MW-37B	VOCs and Explosives
MW-37D	VOCs and Explosives
MW-38A	VOCs and Explosives
MW-38D	VOCs and Explosives
MW-46A	VOCs and Explosives
MW-46B	VOCs and Explosives
MW-46D	VOCs and Explosives
MW-62A	VOCs and Explosives
MW-62B	VOCs and Explosives
MW-62D	VOCs and Explosives

Table 6-2
2002 GMP Groundwater Monitoring Well Analytical Results for COCs Above Target Cleanup Goals
Former Nebraska Ordnance Plant, Mead, Nebraska

Monitoring Well	Collection Date	Analyte	Result	Units
MW-21A[2]	01/20/03	TCE	20	ug/l
MW-21B[3]	01/20/03	TCE	72.9	ug/l
MW-21D	01/20/03	TCE	65.3	ug/l
MW-24A[4]	01/20/03	TCE	63.2	ug/l
MW-24B[3]	01/20/03	TCE	8	ug/l
MW-36A	01/15/03	TCE	47.1	ug/l
MW-36B	01/15/03	TCE	41.7	ug/l
MW-21B[3]	01/20/03	RDX	9.56	ug/l
MW-28B	01/18/03	RDX	11.7	ug/l
MW-32A	01/18/03	RDX	9.52	ug/l
MW-32D	01/18/03	RDX	6.4	ug/l

Notes:

1. TCE = Trichloroethene, RDX = Hexahydro-1,3,5-trinitro-1,3,5-triazine
2. Samples were collected from the top, middle, and bottom of the screen. The greater of the three results was shown.
3. Samples were collected from the middle and bottom of the screen. The greater of the two results was shown.
4. Samples were collected from the top and middle of the screen. The greater of the two results was shown.

Table 6-3
2002 GMP Water Supply Well Sampling Summary
Former Nebraska Ordnance Plant, Mead, Nebraska

Water Supply Well	Analysis Performed
WSW-027	VOCs and Explosives
WSW-029	VOCs and Explosives
WSW-029A	VOCs and Explosives
WSW-032	VOCs and Explosives
WSW-034	VOCs and Explosives
WSW-036	VOCs
WSW-050A	VOCs and Explosives
WSW-050B	VOCs and Explosives
WSW-051	VOCs and Explosives
WSW-051A	VOCs and Explosives
WSW-052A*	VOCs and Explosives
WSW-052B	VOCs and Explosives
WSW-052C	VOCs and Explosives
WSW-053*	VOCs and Explosives
WSW-054*	VOCs and Explosives
WSW-055	VOCs and Explosives
WSW-056	VOCs and Explosives
WSW-057	VOCs and Explosives
WSW-058	VOCs and Explosives
UNFL-09A	VOCs and Explosives
UNFL-10A	VOCs and Explosives
UNFL-12	VOCs and Explosives
UNFL-27	VOCs and Explosives

Notes:

1. * indicates the well is equipped with a granular activated carbon unit

Table 6-4
2003 GMP Groundwater Monitoring Well Sampling Summary
Former Nebraska Ordnance Plant, Mead, Nebraska

Monitoring Well	Analysis Performed
MW-02A	VOCs
MW-02B	VOCs
MW-04A	Explosives
MW-04B	Explosives
MW-05A	VOCs and Explosives
MW-05B	Explosives
MW-07B	Explosives
MW-08B	Explosives
MW-10A	VOCs and Explosives
MW-10B	VOCs and Explosives
MW-18C	VOCs and Explosives
MW-20A	VOCs and Explosives
MW-20B	VOCs and Explosives
MW-20C	VOCs and Explosives
MW-21A	VOCs and Explosives
MW-21B	VOCs and Explosives
MW-21D	VOCs and Explosives
MW-23A	VOCs
MW-23B	VOCs and Explosives
MW-25A	VOCs and Explosives
MW-25B	VOCs and Explosives
MW-25D	VOCs and Explosives
MW-28A	VOCs and Explosives
MW-28B	VOCs and Explosives
MW-28D	VOCs and Explosives
MW-29A	VOCs and Explosives
MW-29B	VOCs and Explosives
MW-32A	Explosives
MW-32B	Explosives
MW-32D	Explosives
MW-33A	VOCs and Explosives
MW-33B	VOCs and Explosives
MW-34A	Explosives
MW-34B	Explosives
MW-34D	Explosives
MW-35A	Explosives
MW-35B	Explosives
MW-35D	Explosives
MW-36A	VOCs and Explosives
MW-36B	VOCs and Explosives
MW-36D	VOCs and Explosives
MW-41A	VOCs and Explosives
MW-41B	VOCs and Explosives
MW-41D	VOCs and Explosives
MW-42A	VOCs
MW-42B	VOCs
MW-42D	VOCs
MW-43A	VOCs and Explosives

Table 6-4
2003 GMP Groundwater Monitoring Well Sampling Summary
Former Nebraska Ordnance Plant, Mead, Nebraska

Monitoring Well	Analysis Performed
MW-43B	VOCs and Explosives
MW-43D	VOCs and Explosives
MW-44A	VOCs and Explosives
MW-44B	VOCs and Explosives
MW-44D	VOCs and Explosives
MW-45A	VOCs and Explosives
MW-45B	VOCs and Explosives
MW-45D	VOCs and Explosives
MW-60A	Explosives
MW-60B	Explosives
MW-61A	VOCs and Explosives
MW-61B	VOCs and Explosives
MW-61D	VOCs and Explosives
MW-62A	VOCs and Explosives
MW-62B	VOCs and Explosives
MW-62D	VOCs and Explosives

Table 6-5
2003 GMP Groundwater Monitoring Well Analytical Results for COCs Above Target Cleanup Goals
Former Nebraska Ordnance Plant, Mead, Nebraska

Monitorng Well	Collection Date	Analyte	Result	Units
MW-02A	09/10/03	TCE	12.8	ug/l
MW-02B	09/10/03	TCE	5.46	ug/l
MW-18C	03/11/03	TCE	30.8	ug/l
MW-21A	09/11/03	TCE	11.8	ug/l
MW-21A*	09/11/03	TCE	11.7	ug/l
MW-21B	09/11/03	TCE	61	ug/l
MW-21D	09/11/03	TCE	75	ug/l
MW-21B	10/23/03	TCE	71.1	ug/l
MW-21D	10/23/03	TCE	76.5	ug/l
MW-23B	03/10/03	TCE	5.8	ug/l
MW-36A	09/17/03	TCE	46.2	ug/l
MW-36A*	09/17/03	TCE	45.5	ug/l
MW-36B	09/17/03	TCE	45.3	ug/l
MW-43B	03/09/03	TCE	14.4	ug/l
MW-43B*	03/09/03	TCE	14.3	ug/l
MW-44A	03/07/03	TCE	308	ug/l
MW-44A	09/13/03	TCE	308	ug/l
MW-44A*	09/13/03	TCE	337	ug/l
MW-44A	10/23/03	TCE	425	ug/l
MW-44A*	10/23/03	TCE	388	ug/l
MW-44B	03/08/03	TCE	7.45	ug/l
MW-44B	09/15/03	TCE	46.7	ug/l
MW-44D	03/08/03	TCE	16.2	ug/l
MW-44D	09/15/03	TCE	18	ug/l
MW-45A	03/11/03	TCE	20.6	ug/l
MW-45A*	03/11/03	TCE	20.5	ug/l
MW-45B	03/11/03	TCE	27.1	ug/l
MW-45D	03/11/03	TCE	30.7	ug/l
MW-04B	03/11/03	RDX	12.2	ug/l
MW-05B	09/10/03	RDX	30.9	ug/l
MW-18C	03/11/03	RDX	5.72	ug/l
MW-21B	09/11/03	RDX	9.57	ug/l
MW-28B	03/10/03	RDX	7.42	ug/l
MW-32A	09/12/03	RDX	9.9	ug/l
MW-32A*	09/12/03	RDX	9.53	ug/l
MW-32D	09/12/03	RDX	6.76	ug/l
MW-33A	03/10/03	RDX	5.73	ug/l
MW-33B	03/10/03	RDX	3.19	ug/l

Table 6-5
2003 GMP Groundwater Monitoring Well Analytical Results for COCs Above Target Cleanup Goals
Former Nebraska Ordnance Plant, Mead, Nebraska

Monitorng Well	Collection Date	Analyte	Result	Units
MW-43B	03/09/03	RDX	14.1	ug/l
MW-43B*	03/09/03	RDX	13.9	ug/l
MW-45A	03/11/03	RDX	5.11	ug/l
MW-45A*	03/11/03	RDX	4.99	ug/l
MW-45B	03/11/03	RDX	4.99	ug/l
MW-45D	03/11/03	RDX	3.96	ug/l
MW-05B	09/10/03	DNT	1.72	ug/l
MW-05B	09/10/03	TNB	2.69	ug/l
MW-05B	09/10/03	TNT	32.3	ug/l
MW-07B	03/11/03	TNT	4.23	ug/l

Notes:

1. * indicates that the sample is a field duplicate sample.
2. TCE = Trichloroethene, RDX = Hexahydro-1,3,5-trinitro-1,3,5-triazine
3. TNB = 1,3,5-Trinitrobenzene, TNT = 2,4,6- Trinitrotoluene
4. DNT = 2,4-Dinitrotoluene

Table 6-6
2003 GMP Water Supply Well Sampling Summary
Former Nebraska Ordnance Plant, Mead, Nebraska

Water Supply Well	Analysis Performed
WSW-027	VOCs and Explosives
WSW-029	VOCs and Explosives
WSW-029A	VOCs and Explosives
WSW-032	VOCs and Explosives
WSW-034	VOCs and Explosives
WSW-036	Explosives
WSW-050A	VOCs and Explosives
WSW-050B	VOCs and Explosives
WSW-051	VOCs and Explosives
WSW-051A	VOCs and Explosives
WSW-052B	VOCs and Explosives
WSW-052C*	VOCs and Explosives
WSW-053*	VOCs and Explosives
WSW-054*	VOCs and Explosives
WSW-055	VOCs and Explosives
WSW-056	VOCs and Explosives
WSW-057	VOCs and Explosives
WSW-058	VOCs and Explosives
ARTESIAN	VOCs and Explosives
UNFL-09A	VOCs and Explosives
UNFL-10A	VOCs and Explosives
UNFL-27	VOCs and Explosives

Notes:

1. * indicates the well is equipped with a granular activated carbon unit

Table 6-7
2004 GMP Groundwater Monitoring Well Sampling Summary
Former Nebraska Ordnance Plant, Mead, Nebraska

Monitoring Well	Analysis Performed
MW-09A	Explosives
MW-09B	Explosives
MW-09D	Explosives
MW-10A	VOCs and Explosives
MW-10B	VOCs and Explosives
MW-17A	VOCs and Explosives
MW-17B	VOCs and Explosives
MW-17C	VOCs and Explosives
MW-20A	VOCs and Explosives
MW-20B	VOCs and Explosives
MW-21A	VOCs and Explosives
MW-21B	VOCs and Explosives
MW-21D	VOCs and Explosives
MW-24A	VOCs and Explosives
MW-24B	VOCs and Explosives
MW-28A	VOCs and Explosives
MW-28B	VOCs and Explosives
MW-28D	VOCs and Explosives
MW-29A	VOCs and Explosives
MW-29B	VOCs and Explosives
MW-31A	VOCs and Explosives
MW-31B	VOCs and Explosives
MW-32A	VOCs and Explosives
MW-32B	VOCs and Explosives
MW-32D	VOCs and Explosives
MW-33A	VOCs and Explosives
MW-33B	VOCs and Explosives
MW-34A	VOCs and Explosives
MW-34B	VOCs and Explosives
MW-34D	VOCs and Explosives
MW-35A	VOCs and Explosives
MW-35B	VOCs and Explosives
MW-35D	VOCs and Explosives
MW-36A	VOCs and Explosives
MW-36B	VOCs and Explosives
MW-36D	VOCs and Explosives
MW-37A	VOCs and Explosives
MW-37B	VOCs and Explosives
MW-37D	VOCs and Explosives
MW-38A	VOCs and Explosives
MW-38D	VOCs and Explosives
MW-40B	VOCs
MW-42A	VOCs and Explosives
MW-42B	VOCs and Explosives
MW-42D	VOCs and Explosives
MW-43A	VOCs and Explosives
MW-43B	VOCs and Explosives
MW-43D	VOCs and Explosives

Table 6-7
2004 GMP Groundwater Monitoring Well Sampling Summary
Former Nebraska Ordnance Plant, Mead, Nebraska

Monitoring Well	Analysis Performed
MW-44A	VOCs
MW-44B	VOCs and Explosives
MW-44D	VOCs and Explosives
MW-45A	VOCs and Explosives
MW-45B	VOCs and Explosives
MW-45D	VOCs and Explosives
MW-46A	VOCs and Explosives
MW-46B	VOCs and Explosives
MW-46D	VOCs and Explosives
MW-60A	VOCs and Explosives
MW-60B	VOCs and Explosives
MW-61A	VOCs and Explosives
MW-61B	VOCs and Explosives
MW-61D	VOCs and Explosives
MW-62A	VOCs and Explosives
MW-62B	VOCs and Explosives
MW-62D	VOCs and Explosives
MW-65A	Explosives
MW-65B	Explosives
MW-66A	Explosives
MW-67A	Explosives
MW-67B	Explosives
MW-72A	VOCs
MW-72B	VOCs
MW-73A	VOCs
MW-73B	VOCs
MW-82A	VOCs and Explosives
MW-82B	VOCs and Explosives
MW-82D	VOCs and Explosives
MW-83A	VOCs and Explosives
MW-83B	VOCs and Explosives
MW-83D	VOCs and Explosives
MW-84A	VOCs and Explosives
MW-84AR	VOCs and Explosives
MW-84B	VOCs and Explosives
MW-84D	VOCs and Explosives
MW-85A	VOCs and Explosives
MW-85B	VOCs and Explosives
MW-85D	VOCs and Explosives

1. Well clusters MW-40, 65, 66,67, 72, and 73 were sampled as part of the O&M monitoring.

Table 6-8
2004 GMP Groundwater Monitoring Well Analytical Results for COCs Above Target Cleanup Goals
Former Nebraska Ordnance Plant, Mead, Nebraska

Monitorng Well	Collection Date	Analyte	Result	Units
MW-21A	09/17/04	TCE	12	ug/l
MW-21B	09/17/04	TCE	72	ug/l
MW-21B*	09/17/04	TCE	69	ug/l
MW-21D	09/17/04	TCE	160	ug/l
MW-24A	09/15/04	TCE	190	ug/l
MW-24B	09/15/04	TCE	28	ug/l
MW-36A	09/14/04	TCE	47	ug/l
MW-36A*	09/14/04	TCE	47	ug/l
MW-36B	09/14/04	TCE	43	ug/l
MW-40B	05/25/04	TCE	170	ug/l
MW-43B	03/22/04	TCE	10	ug/l
MW-44A	09/15/04	TCE	350	ug/l
MW-44B	09/15/04	TCE	14	ug/l
MW-44D	09/15/04	TCE	13	ug/l
MW-44D*	09/15/04	TCE	13	ug/l
MW-45A	09/16/04	TCE	19	ug/l
MW-45B	09/16/04	TCE	26	ug/l
MW-45B*	09/16/04	TCE	27	ug/l
MW-45D	09/16/04	TCE	23	ug/l
MW-72A	05/25/04	TCE	71	ug/l
MW-72B	05/25/04	TCE	6300	ug/l
MW-73A	05/25/04	TCE	130	ug/l
MW-73B	05/25/04	TCE	280	ug/l
MW-21B	09/17/04	RDX	9.9	ug/l
MW-21B*	09/17/04	RDX	9.9	ug/l
MW-28B	09/20/04	RDX	11	ug/l
MW-32A	03/22/04	RDX	9.3	ug/l
MW-33A	09/17/04	RDX	4.4	ug/l
MW-43B	03/22/04	RDX	20	ug/l
MW-45A	09/16/04	RDX	4.8	ug/l
MW-45B	09/16/04	RDX	5.4	ug/l
MW-45B*	09/16/04	RDX	5.1	ug/l
MW-45D	09/16/04	RDX	3.7	ug/l
MW-65B	05/26/04	RDX	46	ug/l
MW-66A	05/26/04	RDX	2.4	ug/l
MW-67A	05/26/04	RDX	3.1	ug/l
MW-67B	05/26/04	RDX	2	ug/l
MW-85B	11/29/04	RDX	10	ug/l

Notes:

1. * indicates that the sample is a field duplicate sample.
2. TCE = Trichloroethene, RDX = Hexahydro-1,3,5-trinitro-1,3,5-triazine
3. Well clusters MW-40, 65, 66, 67, 72, and 73 were sampled as part of the O&M monitoring.

Table 6-9
2004 GMP Water Supply Well Sampling Summary
Former Nebraska Ordnance Plant, Mead, Nebraska

Water Supply Well	Analysis Performed
WSW-027	VOCs and Explosives
WSW-029	VOCs and Explosives
WSW-029A	VOCs and Explosives
WSW-032	VOCs and Explosives
WSW-034	VOCs and Explosives
WSW-036	Explosives
WSW-050A	VOCs and Explosives
WSW-050B	VOCs and Explosives
WSW-051	VOCs and Explosives
WSW-051A	VOCs and Explosives
WSW-052A*	VOCs and Explosives
WSW-052B	VOCs and Explosives
WSW-052C*	VOCs and Explosives
WSW-053*	VOCs and Explosives
WSW-054*	VOCs and Explosives
WSW-055	VOCs and Explosives
WSW-056	VOCs and Explosives
WSW-057	VOCs and Explosives
WSW-058	VOCs and Explosives
WSW-059	VOCs and Explosives
WSW-060	VOCs and Explosives
WSW-061	VOCs and Explosives
WSW-062	VOCs and Explosives
WSW-063	VOCs and Explosives
WSW-064	VOCs and Explosives
WSW-065	VOCs and Explosives
WSW-066	VOCs and Explosives
WSW-067	VOCs and Explosives
WSW-068	VOCs and Explosives
WSW-073	VOCs and Explosives
WSW-074	VOCs and Explosives
WSW-075	VOCs and Explosives
WSW-076	VOCs and Explosives
WSW-077	VOCs and Explosives
WSW-079	VOCs and Explosives
WSW-080	VOCs and Explosives
WSW-081	VOCs and Explosives
WSW-082	VOCs and Explosives
WSW-084	VOCs and Explosives
WSW-086	VOCs and Explosives
WSW-087	VOCs and Explosives
WSW-089	VOCs and Explosives
WSW-090	VOCs and Explosives
WSW-091	VOCs and Explosives
WSW-092	VOCs and Explosives
WSW-093	VOCs and Explosives
WSW-094	VOCs and Explosives
WSW-095	VOCs and Explosives

Table 6-9
2004 GMP Water Supply Well Sampling Summary
Former Nebraska Ordnance Plant, Mead, Nebraska

Water Supply Well	Analysis Performed
WSW-096	VOCs and Explosives
WSW-097	VOCs and Explosives
WSW-099	VOCs and Explosives
WSW-100	VOCs and Explosives
WSW-101	VOCs and Explosives
WSW-102	VOCs and Explosives
WSW-103	VOCs and Explosives
WSW-104	VOCs and Explosives
ARTESIAN	VOCs and Explosives
UNFL-09A	VOCs and Explosives
UNFL-10A	VOCs and Explosives
UNFL-27	VOCs and Explosives

Notes:

1. * indicates the well is equipped with a granular activated carbon unit

Table 6-10
2005 GMP Groundwater Monitoring Well Sampling Summary
Former Nebraska Ordnance Plant, Mead, Nebraska

Monitoring Well	Analysis Performed
MW-09A	VOCs
MW-09B	VOCs
MW-09D	VOCs
MW-10A	VOCs and Explosives
MW-10A	VOCs and Explosives
MW-10B	VOCs and Explosives
MW-10B	VOCs and Explosives
MW-17A	VOCs and Explosives
MW-17B	VOCs and Explosives
MW-18A	VOCs and Explosives
MW-20A	VOCs and Explosives
MW-20B	VOCs and Explosives
MW-21A	VOCs and Explosives
MW-21B	VOCs and Explosives
MW-21D	VOCs and Explosives
MW-24A	VOCs and Explosives
MW-24B	VOCs and Explosives
MW-28A	Explosives
MW-28B	Explosives
MW-29A	Explosives
MW-31A	Explosives
MW-31B	Explosives
MW-32A	Explosives
MW-32B	Explosives
MW-32D	Explosives
MW-33A	VOCs and Explosives
MW-33B	VOCs and Explosives
MW-33D	VOCs and Explosives
MW-34A	Explosives
MW-34B	Explosives
MW-35A	Explosives
MW-35B	Explosives
MW-35D	Explosives
MW-36A	VOCs and Explosives
MW-36B	VOCs and Explosives
MW-36D	Explosives
MW-37A	VOCs and Explosives
MW-37B	VOCs and Explosives
MW-37D	VOCs and Explosives
MW-38A	VOCs
MW-38D	VOCs
MW-40B	VOCs
MW-41A	VOCs
MW-41B	VOCs
MW-41D	VOCs
MW-42A	VOCs and Explosives
MW-42B	VOCs and Explosives
MW-42D	VOCs and Explosives

Table 6-10
2005 GMP Groundwater Monitoring Well Sampling Summary
Former Nebraska Ordnance Plant, Mead, Nebraska

