U.S. ARMY CORPS

OF ENGINEERS

FIVE-YEAR REVIEW REPORT

THIRD FIVE-YEAR REVIEW

FORMER WEST VIRGINIA ORDNANCE WORKS

OPERABLE UNITS 1, 2, 3, 4, AND 5

FUDS PROPERTY #G03WV0015

POINT PLEASANT, MASON COUNTY, WEST VIRGINIA

FINAL REPORT - MAY 2005

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10 June 05
Date

TABLE OF CONTENTS

SECTION		PAGE
LIST OF TABLES		IV
LIST OF FIGURES		VII
LIST OF APPENDICES		VIII
LIST OF ACRONYMS		IX
EXECUTIVE SUMMARY		XIII
1.0	INTRODUCTION	1
1.1	PURPOSE OF REVIEW	1
1.2	SITE OVERVIEW	2
1.3	SITE OUS, ESIS, AND AOCS	2
1.3.1	Description of OUs, ESIs, and AOCs	2
1.3.2	Current Status of OUs, ESIs, and AOCs	3
2.0	SITE BACKGROUND	9
2.1	SITE HISTORY	9
2.1.1	Early Decontamination Efforts	9
2.1.2	Preliminary Investigations	10
2.2	SITE CHARACTERISTICS	10
2.2.1	Surface Water and Topography	10
2.2.2	Hydrogeologic Setting	11
2.2.3	Current and Projected Uses of the Former WVOW and Surrounding Area	12
3.0	PRIOR REVIEW PROTECTIVENESS STATEMENT AND RECOMMENDATIONS	14
3.1	PRIOR FYR PROTECTIVENESS STATEMENT	14
3.2	PRIOR FYR RECOMMENDATIONS	14
4.0	REVIEW PROCESS AND FINDINGS	15
4.1	ADMINISTRATIVE COMPONENTS	15
4.2	STAKEHOLDER AND COMMUNITY NOTIFICATION AND INVOLVEMENT	15
4.3	DOCUMENTATION AND DATA REVIEWS	15
4.4	INTERVIEWS	15
4.5	SITE CONDITIONS INSPECTION	16
5.0	OPERABLE UNIT 1	17
5.1	SITE DESCRIPTION	17
5.1.1	Former Burning Grounds	17
5.1.2	Former TNT Manufacturing Area	18
5.1.3	Former Industrial Wastewater Sewer Lines	19
5.2	REMEDIAL OBJECTIVES	19
5.3	REMEDY SELECTION	20
5.4	REMEDY IMPLEMENTATION	21
5.5	FOLLOW UP ACTIONS	22
5.6	SYSTEM OPERATIONS/O&M	24
5.6.1	Quarterly Site Inspections and Corrective Actions Taken	25
5.6.2	Operation and Maintenance Repairs	25
5.7	CURRENT SITE CONDITIONS	26
5.8	TECHNICAL ASSESSMENT	26
5.8.1	Question A: Is the remedy functioning as intended by the decision documents?	26

5.8.2 Question B: Are the exposure assumptions, toxicity data, cleanup levels, and remedial action objectives (RAOs) used at the time of the remedy still valid? 27
5.8.3 Question C: Has any other information come to light that could call into question the protectiveness of the remedy? 30
5.9 OU-1 PROTECTIVENESS STATEMENT 30

6.0 OPERABLE UNIT 2 31

6.1 SITE DESCRIPTION 31
6.2 REMEDIAL OBJECTIVES 31
6.3 REMEDY SELECTION 32
6.4 REMEDY IMPLEMENTATION 34
6.5 FOLLOW-UP ACTIONS 34
6.6 SYSTEM OPERATIONS/O&M 34
6.6.1 Quarterly Site Inspections and Corrective Actions Taken 34
6.6.2 Operation and Maintenance Repairs 35
6.7 CURRENT SITE CONDITIONS 35
6.8 TECHNICAL ASSESSMENT 35
6.8.1 Question A: Is the remedy functioning as intended by the decision documents? 35
6.8.2 Question B: Are the exposure assumptions, toxicity data, cleanup levels, and RAOs used at the time of the remedy still valid? 36
6.8.3 Question C: Has any other information come to light that could call into question the protectiveness of the remedy? 38
6.9 OU-2 PROTECTIVENESS STATEMENT 38

7.0 OPERABLE UNIT 3 39

7.1 SITE DESCRIPTION 39
7.2 REMEDIAL OBJECTIVES 39
7.3 REMEDY SELECTION 40
7.4 REMEDY IMPLEMENTATION 41
7.5 FOLLOW-UP ACTIONS 42
7.6 SYSTEM OPERATIONS/O&M 42
7.6.1 Quarterly Site Inspections and Corrective Actions Taken 42
7.6.2 O&M Repairs 42
7.7 CURRENT SITE CONDITIONS 43
7.8 TECHNICAL ASSESSMENT 43
7.8.1 Question A: Is the remedy functioning as intended by the decision documents? 43
7.8.2 Question B: Are the exposure assumptions, toxicity data, cleanup levels, and RAOs used at the time of the remedy still valid? 44
7.8.3 Question C: Has any other information come to light that could call into question the protectiveness of the remedy? 45
7.9 OU-3 PROTECTIVENESS STATEMENT 45