Monitoring Well	Analysis Performed
MW-43A	VOCs and Explosives
MW-43B	VOCs and Explosives
MW-43D	VOCs and Explosives
MW-44A	VOCs and Explosives
MW-44B	VOCs and Explosives
MW-44D	VOCs and Explosives
MW-45A	VOCs and Explosives
MW-45B	VOCs and Explosives
MW-45D	VOCs and Explosives
MW-46A	VOCs and Explosives
MW-46D	VOCs and Explosives
MW-55A	VOCs and Explosives
MW-55B	VOCs and Explosives
MW-61A	VOCs and Explosives
MW-61B	VOCs and Explosives
MW-61D	VOCs and Explosives
MW-62A	VOCs and Explosives
MW-62B	VOCs and Explosives
MW-62D	VOCs and Explosives
MW-65A	Explosives
MW-65B	Explosives
MW-66A	Explosives
MW-67A	Explosives
MW-67B	Explosives
MW-72A	VOCs
MW-72B	VOCs
MW-73A	VOCs
MW-73B	VOCs
MW-79A	VOCs and Explosives
MW-79B	VOCs and Explosives
MW-80A	VOCs and Explosives
MW-80B	VOCs and Explosives
MW-80D	VOCs and Explosives
MW-81A	VOCs and Explosives
MW-81B	VOCs and Explosives
MW-81D	VOCs and Explosives
MW-82A	VOCs and Explosives
MW-82B	VOCs and Explosives
MW-82D	VOCs and Explosives
MW-83A	VOCs and Explosives
MW-83B	VOCs and Explosives
MW-83D	VOCs and Explosives
MW-84A	VOCs and Explosives
MW-84B	VOCs and Explosives
MW-84D	VOCs and Explosives
MW-85A	VOCs and Explosives
MW-85B	VOCs and Explosives
MW-85D	VOCs and Explosives

Table 6-10
2005 GMP Groundwater Monitoring Well Sampling Summary
Former Nebraska Ordnance Plant, Mead, Nebraska

Monitoring Well	Analysis Performed
MW-89A	VOCs and Explosives
MW-89B	VOCs and Explosives
MW-89D	VOCs and Explosives
MW-90A	VOCs and Explosives
MW-90B	VOCs and Explosives
MW-90D	VOCs and Explosives
MW-91A	VOCs and Explosives
MW-91B	VOCs and Explosives
MW-91D	VOCs and Explosives
MW-92A	VOCs and Explosives
MW-92B	VOCs and Explosives
MW-93A	VOCs and Explosives
MW-93B	VOCs and Explosives

1. Well clusters MW-40, 65, 66, 67, 72, and 73 were sampled as part of the O&M monitoring.

Table 6-11
2005 GMP Groundwater Monitoring Well Analytical Results for COCs Above Target Cleanup Goals
Former Nebraska Ordnance Plant, Mead, Nebraska

Monitorng Well	Collection Date	Analyte	Result	Units
MW-09A	06/15/05	TCE	200	ug/l
MW-09A*	06/15/05	TCE	210	ug/l
MW-09B	06/15/05	TCE	150 J	ug/l
MW-09D	06/15/05	TCE	220 J	ug/l
MW-09D*	06/15/05	TCE	250 J	ug/l
MW-21A	03/18/05	TCE	26	ug/l
MW-21A	10/04/05	TCE	33 J	ug/l
MW-21B	03/18/05	TCE	64	ug/l
MW-21B*	03/18/05	TCE	71	ug/l
MW-21B	10/04/05	TCE	54 J	ug/l
MW-21B*	10/04/05	TCE	53 J	ug/l
MW-21D	03/18/05	TCE	190	ug/l
MW-21D	10/04/05	TCE	290 J	ug/l
MW-24A	03/21/05	TCE	160	ug/l
MW-24B	03/21/05	TCE	82	ug/l
MW-24B*	03/22/05	TCE	79	ug/l
MW-36A	03/16/05	TCE	41	ug/l
MW-36A*	03/16/05	TCE	40	ug/l
MW-36B	03/16/05	TCE	38	ug/l
MW-40B	06/21/05	TCE	55	ug/l
MW-43A	03/17/05	TCE	20	ug/l
MW-43A	10/06/05	TCE	13	ug/l
MW-43B	03/17/05	TCE	11	ug/l
MW-43B*	03/17/05	TCE	10	ug/l
MW-43B	10/06/05	TCE	8.7	ug/l
MW-43B*	10/06/05	TCE	8.5	ug/l
MW-44A	03/17/05	TCE	410	ug/l
MW-44A	10/06/05	TCE	540	ug/l
MW-44B	03/17/05	TCE	18	ug/l
MW-44B	10/06/05	TCE	12	ug/l
MW-44B*	10/06/05	TCE	12	ug/l
MW-44D	03/17/05	TCE	30	ug/l
MW-44D	10/06/05	TCE	30	ug/l
MW-45A	03/16/05	TCE	19	ug/l
MW-45A*	03/16/05	TCE	20	ug/l
MW-45A	10/06/05	TCE	18	ug/l
MW-45A*	10/06/05	TCE	18	ug/l
MW-45B	03/16/05	TCE	28	ug/l
MW-45B	10/06/05	TCE	23	ug/l
MW-45B*	10/06/05	TCE	24	ug/l
MW-45D	03/16/05	TCE	24	ug/l
MW-45D	10/06/05	TCE	19	ug/l
MW-72A	06/21/05	TCE	34	ug/l
MW-72B	06/21/05	TCE	5400	ug/l
MW-73A	06/21/05	TCE	51	ug/l
MW-73B	06/21/05	TCE	56	ug/l
MW-80A	09/27/05	TCE	12	ug/l
MW-80A	12/13/05	TCE	15	ug/l
MW-80A*	12/13/05	TCE	15.1	ug/l

Table 6-11
2005 GMP Groundwater Monitoring Well Analytical Results for COCs Above Target Cleanup Goals
Former Nebraska Ordnance Plant, Mead, Nebraska

Monitorng Well	Collection Date	Analyte	Result	Units
MW-80B	09/27/05	TCE	7.3	ug/l
MW-80B	12/13/05	TCE	12.7	ug/l
MW-90A	09/28/05	TCE	12	ug/l
MW-90A*	09/28/05	TCE	13	ug/l
MW-90A	12/14/05	TCE	15.6	ug/l
MW-90B	09/29/05	TCE	5.4	ug/l
MW-90D	09/29/05	TCE	7	ug/l
MW-90D	12/14/05	TCE	8.85	ug/l
MW-90D*	12/14/05	TCE	9.09	ug/l
MW-21B	03/18/05	RDX	6.6	ug/l
MW-21B*	03/18/05	RDX	6.51	ug/l
MW-21B	10/04/05	RDX	11.2	ug/l
MW-21B*	10/04/05	RDX	11.3	ug/l
MW-28B	03/22/05	RDX	10.6	ug/l
MW-31B	03/23/05	RDX	2.53	ug/l
MW-32A	03/22/05	RDX	9.39	ug/l
MW-32A*	03/22/05	RDX	9.36	ug/l
MW-32B	03/22/05	RDX	2.47	ug/l
MW-32D	03/22/05	RDX	6.47	ug/l
MW-33A	03/23/05	RDX	5.35	ug/l
MW-42A	03/17/05	RDX	3.66	ug/l
MW-42D	03/17/05	RDX	2.05	ug/l
MW-43B	03/17/05	RDX	25.5	ug/l
MW-43B*	03/17/05	RDX	25.5	ug/l
MW-43B	10/06/05	RDX	20.2	ug/l
MW-43B*	10/06/05	RDX	20.1	ug/l
MW-45A	03/16/05	RDX	5.86	ug/l
MW-45A*	03/16/05	RDX	5.36	ug/l
MW-45A	10/06/05	RDX	4.46	ug/l
MW-45A*	10/06/05	RDX	4.54	ug/l
MW-45B	03/16/05	RDX	6.3	ug/l
MW-45B	10/06/05	RDX	5.37	ug/l
MW-45B*	10/06/05	RDX	5.29	ug/l
MW-45D	03/16/05	RDX	4.37	ug/l
MW-45D	10/06/05	RDX	3.79	ug/l
MW-65B	08/25/05	RDX	50	ug/l
MW-66A	08/25/05	RDX	2.1	ug/l
MW-67A	08/25/05	RDX	3.56	ug/l
MW-21B	03/18/05	Methylene Chloride	6.1 J	ug/l
MW-21B*	03/18/05	Methylene Chloride	6.4 J	ug/l
MW-41A	10/07/05	Methylene Chloride	5 J	ug/l
MW-41B	10/07/05	Methylene Chloride	6.3 J	ug/l
MW-61A	10/07/05	Methylene Chloride	8.7 J	ug/l
MW-61B	10/07/05	Methylene Chloride	12 J	ug/l

Notes:

1. * indicates that the sample is a field duplicate sample.
2. TCE = Trichloroethene, RDX = Hexahydro-1,3,5-trinitro-1,3,5-triazine
3. Well clusters MW-40, 65, 66, 67, 72, and 73 were sampled as part of the O&M monitoring.

Table 6-12
2005 GMP Water Supply Well Sampling Summary
Former Nebraska Ordnance Plant, Mead, Nebraska

Water Supply Well	Analysis Performed
WSW-027	VOCs and Explosives
WSW-029	VOCs and Explosives
WSW-029A	VOCs and Explosives
WSW-032	VOCs and Explosives
WSW-034	VOCs and Explosives
WSW-036	Explosives
WSW-050A	VOCs and Explosives
WSW-050B	VOCs and Explosives
WSW-051	VOCs and Explosives
WSW-051A	VOCs and Explosives
WSW-052A*	VOCs and Explosives
WSW-052B	VOCs and Explosives
WSW-052C*	VOCs and Explosives
WSW-053*	VOCs and Explosives
WSW-054*	VOCs and Explosives
WSW-055	VOCs and Explosives
WSW-056	VOCs and Explosives
WSW-057	VOCs and Explosives
WSW-058	VOCs and Explosives
WSW-059	VOCs and Explosives
WSW-060	VOCs and Explosives
WSW-061	VOCs and Explosives
WSW-062	VOCs and Explosives
WSW-063	VOCs and Explosives
WSW-064	VOCs and Explosives
WSW-065	VOCs and Explosives
WSW-066	VOCs and Explosives
WSW-067	VOCs and Explosives
WSW-068	VOCs and Explosives
WSW-073	VOCs and Explosives
WSW-074	VOCs and Explosives
WSW-075	VOCs and Explosives
WSW-076	VOCs and Explosives
WSW-077	VOCs and Explosives
WSW-079	VOCs and Explosives
WSW-080	VOCs and Explosives
WSW-081	VOCs and Explosives
WSW-082	VOCs and Explosives
WSW-084	VOCs and Explosives
WSW-086	VOCs and Explosives
WSW-087	VOCs and Explosives
WSW-089	VOCs and Explosives
WSW-090	VOCs and Explosives
WSW-091	VOCs and Explosives
WSW-092	VOCs and Explosives
WSW-093	VOCs and Explosives
WSW-094	VOCs and Explosives
WSW-095	VOCs and Explosives

Table 6-12
2005 GMP Water Supply Well Sampling Summary
Former Nebraska Ordnance Plant, Mead, Nebraska

Water Supply Well	Analysis Performed
WSW-096	VOCs and Explosives
WSW-097	VOCs and Explosives
WSW-099	VOCs and Explosives
WSW-100	VOCs and Explosives
WSW-101	VOCs and Explosives
WSW-102	VOCs and Explosives
WSW-103	VOCs and Explosives
WSW-104	VOCs and Explosives
WSW-105	VOCs and Explosives
WSW-106	VOCs and Explosives
WSW-107	VOCs and Explosives
WSW-108	VOCs and Explosives
WSW-109	VOCs and Explosives
WSW-110	VOCs and Explosives
WSW-111	VOCs and Explosives
ARTESIAN	VOCs and Explosives
UNFL-10A	VOCs and Explosives
UNFL-23	VOCs and Explosives
UNFL-27	VOCs and Explosives
ASH-002	Explosives
LIN-032-5B	Explosives
LIN-056-9	Explosives
WSW-NEWMWS	Explosives
WSW-OLDMWS	Explosives

Notes:

1. * indicates the well is equipped with a granular activated carbon unit

Table 6-13
2006 GMP Groundwater Monitoring Well Sampling Summary
Former Nebraska Ordnance Plant, Mead, Nebraska

Monitoring Well	Analysis Performed
MW-09A	VOCs and Explosives
MW-09B	VOCs and Explosives
MW-09D	VOCs and Explosives
MW-10A	VOCs and Explosives
MW-10B	VOCs and Explosives
MW-11	VOCs and Explosives
MW-18A	VOCs and Explosives
MW-18B	VOCs and Explosives
MW-18C	VOCs and Explosives
MW-19A	VOCs
MW-19B	VOCs
MW-20A	VOCs and Explosives
MW-20B	VOCs and Explosives
MW-21A	VOCs and Explosives
MW-21B	VOCs and Explosives
MW-21D	VOCs and Explosives
MW-24A	VOCs and Explosives
MW-24B	VOCs and Explosives
MW-28A	Explosives
MW-28B	Explosives
MW-28D	Explosives
MW-29A	VOCs and Explosives
MW-29B	VOCs and Explosives
MW-31A	Explosives
MW-31B	Explosives
MW-32A	VOCs and Explosives
MW-32B	VOCs and Explosives
MW-32D	VOCs and Explosives
MW-33A	Explosives
MW-33B	Explosives
MW-33D	Explosives
MW-34A	VOCs and Explosives
MW-34B	VOCs and Explosives
MW-34D	VOCs and Explosives
MW-35A	VOCs and Explosives
MW-35B	VOCs and Explosives
MW-35D	VOCs and Explosives
MW-36A	VOCs and Explosives
MW-36B	VOCs and Explosives
MW-36D	VOCs and Explosives
MW-37A	VOCs and Explosives
MW-37B	VOCs and Explosives
MW-37D	VOCs and Explosives
MW-38A	VOCs and Explosives
MW-38D	VOCs and Explosives
MW-39A	VOCs and Explosives
MW-39D	VOCs and Explosives
MW-40B	VOCs

Table 6-13
2006 GMP Groundwater Monitoring Well Sampling Summary
Former Nebraska Ordnance Plant, Mead, Nebraska

Monitoring Well	Analysis Performed
MW-41A	VOCs
MW-41B	VOCs
MW-41D	VOCs
MW-42A	VOCs and Explosives
MW-42B	VOCs and Explosives
MW-42D	VOCs and Explosives
MW-43A	VOCs and Explosives
MW-43B	VOCs and Explosives
MW-43D	VOCs and Explosives
MW-44A	VOCs and Explosives
MW-44B	VOCs and Explosives
MW-44D	VOCs and Explosives
MW-45A	VOCs and Explosives
MW-45B	VOCs and Explosives
MW-45D	VOCs and Explosives
MW-46A	VOCs and Explosives
MW-46B	VOCs and Explosives
MW-46D	VOCs and Explosives
MW-54A	VOCs and Explosives
MW-54B	VOCs and Explosives
MW-61A	VOCs and Explosives
MW-61B	VOCs and Explosives
MW-61D	VOCs and Explosives
MW-62A	VOCs and Explosives
MW-62B	VOCs and Explosives
MW-62D	VOCs and Explosives
MW-65A	Explosives
MW-65B	Explosives
MW-66A	Explosives
MW-67A	Explosives
MW-67B	Explosives
MW-72A	VOCs
MW-72B	VOCs
MW-73A	VOCs
MW-73B	VOCs
MW-79A	VOCs and Explosives
MW-79B	VOCs and Explosives
MW-80A	VOCs and Explosives
MW-80B	VOCs and Explosives
MW-80D	VOCs and Explosives
MW-81A	VOCs and Explosives
MW-81B	VOCs and Explosives
MW-81D	VOCs and Explosives
MW-82A	VOCs and Explosives
MW-82B	VOCs and Explosives
MW-82D	VOCs and Explosives
MW-83A	VOCs and Explosives
MW-83B	VOCs and Explosives

Table 6-13
2006 GMP Groundwater Monitoring Well Sampling Summary
Former Nebraska Ordnance Plant, Mead, Nebraska

Monitoring Well	Analysis Performed
MW-83D	VOCs and Explosives
MW-84A	VOCs and Explosives
MW-84B	VOCs and Explosives
MW-84D	VOCs and Explosives
MW-85A	VOCs and Explosives
MW-85B	VOCs and Explosives
MW-85D	VOCs and Explosives
MW-89A	VOCs and Explosives
MW-89B	VOCs and Explosives
MW-89D	VOCs and Explosives
MW-90A	VOCs and Explosives
MW-90B	VOCs and Explosives
MW-90D	VOCs and Explosives
MW-91A	VOCs and Explosives
MW-91B	VOCs and Explosives
MW-91D	VOCs and Explosives
MW-92A	VOCs and Explosives
MW-92B	VOCs and Explosives
MW-93A	VOCs and Explosives
MW-93B	VOCs and Explosives

1. Well clusters MW-40, 65, 66, 67, 72, and 73 were sampled as part of the O&M monitoring.

Table 6-14
2006 GMP Groundwater Monitoring Well Analytical Results for COCs Above Target Cleanup Goals
Former Nebraska Ordnance Plant, Mead, Nebraska

Monitorng Well	Collection Date	Analyte	Result	Units
MW-09A	03/24/06	TCE	752	ug/l
MW-09B	03/24/06	TCE	235	ug/l
MW-09D	03/24/06	TCE	364	ug/l
MW-18C	03/23/06	TCE	25.5	ug/l
MW-18C	09/12/06	TCE	23.1	ug/l
MW-21A	03/28/06	TCE	32.2	ug/l
MW-21B	03/28/06	TCE	70.2	ug/l
MW-21D	03/28/06	TCE	269	ug/l
MW-24A	03/28/06	TCE	462	ug/l
MW-24B	03/28/06	TCE	155	ug/l
MW-24B*	03/28/06	TCE	160	ug/l
MW-36A	04/03/06	TCE	35	ug/l
MW-36A	09/15/06	TCE	27.5	ug/l
MW-36B	04/03/06	TCE	26.9	ug/l
MW-36B*	04/03/06	TCE	29.8	ug/l
MW-36B	09/15/06	TCE	26	ug/l
MW-36B*	09/15/06	TCE	25.4	ug/l
MW-40B	06/06/06	TCE	155	ug/l
MW-43A	03/28/06	TCE	27.4	ug/l
MW-43A	09/15/06	TCE	23.3	ug/l
MW-43B	03/28/06	TCE	9.77	ug/l
MW-43B*	03/28/06	TCE	9.88	ug/l
MW-43B	09/19/06	TCE	6.86	ug/l
MW-43B*	09/19/06	TCE	6.94	ug/l
MW-44A	03/23/06	TCE	682	ug/l
MW-44A	09/19/06	TCE	516	ug/l
MW-44B	03/23/06	TCE	19.8	ug/l
MW-44B	09/19/06	TCE	24.7	ug/l
MW-44B*	09/19/06	TCE	24.3	ug/l
MW-44D	03/23/06	TCE	23.6	ug/l
MW-44D	09/19/06	TCE	26.8	ug/l
MW-45A	04/03/06	TCE	13.5	ug/l
MW-45A*	04/03/06	TCE	12.9	ug/l
MW-45A	09/13/06	TCE	17.8	ug/l
MW-45A*	09/13/06	TCE	18.1	ug/l
MW-45B	04/03/06	TCE	15.8	ug/l
MW-45B*	04/03/06	TCE	17.4	ug/l
MW-45B	09/13/06	TCE	21.5	ug/l
MW-45B*	09/13/06	TCE	21.5	ug/l
MW-45D	04/03/06	TCE	17	ug/l
MW-45D	09/13/06	TCE	18.7	ug/l
MW-72B	06/06/06	TCE	3480	ug/l
MW-73A	06/06/06	TCE	7.5	ug/l
MW-73B	06/06/06	TCE	274	ug/l
MW-80A	03/08/06	TCE	17.5	ug/l
MW-80A	04/05/06	TCE	12.5	ug/l
MW-80A	05/09/06	TCE	7.86	ug/l
MW-80B	03/08/06	TCE	18	ug/l

Table 6-14
2006 GMP Groundwater Monitoring Well Analytical Results for COCs Above Target Cleanup Goals
Former Nebraska Ordnance Plant, Mead, Nebraska

Monitorng Well	Collection Date	Analyte	Result	Units
MW-80B	04/05/06	TCE	17.8	ug/l
MW-80B*	04/05/06	TCE	17	ug/l
MW-80B	05/09/06	TCE	17	ug/l
MW-80B*	05/09/06	TCE	17	ug/l
MW-80B	09/06/06	TCE	10.3	ug/l
MW-80B*	09/06/06	TCE	12.9	ug/l
MW-80B	12/04/06	TCE	7.54	ug/l
MW-80B*	12/04/06	TCE	8.13	ug/l
MW-90A	03/07/06	TCE	17.2	ug/l
MW-90A*	03/07/06	TCE	17.9	ug/l
MW-90A	04/04/06	TCE	19.2	ug/l
MW-90A*	04/04/06	TCE	18.5	ug/l
MW-90A	05/08/06	TCE	22.4	ug/l
MW-90A*	05/08/06	TCE	22.7	ug/l
MW-90A	09/05/06	TCE	31.3	ug/l
MW-90A*	09/05/06	TCE	30.6	ug/l
MW-90A	12/05/06	TCE	34.2	ug/l
MW-90A*	12/05/06	TCE	32.8	ug/l
MW-90B	03/09/06	TCE	14.9	ug/l
MW-90B	04/04/06	TCE	19.3	ug/l
MW-90B	05/08/06	TCE	52	ug/l
MW-90B	09/05/06	TCE	84.4	ug/l
MW-90B	12/05/06	TCE	101	ug/l
MW-90D	03/09/06	TCE	12.2	ug/l
MW-90D	04/04/06	TCE	10.5	ug/l
MW-90D	05/08/06	TCE	13.5	ug/l
MW-90D	09/05/06	TCE	16.7	ug/l
MW-90D	12/05/06	TCE	27.1	ug/l
MW-18C	03/23/06	RDX	6.37	ug/l
MW-18C	09/12/06	RDX	5.81	ug/l
MW-21B	03/28/06	RDX	10.6	ug/l
MW-28B	03/24/06	RDX	6.84	ug/l
MW-28B	09/20/06	RDX	4.35	ug/l
MW-29A	03/23/06	RDX	2.73	ug/l
MW-29A	09/13/06	RDX	2.07	ug/l
MW-32A	03/29/06	RDX	6.39	ug/l
MW-32B	03/29/06	RDX	3.04	ug/l
MW-32D	03/29/06	RDX	6.82 J	ug/l
MW-33A	03/31/06	RDX	3.11	ug/l
MW-42A	03/31/06	RDX	4.81	ug/l
MW-42A	09/20/06	RDX	4.49	ug/l
MW-42D	03/31/06	RDX	2.1	ug/l
MW-42D	09/20/06	RDX	2.31	ug/l
MW-43B	03/28/06	RDX	17.1	ug/l
MW-43B*	03/28/06	RDX	17.6	ug/l
MW-43B	09/19/06	RDX	14.6	ug/l
MW-43B*	09/19/06	RDX	12.7	ug/l
MW-45A	04/03/06	RDX	4.23	ug/l

Table 6-14
2006 GMP Groundwater Monitoring Well Analytical Results for COCs Above Target Cleanup Goals
Former Nebraska Ordnance Plant, Mead, Nebraska

Monitorng Well	Collection Date	Analyte	Result	Units
MW-45A*	04/03/06	RDX	4.2	ug/l
MW-45A	09/13/06	RDX	4	ug/l
MW-45A*	09/13/06	RDX	4.02	ug/l
MW-45B	04/03/06	RDX	5.2	ug/l
MW-45B*	04/03/06	RDX	5.27	ug/l
MW-45B	09/13/06	RDX	4.88	ug/l
MW-45D	04/03/06	RDX	3.86	ug/l
MW-45D	09/13/06	RDX	3.26	ug/l
MW-65B	06/07/06	RDX	46.7	ug/l
MW-67A	06/07/06	RDX	2.22	ug/l

Notes:

1. * indicates that the sample is a field duplicate sample.
2. TCE = Trichloroethene, RDX = Hexahydro-1,3,5-trinitro-1,3,5-triazine
3. Well clusters MW-40, 65, 67, 72, and 73 were sampled as part of the O&M monitoring.