8.0 OPERABLE UNIT 4 46

8.1 SITE DESCRIPTION 46
8.2 REMEDIAL OBJECTIVES 46
8.3 REMEDY SELECTION 47
8.4 REMEDY IMPLEMENTATION 47
8.4.1 Design and Construction of Groundwater Extraction and Treatment System 47
8.4.2 Initial System Operation and Maintenance 47
8.5 FOLLOW-UP ACTIONS 48
8.5.1 Alternative Analysis Study 48
8.5.2 System Monitoring and Reporting Requirements 49
8.5.3 Remediation System Evaluation Study 50
8.6 SYSTEM OPERATIONS/O&M 50
8.7 CURRENT SITE CONDITIONS 51
8.8 TECHNICAL ASSESSMENT 54

8.8.1 Question A: Is the remedy functioning as intended by the decision documents? 54
8.8.2 Question B: Are the exposure assumptions, toxicity data, cleanup levels, and RAOs used at the time of the remedy still valid? 54
8.8.3 Question C: Has any other information come to light that could call into question the protectiveness of the remedy? 56
8.9 OU-4 PROTECTIVENESS STATEMENT 56

9.0 OPERABLE UNIT 5 58

9.1 SITE DESCRIPTION 58
9.2 REMEDIAL OBJECTIVES 58
9.3 REMEDY SELECTION 59
9.4 REMEDY IMPLEMENTATION 60
9.5 FOLLOW-UP ACTIONS 60
9.6 SYSTEM OPERATIONS/O&M 61
9.7 CURRENT SITE CONDITIONS 62
9.8 TECHNICAL ASSESSMENT 62
9.8.1 Question A: Is the remedy functioning as intended by the decision documents? 62
9.8.2 Question B: Are the exposure assumptions, toxicity data, cleanup levels, and RAOs used at the time of the remedy still valid? 63
9.8.3 Question C: Has any other information come to light that could call into question the protectiveness of the remedy? 63
9.9 OU-5 PROTECTIVENESS STATEMENT 64

10.0 RECOMMENDATIONS 65

10.1 OPERABLE UNIT 1 RECOMMENDATIONS 65
10.2 OPERABLE UNIT 2 RECOMMENDATIONS 65
10.3 OPERABLE UNIT 3 RECOMMENDATIONS 66
10.4 OPERABLE UNIT 4 RECOMMENDATIONS 66
10.4.1 Groundwater Plume Capture 66
10.4.2 Groundwater Remediation Goals 66
10.4.3 System O&M Cost Reduction 67
10.4.4 Consideration of Monitored Natural Attenuation 67
10.4.5 Removal of Nitroaromatic Sources to Groundwater 67
10.4.6 Potential Accumulation of Metals in Sediment 68
10.4.7 Selection of Pond 13/Wet Well Area Remedial Objectives 68
10.5 OPERABLE UNIT 5 RECOMMENDATIONS 68
10.6 GENERAL RECOMMENDATIONS 68
10.6.1 LTM Program Review 68
10.6.2 Public Information Needs Service 69
10.6.3 GIS Development and Application 69

11.0 STATEMENT OF PROTECTIVENESS 70

12.0 NEXT REVIEW 71

13.0 REFERENCES 72

TABLES

FIGURES

APPENDICES

LIST OF TABLES

Table 2-1	Chronology of major site events through April 2004
Table 5-1	OU-1 ARAR's
Table 5-2	OU-1 ROD Acceptable Soil, Sediment, and Water Contamination Levels
Table 5-3	Risk Summary for a Construction Worker Exposed to Nitroaromatics in McClintic Soils at OU-1 ROD Levels
Table 5-4	Risk Summary for a Construction Worker Exposed to Total Nitroaromatics in McClintic Soils at OU-1 ROD Levels
Table 5-5	Risk Summary for a Construction Worker Exposed to Nitroaromatics in Pond Sediments at OU-1 ROD Levels
Table 5-6	Risk Summary for a Construction Worker Exposed to Nitroaromatics in Pond Water at OU-1 ROD Levels
Table 5-7	Risk Summary for a Construction Worker Exposed to Nitroaromatics in Surficial Soil at OU-1 ROD Levels
Table 5-8	Risk Summary for a Construction Worker Exposed to Total Nitroaromatics in Surficial Soil at OU-1 ROD Levels
Table 5-9	Risk Summary for a Maintenance Worker Exposed to Nitroaromatics in McClintic Soils at OU-1 ROD Levels
Table 5-10	Risk Summary for a Maintenance Worker Exposed to Total Nitroaromatics in McClintic Soils at OU-1 ROD Levels
Table 5-11	Risk Summary for a Maintenance Worker Exposed to Nitroaromatics in Pond Sediments at OU-1 ROD Levels
Table 5-12	Risk Summary for a Maintenance Worker Exposed to Nitroaromatics in Pond Water at OU-1 ROD Levels
Table 5-13	Risk Summary for a Maintenance Worker Exposed to Nitroaromatics in Surficial Soil at OU-1 ROD Levels
Table 5-14	Risk Summary for a Maintenance Worker Exposed to Total Nitroaromatics in Surficial Soil at OU-1 ROD Levels
Table 6-1	OU-2 ARARs
Table 6-2	OU-2 ROD Remedial Objectives
Table 6-3	Risk Summary for a Construction Worker Exposed to Nitroaromatics in Soil Assuming Industrial Land Use at OU-2 ROD Levels