Table 6-15
2006 GMP Water Supply Well Sampling Summary
Former Nebraska Ordnance Plant, Mead, Nebraska

Water Supply Well	Analysis Performed
WSW-027	VOCs and Explosives
WSW-029	VOCs and Explosives
WSW-029A	VOCs and Explosives
WSW-032	VOCs and Explosives
WSW-034	VOCs and Explosives
WSW-036	VOCs and Explosives
WSW-050A	VOCs and Explosives
WSW-050B	VOCs and Explosives
WSW-051	VOCs and Explosives
WSW-051A*	VOCs and Explosives
WSW-052B	VOCs and Explosives
WSW-052C*	VOCs and Explosives
WSW-053*	VOCs and Explosives
WSW-054*	VOCs and Explosives
WSW-055	VOCs and Explosives
WSW-056	VOCs and Explosives
WSW-057	VOCs and Explosives
WSW-058	VOCs and Explosives
WSW-059	VOCs and Explosives
WSW-060	VOCs and Explosives
WSW-061	VOCs and Explosives
WSW-062	VOCs and Explosives
WSW-063	VOCs and Explosives
WSW-064	VOCs and Explosives
WSW-065	VOCs and Explosives
WSW-066	VOCs and Explosives
WSW-067	VOCs and Explosives
WSW-068	VOCs and Explosives
WSW-073	VOCs and Explosives
WSW-074	VOCs and Explosives
WSW-075	VOCs and Explosives
WSW-076	VOCs and Explosives
WSW-077	VOCs and Explosives
WSW-079	VOCs and Explosives
WSW-080	VOCs and Explosives
WSW-081	VOCs and Explosives
WSW-082	VOCs and Explosives
WSW-084	VOCs and Explosives
WSW-086	VOCs and Explosives
WSW-087	VOCs and Explosives
WSW-089	VOCs and Explosives
WSW-090	VOCs and Explosives
WSW-091	VOCs and Explosives
WSW-092	VOCs and Explosives
WSW-093	VOCs and Explosives
WSW-094	VOCs and Explosives
WSW-095	VOCs and Explosives
WSW-096	VOCs and Explosives
WSW-097	VOCs and Explosives

Table 6-15
2006 GMP Water Supply Well Sampling Summary
Former Nebraska Ordnance Plant, Mead, Nebraska

Water Supply Well	Analysis Performed
WSW-099	VOCs and Explosives
WSW-100	VOCs and Explosives
WSW-101	VOCs and Explosives
WSW-102	VOCs and Explosives
WSW-103	VOCs and Explosives
WSW-104	VOCs and Explosives
WSW-105	VOCs and Explosives
WSW-106	VOCs and Explosives
WSW-106	VOCs and Explosives
WSW-107	VOCs and Explosives
WSW-108	VOCs and Explosives
WSW-109	VOCs and Explosives
WSW-110	VOCs and Explosives
WSW-111	VOCs and Explosives
WSW-112	VOCs and Explosives
UNFL-10A	VOCs and Explosives
UNFL-10A	VOCs and Explosives
UNFL-12	VOCs and Explosives

Notes:

1. * indicates the well is equipped with a granular activated carbon unit

Table 6-16
Newly Installed Eastern and Southern Perimeter Groundwater Monitoring Well Sampling Summary
Former Nebraska Ordnance Plant, Mead, Nebraska

Monitoring Well	Analysis Performed
MW-86A	VOCs and Explosives
MW-86B	VOCs and Explosives
MW-86D	VOCs and Explosives
MW-87A	VOCs and Explosives
MW-87B	VOCs and Explosives
MW-87D	VOCs and Explosives
MW-88A	VOCs and Explosives
MW-88B	VOCs and Explosives
MW-88D	VOCs and Explosives
MW-94A	Explosives
MW-94B	Explosives
MW-94D	Explosives
MW-95A	Explosives
MW-95B	Explosives
MW-95D	Explosives
MW-96A	Explosives
MW-96B	Explosives
MW-96D	Explosives
MW-97A	Explosives
MW-97B	Explosives
MW-97D	Explosives
MW-98A	Explosives
MW-98B	Explosives
MW-98D	Explosives
MW-99A	Explosives
MW-99B	Explosives
MW-99D	Explosives
MW-100A	Explosives
MW-100B	Explosives
MW-100D	Explosives
MW-101A	VOCs and Explosives
MW-101B	VOCs and Explosives
MW-101D	VOCs and Explosives
MW-102A	VOCs
MW-102B	VOCs
MW-102D	VOCs
MW-103A	VOCs
MW-103B	VOCs
MW-103D	VOCs
MW-106A	VOCs and Explosives
MW-106B	VOCs and Explosives
MW-106D	VOCs and Explosives
MW-107A	VOCs and Explosives
MW-107B	VOCs and Explosives
MW-107D	VOCs and Explosives
MW-108A	VOCs and Explosives
MW-108B	VOCs and Explosives
MW-108D	VOCs and Explosives

Table 6-16
Newly Installed Eastern and Southern Perimeter
Groundwater Monitoring Well Sampling Summary
Former Nebraska Ordnance Plant, Mead, Nebraska

Monitoring Well	Analysis Performed
MW-110A	VOCs and Explosives
MW-110B	VOCs and Explosives
MW-110D	VOCs and Explosives
MW-112A	VOCs and Explosives
MW-112B	VOCs and Explosives
MW-113A	VOCs and Explosives
MW-113B	VOCs and Explosives
MW-113D	VOCs and Explosives
MW-114A	VOCs and Explosives
MW-114B	VOCs and Explosives
MW-114D	VOCs and Explosives
MW-115A	VOCs and Explosives
MW-115B	VOCs and Explosives
MW-115D	VOCs and Explosives
MW-116A	VOCs and Explosives
MW-116B	VOCs and Explosives
MW-116D	VOCs and Explosives
MW-117A	VOCs and Explosives
MW-117B	VOCs and Explosives
MW-117D	VOCs and Explosives
MW-118A	Explosives
MW-118B	Explosives

Table 6-17
TCE and RDX in Southern and Eastern Perimeter Monitoring Wells
Former Nebraska Ordnance Plant, Mead, Nebraska

Location	Type	TCE Result	RDX Result	Date VOCs Last Collected	Date Explosives Last Collected
MW-86A	Intermed.	ND	1.07	Jan-07	Jan-07
MW-86B	Shallow	ND	ND	Jan-07	Jan-07
MW-86D	Deep	ND	1.71	Jan-07	Jan-07
MW-87A	Intermed.	ND	ND	Jan-07	Jan-07
MW-87B	Shallow	ND	0.384	Jan-07	Jan-07
MW-87D	Deep	ND	ND	Jan-07	Jan-07
MW-88A	Intermed.	ND	ND	Jan-07	Jan-07
MW-88B	Shallow	ND	ND	Jan-07	Jan-07
MW-88D	Deep	ND	ND	Jan-07	Jan-07
MW-94A	Intermed.	NA	ND	NA	Jan-07
MW-94B	Shallow	NA	ND	NA	Jan-07
MW-94D	Deep	NA	ND	NA	Jan-07
MW-95A	Intermed.	NA	ND	NA	Jan-07
MW-95B	Shallow	NA	ND	NA	Jan-07
MW-95D	Deep	NA	ND	NA	Jan-07
MW-96A	Intermed.	NA	ND	NA	Jan-07
MW-96B	Shallow	NA	ND	NA	Jan-07
MW-96D	Deep	NA	ND	NA	Jan-07
MW-97A	Intermed.	NA	ND	NA	Jan-07
MW-97B	Shallow	NA	ND	NA	Jan-07
MW-97D	Deep	NA	ND	NA	Jan-07
MW-98A	Intermed.	NA	ND	NA	Feb-07
MW-98B	Shallow	NA	ND	NA	Feb-07
MW-98D	Deep	NA	ND	NA	Feb-07
MW-99A	Intermed.	NA	3.16	NA	Feb-07
MW-99A*	Intermed.	NA	2.72	NA	Feb-07
MW-99B	Shallow	NA	3.78	NA	Feb-07
MW-99D	Deep	NA	4.08	NA	Feb-07
MW-100A	Intermed.	NA	0.849	NA	Feb-07
MW-100B	Shallow	NA	0.992	NA	Feb-07
MW-100D	Deep	NA	ND	NA	Feb-07
MW-101A	Intermed.	ND	ND	Jan-07	Jan-07
MW-101A*	Intermed.	ND	NA	Jan-07	NA
MW-101B	Shallow	ND	ND	Jan-07	Jan-07
MW-101D	Deep	ND	ND	Jan-07	Jan-07
MW-102A	Intermed.	ND	NA	Jan-07	NA
MW-102B	Shallow	ND	NA	Jan-07	NA
MW-102D	Deep	ND	NA	Jan-07	NA
MW-103A	Intermed.	ND	NA	Jan-07	NA
MW-103A*	Intermed.	ND	NA	Jan-07	NA
MW-103B	Shallow	ND	NA	Jan-07	NA
MW-103D	Deep	ND	NA	Jan-07	NA
MW-106A	Intermed.	ND	ND	Jan-07	Jan-07
MW-106B	Shallow	ND	ND	Jan-07	Jan-07
MW-106D	Deep	ND	ND	Jan-07	Jan-07
MW-107A	Intermed.	ND	ND	Jan-07	Jan-07
MW-107B	Shallow	ND	ND	Jan-07	Jan-07
MW-107D	Deep	ND	ND	Jan-07	Jan-07
MW-108A	Intermed.	ND	ND	Jan-07	Jan-07

Table 6-17
TCE and RDX in Southern and Eastern Perimeter Monitoring Wells
Former Nebraska Ordnance Plant, Mead, Nebraska

Location	Type	TCE Result	RDX Result	Date VOCs Last Collected	Date Explosives Last Collected
MW-108B	Shallow	ND	ND	Jan-07	Jan-07
MW-108D	Deep	ND	ND	Jan-07	Jan-07
MW-110A	Intermed.	ND	ND	Jan-07	Jan-07
MW-110B	Shallow	ND	ND	Jan-07	Jan-07
MW-110D	Deep	ND	ND	Jan-07	Jan-07
MW-112A	Intermed.	ND	ND	Jan-07	Jan-07
MW-112B	Shallow	ND	ND	Jan-07	Jan-07
MW-113A	Intermed.	ND	ND	Jan-07	Jan-07
MW-113B	Shallow	ND	ND	Jan-07	Jan-07
MW-113D	Deep	ND	ND	Jan-07	Jan-07
MW-114A	Intermed.	ND	ND	Jan-07	Jan-07
MW-114B	Shallow	ND	ND	Jan-07	Jan-07
MW-114D	Deep	ND	ND	Jan-07	Jan-07
MW-115A	Intermed.	ND	ND	Jan-07	Jan-07
MW-115B	Shallow	ND	ND	Jan-07	Jan-07
MW-115D	Deep	ND	ND	Jan-07	Jan-07
MW-116A	Intermed.	ND	ND	Jan-07	Jan-07
MW-116A*	Intermed.	ND	ND	Jan-07	Jan-07
MW-116B	Shallow	ND	ND	Jan-07	Jan-07
MW-116D	Deep	ND	ND	Jan-07	Jan-07
MW-117A	Intermed.	ND	ND	Feb-07	Feb-07
MW-117A*	Intermed.	ND	ND	Feb-07	Feb-07
MW-117B	Shallow	ND	ND	Feb-07	Feb-07
MW-117D	Deep	ND	ND	Feb-07	Feb-07
MW-118A	Intermed.	NA	ND	NA	Jan-07
MW-118A*	Intermed.	NA	ND	NA	Jan-07
MW-118B	Shallow	NA	0.553	NA	Jan-07

Notes:

1. NA = Not Analyzed or Applicable, ND = Non-Detect, * = Field Duplicate Sample

Table 6-18
Extraction Well Sampling - TCE Results
Former Nebraska Ordnance Plant, Mead, Nebraska

Date Sampled	EW-1	EW-2	EW-3	EW-4	EW-5	EW-6	EW-7	EW-8	EW-9	EW-10	EW-11	Date Sampled	EW-12	EW-13
2/27/02	0.88J	ND	ND	ND	ND	ND	ND	5.25	ND	ND	NS	NS	NS	NS
6/4/02	1.36J	ND	ND	ND	ND	ND	ND	7.61	ND	ND	NS	NS	NS	NS
8/13/02	1.55	ND	ND	ND	ND	ND	ND	8.94	ND	ND	NS	NS	NS	NS
11/5/02	1.69	ND	ND	ND	ND	ND	ND	9.49	ND	ND	NS	NS	NS	NS
2/5/03	1.335	ND	ND	ND	ND	ND	ND	7.17	ND	ND	NS	NS	NS	NS
5/6/03	2.1	ND	ND	ND	ND	ND	ND	10.6	ND	ND	NS	NS	NS	NS
8/5/03	2.88	ND	ND	ND	ND	ND	ND	12.3	ND	1.76J	NS	NS	NS	NS
11/4/03	3.3	ND	ND	ND	ND	ND	ND	15.6	ND	ND	NS	NS	NS	NS
2/3/04	NS	ND	ND	ND	ND	ND	ND	16.8	ND	ND	NS	2/13/06	11.4	NS
3/1/04	3.97	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	2/20/06	11.7	NS
4/22/04	4	ND	ND	ND	ND	ND	ND	19	ND	ND	NS	2/27/06	13.6	NS
8/3/04	5	ND	ND	ND	ND	ND	ND	24	ND	ND	NS	3/6/06	14.6	NS
11/2/04	5	ND	ND	ND	ND	ND	ND	30	ND	ND	NS	3/13/06	15	NS
2/1/05	5.5	ND	ND	ND	ND	ND	ND	40	ND	ND	NS	4/3/06	15.5	NS
3/23/05	6.9	ND	ND	ND	ND	ND	ND	NS	NS	NS	NS	5/1/06	16.5	NS
5/3/05	7.5	ND	ND	ND	ND	ND	ND	64	ND	ND	NS	6/5/06	17.4	NS
8/2/05	6.4	ND	ND	ND	ND	ND	ND	64	ND	ND	NS	7/5/06	17.9	NS
11/1/05	6.42	ND	ND	ND	ND	ND	ND	75.9	ND	ND	NS	8/1/06	17.8	NS
2/7/06	6.36	ND	ND	ND	ND	ND	ND	77	ND	ND	NS	9/6/06	15.7	NS
5/2& 5/3/06	6.97	ND	ND	ND	ND	ND	ND	95.7	ND	ND	NS	10/2/06	18.9	NS
8/2/2006	7.68	ND	ND	ND	ND	ND	ND	92.1	ND	ND	NS	11/1/06	15.9	NS
11/2/2006	7.84	ND	ND	ND	ND	ND	ND	95.7	ND	ND	NS	12/4/06	15.3	NS

Notes:

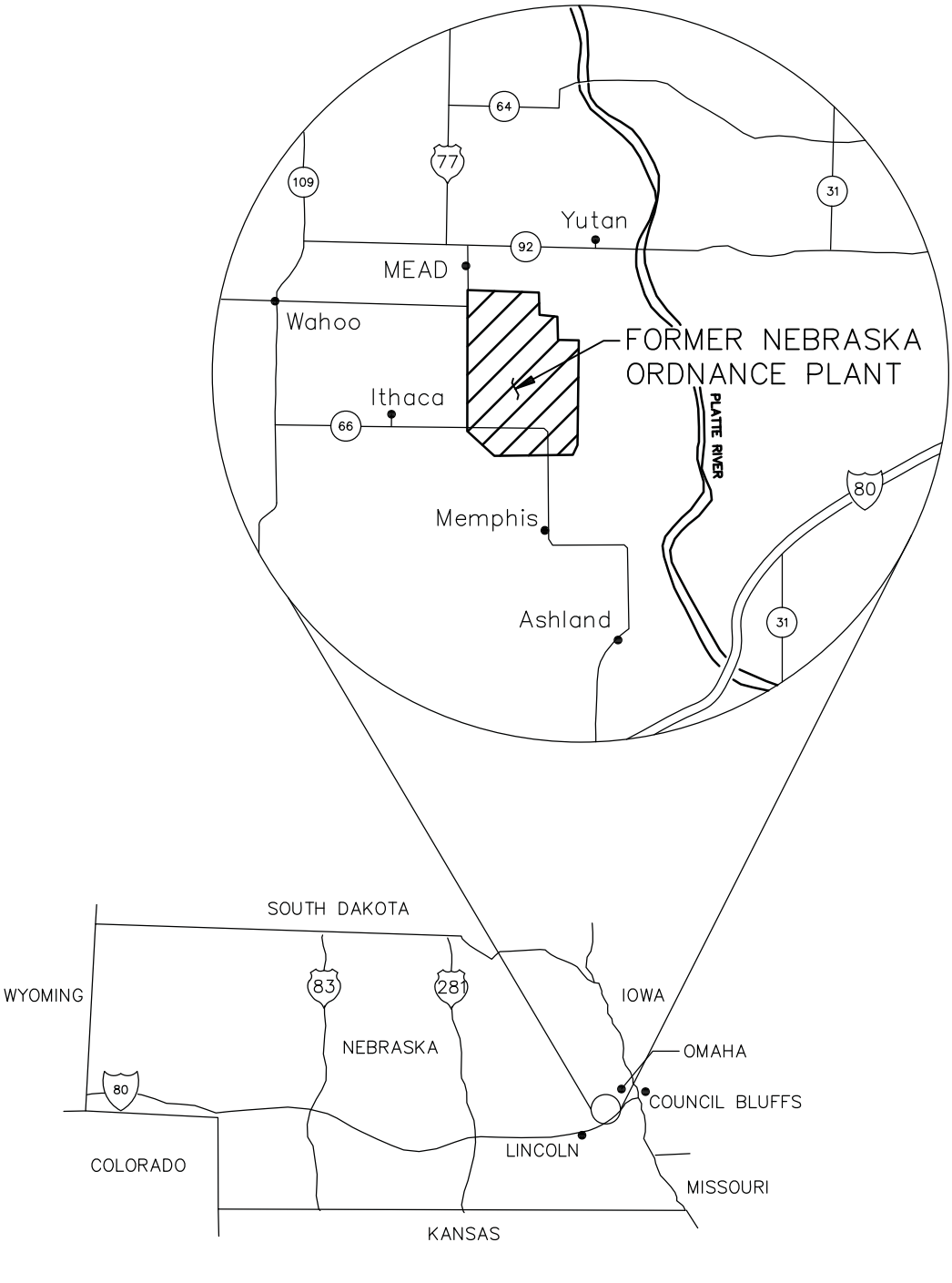
1. ND = Non-Detect, NS = Not Sampled, J = Estimated Value, and EW = Extraction Well.
2. Data presented is from the Monthly Operation, Maintenance and Monitoring Report (#61), Main and Load Line 1 (LL1) Treatment Plant, February 2007.

Table 6-19
Extraction Well Sampling - RDX Results
Former Nebraska Ordnance Plant, Mead, Nebraska

Date Sampled	EW-1	EW-2	EW-3	EW-4	EW-5	EW-6	EW-7	EW-8	EW-9	EW-10	EW-11	Date Sampled	EW-12	EW-13
2/27/02	0.21J	4.02	3.85	1.42	0.988	1.22	2.85	0.282J	5.8	ND	NS	NS	NS	NS
6/4/02	0.167J	2.77	3.85	1.37	0.71	1.75	2.22	0.25J	4.89	ND	NS	NS	NS	NS
8/13/02	ND	2.5	3.28	1.29	0.724	1.47	2.15	ND	4.21	ND	NS	NS	NS	NS
11/5/02	0.266	2.67	3.72	1.51	0.863	1.97	2.61	0.377	4.83	0.36	NS	NS	NS	NS
2/5/03	0.174J	1.42	2.16	0.734	0.43J	1.17	1.11	0.176J	3.02	0.211J	NS	NS	NS	NS
5/6/03	ND	2.32	4	1.57	0.728	1.59	2.35	0.271J	4.5	0.372J	NS	NS	NS	NS
8/5/03	0.29J	2.08	3.77	1.64	0.795	1.45	2.41	0.378	5.02	0.507	NS	NS	NS	NS
11/4/03	0.252J	2.02	4.14	1.78	0.76	1.52	2.22	0.286J	4.99	0.47	NS	NS	NS	NS
2/3/04	NS	1.86	3.93	1.8	0.688	1.58	2.37	0.216	4.92	0.424	NS	2/13/06	ND	NS
3/1/04	0.279J	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	2/20/06	ND	NS
4/22/04	ND	1.3	3.6	1.7	0.76	1.5	2	ND	4.5	ND	NS	2/27/06	ND	NS
8/3/04	ND	1.6	3.7	1.9	0.64	1.3	2.4	0.2J	5	0.53J	NS	3/6/06	ND	NS
11/2/04	ND	1.4	3.5	2.1	ND	1.3	2.3	ND	5.6	ND	NS	3/13/06	ND	NS
2/1/05	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NS	4/3/06	ND	NS
3/23/05	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NS	5/1/06	ND	NS
5/3/05	ND	1.3	3.68	2.43	0.721	1.49	2.66	ND	6.82	0.85	NS	6/5/06	ND	NS
8/2/05	ND	1.24	3.71	2.62	0.74	1.37	2.71	0.2J	7.24E	0.82	NS	7/5/06	ND	NS
11/1/05	ND	1.19	1.99	2.67	0.745	1.46	2.84	0.234	7.54E	0.99	NS	8/1/06	ND	NS
2/7/06	ND	1.03	3.39	2.37	0.625	1.22	2.62	ND	6.47	0.896	NS	9/6/06	ND	NS
5/2& 5/3/06	0.127J	1.11	3.62	3.04	0.827	1.55	3.35	0.254J	8.46	1.02	NS	10/2/06	ND	NS
8/2/2006	ND	0.709	2.87	2.5	0.666	ND	2.05	ND	7.02	1.05	NS	11/1/06	ND	NS
11/2/2006	ND	1.04	3.42	2.99	0.843	1.44	3.64	ND	9.69	1.3	NS	12/4/06	ND	NS

Notes:

1. ND = Non-Detect, NA = Not Analyzed, NS = Not Sampled, J or E = Estimated Value, and EW = Extraction Well.
2. Data presented is from the Monthly Operation, Maintenance and Monitoring Report (#61), Main and Load Line 1 (LL1) Treatment Plant, February 2007.



URS Group Inc. 8300 College Boulevard, Suite 200 Overland Park, Kansas 66210		U.S. ARMY ENGINEER DISTRICT CORPS OF ENGINEERS KANSAS CITY, MISSOURI
Designed by: D.C.C.	U.S. Army Corps of Engineers	FIVE – YEAR REVIEW FOR OPERABLE UNIT 2 FMR NEBRASKA ORDNANCE PLANT – MEAD, NEBRASKA
Drawn by: T.M.S.		**GENERAL SITE LOCATION MAP**
Checked by: R.J.E	Scale: NONE	Figure number: 1 – 1
Submitted by: L.A.T.	Date: **MAY 2009** Dwg. No.: 1–1	

July 23, 2007 12:49.45 pm (rob)
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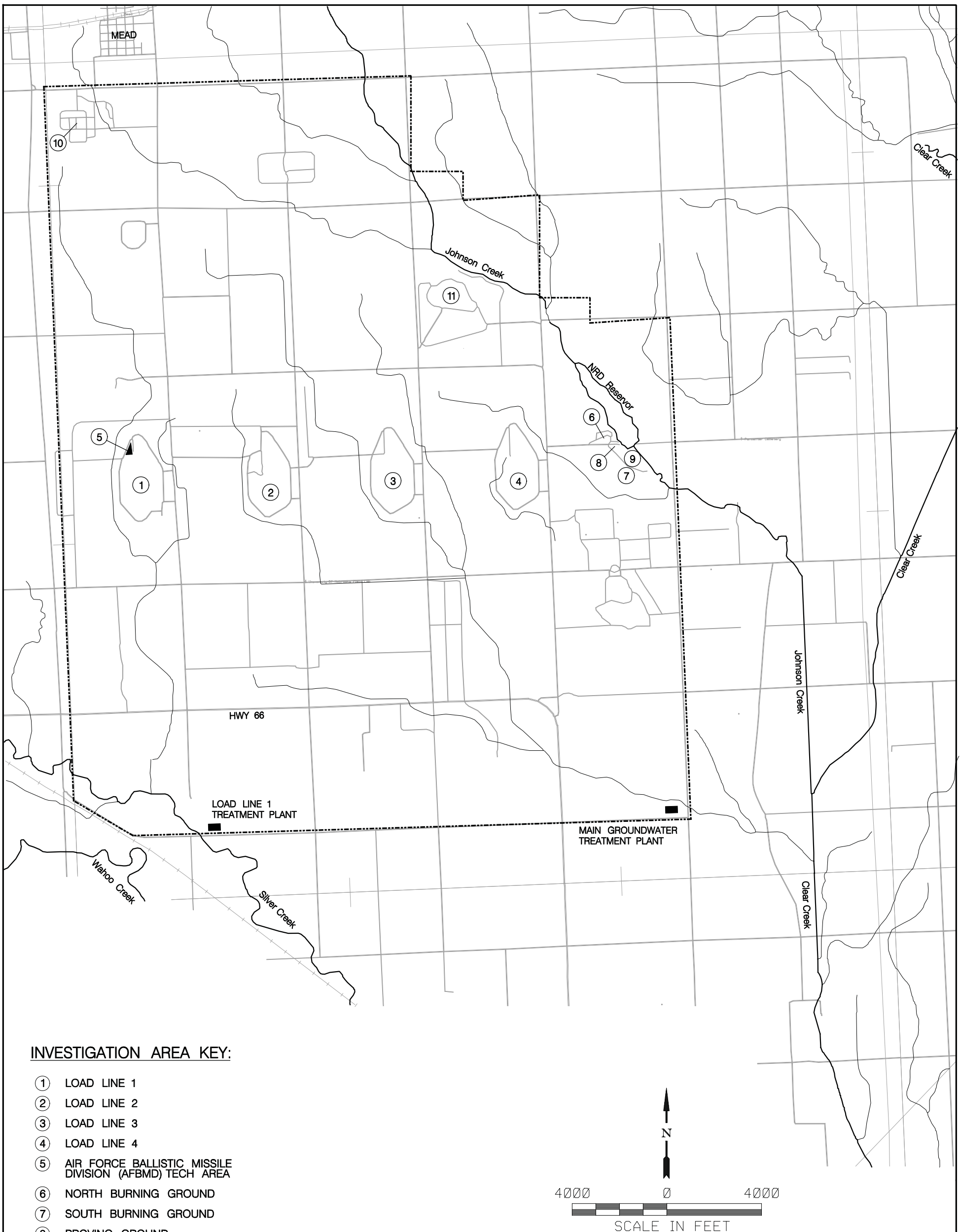


INVESTIGATION AREA KEY:

1. LOAD LINE 1
2. LOAD LINE 2
3. LOAD LINE 3
4. LOAD LINE 4
5. AIR FORCE BALLISTIC MISSILE DIVISION (AFBMD) TECH AREA
6. NORTH BURNING GROUND
7. SOUTH BURNING GROUND
8. PROVING GROUND
9. FORMER NOP LANDFILL AREA
10. ADMINISTRATION AREA
11. ATLAS MISSILE AREA

LEGEND:

- FORMER NOP BOUNDARY
- INTERMITTENT DRAINAGES
- JOHNSON, CLEAR, SILVER AND WAHOO CREEKS

Revisions			
Symbol	Descriptions	Date	Approved

URS Group Inc.
8300 College Boulevard, Suite 200
Overland Park, Kansas 66210

U.S. ARMY ENGINEER DISTRICT
CORPS OF ENGINEERS
KANSAS CITY, MISSOURI

Designed by: LAT
Drawn by: TMS
Checked by: DCC
Submitted by: LAT

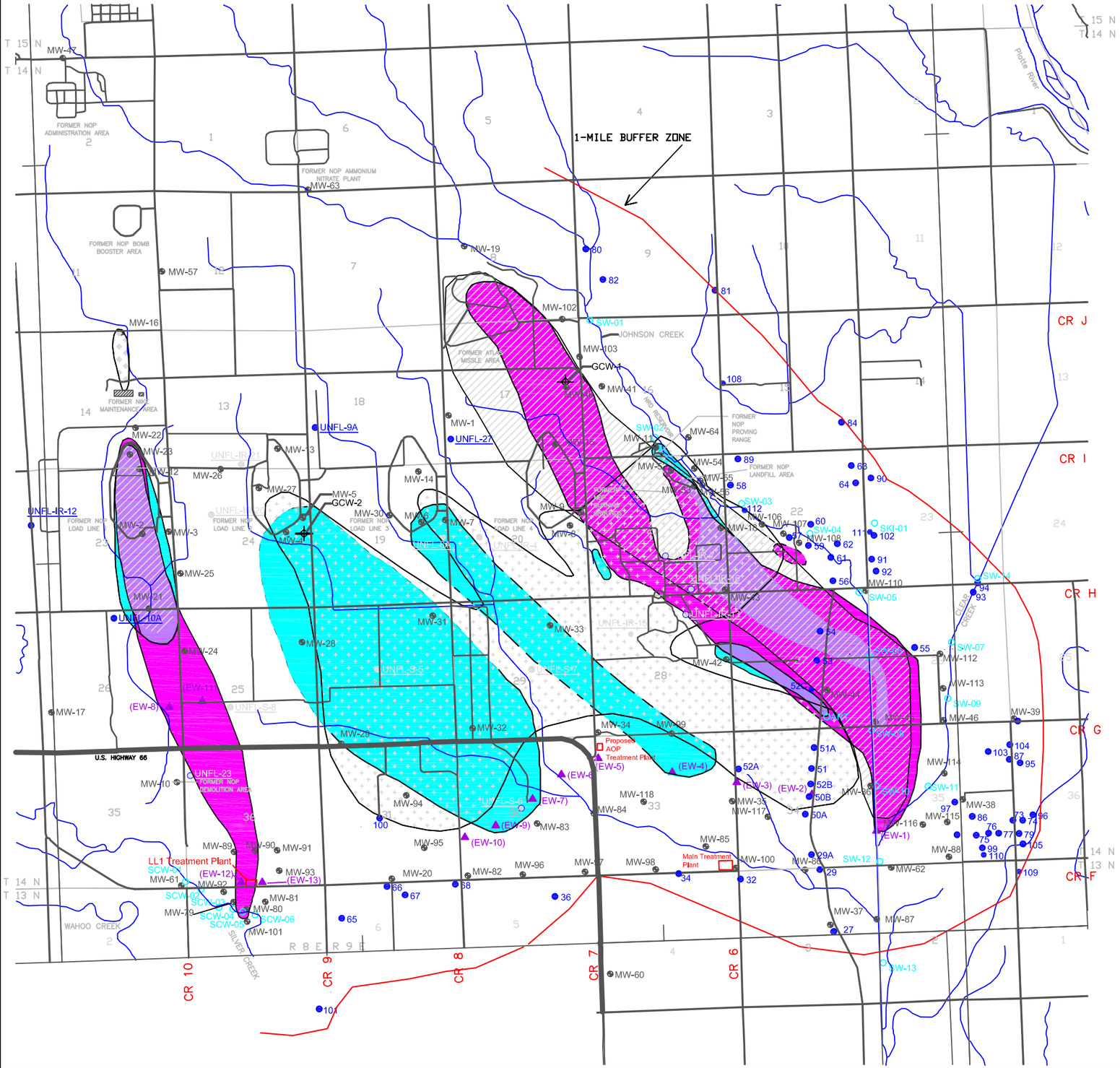
U.S. Army Corps of Engineers

FIVE - YEAR REVIEW
FOR OPERABLE UNIT 2
FMR. NEBRASKA ORDNANCE PLANT - MEAD, NEBRASKA

DETAILED SITE LOCATION PLAN

Scale: 1 IN = 4000 FT
Date: MAY 2009
Dwg. No.: 3–1
Sheet number: 1

J:\MEAD ± OU2-5YR-3-2.DGN



EXPLANATION:

- ESTIMATED PLUME BOUNDARY
- 55 — WATER SUPPLY WELL LOCATION (grey = agricultural or non potable)
- METROPOLITAN UTILITIES DISTRICT EXTRACTION WELL LOCATION
- MW-20 — MONITORING WELL CLUSTER LOCATION
- EW-4 — EXTRACTION WELL LOCATION
- SW-01 — SURFACE WATER SAMPLING LOCATION
- GCW-2 — GROUNDWATER CIRCULATION WELL LOCATION
- APPROXIMATE AREA OF TCE CONTAMINATED GROUNDWATER (CONCENTRATIONS GREATER THAN OR EQUAL TO THE MCL OF 5 µg/L)
- APPROXIMATE AREA OF RDX CONTAMINATED GROUNDWATER (CONCENTRATIONS GREATER THAN OR EQUAL TO THE LIFETIME HEALTH ADVISORY OF 2 µg/L)
- APPROXIMATE AREA OF COMBINED TCE AND RDX CONTAMINATED GROUNDWATER (TCE AND RDX CONCENTRATIONS GREATER THAN OR EQUAL TO 5 µg/L AND 2 µg/L, RESPECTIVELY
- APPROXIMATE AREA OF RDX CONTAMINATED GROUNDWATER (CONCENTRATIONS GREATER THAN OR EQUAL TO THE LIFETIME HEALTH ADVISORY OF 2 µg/L PER THE 1997 ROD
- APPROXIMATE AREA OF TCE CONTAMINATED GROUNDWATER (CONCENTRATIONS GREATER THAN OR EQUAL TO THE MCL OF 5 µg/L PER THE 1997 ROD

1 ½ 0 1 MILE

1000 0 1000 2000 3000 4000 5000 6000 7000 FEET

1 .5 0 1 KILOMETER

URS Group Inc.
8300 College Boulevard, Suite 200
Overland Park, Kansas 66210

U.S. ARMY ENGINEER DISTRICT
CORPS OF ENGINEERS
KANSAS CITY, MISSOURI

Designed by: L.A.T.
Drawn by: C.C.S.
Checked by: R.J.E.
Submitted by: L.A.T.

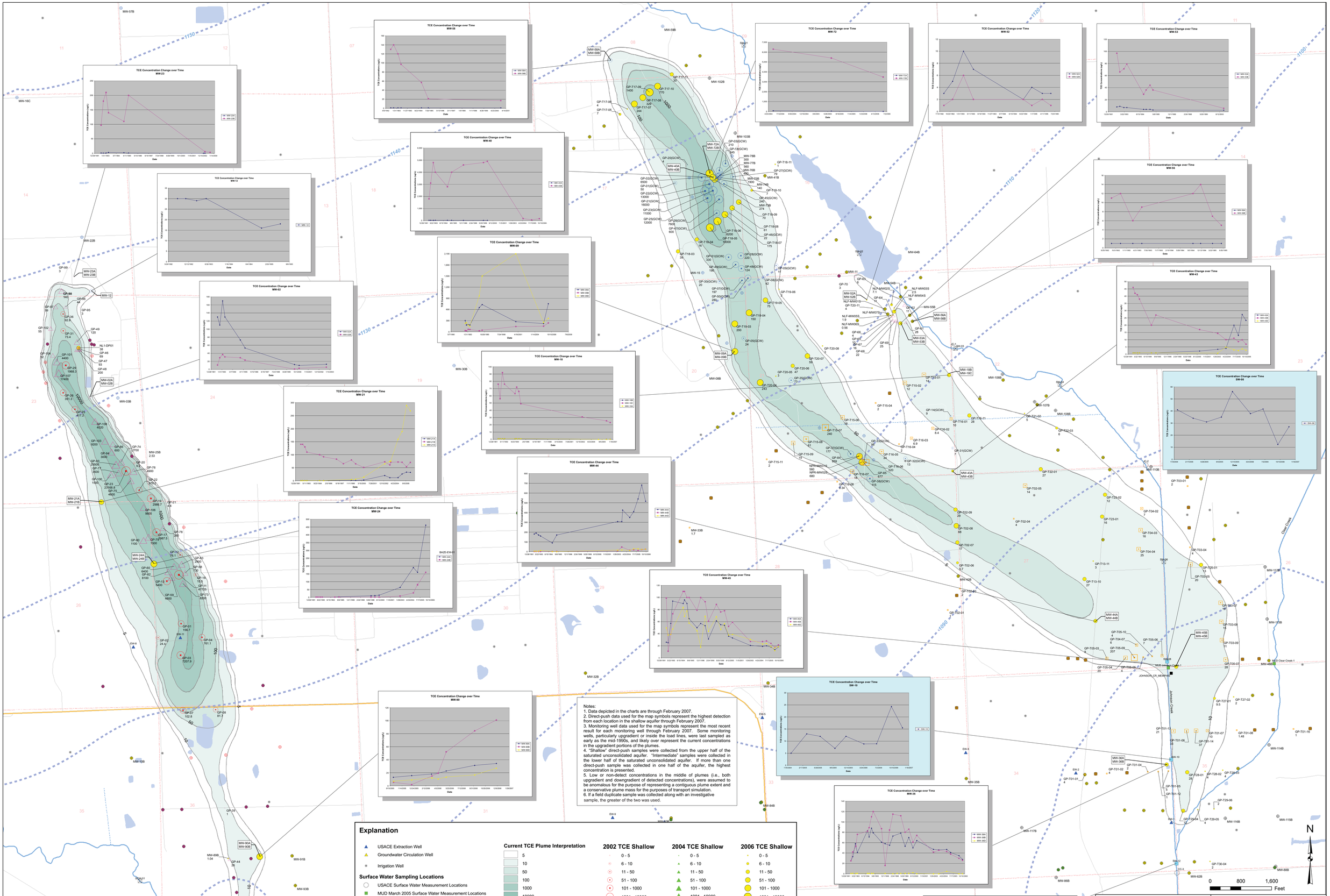
U.S. Army Corps of Engineers

FIVE-YEAR REVIEW
FOR OPERABLE UNIT 2
FMR NEBRASKA ORDNANCE
PLANT - MEAD, NEBRASKA

GENERAL SITE LOCATION MAP

Scale: NONE
Date: MAY 2009
Dwg. No.: 4–1
Figure number: 4–1

July 23, 2007 12:53:39 pm (cst)
U:\18269979 Weskosk Support\5-Year Review\Draft Report\Figures\drawing files\base_kkp_revised-4-08 version12.dwg



URS

U. S. ARMY ENGINEER DISTRICT
CORPS OF ENGINEERS
KANSAS CITY, MISSOURI

Designed by: MEW

Drawn by: JLC

Checked by: RJE

Submitted by: LAT

FIRST FIVE YEAR REVIEW REPORT
OPERABLE UNIT NO. 2
FORMER NEBRASKA ORDNANCE PLANT - MEAD, NE

U.S. Army Corps of Engineers

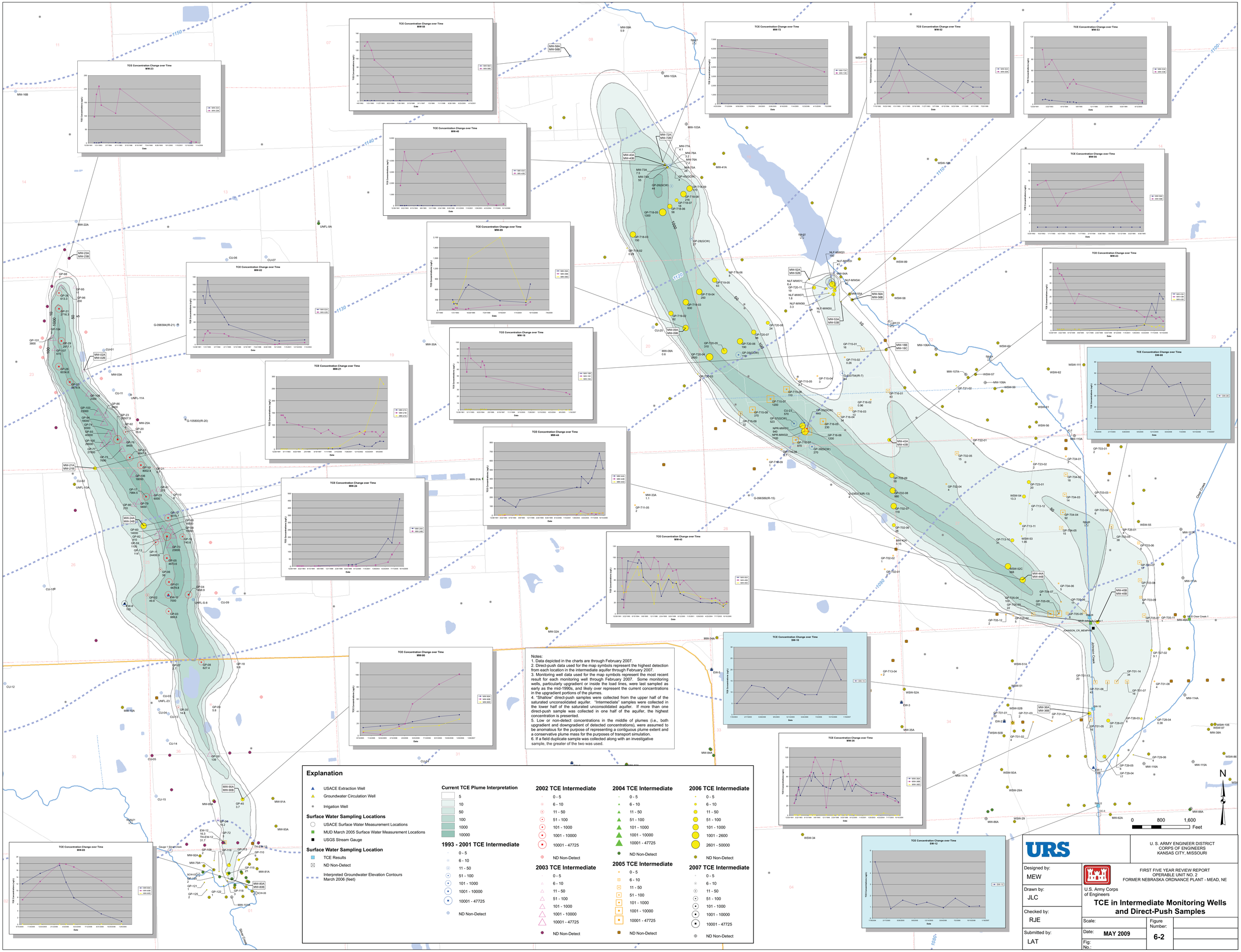
TCE in Shallow Monitoring Wells and Direct-Push Samples

Scale:

Date: MAY 2009

Figure Number: 6-1

Fig: No.:



Notes:
1. Data depicted in the charts are through February 2007.
2. Direct-push data used for the map symbols represent the highest detection from each location in the intermediate aquifer through February 2007.
3. Monitoring well data used for the map symbols represent the most recent result for each monitoring well through February 2007. Some monitoring wells, particularly upgradient or inside the load lines, were last sampled as early as the mid-1990s, and likely over represent the current concentrations in the upgradient portions of the plumes.
4. "Shallow" direct-push samples were collected from the upper half of the saturated unconsolidated aquifer. "Intermediate" samples were collected in the lower half of the saturated unconsolidated aquifer. If more than one direct-push sample was collected in one half of the aquifer, the highest concentration is presented.
5. Low or non-detect concentrations in the middle of plumes (i.e., both upgradient and downgradient of detected concentrations), were assumed to be anomalous for the purpose of representing a contiguous plume extent and a conservative plume mass for the purposes of transport simulation.
6. If a field duplicate sample was collected along with an investigative sample, the greater of the two was used.