Table 6-4	Risk Summary for a Construction Worker Exposed to 200 ppm Total Nitroaromatics in Soil Assuming Industrial Land Use
Table 6-5	Risk Summary for a Construction Worker Exposed to Nitroaromatics in McClintic Surface Water at OU-2 ROD Levels
Table 6-6	Risk Summary for a Maintenance Worker Exposed to Nitroaromatics in Soil Assuming Industrial Land Use at OU-2 ROD Levels
Table 6-7	Risk Summary for a Maintenance Worker Exposed to 200 ppm Total Nitroaromatics in Soil Assuming Industrial Land Use
Table 6-8	Risk Summary for a Maintenance Worker Exposed to Nitroaromatics in McClintic Surface Water at OU-2 ROD Levels
Table 6-9	Risk Summary for an Adult Resident Exposed to Nitroaromatics in Drinking Water at OU-2 ROD Remedial Objectives via Groundwater
Table 6-10	Risk Summary for a Child Resident Exposed to Nitroaromatics in Drinking Water at OU-2 ROD Remedial Objectives via Groundwater
Table 6-11	Risk Summary for an Adult Resident Exposed to Nitroaromatics in Drinking Water at OU-2 ROD Groundwater Criteria for the Pond 13/Wet Well Area
Table 6-12	Risk Summary for a Child Resident Exposed to Nitroaromatics in Drinking Water at OU-2 ROD Groundwater Criteria for the Pond 13/Wet Well Area
Table 8-1	OU-4 Treatment Plant Influent and Effluent Criteria
Table 8-2	Red Water Treatment Plant Concentration of 1,3,5-Trinitrobenzene in Extraction Wells
Table 8-3	Red Water Treatment Plant Concentration of 1,3-Dinitrobenzene in Extraction Wells
Table 8-4	Red Water Treatment Plant Concentration of 2,4,6-Trinitrotoluene in Extraction Wells
Table 8-5	Red Water Treatment Plant Concentration of 2,4-Dinitrotoluene in Extraction Wells
Table 8-6	Red Water Treatment Plant Concentration of 2,6-Dinitrotoluene in Extraction Wells
Table 8-7	Red Water Treatment Plant Concentration of 2-Amino-4,6-Dinitrotoluene in Extraction Wells
Table 8-8	Red Water Treatment Plant Concentration of 4-Amino-2,6-Dinitrotoluene in Extraction Wells
Table 8-9	Yellow Water Treatment Plant Concentration of 1,3,5-Trinitrobenzene in Extraction Wells

Table 8-10	Yellow Water Treatment Plant Concentration of 1,3-Dinitrobenzene in Extraction Wells
Table 8-11	Yellow Water Treatment Plant Concentration of 2,4,6-Trinitrotoluene in Extraction Wells
Table 8-12	Yellow Water Treatment Plant Concentration of 2,4-Dinitrotoluene in Extraction Wells
Table 8-13	Yellow Water Treatment Plant Concentration of 2,6-Dinitrotoluene in Extraction Wells
Table 8-14	Yellow Water Treatment Plant Concentration of 2-Amino-4,6-Dinitrotoluene in Extraction Wells
Table 8-15	Yellow Water Treatment Plant Concentration of 4-Amino-2,6-Dinitrotoluene in Extraction Wells
Table 8-16	Red Water Reservoir Area – Semi-annual OU-4 Groundwater Monitoring Well Data – Nitroaromatics Above ROD Levels – May 2002-May 2004
Table 8-17	Yellow Water Reservoir Area – Semi-annual OU-4 Groundwater Monitoring Well Data – Nitroaromatics Above ROD Levels – May 2002-May 2004

LIST OF FIGURES

Figure 1-1	Location of the former West Virginia Ordnance Works.
Figure 1-2	West Virginia Ordnance Works National Priorities List (NPL) boundary.
Figure 1-3	West Virginia Ordnance Works Operable Units (OUs).
Figure 8-1	OU-4 monitoring wells located in the vicinity of the RWR, shown relative to extraction wells and new monitoring wells that were recently installed during August 2004. The naming convention for the new wells will be revised in the near future.
Figure 8-2	OU-4 monitoring wells located in the vicinity of the RWR, shown relative to extraction wells and new monitoring wells that were recently installed during August 2004. The naming convention for the new wells will be revised in the near future.
Figure 8-3	Extraction Well Flow Rate Measurements for the Red Water and Yellow Water Treatment Plants (August 2002 through November 2003).
Figure 8-4	Extraction Flow Rate Measurements for the Red Water and Yellow Water Treatment Plants (August 2002 through November 2003).
Figure 8-5	Nitroaromatic Compounds Mass Removed from the Red Water and Yellow Water Treatment Plants (August 2002 through November 2003).
Figure 9-1	OU-5 Pond 13/Wet Well Area Remedial Investigation Sampling Locations
Figure 9-2	OU-5 Pond 13/Wet Well Area Pre-Excavation Sampling Results

LIST OF APPENDICES

Appendix A	Site Inspection Checklist and Photographs
Appendix B	Interview Records
Appendix C	Responses to Reviewer Comments
Appendix D	Responsiveness Summary
Appendix E	Five-Year Review Acceptance Letter from USEPA Region III

LIST OF ACRONYMS

AAR	Alternatives Analysis Report
ACM	Asbestos-Containing Material
AOC	Area of Concern
APEC	Area of Potential Environmental Concern
AR	Administrative Record
ARARs	Applicable, or Relevant and Appropriate Regulations
BERA	Baseline Ecological Risk Assessment
BG	Burning Grounds
bgs	Below Ground Surface
BHHRA	Baseline Human Health Risk Assessment
BTAG	Biological Technical Assistance Group
CA	Consensus Agreement
CAA	Clean Air Act
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
CELRH	Corps of Engineers, Huntington District
CELRH-EC-CE	Corps of Engineers, Huntington District, Environmental and Remediation Section
CENAB	Corps of Engineers, Baltimore District
COC	Contaminant of Concern
COPC	Contaminant of Potential Concern
CWA	Clean Water Act
DD	Decision Document
DMR	Discharge Monitoring Report
DNB	Dinitrobenzene
DNT	Dinitrotoluene
DoD	Department of Defense
DOT	Department of Transportation
DQOs	Data Quality Objectives
EA	Environmental Assessment
EBG	East Burning Grounds
EBS	Environmental Baseline Study
EE/CA	Engineering Evaluation/Cost Analysis
ENV	Environmental Unit