URS

U. S. ARMY ENGINEER DISTRICT
CORPS OF ENGINEERS
KANSAS CITY, MISSOURI

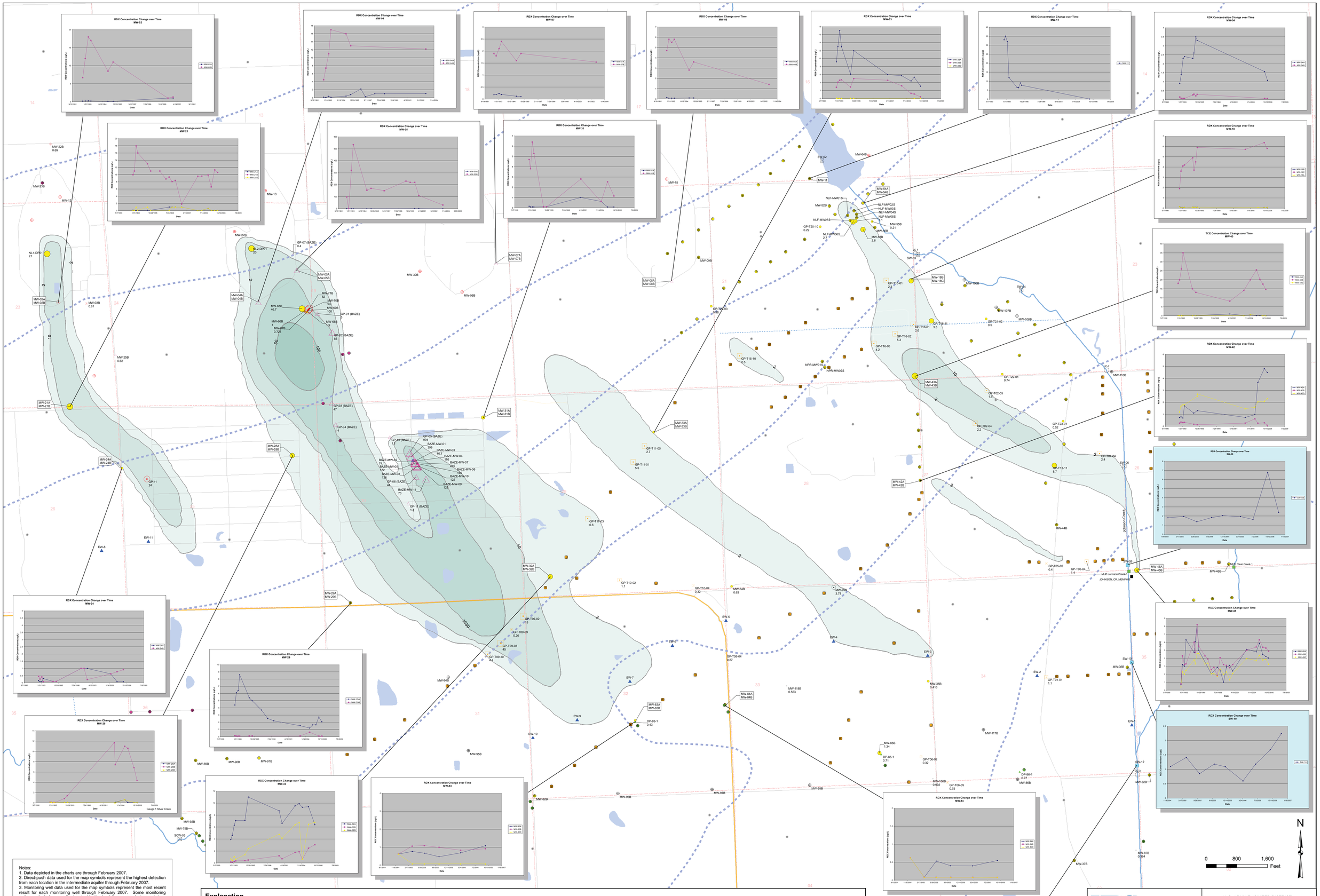
Designed by: MEW
Drawn by: JLC
Checked by: RJE
Submitted by: LAT

U.S. Army Corps of Engineers

FIRST FIVE YEAR REVIEW REPORT
OPERABLE UNIT NO. 2
FORMER NEBRASKA ORDNANCE PLANT - MEAD, NE

TCE in Intermediate Monitoring Wells and Direct-Push Samples

Scale:
Date: MAY 2009
Figure Number: 6-2
Fig. No.:



Notes:
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4. "Shallow" direct-push samples were collected from the upper half of the saturated unconsolidated aquifer. "Intermediate" samples were collected in the lower half of the saturated unconsolidated aquifer. If more than one direct-push sample was collected in one half of the aquifer, the highest concentration is presented.
5. Low or non-detect concentrations in the middle of plumes (i.e., both upgradient and downgradient of detected concentrations), were assumed to be anomalous for the purpose of representing a contiguous plume extent and a conservative plume mass for the purposes of transport simulation.
6. If a field duplicate sample was collected along with an investigative sample, the greater of the two are used.

Explanation

- USACE Extraction Well
- Groundwater Circulation Well
- Irrigation Well

Surface Water Sampling Locations

- USACE Surface Water Measurement Locations
- MUD March 2005 Surface Water Measurement Locations
- USGS Stream Gauge

Surface Water Sampling Location

- RDX Results
- ND Non-Detect

Interpreted Groundwater Elevation Contours March 2006 (feet)

Current RDX Plume Interpretation

- 2
- 10
- 50
- 100

1995-2002 RDX Shallow	2003 RDX Shallow	2004 RDX Shallow	2005 RDX Shallow	2006 RDX Shallow	2007 RDX Shallow
0 - 1	0 - 1	0 - 1	0 - 1	0 - 1	0 - 1
1 - 2	1 - 2	1 - 2	1 - 2	1 - 2	1 - 2
2 - 10	2 - 10	2 - 10	2 - 10	2 - 10	2 - 10
10 - 50	10 - 50	10 - 50	10 - 50	10 - 50	51 - 100
50 - 100	50 - 100	50 - 100	50 - 100	50 - 100	101 - 100
100 - 1000	100 - 1000	100 - 1000	100 - 1000	100 - 1000	ND Non-Detect
ND Non-Detect	ND Non-Detect	ND Non-Detect	ND Non-Detect	ND Non-Detect	

URS

U. S. ARMY ENGINEER DISTRICT
CORPS OF ENGINEERS
KANSAS CITY, MISSOURI

Designed by: MEW

Drawn by: JLC

Checked by: RJE

Submitted by: LAT

U.S. Army Corps of Engineers

FIRST FIVE YEAR REVIEW REPORT
OPERABLE UNIT NO. 2
FORMER NEBRASKA ORDNANCE PLANT - MEAD, NE

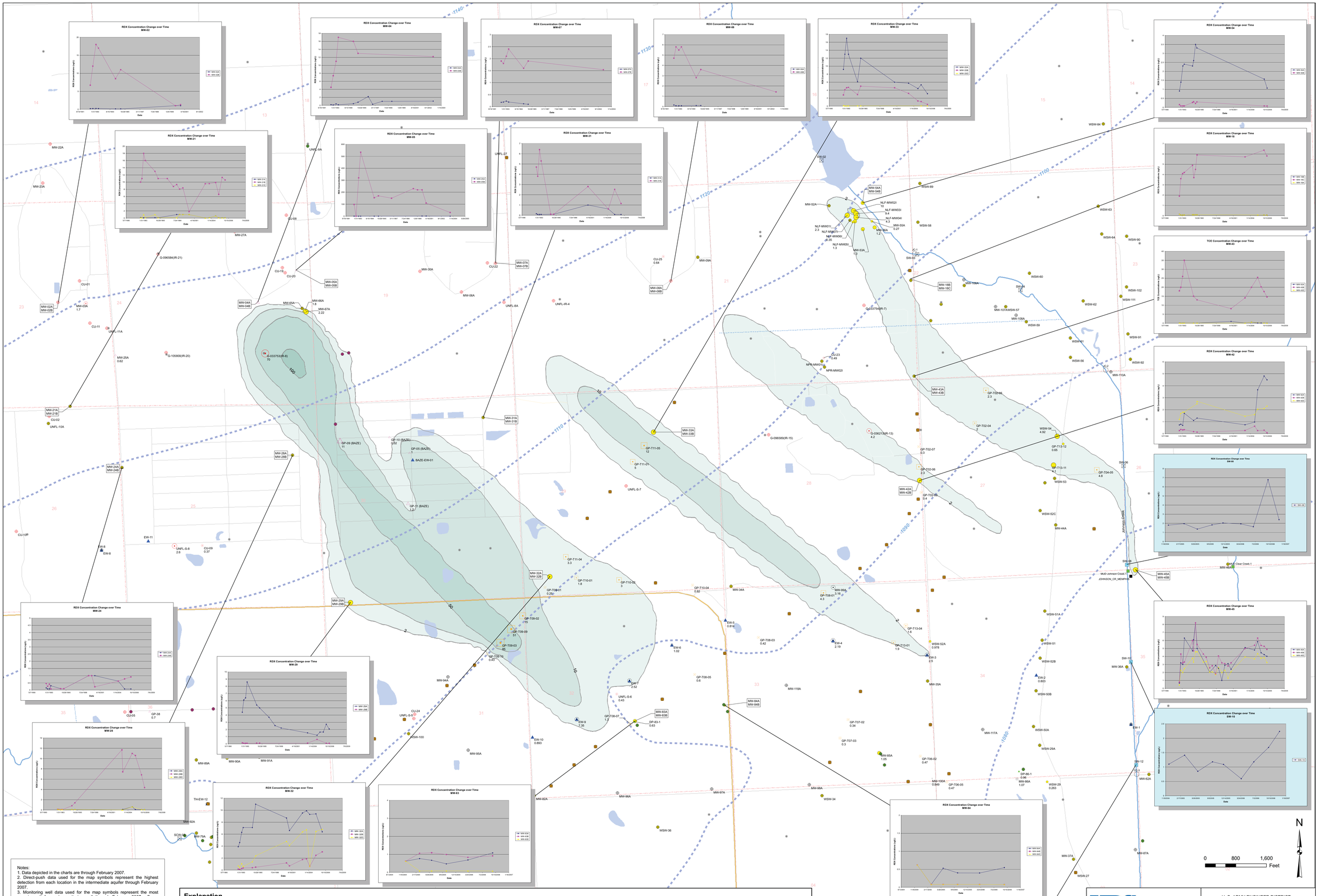
RDX in Shallow Monitoring Wells and Direct-Push Samples

Scale:

Date: MAY 2009

Figure Number: 6-3

Fig: No.:



Notes:
1. Data depicted in the charts are through February 2007.
2. Direct-push data used for the map symbols represent the highest detection from each location in the intermediate aquifer through February 2007.
3. Monitoring well data used for the map symbols represent the most recent result for each monitoring well through February 2007. Some monitoring wells, particularly upgradient or inside the load lines, were last sampled as early as the mid-1990s, and likely over represent the current concentrations in the upgradient portions of the plumes.
4. "Shallow" direct-push samples were collected from the upper half of the saturated unconsolidated aquifer. "Intermediate" samples were collected in the lower half of the saturated unconsolidated aquifer. If more than one direct-push sample was collected in one half of the aquifer, the highest concentration is presented.
5. Low or non-detect concentrations in the middle of plumes (i.e., both upgradient and downgradient of detected concentrations), were assumed to be anomalous for the purpose of representing a contiguous plume extent and a conservative plume mass for the purposes of transport simulation.
6. If a field duplicate sample was collected along with an investigative sample, the greater of the two are used.

Explanation

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- Irrigation Well

Surface Water Sampling Locations

- USACE Surface Water Measurement Locations
- MUD March 2005 Surface Water Measurement Locations
- USGS Stream Gauge

Surface Water Sampling Location

- RDX Results
- ND Non-Detect

Interpreted Groundwater Elevation Contours March 2006 (feet)

Current RDX Plume Interpretation

- 2
- 10
- 50
- 100

1995-2002 RDX Intermediate	2003 RDX Intermediate	2004 RDX Intermediate	2005 RDX Intermediate	2006 RDX Intermediate	2007 RDX Intermediate
0 - 1	0 - 1	0 - 1	0 - 1	0 - 1	0 - 1
1 - 2	1 - 2	1 - 2	1 - 2	1 - 2	1 - 2
2 - 10	2 - 10	2 - 10	2 - 10	2 - 10	2 - 10
10 - 50	10 - 50	10 - 50	10 - 50	10 - 50	11 - 50
50 - 100	50 - 100	50 - 100	50 - 100	50 - 100	51 - 100
100 - 1000	100 - 1000	100 - 1000	100 - 1000	100 - 1000	101 - 1000
ND Non-Detect	ND Non-Detect	ND Non-Detect	ND Non-Detect	ND Non-Detect	ND Non-Detect

URS

U. S. ARMY ENGINEER DISTRICT
CORPS OF ENGINEERS
KANSAS CITY, MISSOURI

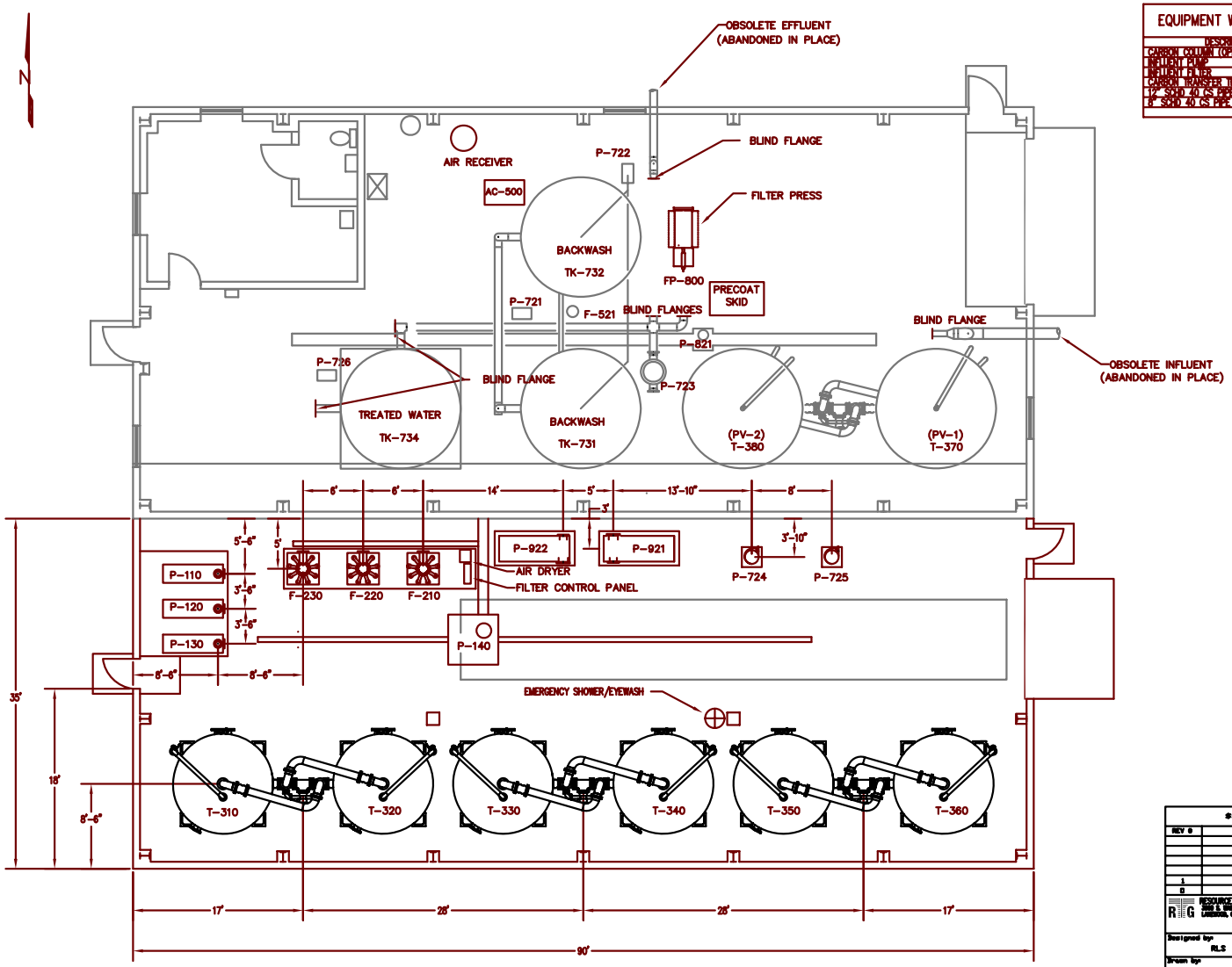
Designed by: MEW
Drawn by: JLC
Checked by: RJE
Submitted by: LAT

U.S. Army Corps of Engineers

FIRST FIVE YEAR REVIEW REPORT
OPERABLE UNIT NO. 2
FORMER NEBRASKA ORDNANCE PLANT - MEAD, NE

RDX in Intermediate Monitoring Wells and Direct-Push Samples

Scale:
Date: MAY 2009
Figure Number: 6-4
Fig: No.:



EQUIPMENT WEIGHTS: (CONCRETE FLOOR LOADING)

DESCRIPTION	QTY.	WEIGHT (lbs. EACH UNIT)
CARBON COLUMN (OPERATING)	6	107,000
INFLUENT PUMP	3	450
INFLUENT FILTER	3	425
CARBON TRANSFER TRUCK (FULLY LOADED)	1	120,000
12" SCHD 40 CS PIPE & WATER	A/R	102.5 lbs/ft
8" SCHD 40 CS PIPE & WATER	A/R	50.5 lbs/ft

** - THINK VALUE ENGINEERING - **

REV #	Revisions	Date	Approved
1	AS BUILT	02/14/02	
0	ISSUED FOR CONSTRUCTION	06/05/02	

RESOURCE TECHNOLOGIES GROUP, INC.
3200 E. BRANDON BLVD, STE 100
LAKEWOOD, COLORADO 80228

U.S. ARMY ENGINEER DISTRICT
CORPS OF ENGINEERS
KANSAS CITY, MISSOURI

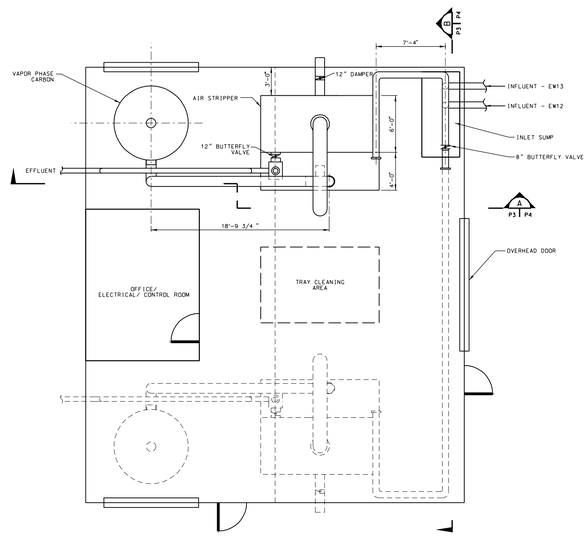
Designed by: RLS
Drawn by: RLS
Checked by: DEC
Reviewed by: PRL
Submitted by: PRL

FORMER NEBRASKA ORDNANCE WORKS — MEAD, NEBRASKA

OU2 GROUNDWATER TREATMENT
EQUIPMENT LAYOUT

Scale: AS SHOWN
Spec. No.: -
Contract No.: -
Sheet reference number: P2
Date: 14 FEB 02
Drawing Code: -

Computer Aided Design & Drafting



TREATMENT BUILDING - PLAN

SCALE : 1/4 " = 1'-0"

GENERAL NOTE

1. THESE DRAWINGS ARE CONCEPTUAL IN NATURE AND ARE INTENDED TO DEPICT THE LOCATIONS OF MAJOR EQUIPMENT. THEY ARE NOT INTENDED TO BE DETAILED DESIGN OF THE FACILITIES, INCLUDING GEOTECHNICAL, CIVIL, STRUCTURAL, ARCHITECTURAL, MECHANICAL AND ELECTRICAL ELEMENTS HAVE NOT BEEN COMPLETED AND ARE THE RESPONSIBILITY OF THE REMEDIAL ACTION CONTRACTOR.

$$ - THINK VALUE ENGINEERING - $$

Revisions

Symbol	Description	Date	Approved

URS Group Inc.
10975 Ellsworth, Suite 100
Overland Park, Kansas 66211

U.S. ARMY ENGINEER DISTRICT
CORPS OF ENGINEERS
KANSAS CITY, MISSOURI

FORMER NEBRASKA ORDNANCE PLANT — MEAD, NEBRASKA

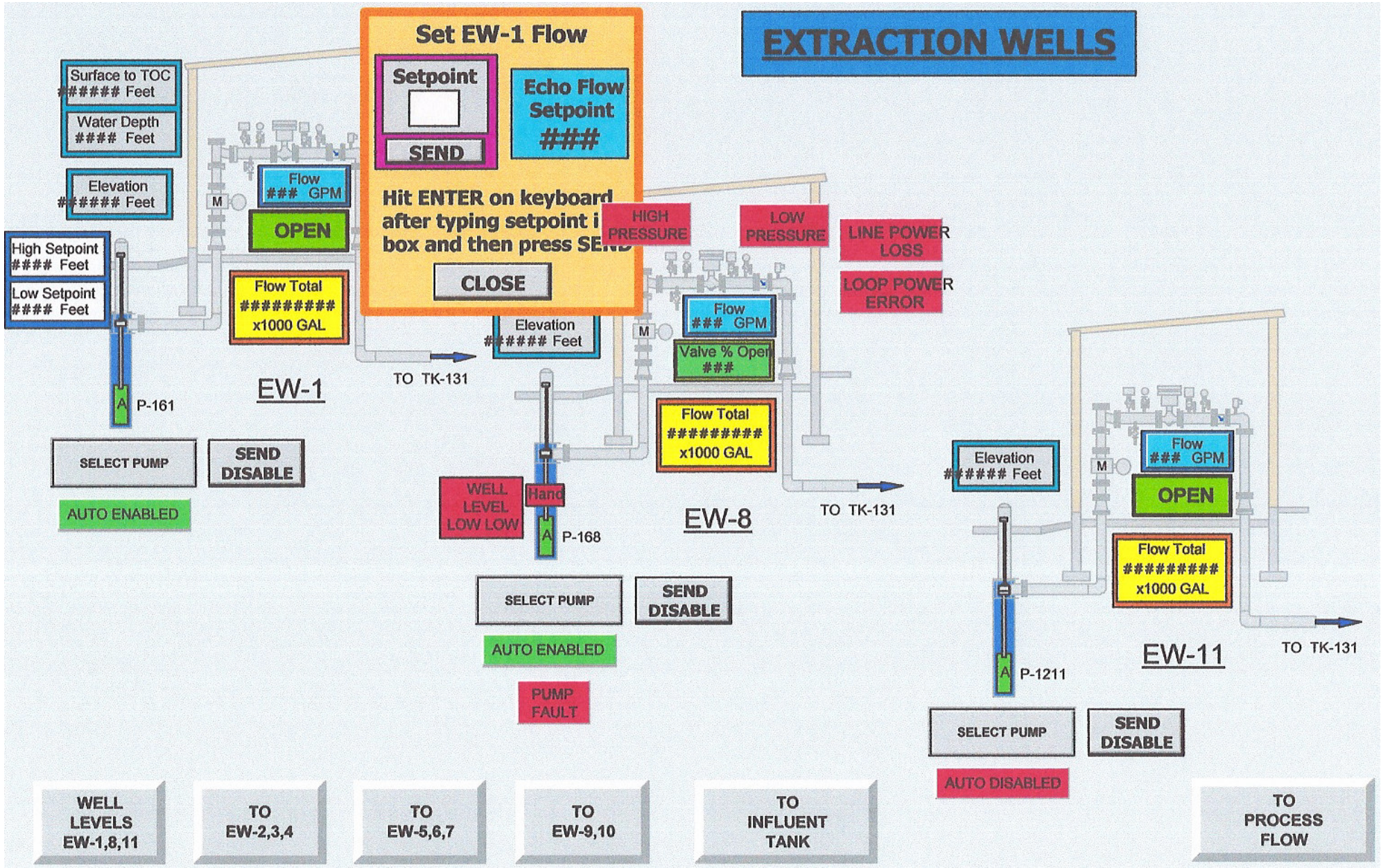
LOAD LINE 1 CONTAINMENT SYSTEM
REMEDIAL DESIGN
TREATMENT BUILDING EQUIPMENT
LAYOUT AND PIPING PLAN

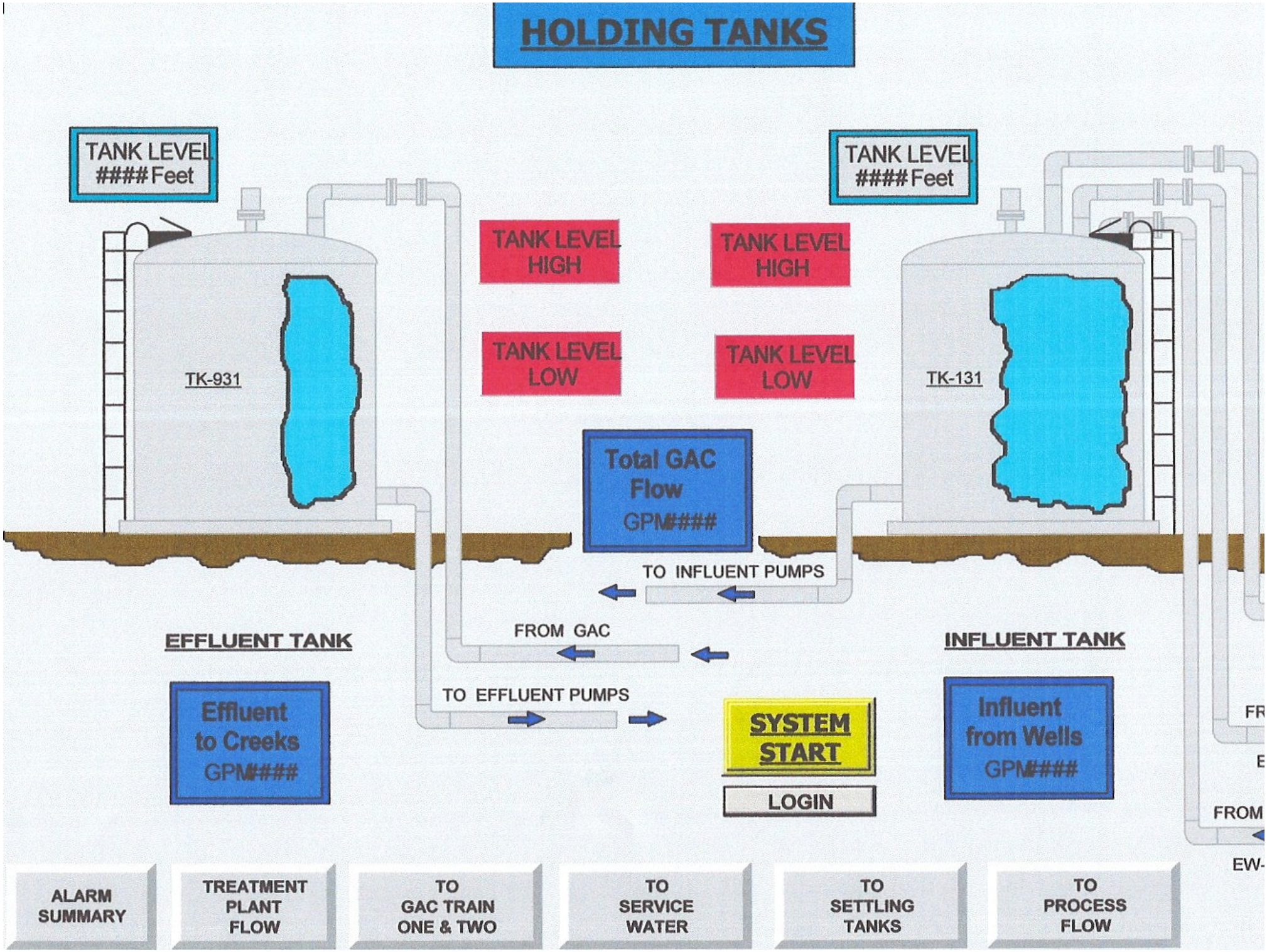
Designed by:	DO/CL
Drawn by:	BAG
Checked by:	MNK
Reviewed by:	RDJ
Submitted by:	MNK
Scale:	AS SHOWN
Spec. No.:	
Contract No.	
Sheet reference number:	P3
Date:	APRIL 2005
Drawing Code:	

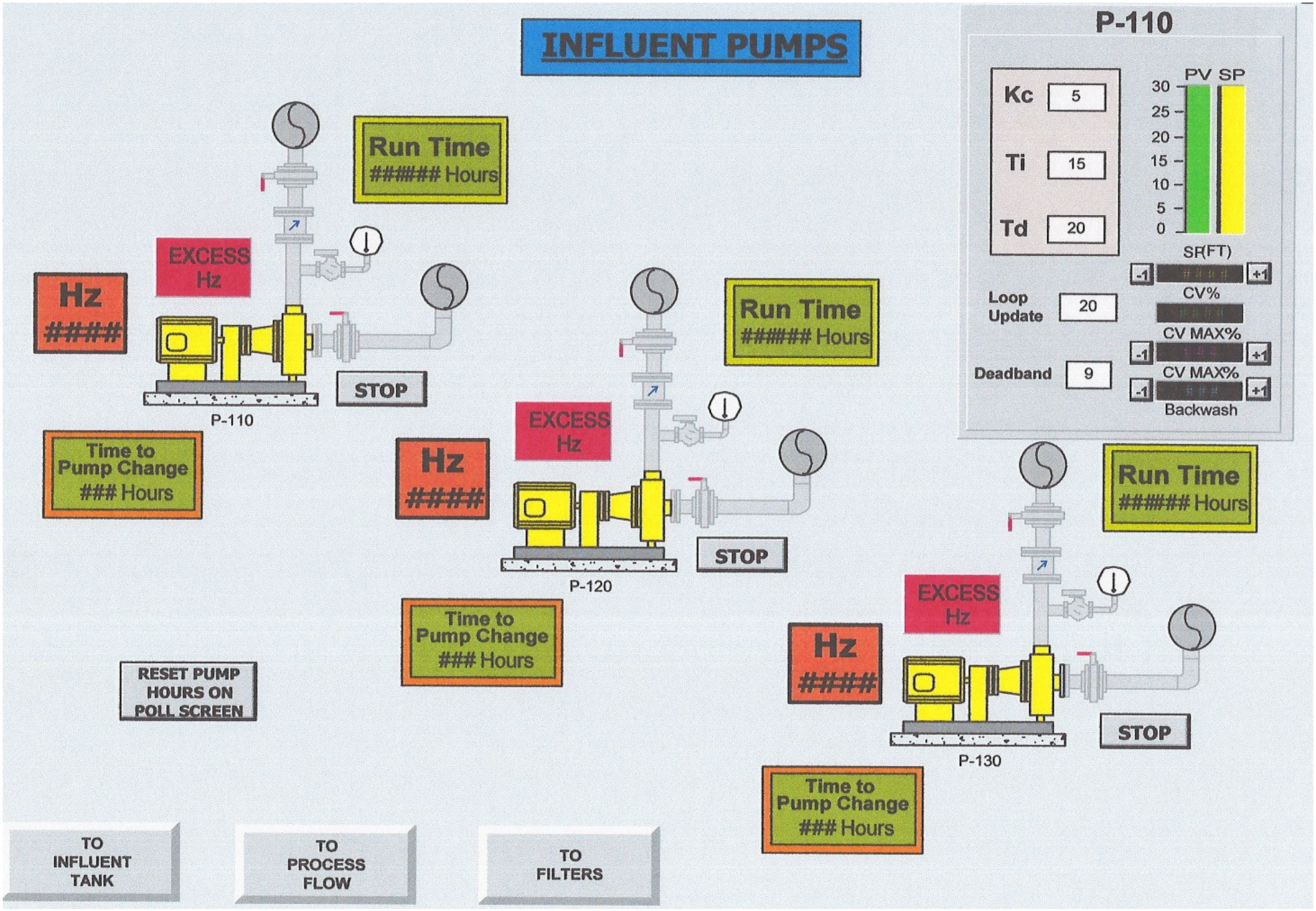
COMPUTER AIDED DESIGN & DRAFTING

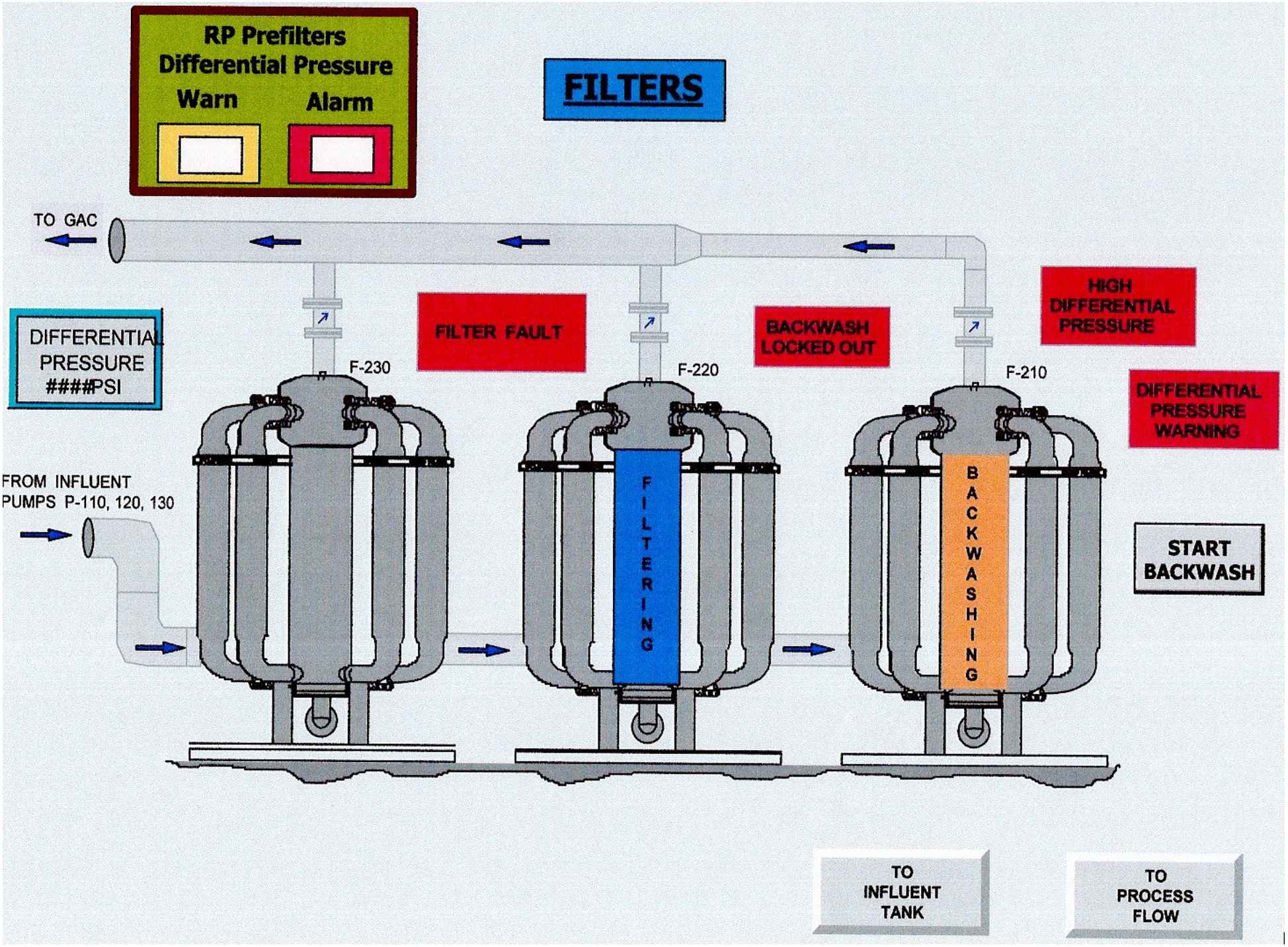
SYM	DESCRIPTION	DATE	BY	CHK	APP	REV	SYM	DESCRIPTION	DATE	BY	CHK	APP

.../phase2 load line 1/1616p3.dgn 03/23/2005 04:59:39 PM

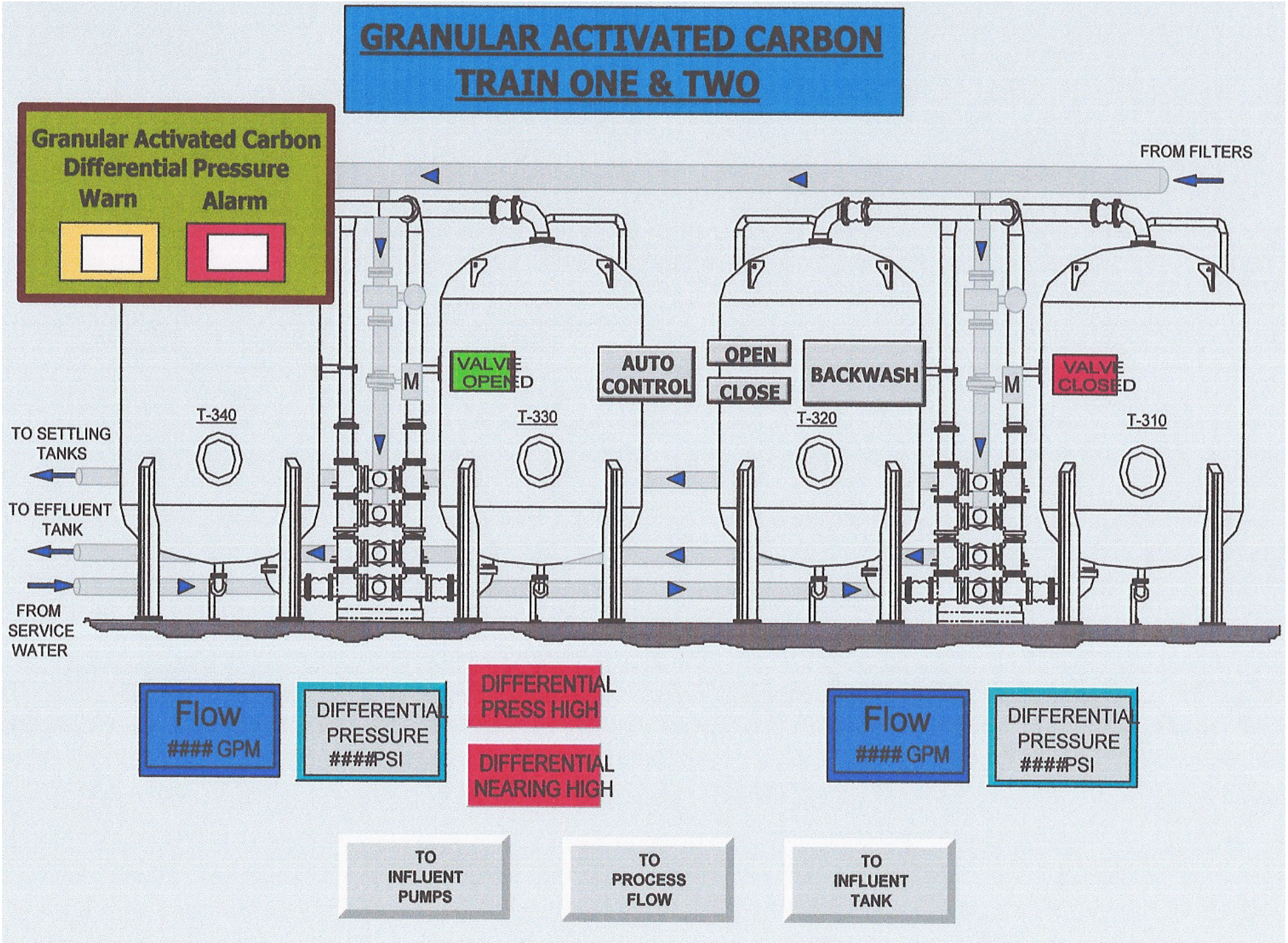

EXTRACTION WELLS
Set EW-1 Flow
Setpoint
SEND
Echo Flow Setpoint
###
Hit ENTER on keyboard after typing setpoint in box and then press SEND
CLOSE
Surface to TOC
Feet
Water Depth
Feet
Elevation
Feet
High Setpoint
Feet
Low Setpoint
Feet
Flow
GPM
OPEN
Flow Total
#########
x1000 GAL
M
A
P-161
EW-1
TO TK-131
SELECT PUMP
SEND DISABLE
AUTO ENABLED
HIGH PRESSURE
LOW PRESSURE
LINE POWER LOSS
LOOP POWER ERROR
Elevation
Feet
Flow
GPM
Valve % Open
###
Flow Total
#########
x1000 GAL
WELL LEVEL LOW LOW
Hand
P-168
EW-8
TO TK-131
SELECT PUMP
SEND DISABLE
AUTO ENABLED
PUMP FAULT
Elevation
Feet
Flow
GPM
OPEN
Flow Total
#########
x1000 GAL
P-1211
EW-11
TO TK-131
SELECT PUMP
SEND DISABLE
AUTO DISABLED
WELL LEVELS EW-1,8,11
TO EW-2,3,4
TO EW-5,6,7
TO EW-9,10
TO INFLUENT TANK
TO PROCESS FLOW