ESD	Explanation of Significant Differences
ESI	Expanded Site Investigation
ESD	Explanation of Significant Differences
ESE	Environmental Science and Engineering, Inc.
FI	Focused Investigation
FONSI	Finding of No Significant Impact
FOST	Finding of Suitability to Transfer
FS	Feasibility Study
ft	Feet
FUDS	Formerly Used Defense Sites
FY	Fiscal Year
FYR	Five-Year Review
GAC	Granular Activated Carbon
GIS	Geographic Information System
GPM	Gallons Per Minute
HHRE BRA	Human Health Risk Evaluation Baseline Risk Assessment
HI	Hazard Index
HTRW-CX	USACE Hazardous, Toxic, and Radioactive Waste Center of Expertise
IAG	Inter-Agency Agreement
ILCR	Incremental Lifetime Cancer Risk
IRIS	USEPA Integrated Risk Information System
IT	The IT Corporation
IWSL	Industrial Wastewater Sewer Line
LTM	Long Term Monitoring
LTMP	Long Term Monitoring Plan/Program
LUST	Leaking Underground Storage Tank
MCC	Mason County Commission
MCDA	Mason County Development Authority
MCL	Maximum Contaminant Level
MDC	Maximum Detected Concentration
MfA	Manufacturing Area
MNA	Monitored Natural Attenuation
MSL	Mean Sea Level
MUCEGAS	Marshall University Center for Environmental, Geotechnical, and Applied Science

MWMA	Clifton F. McClintic Wildlife Management Area
NCP	National Contingency Plan
NFA	No Further Action
NPL	National Priorities List
O&M	Operation and Maintenance
OHM	O.H. Materials Remediation Services Corporation
OP&S	Operating Properly and Successfully
OU	Operable Unit
OWR	Office of Water Resources
OYWR	Old Yellow Water Reservoir
P&T	Pump and Treat
PCBs	Polychlorinated Biphenyls
PDP	Power Distribution Products
PLC	Programmable Logic Controller
PM	Project Manager
POC	Point of Compliance
PPLF	Point Pleasant Landfill
PPLV	Preliminary Pollutant Limit Value
ppm	Parts per million
PPPWS	Point Pleasant Public Water Supply
PR	Public Repository
PRGs	Preliminary Remediation Goals
PRP	Potentially Responsible Party
RA	Remedial Action
RAB	Restoration Advisory Board
RAGS	Risk Assessment Guidance for Superfund
RAO	Remedial Action Objective
RBC	Risk-Based Concentration
RCRA	Resource Conservation and Recovery Act
RfD	Reference Dose
RFW	Roy F. Weston, Inc.
RO	Remedial Objective
ROD	Record of Decision
RPM	Remedial Project Manager
RSE	Remediation System Evaluation

RWR	Red Water Reservoir
RWRTP	Red Water Reservoir Treatment Plant
RWSL	Red Water Sewer Line
SARA	Superfund Amendments and Reauthorization Act
SDWA	Safe Drinking Water Act
SF	Slope Factor
SLERA	Screening Level Ecological Risk Assessment
SOW	Scope of Work
TBCs	To Be Considereds
TNT	Trinitrotoluene
TG	Task Group
TRC	Technical Review Committee
µg/g	Micrograms per gram
µg/L	Micrograms per Liter
USACE	U.S. Army Corps of Engineers
USACHPPM	U.S. Army Center for Health Promotion and Preventive Medicine
USATHAMA	United States Army Toxic and Hazardous Materials Agency
USEPA	U.S. Environmental Protection Agency
USFWS	U.S. Fish & Wildlife Service
WBG	West Burning Grounds
WBZ	Water-Bearing Zone
WCC	Woodward-Clyde Corporation
WTI	WasteTron, Inc.
WVDA	West Virginia Department of Agriculture
WVDEP	West Virginia Department of Environmental Protection
WVDNR	West Virginia Division of Natural Resources
WVOW	West Virginia Ordnance Works
WVU	West Virginia University
Y2K	Year 2000
YWR	Yellow Water Reservoir
YWRTP	Yellow Water Reservoir Treatment Plant

EXECUTIVE SUMMARY

The U.S. Army Corps of Engineers (USACE), Huntington District, Environmental and Remediation Section, with technical support provided by the USACE, Nashville District, Environmental Restoration Branch, and the USACE, Hazardous, Toxic, and Radioactive Waste Center of Expertise, conducted a Five-Year Review (FYR) of the former West Virginia Ordnance Works (WVOW). The purpose of this review was to ensure that implemented remedial actions are functioning as intended and are protective of human health and the environment. The review process consisted of the notification and involvement of stakeholders, the review of existing and relevant documentation and data, the identification and review of recent and new information, and an assessment of site conditions. This report documents employed review process methodologies, and presents the findings, conclusions, and recommendations attained.

This is the third FYR of the WVOW property. The triggering actions for this study are the prior initiations of the response actions at Operable Units (OUs)-1, OU-2, OU-3, OU-4, and OU-5. The FYR is required due to the fact that contaminants remain at the site above levels that allow for unlimited use and unrestricted exposure. The Records of Decisions (RODs) for OU-10, OU-11, and OU-12 required that no remedial actions or institutional controls be taken to protect human health and the environment; therefore, a FYR of the remedies for these OUs was not required.