HOLDING TANKS
TANK LEVEL ####Feet
TANK LEVEL ####Feet
TANK LEVEL HIGH
TANK LEVEL HIGH
TANK LEVEL LOW
TANK LEVEL LOW
TK-931
TK-131
Total GAC Flow GPM####
TO INFLUENT PUMPS
FROM GAC
EFFLUENT TANK
INFLUENT TANK
TO EFFLUENT PUMPS
Effluent to Creeks GPM####
SYSTEM START
LOGIN
Influent from Wells GPM####
FROM
ALARM SUMMARY
TREATMENT PLANT FLOW
TO GAC TRAIN ONE & TWO
TO SERVICE WATER
TO SETTLING TANKS
TO PROCESS FLOW

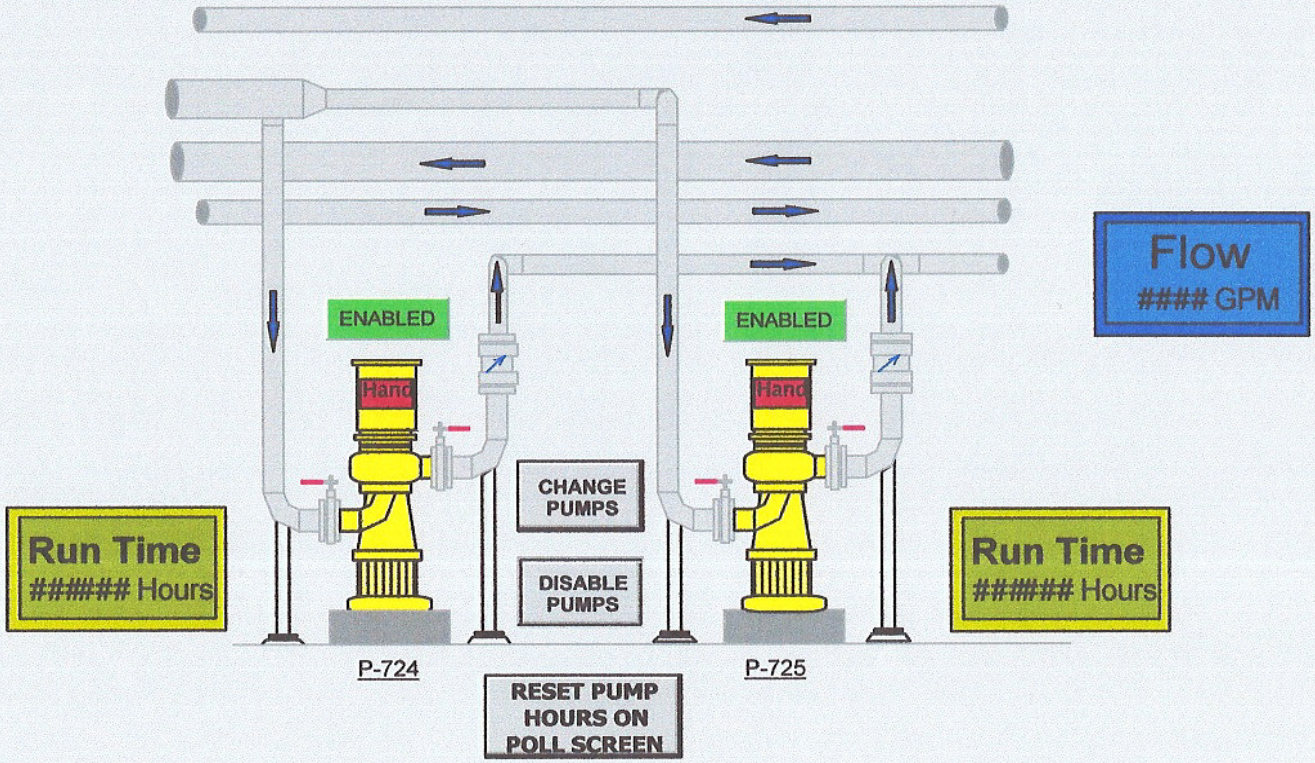

INFLUENT PUMPS
P-110
Kc
5
Ti
15
Td
20
PV SP
30
25
20
15
10
5
0
SP(FT)
-1
+1
Loop Update
20
CV%
CV MAX%
Deadband
9
CV MAX%
Backwash
Run Time
Hours
EXCESS Hz
Hz
####
STOP
P-110
Time to Pump Change
Hours
Run Time
Hours
EXCESS Hz
Hz
####
STOP
P-120
Time to Pump Change
Hours
Run Time
Hours
EXCESS Hz
Hz
####
STOP
P-130
Time to Pump Change
Hours
RESET PUMP HOURS ON POLL SCREEN
TO INFLUENT TANK
TO PROCESS FLOW
TO FILTERS


RP Prefilters
Differential Pressure
Warn
Alarm
FILTERS
TO GAC
DIFFERENTIAL PRESSURE ####PSI
FILTER FAULT
BACKWASH LOCKED OUT
HIGH DIFFERENTIAL PRESSURE
DIFFERENTIAL PRESSURE WARNING
F-230
F-220
F-210
FROM INFLUENT PUMPS P-110, 120, 130
FILTERING
BACKWASHING
START BACKWASH
TO INFLUENT TANK
TO PROCESS FLOW

GRANULAR ACTIVATED CARBON TRAIN ONE & TWO



EFFLUENT PUMPS TO CLEAR CREEK

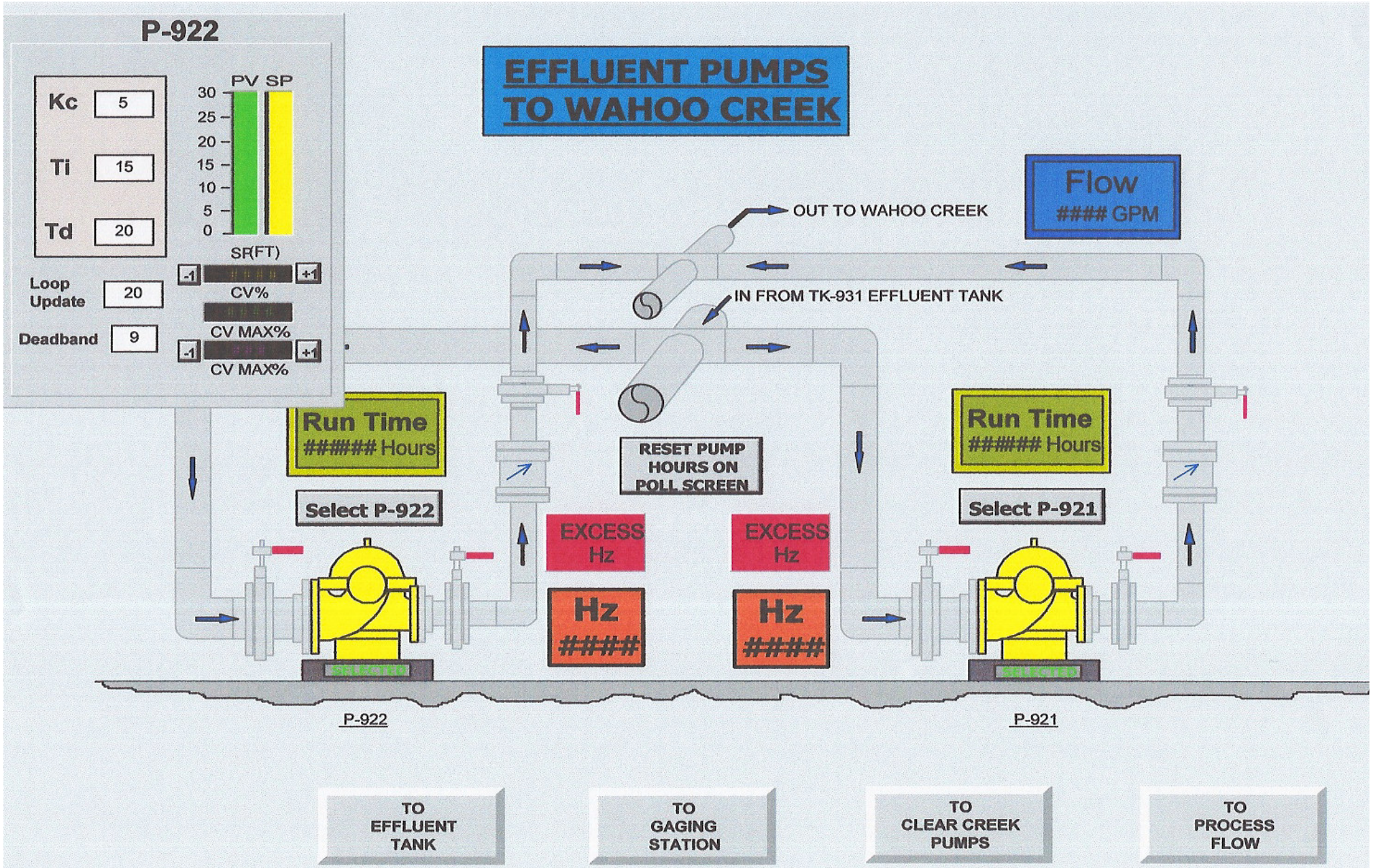


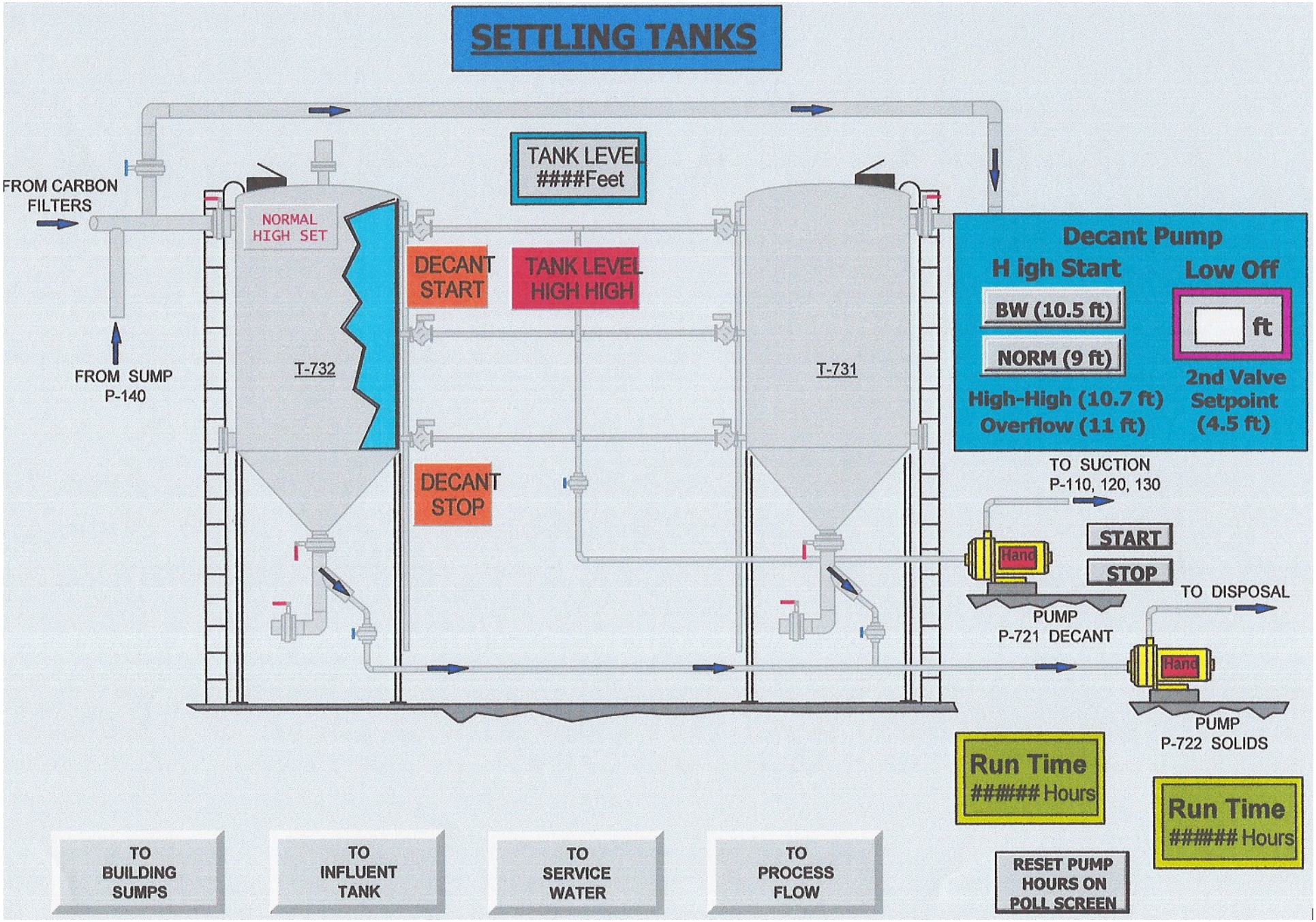
TO EFFLUENT TANK

TO GAGING STATION

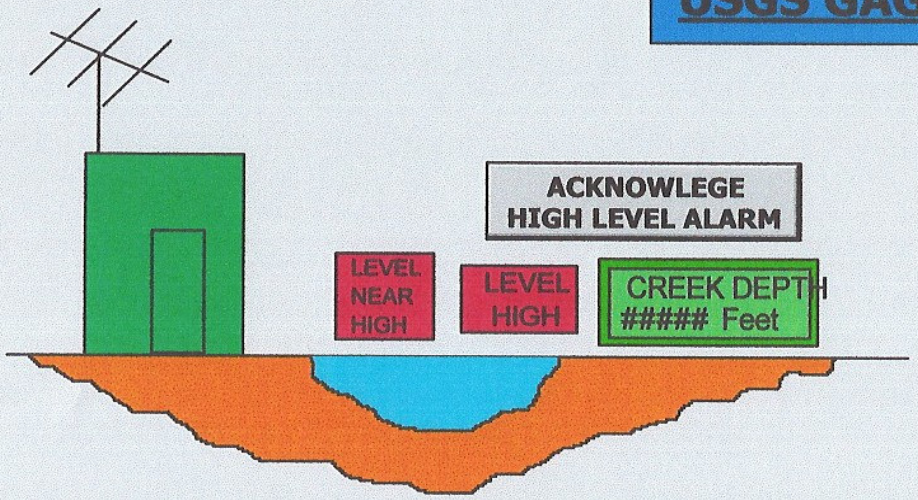
TO WAHOO CREEK PUMPS

TO PROCESS FLOW


P-922
Kc
5
Ti
15
Td
20
Loop Update
20
Deadband
9
PV SP
30
25
20
15
10
5
0
SR(FT)
-1
+1
CV%
CV MAX%
-1
+1
CV MAX%
EFFLUENT PUMPS TO WAHOO CREEK
Flow
GPM
OUT TO WAHOO CREEK
IN FROM TK-931 EFFLUENT TANK
Run Time
Hours
Select P-922
RESET PUMP HOURS ON POLL SCREEN
EXCESS Hz
Hz
####
EXCESS Hz
Hz
####
Run Time
Hours
Select P-921
P-922
P-921
TO EFFLUENT TANK
TO GAGING STATION
TO CLEAR CREEK PUMPS
TO PROCESS FLOW


SETTLING TANKS
FROM CARBON FILTERS
FROM SUMP P-140
NORMAL HIGH SET
T-732
T-731
TANK LEVEL ####Feet
DECANT START
TANK LEVEL HIGH HIGH
DECANT STOP
Decant Pump
H igh Start
Low Off
BW (10.5 ft)
NORM (9 ft)
ft
High-High (10.7 ft)
Overflow (11 ft)
2nd Valve Setpoint (4.5 ft)
TO SUCTION P-110, 120, 130
START
STOP
Hand
PUMP P-721 DECANT
TO DISPOSAL
Hand
PUMP P-722 SOLIDS
Run Time ###### Hours
Run Time ###### Hours
TO BUILDING SUMPS
TO INFLUENT TANK
TO SERVICE WATER
TO PROCESS FLOW
RESET PUMP HOURS ON POLL SCREEN

USGS GAGING STATIONS



AT CLEAR CREEK

ALARM SETPOINTS

Clear Creek HIGH
17 ft

HIGH Offset
2 ft

HIGH Reset
ft

Clear Creek
Near High
15 ft

Near High Reset
ft

ALARM SETPOINTS

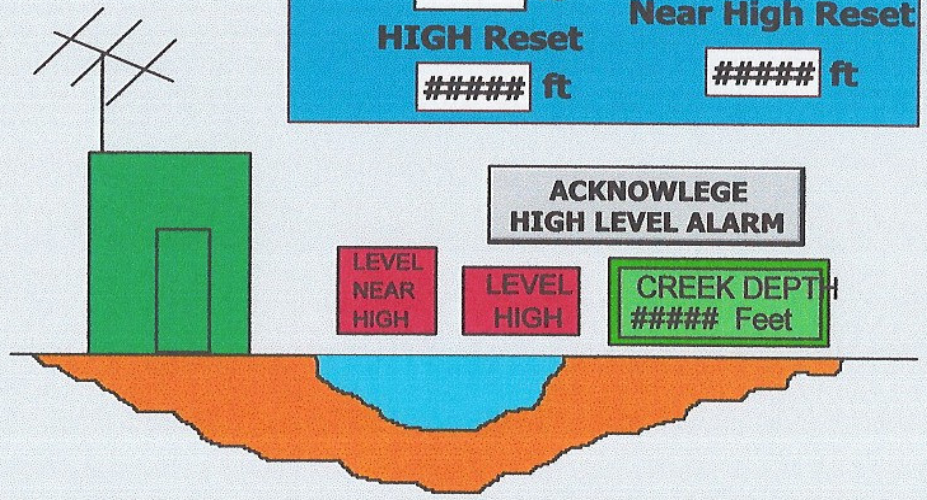
Wahoo Creek HIGH
19 ft

HIGH Offset
2 ft

HIGH Reset
ft

Wahoo Near High
17 ft

Near High Reset
ft



AT WAHOO CREEK

TO
CLEAR CREEK
PUMPS

TO
WAHOO CREEK
PUMPS

TO
EFFLUENT
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Notice of Five-Year CERCLA Review

Period of Review: February 2002 through February 2007

Former Nebraska Ordnance Plant (NOP)

Mead, Nebraska

The U.S. Army Corps of Engineers, as the lead agency, is initiating the first Five-Year Review for Operable Unit (OU) No. 2 (groundwater) at the Former Nebraska Ordnance Plant. The Five-Year Review Team includes the U.S. Environmental Protection Agency, the Nebraska Department of Environmental Quality, and other local agencies. Components of the selected remedy for OU2 include groundwater extraction and treatment, hydraulic containment, alternate potable water supply. The selected remedy addresses groundwater contaminated with explosives and chlorinated solvents in excess of the cleanup goals established in the October 1996 Record of Decision for OU2. A review of the selected remedy with regard to protection of human health and the environment will be included in the Five-Year Review Report. This Five-Year Review is being conducted as a matter of policy. The selected remedial action for OU2 will take longer than five years to complete but will, upon completion, result in unlimited use and unrestricted exposure. The report for this Five-Year Review will be made available to the public after finalization in July 2007. The public may participate through the Restoration Advisory Board (RAB) or by contacting:

Mr. Garth Anderson

U.S. Army Corps of Engineers

700 Federal Building

601 East 12th Street

Kansas City, Missouri 64106

816.389.3255

H.Garth.Anderson@usace.army.mil

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Proof of publication

AFFIDAVIT

State of Nebraska, County of Douglas, ss:

Joyce Sawatzki, being duly sworn, deposes and says that he/she is an employee of The Omaha World-Herald, a legal daily newspaper printed and published in the county of Douglas and State of Nebraska, and of general circulation in the Counties of Douglas, and Sarpy and State of Nebraska, and that the attached printed notice was published in the said newspaper on the 12th day of April, 2007, and that said newspaper is a legal newspaper under the statutes of the State of Nebraska. The above facts are within my personal knowledge. The Omaha World-Herald has an average circulation of 188,248 Daily and 235,161 Sunday, in 2007.