Remedial actions at OU-1 consisted of *in situ* flaming of reactive TNT residue on the ground surface within the Burning Grounds and the TNT Manufacturing Area (TNT MfA), excavation and flaming of the reactive main trunk wastewater sewer line and laterals within the TNT MfA, removal of loose asbestos materials at the Burning Grounds, and the placement of two-foot thick protective soil covers over areas of greater than 50 ppm total nitroaromatics contamination. Remedial actions at OU-2 consisted of draining and capping contaminated sediments in the former Red and Yellow Water Reservoirs (RWR and YWR), placement of a soil cover over the Pond13/Wet Well and seep areas, and extracting and treating nitroaromatic-contaminated groundwater. Following signature of the OU-2 ROD, the RWR was designated OU-2, the YWR was designated OU-3, the groundwater treatment remedy was designated OU-4, and the Pond 13/Wet Well Area was designated OU-5; the Remedial Action Objectives (RAOs) for each of these OUs are contained in the OU-2 ROD.

The OU-1 soil covers are functioning as intended by the OU-1 ROD; however, contamination remains in place which requires long-term operation and maintenance (O&M) of the soil covers and protective warning signs. Soil covers at OU-2 and OU-3 are functioning as intended; however, long-term O&M of these soils covers and long-term groundwater monitoring are required by the OU-2 ROD since contamination remains in place. The OU-4 groundwater treatment remedy is in place and functioning as intended (data indicate the system is effectively containing and treating contaminated groundwater); however, nitroaromatics still exist in groundwater above the RAOs. The remedy at OU-5, as stated in the OU-2 ROD, has not yet been installed, and nitroaromatic-contaminated soil and groundwater exist above the RAOs. However, a removal action for nitroaromatic-contaminated subsurface soil was completed in 2004 in lieu of capping and groundwater extraction from this area is expected to resume in summer 2005. An Explanation of Significant Differences was agreed upon in principle by the Tier 1 team and is currently being routed for signatures. Based on the risk evaluation conducted for this FYR, some OU-1 and OU-2 ROD levels are not protective of human health. Additionally, no ROD levels protective of the ecological receptors were developed.

This review concludes that the remedies that are in place for OU-1, OU-2, OU-3, and OU-4 are functioning as intended, but may not be protective based upon risk evaluation. For the FYR, each compound's effect for each medium on each receptor was evaluated. In order to evaluate the total nitroaromatics cleanup levels, each parameter singly was assumed to be present at that total

concentration. Protectiveness was assumed when ILCRs are less than $5x10^{-5}$ and HIs are not greater than 1. The next FYR will determine whether the revised remedy employed at OU-5 is protective.

USACE, as the lead agency for environmental restoration of the former WVOW, is taking necessary measures to assure that all remedies function as intended and are protective. Additional studies are being conducted to address contamination that remains in place at all of these OUs. Actions that are required to address contamination that remains in place are as follows:

- Development and adoption of new ROD levels, which are protective of human health and the environment;
- Continuation of the O&M of the RCRA soil caps and protective soil covers at OUs 1, 2, and 3;
- Enhancement of the groundwater monitoring network at OU-4 and continuation of groundwater treatment until the OU-2 ROD RAOs are met;
- Completion of the nitroaromatic-contaminated soil removal action at OU-5, composting treatment of the soil from the OU-5 removal action, installation of groundwater extraction wells, and extracting and treating nitroaromatic-contaminated groundwater until the OU-2 ROD RAOs are met;
- Completion of the investigations at OUs 8, 8b, and 9, to determine remedies for nitroaromatic-contaminated soil and groundwater within OU-1;
- Continuation of the long-term monitoring program requirements for all OUs; and
- Completion of the remedial investigations for the remaining site OUs and areas of concern.

Subsequent FYRs are required to assure that the remedies perform as intended, and are protective of human health and the environment, as long as contamination currently remains in place above levels that prohibit unrestricted use.

The next (fourth) FYR will be completed by June 2010.

Five-Year Review Summary Form

Site name: Former West Virginia Ordnance Works	FUDS Property #: G03WV0015 EPA ID #: WVD 980713036
State: West Virginia	City/County: Point Pleasant/Mason County
Multiple OUs: Yes	Remediation Status: Operating for OUs-1, 2, 3, 4, and 5
Fund/PRP Lead: USEPA, Region III	NPL status: Currently on NPL
Lead agency: U.S. Army Corps of Engineers (USACE), Huntington District	
Who conducted the review (EPA Region, state, Federal agencies or contractor): USACE, Huntington District	
Dates review conducted: From: 5/15/04 To: 9/30/04	Date(s) of site visit: August 6, 2004
Whether first or successive review: Third Review	
Circle: Statutory	Due date: June 30, 2005
Trigger for this review (name and date): Five years from beginning of response actions	
Recycling, reuse, redevelopment site (highlight): Yes	

Issues:

- OU-1 and OU-2 Records of Decision (RODs) required placement of protective soil covers over nitroaromatic-contaminated soil to prevent exposure to humans and the environment. However, the contamination that was left in place can be a continued source for groundwater contamination because the protective soil covers at the Burning Grounds and TNT Manufacturing Area were designed to prevent surficial exposure, but not necessarily the infiltration of contaminants to the groundwater.
- The remedies at OUs-1, 2, 3, and 4 have been implemented in accordance with the RAOs of the OU-1 and OU-2 RODs, are functioning as intended, and assure short-term protectiveness. However, contamination remains in place in both soil and groundwater above the RAOs, which requires continued O&M of the remedies to assure long-term protectiveness. Closeout of OUs-1, 2, and 3 is not foreseeable at this time due to the remedies (soil covers/RCRA caps) that are in place; these require monitoring for an indefinite period to ensure protectiveness. The USACE, as the lead agency for environmental restoration of the WVOW property, needs to take necessary measures to assure that the remedies remain protective and conduct additional studies to address wastes that remain in place, to eventually achieve closeout of these OUs.
- OU-2 ROD groundwater remediation goals for 2,4-DNT, 2,6-DNT, and 1,3,5-TNB are below the ecotoxicity screening levels, USEPA Region III RBSCs, USEPA Region IX PRGs, and MCLs. However, the combined toxicity of 2,4-DNT, 2,6-DNT and 2,4,6-TNT exceed some of these values. Additionally, the cleanup criteria for 2,4,6-TNT and 1,3-DNB are less stringent than the RBSCs.
- The OU-2 ROD remedy for OU-5 was determined not to be practicable or effective, however the revised remedy is in the process of being implemented.

Recommendations and Follow-up Actions:

- Continuation of the O&M of the RCRA soil caps and protective soil covers at OUs 1, 2, and 3.
  Responsible party: USACE
  Oversight agencies: WVDEP and USEPA
  Milestone date: Ongoing
  Does the action affect current protectiveness: N
  Does the action affect future protectiveness: Y

- Evaluate the removal and treatment (i.e., composting) of the nitroaromatic-contaminated soil and sediments beneath the protective soil caps and covers at OUs 1, 2, and 3. Removal could expedite the OU-4 remedy, eliminate cap O&M costs, and make progress towards eventual closeout of these OUs.
  Responsible party: USACE
  Oversight agency: WVDEP and USEPA
  Milestone date: To be determined by the WVOW Tier I Team
  Does the action affect current protectiveness: N
  Does the action affect future protectiveness: Y

- Develop ROs which address ecological risks and add to respective RODs via ESDs
  Responsible party: USACE
  Oversight agencies: WVDEP and USEPA
  Milestone date: To be determined by the WVOW Tier I Team
  Does the action affect current protectiveness: Y
  Does the action affect future protectiveness: Y

- Develop revised, protective ROs for human health risks and add to respective RODs via ESDs
  Responsible party: USACE
  Oversight agencies: WVDEP and USEPA
  Milestone date: To be determined by the WVOW Tier I Team
  Does the action affect current protectiveness: Y
  Does the action affect future protectiveness: Y

- Develop ROs for other nitroaromatic compounds detected at the site and add to respective RODs via ESDs
  Responsible party: USACE
  Oversight agencies: WVDEP and USEPA
  Milestone date: To be determined by the WVOW Tier I Team
  Does the action affect current protectiveness: Y
  Does the action affect future protectiveness: Y

- Perform removal action for nitroaromatic-contaminated soil along/beneath the IWSL, using new ROs
  Responsible party: USACE
  Oversight agencies: WVDEP and USEPA
  Milestone date: To be determined by the WVOW Tier I Team
  Does the action affect current protectiveness: Y
  Does the action affect future protectiveness: Y

- Completion of the investigations at OUs 8and 9 to determine remedies for nitroaromatic-contaminated soil and groundwater within OU-1.
  Responsible party: USACE
  Oversight agencies: WVDEP and USEPA
  Milestone date: Sep 2005
  Does the action affect current protectiveness: Y
  Does the action affect future protectiveness: Y

- Evaluate the results from the Enhanced *In situ* Bioremediation pilot study at OU-9 for application to site-wide groundwater, i.e., OU-4.
  Responsible party: USACE
  Oversight agencies: WVDEP and USEPA
  Milestone date: To be determined by the WVOW Tier I Team
  Does the action affect current protectiveness: Y
  Does the action affect future protectiveness: Y

- Enhancement of the groundwater monitoring network and optimization of the extraction and treatment system at OU-4, and continuation of groundwater treatment until the OU-2 ROD RAOs are met.
  Responsible party: USACE
  Oversight agency: State/USEPA
  Milestone date: Ongoing
  Does the action affect current protectiveness: Y
  Does the action affect future protectiveness: Y

- Evaluation of the soil removal action at OU-5, installation of groundwater extraction wells, and extracting and treating nitroaromatic-contaminated groundwater until OU-2 ROD RAOs are met.
  Responsible party: USACE
  Oversight agencies: WVDEP and USEPA
  Milestone date: Ongoing
  Does the action affect current protectiveness: Y
  Does the action affect future protectiveness: Y

- Prepare an Explanation of Significant Differences to the OU-2 ROD for the new remedy for OU-5.
  Responsible party: USACE
  Oversight agencies: WVDEP and USEPA
  Milestone date: To be determined by the WVOW Tier I Team
  Does the action affect current protectiveness: N
  Does the action affect future protectiveness: N

- Continuation of the long-term monitoring program requirements and optimization of the program for all OUs.
  Responsible party: USACE
  Oversight agencies: WVDEP and USEPA
  Milestone date: Ongoing
  Does the action affect current protectiveness: N
  Does the action affect future protectiveness: Y

- Address the issue of the possibility of metals accumulation in sediment in the Red Water Sedimentation Basin due to the Red Water Treatment Plant's discharge and determine the path forward.
  Responsible party: WVOW Tier 1 Team
  Oversight agencies: WVDEP and USEPA
  Milestone date: To be determined by the WVOW Tier I Team
  Does the action affect current protectiveness: Y
  Does the action affect future protectiveness: Y