(Signed) Joyce Sawatzki Title: **Account Executive**

Subscribed in my presence and sworn to before me this 12th day of April, 2007.

Connie J. Lee
Notary Public

Printer's Fee $ _____
Affidavit _____
Paid By _____

STATE OF NEBRASKA GENERAL NOTARY
CONNIE J. LEE
MY COMMISSION EXPIRES
January 22, 2010

Notice of Five-Year CERCLA Review
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Kansas City, Missouri 64106
816.389.3255
H.Garth.Anderson@usace.army.mil

ASHLAND

Notice of Five-Year CERCLA Review
Period of Review: February 2002 through February 2007
Former Nebraska Ordnance Plant (NOP)
Mead, Nebraska

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Kansas City, Missouri 64106
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AFFIDAVIT OF PUBLICATION

State of Nebraska } ss.
LANCASTER COUNTY,

Notice of Five-Year CERCLA Review
Period of Review: February 2002 through February 2007
Former Nebraska Ordnance Plant (NOP)
Mead, Nebraska

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U.S. Army Corps of Engineers
700 Federal Building
601 East 12th Street
Kansas City, Missouri 64106
816.389.3255
H.Garth.Anderson@usace.army.mil
#4383631 1x April 12

The undersigned, being first duly sworn, deposes and says that she/he is a Clerk of the Lincoln Journal Star, legal newspaper printed, published and having a general circulation in the County of Lancaster and State of Nebraska, and that the attached printed notice was published in said newspaper one successive time(s) the first insertion having been on the 12TH day of April A.D., 20 07 ~~and thereafter on~~ _____, 20____ and that said newspaper is the legal newspaper under the statutes of the State of Nebraska. The above facts are within my personal knowledge and are further verified by my personal inspection of each notice in each of said issues.

Belle White

Subscribed in my presence and sworn to before me this _____
day of April, 2007

Julana Anne Nordmeyer Notary Public

4383631

Printer's Fee, $_____

GENERAL NOTARY - State of Nebraska
JULANA ANNE NORDMEYER
My Comm. Exp. Jan. 28, 2008

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Site Inspection Checklist

I. SITE INFORMATION	
Site name: Former Nebraska Ordnance Plant – Operable Unit 2 Groundwater	**Date of inspection:** April 18, 2007
Location and Region: Nebraska, VII	**EPA ID**: NE6211890011
Agency, office, or company leading the five-year review: U.S. Army Corps of Engineers	**Weather/temperature:** Sunny, mid-60s, light wind out of south west

Remedy Includes: (Check all that apply)

- ☐ Landfill cover/containment
- ☐ Monitored natural attenuation
- ☐ Access controls
- ■ Groundwater containment
- ☐ Institutional controls
- ☐ Vertical barrier walls
- ■ Groundwater pump and treatment
- ☐ Surface water collection and treatment
- ■ Other Focused extraction, site-wide monitoring of groundwater monitoring, domestic, and supply wells

Attachments: ■ Inspection team roster attached ■ Site map attached

II. INTERVIEWS (Check all that apply)

1. **O&M Manager** Ganesh Subramaniam (Name) ECC-Project Engineer (Title) 22-May-2007 (Date)

   Interviewed ☐ at site ☐ at office ■ by phone Phone no. (720) 560-3094

   Problems, suggestions; ☐ Report attached Summarized in Report

2. **O&M staff** Tim Thares (Name) ECC-Lead Plant Operator (Title) 18-April-2007 (Date)

   Interviewed ■ at site ☐ at office ☐ by phone Phone no. (402) 944-2964

   Problems, suggestions; ☐ Report attached Summarized in Report

3. **Local regulatory authorities and response agencies** (i.e., State and Tribal offices, emergency response office, police department, office of public health or environmental health, zoning office, recorder of deeds, or other city and county offices, etc.) Fill in all that apply.

Agency _____

Contact _____ _____ _____ _____

Name Title Date Phone no.

Problems; suggestions; ☐ Report attached _____

_____

Agency _____

Contact _____ _____ _____ _____

Name Title Date Phone no.

Problems; suggestions; ☐ Report attached _____

_____

Agency _____

Contact _____ _____ _____ _____

Name Title Date Phone no.

Problems; suggestions; ☐ Report attached _____

_____

Agency _____

Contact _____ _____ _____ _____

Name Title Date Phone no.

Problems; suggestions; ☐ Report attached _____

_____

4. **Other interviews** (optional) ☐ Report attached.

Brady Bigelow – ECC Project Manager (303) 590-1146

Interviewed by phone on 22-May-2007

III. ON-SITE DOCUMENTS & RECORDS VERIFIED (Check all that apply)

1. **O&M Documents**

■ O&M manual	■ Readily available	■ Up to date	☐ N/A
■ As-built drawings	■ Readily available	■ Up to date	☐ N/A
■ Maintenance logs	■ Readily available	■ Up to date	☐ N/A

Remarks Maintenance Logs are electronic (Express Maintenance is the software used)

2. **Site-Specific Health and Safety Plan** ■ Readily available ■ Up to date ☐ N/A

☐ Contingency plan/emergency response plan ☐ Readily available ☐ Up to date ☐ N/A

Remarks Lock-Out tag-out, safety tailout, auxiliary training

3. **O&M and OSHA Training Records** ■ Readily available ■ Up to date ☐ N/A

Remarks

4. **Permits and Service Agreements**

■ Air discharge permit	☐ Readily available	☐ Up to date	☐ N/A
■ Effluent discharge	■ Readily available	☐ Up to date	☐ N/A
☐ Waste disposal, POTW	☐ Readily available	☐ Up to date	☐ N/A
☐ Other permits_____	☐ Readily available	☐ Up to date	☐ N/A

Remarks Effluent discharge permits for Clear and Wahoo Creeks/air discharge requirements followed as per the Load Line 1 remedial design. A waste profile on the backwash residue is kept in order to dispose of it. Waste profile data is on-file. WMI 473007 good through July 2008 for Douglas County Landfill

5. **Gas Generation Records** ☐ Readily available ☐ Up to date ■ N/A

Remarks

6. **Settlement Monument Records** ☐ Readily available ☐ Up to date ■ N/A

Remarks

7. **Groundwater Monitoring Records** ☐ Readily available ■ Up to date ☐ N/A

Remarks Kept off-site

8. **Leachate Extraction Records** ☐ Readily available ☐ Up to date ■ N/A

Remarks

9. **Discharge Compliance Records**

■ Air ☐ Readily available ■ Up to date ☐ N/A

■ Water (effluent) ☐ Readily available ■ Up to date ☐ N/A

Remarks Available offsite. A quarterly report is transmitted by O&M operator to state of Nebraska that includes surface water discharge and air discharge analytical summaries

10. **Daily Access/Security Logs** ■ Readily available ☐ Up to date ☐ N/A

Remarks Security is adequate for site. Locking gates; lighting outside each extraction well house and treatment plants

IV. O&M COSTS

2. **O&M Cost Records**

☐ Readily available ■ Up to date

☐ Funding mechanism/agreement in place

Original O&M cost estimate_____ ☐ Breakdown attached

Total annual cost by year for review period if available

From	02/01/02	To	12/31/02	$1,841,000	■ Breakdown attached
	Date		Date	Total cost	
From	01/01/03	To	12/31/03	$1,386,496	■ Breakdown attached
	Date		Date	Total cost	
From	01/01/04	To	12/31/04	$1,488,118	■ Breakdown attached
	Date		Date	Total cost	
From	01/01/05	To	12/31/05	$1,828,000	■ Breakdown attached
	Date		Date	Total cost	
From	01/01/06	To	12/31/06	$3,267,000	■ Breakdown attached
	Date		Date	Total cost	

3. **Unanticipated or Unusually High O&M Costs During Review Period**

Describe costs and reasons: _____

_____

_____

_____

_____

V. ACCESS AND INSTITUTIONAL CONTROLS ■ Applicable ☐ N/A

A. Fencing

1. **Fencing damaged** ☐ Location shown on site map ■ Gates secured ☐ N/A

Remarks Fencing around Load Line 1 and main treatment plant

B. Other Access Restrictions

1. **Signs and other security measures** ☐ Location shown on site map ☐ N/A

Remarks Signage/"No trespassing" at Wahoo Creek only. No signage at Clear Creek discharge although there is no physical structure as there is at Wahoo discharge.

C. Institutional Controls (ICs)

. **Implementation and enforcement**

Site conditions imply ICs not properly implemented ☐ Yes ☐ No ■ N/A

Site conditions imply ICs not being fully enforced ☐ Yes ☐ No ■ N/A

Type of monitoring (*e.g.*, self-reporting, drive by) _____

Frequency _____

Responsible party/agency _____

Contact _____ _____ _____ _____

Name Title Date Phone no.

Reporting is up-to-date ☐ Yes ☐ No ■ N/A

Reports are verified by the lead agency ☐ Yes ☐ No ■ N/A

Specific requirements in deed or decision documents have been met ☐ Yes ☐ No ■ N/A

Violations have been reported ☐ Yes ☐ No ■ N/A

Other problems or suggestions: ☐ Report attached

2. **Adequacy** ☐ ICs are adequate ☐ ICs are inadequate ■ N/A

Remarks_____

D. General

1. **Vandalism/trespassing** ☐ Location shown on site map ■ No vandalism evident

Remarks_____

_____

2. **Land use changes on site** ■ N/A

Remarks No major land use changes

_____

3. **Land use changes off site** ■ ☐ N/A

Remarks No major land use changes

_____

VI. GENERAL SITE CONDITIONS

A. Roads ■ Applicable ☐ N/A

1. **Roads damaged** ☐ Location shown on site map ■ Roads adequate ☐ N/A

Remarks_____

_____

B. Other Site Conditions

Remarks _____

_____

_____

_____

_____

_____

VII. LANDFILL COVERS ☐ Applicable ■ N/A

A. Landfill Surface

1. **Settlement** (Low spots) ☐ Location shown on site map ☐ Settlement not evident

Areal extent_____ Depth_____

Remarks_____

_____

2. **Cracks** ☐ Location shown on site map ☐ Cracking not evident

Lengths_____ Widths_____ Depths_____

Remarks_____

_____

3. **Erosion** ☐ Location shown on site map ☐ Erosion not evident

Areal extent_____ Depth_____

Remarks_____

_____

4. **Holes** ☐ Location shown on site map ☐ Holes not evident

Areal extent_____ Depth_____

Remarks_____

_____

5. **Vegetative Cover** ☐ Grass ☐ Cover properly established ☐ No signs of stress

☐ Trees/Shrubs (indicate size and locations on a diagram)

Remarks_____

_____

6. **Alternative Cover (armored rock, concrete, etc.)** ☐ N/A

Remarks_____

_____

7. **Bulges** ☐ Location shown on site map ☐ Bulges not evident

Areal extent_____ Height_____

Remarks_____

_____

8. **Wet Areas/Water Damage** ☐ Wet areas/water damage not evident

☐ Wet areas ☐ Location shown on site map Areal extent_____

☐ Ponding ☐ Location shown on site map Areal extent_____

☐ Seeps ☐ Location shown on site map Areal extent_____

☐ Soft subgrade ☐ Location shown on site map Areal extent_____

Remarks_____

_____

9. **Slope Instability** ☐ Slides ☐ Location shown on site map ☐ No evidence of slope instability

Areal extent_____

Remarks_____

_____

B. Benches ☐ Applicable ■ N/A

(Horizontally constructed mounds of earth placed across a steep landfill side slope to interrupt the slope in order to slow down the velocity of surface runoff and intercept and convey the runoff to a lined channel.)

1. **Flows Bypass Bench** ☐ Location shown on site map ☐ N/A or okay

Remarks_____

_____

2. **Bench Breached** ☐ Location shown on site map ☐ N/A or okay

Remarks_____

_____

3. **Bench Overtopped** ☐ Location shown on site map ☐ N/A or okay

Remarks_____

_____

C. Letdown Channels ☐ Applicable ■ N/A

(Channel lined with erosion control mats, riprap, grout bags, or gabions that descend down the steep side slope of the cover and will allow the runoff water collected by the benches to move off of the landfill cover without creating erosion gullies.)

1. **Settlement** ☐ Location shown on site map ☐ No evidence of settlement

Areal extent_____ Depth_____

Remarks_____

_____

2. **Material Degradation** ☐ Location shown on site map ☐ No evidence of degradation

Material type_____ Areal extent_____

Remarks_____

_____

3. **Erosion** ☐ Location shown on site map ☐ No evidence of erosion

Areal extent_____ Depth_____

Remarks_____

_____

4. **Undercutting** ☐ Location shown on site map ☐ No evidence of undercutting

Areal extent_____ Depth_____

Remarks_____

_____

5. **Obstructions** Type_____ ☐ No obstructions

☐ Location shown on site map Areal extent_____

Size_____

Remarks_____

_____

6. **Excessive Vegetative Growth** Type_____

☐ No evidence of excessive growth

☐ Vegetation in channels does not obstruct flow

☐ Location shown on site map Areal extent_____

Remarks_____

_____

D. Cover Penetrations ☐ Applicable ■ N/A

1. **Gas Vents** ☐ Active ☐ Passive

☐ Properly secured/locked ☐ Functioning ☐ Routinely sampled ☐ Good condition

☐ Evidence of leakage at penetration ☐ Needs Maintenance

☐ N/A

Remarks_____

_____

2. **Gas Monitoring Probes**

☐ Properly secured/locked ☐ Functioning ☐ Routinely sampled ☐ Good condition

☐ Evidence of leakage at penetration ☐ Needs Maintenance ☐ N/A

Remarks_____

_____

3. **Monitoring Wells** (within surface area of landfill)

☐ Properly secured/locked ☐ Functioning ☐ Routinely sampled ☐ Good condition

☐ Evidence of leakage at penetration ☐ Needs Maintenance ☐ N/A

Remarks_____

_____

4. **Leachate Extraction Wells**

☐ Properly secured/locked ☐ Functioning ☐ Routinely sampled ☐ Good condition

☐ Evidence of leakage at penetration ☐ Needs Maintenance ☐ N/A

Remarks_____

_____

5. **Settlement Monuments** ☐ Located ☐ Routinely surveyed ☐ N/A

Remarks_____

_____

E. Gas Collection and Treatment ☐ Applicable ■ N/A

1. **Gas Treatment Facilities**

☐ Flaring ☐ Thermal destruction ☐ Collection for reuse

☐ Good condition ☐ Needs Maintenance

Remarks_____

_____

2. **Gas Collection Wells, Manifolds and Piping**

☐ Good condition ☐ Needs Maintenance

Remarks_____

_____

3. **Gas Monitoring Facilities** (*e.g.*, gas monitoring of adjacent homes or buildings)

☐ Good condition ☐ Needs Maintenance ☐ N/A

Remarks_____

_____

F. Cover Drainage Layer ☐ Applicable ■ N/A

1. **Outlet Pipes Inspected** ☐ Functioning ☐ N/A

Remarks_____

_____

2. **Outlet Rock Inspected** ☐ Functioning ☐ N/A

Remarks_____

_____

G. Detention/Sedimentation Ponds ☐ Applicable ■ N/A

1. **Siltation** Areal extent_____ Depth_____ ☐ N/A

☐ Siltation not evident

Remarks_____

_____

2. **Erosion** Areal extent_____ Depth_____

☐ Erosion not evident

Remarks_____

_____

3. **Outlet Works** ☐ Functioning ☐ N/A

Remarks_____

_____

4. **Dam** ☐ Functioning ☐ N/A

Remarks_____

_____

H. Retaining Walls ☐ Applicable ■ N/A

1. **Deformations** ☐ Location shown on site map ☐ Deformation not evident

Horizontal displacement_____ Vertical displacement_____

Rotational displacement_____

Remarks_____

_____

2. **Degradation** ☐ Location shown on site map ☐ Degradation not evident

Remarks_____

_____

I. Perimeter Ditches/Off-Site Discharge ☐ Applicable ■ N/A

1. **Siltation** ☐ Location shown on site map ☐ Siltation not evident

Areal extent_____ Depth_____

Remarks_____

_____

2. **Vegetative Growth** ☐ Location shown on site map ☐ N/A

☐ Vegetation does not impede flow

Areal extent_____ Type_____

Remarks_____

_____

3. **Erosion** ☐ Location shown on site map ☐ Erosion not evident

Areal extent_____ Depth_____

Remarks_____

_____

4. **Discharge Structure** ☐ Functioning ☐ N/A

Remarks_____

VIII. VERTICAL BARRIER WALLS ☐ Applicable ■ N/A

1. **Settlement** ☐ Location shown on site map ☐ Settlement not evident

Areal extent_____ Depth_____

Remarks_____

_____

2. **Performance Monitoring** Type of monitoring_____

☐ Performance not monitored

Frequency_____ ☐ Evidence of breaching

Head differential_____

Remarks_____

_____

C. Treatment System ■ Applicable ☐ N/A

1. **Treatment Train** (Check components that apply)

☐ Metals removal ☐ Oil/water separation ☐ Bioremediation

■ Air stripping ☐ Carbon adsorbers

■ Filters Granulated activated carbon

☐ Additive (*e.g.*, chelation agent, flocculent)_____

☐ Others_____

■ Good condition ☐ Needs Maintenance

■ Sampling ports properly marked and functional

■ Sampling/maintenance log displayed and up to date

■ Equipment properly identified

■ Quantity of groundwater treated annually 1,020,677,000 at the main treatment plant

☐ Quantity of surface water treated annually NA

Remarks Sampling/maintenance logs maintained electronically and in log book on-site.

_____

2. **Electrical Enclosures and Panels** (properly rated and functional)

☐ N/A ■ Good condition ☐ Needs Maintenance

Remarks_____

_____

3. **Tanks, Vaults, Storage Vessels**

☐ N/A ■ Good condition ☐ Proper secondary containment ☐ Needs Maintenance

Remarks_____

_____

4. **Discharge Structure and Appurtenances**

☐ N/A ■ Good condition ☐ Needs Maintenance

Remarks_____

_____

5. **Treatment Building(s)**

☐ N/A ■ Good condition (esp. roof and doorways) ☐ Needs repair

■ Chemicals and equipment properly stored

Remarks_____

_____

6. **Monitoring Wells** (pump and treatment remedy)

■ Properly secured/locked ■ Functioning ■ Routinely sampled ☐ Good condition

☐ All required wells located ☐ Needs Maintenance ☐ N/A

Remarks Pad repair, protective casing painting is in progress for monitoring wells on a site-wide basis.

_____

D. Monitoring Data

1. Monitoring Data
■ Is routinely submitted on time ■ Is of acceptable quality

2. Monitoring data suggests:
■ Groundwater plume is effectively contained ■ Contaminant concentrations are declining

D. Monitored Natural Attenuation

1. **Monitoring Wells** (natural attenuation remedy)

☐ Properly secured/locked ☐ Functioning ☐ Routinely sampled ☐ Good condition

☐ All required wells located ☐ Needs Maintenance ■ N/A

Remarks_____

_____

X. OTHER REMEDIES

If there are remedies applied at the site which are not covered above, attach an inspection sheet describing the physical nature and condition of any facility associated with the remedy. An example would be soil vapor extraction.

XI. OVERALL OBSERVATIONS

A. Implementation of the Remedy

Describe issues and observations relating to whether the remedy is effective and functioning as designed. Begin with a brief statement of what the remedy is to accomplish (i.e., to contain contaminant plume, minimize infiltration and gas emission, etc.).

_____

_____

_____

_____

_____

_____

_____

_____

_____

B. Adequacy of O&M

Describe issues and observations related to the implementation and scope of O&M procedures. In particular, discuss their relationship to the current and long-term protectiveness of the remedy.

_____

_____

_____

_____

_____

_____

_____

_____

_____

C.	Early Indicators of Potential Remedy Problems
	Describe issues and observations such as unexpected changes in the cost or scope of O&M or a high frequency of unscheduled repairs, that suggest that the protectiveness of the remedy may be compromised in the future.

D.	Opportunities for Optimization
	Describe possible opportunities for optimization in monitoring tasks or the operation of the remedy.

URS

PHOTOGRAPHIC LOG

Site Location:

Former Nebraska Ordnance Plant, Mead, NE

Photo No.
1

Description:

View of main groundwater treatment plant.

Photo No.
2

Description:

View of GAC vessel at main treatment plant.

URS

PHOTOGRAPHIC LOG

Site Location:

Former Nebraska Ordnance Plant, Mead, NE

Photo No.
3

Description:

View of effluent tank at main treatment plant.

Photo No.
4

Description:

View of Load Line 1 Groundwater Treatment Plant.

URS

PHOTOGRAPHIC LOG

Site Location:

Former Nebraska Ordnance Plant, Mead, NE

Photo No.
5

Description:

View of EW-5, (typical extraction well pump house and well head).

Photo No.
6

Description:

View of Wahoo Creek discharge point.

URS

PHOTOGRAPHIC LOG

Site Location:

Former Nebraska Ordnance Plant, Mead, NE

Photo No.
7

Description:

View of No Trespassing sign at Wahoo Creek discharge point.

Photo No.
8

Description:

View of Clear Creek discharge point.

URS

PHOTOGRAPHIC LOG

Site Location:

Former Nebraska Ordnance Plant, Mead, NE

Photo No.
9

Description:

View of GCW-1 (TCE treatment).

Photo No.
10

Description:

View of GCW-2 (RDX treatment).

URS

PHOTOGRAPHIC LOG

Site Location:

Former Nebraska Ordnance Plant, Mead, NE

Photo No.
11

Description:

View of typical groundwater monitoring well cluster.