- Determine which OU-2 ROD table (Table 4 or Table 14) applies to the treatment of groundwater in the Pond 13/Wet Well Area and document team agreement on that selection.
  Responsible party: WVOW Tier 1 Team
  Oversight agencies: WVDEP and USEPA
  Milestone date: To be determined by the WVOW Tier I Team
  Does the action affect current protectiveness: N
  Does the action affect future protectiveness: Y

- Continue to inform and involve the public, through the Restoration Advisory Board (RAB) web site, public repository, FUDS newsletter, quarterly fact sheets, and RAB and public meetings
  Responsible party: USACE
  Oversight agencies: WVDEP and USEPA
  Milestone date: N/A
  Does the action affect current protectiveness: N
  Does the action affect future protectiveness: N

- Continue to update, apply, and develop GIS of project information and evaluate web-based information exchange
  Responsible party: USACE
  Oversight agencies: WVDEP and USEPA
  Milestone date: To be determined by the WVOW Tier I Team
  Does the action affect current protectiveness: N
  Does the action affect future protectiveness: N

- Completion of the remedial investigations for the remaining OUs and areas of concern on site.
  Responsible party: USACE
  Oversight agencies: WVDEP and USEPA
  Milestone date: To be determined by the WVOW Tier I Team
  Does the action affect current protectiveness: N
  Does the action affect future protectiveness: Y

- OU-2 groundwater RAOs (OU-4) for 2,4-DNT, 2,6-DNT, and 1,3,5-TNB appear to be very

conservative; the RAOs for 2,4,6-TNT and 1,3-DNB appear to not be stringent enough. All of these RAOs should be re-evaluated given the land use at WVOW and the fact that nitroaromatic influent concentrations at the OU-4 treatment plants represent an excess cancer risk of 10^{-6}.
Responsible party: USACE
Oversight agencies: WVDEP and USEPA
Milestone date: To be determined by the WVOW Tier I Team
Does the action affect current protectiveness: N
Does the action affect future protectiveness: Y

Protectiveness Statements:

OU-1 - The remedy at OU-1 may not protect human health and the environment in the short-term or in the long-term, based on the risk evaluation discussed in Section 5.8.2. Specifically, ROD levels for McClintic soils and surficial soils are not protective. The remedial action taken at OU-1 may have been protective based on what was known at that time, but new ROD levels should be calculated in order to determine if those actions would still be considered protective.

Risk evaluation aside, it appears that the actions taken were otherwise protective in the short-term because two-foot thick soil covers have been placed over areas in the BG and TNT MfA to prevent direct contact with nitroaromatic-contaminated soil, per the OU-1 ROD determinations. Reactive TNT residue on the ground surface and within the industrial sewer lines has been flamed, which eliminated the reactivity hazard. Furthermore, asbestos-contaminated soils within the WBG have been covered with two-foot protective soil covers to prevent exposure to humans and the environment. For the remedy to remain protective in the long-term, however, continued O&M of the soil covers and protective warning signs is required to prevent human and ecological exposure to the contaminated soil that remains in place. Remedies which eliminate the need for the protective soil covers, i.e., source removal, *in situ* bioremediation, and/or *ex situ* composting of the nitroaromatic-contaminated soil, would also help achieve long-term protectiveness and could provide for unrestricted site use. To achieve this goal, the asbestos-contaminated soil would have to be removed from beneath the WBG area protective soil cover. This removal action may be too costly to propose or fund in the near term. Given the relatively low O&M costs involved with soil cover maintenance, a cost comparative analysis would have to be performed and a management decision made regarding the disposition of the ACM beneath the WBG cover.

OU-2 - The remedy at OU-2 may not protect human health and the environment in the short-term or in the long-term, based on the risk evaluation discussed in Section 6.8.2. Specifically, ROD levels for soils for industrial land use are not protective for non-cancer risks. The remedial action taken at OU-2 may have been protective based on what was known at that time, but new ROD levels should be calculated in order to determine if those actions are still protective.

Risk evaluation aside, it appears that the actions taken were otherwise protective in the short-term because the remedy (RCRA soil caps) has been found to be well-maintained and functioning in accordance with the OU-2 ROD, and is therefore preventing human and ecological exposure to the contaminated sediments that lie beneath the caps. In order for the remedy to be protective in the long-term, however, inspection, maintenance, and repair of the protective RCRA soil caps and warning signs, in conjunction with long-term groundwater monitoring, must continue for as long as the caps are in place. Remedies which eliminate the need for the protective soil caps (i.e., source removal, in-situ bioremediation, and/or composting of the nitroaromatic-contaminated soil) could also help achieve long-term protectiveness and provide for unrestricted site use. The protectiveness statement concerning the groundwater remedy at OU-2 (i.e. the OU-4 groundwater extraction and treatment system) is contained in the OU-4 protectiveness statement.

OU-3 - The remedy at OU-3 may not protect human health and the environment in the short-term or in the long-term, based on the risk evaluation discussed in Section 7.8.2. Specifically, ROD levels for soils for industrial land use are not protective for non-cancer risks. The remedial action taken at OU-3 may have been protective based on what was known at that time, but new ROD levels should be calculated in order to determine if those actions are still protective.

Risk evaluation aside, it appears that the actions taken were otherwise protective in the short-term because the remedy (RCRA soil caps) has been found to be well-maintained and functioning in accordance with the OU-2 ROD, and is therefore preventing human and ecological exposure to the contaminated sediments that lie beneath the caps. In order for the remedy to be protective in the long-term, inspection, maintenance, and repair of the protective RCRA soil caps and warning signs and long-term groundwater monitoring must continue for as long as the caps are in place. Remedies which eliminate the need for the protective soil caps, i.e., source removal, in-situ bioremediation, and/or composting of the nitroaromatic-contaminated soil, could also help achieve long-term protectiveness and provide for unrestricted site use. The protectiveness statement concerning the groundwater remedy at OU-3 (i.e. the OU-4 groundwater extraction and treatment system) is contained in Section 8 9

OU-4 - The remedy at OU-4 may not protect human health and the environment in the short-term or in the long-term, based on the risk evaluation discussed in Section 8.8. Specifically, ROD levels for groundwater used as drinking water are not protective for non-cancer risks. New, protective ROD levels should be calculated, and could easily be implemented since the system is still operating (i.e. the remedial action is ongoing).

Based upon the evaluation of recent groundwater modeling, and on-site and off-site sampling and analysis data, the OU-4 groundwater extraction and treatment system appears to effectively capture the nitroaromatic-contaminated plume and the system is removing nitroaromatics from the groundwater. The OU-4 system has consistently discharged treated effluent per OU-2 ROD requirements and below established surface water criteria since the system was re-started in the Fall of 2000. There is no current exposure to groundwater because the site is a wildlife management area, with restrictions that prohibit both groundwater use and residential development.

Data (Tables 8-2 through 8-17) from groundwater monitoring wells and sampling points throughout the OU-4 system indicate that groundwater contamination still exists above the OU-2 RAOs. However, the selected remedy is working and continued implementation is necessary to achieve the final cleanup goals as specified in the OU-2 ROD. The USACE is taking the necessary steps to ensure that the remedy is protective, such as expanding the monitoring network around the OU-4 system (see Figures 8-1 and 8-2) to further define the plume and capture zone.

OU-5 - The OU-5 remedy has not been installed per the recommendations contained in the OU-2 ROD, and is therefore not functioning as intended. To ensure protectiveness in both the short- and long-terms, the USACE is taking, or plans to take, the following actions:

- Installation of two new groundwater extraction wells in the intermediate water-bearing zone and resumption of the OU-4 system in this area;
- Extraction of the groundwater until the RAOs of the OU-2 ROD are met;
- Discharge of treated effluent in accordance with OU-2 ROD RAOs;
- Completion of an ESDto detail the current objectives of OU-5, in relation to the OU-2 ROD.

Site Protectiveness - The USACE has implemented the remedies at OUs-1, 2, 3, and 4 in accordance with the remedial action objectives of the OU-1 and OU-2 Records of Decision, and they are currently functioning as intended. However, contamination remains in place. Also, some of the ROD levels do not appear to be protective.

For the remedies to be protective of human health and the environment in the long-term, continued O&M of the remedies must continue until RAOs have been met. Also, revised, protective ROD levels for human health and ecological risks should be developed. The USACE, as the lead agency for environmental restoration of the WVOW property, is taking necessary measures to assure that the remedies are protective, and is conducting additional studies to address wastes that remain in place. Actions that the USACE is taking, or plans to take, to assure that the remedies are protective of human health and the environment, are as follows:

- Continuation of the O&M of the RCRA soil caps and protective soil covers at OUs-1, 2, and 3;
- Completion of the investigations at OUs-8 and 9, to determine remedies for nitroaromatic-contaminated soil and groundwater within OU-1;
- Enhancement of the groundwater monitoring network at OU-4 and continuation of groundwater treatment until the OU-2 ROD RAOs are met;
- Evaluation of the soil removal action at OU-5, installation of groundwater extraction wells, and extracting and treating nitroaromatic-contaminated groundwater until OU-2 ROD RAOs are met;
- Continuation of the long-term groundwater monitoring requirements for all OUs.
- Completion of the remedial investigations for the remaining OUs and areas of concern on Site.

1.0 INTRODUCTION

This report presents the methods, findings, conclusions, and recommendations for the Five-Year Review (FYR) of the former West Virginia Ordnance Works (WVOW) site. The purpose of conducting a FYR is to evaluate the implementation and performance of a remedy in order to determine if it is, or will be, protective of human health and the environment. Protectiveness is generally defined in the National Contingency Plan (NCP) by the risk range and hazard index (HI).

The U.S. Army Corps of Engineers prepared this FYR report pursuant to CERCLA 121 and the NCP. CERCLA 121 states:

If the President selects a remedial action that results in any hazardous substances, pollutants, or contaminants remaining at the site, the President shall review such remedial action no less often than each five years after the initiation of such remedial action to assure that human health and the environment are being protected by the remedial action being implemented In addition, if upon such review it is the judgment of the President that action is appropriate at such site in accordance with section {104} or {106}, the President shall take or require such action. The President shall report to the congress a list of facilities for which such review is required, the results of all such reviews, and any actions taken as a result of such review.

The United States Environmental Protection Agency (USEPA) interpreted this requirement further in NCP, 40 CFR 300.430(f) (4) (ii) as.

If a remedial action is selected that results in hazardous substances, pollutants, or contaminants remaining at the site above levels that allow for unlimited use and unrestricted exposure, the lead agency shall review such action no less often than every five years after the initiation of the selected remedial action.

This is the third FYR for the WVOW Site. The triggering actions for this statutory review are the prior initiations of the response actions at Operable Unit (OU)-1, OU-2, OU-3, OU-4, and OU-5. The FYR is required due to the fact that hazardous substances, pollutants, or contaminants remain at the site above levels that allow for unlimited use and unrestricted exposure.

This FYR has been prepared by the U.S. Army Corps of Engineers (USACE), Huntington District, under the direction of the USEPA Region III. This FYR was performed in a manner consistent with the following USEPA guidance document:

- Comprehensive Five-Year Review Guidance, Office of Emergency and Remedial Response (5204G), EPA 540-R-01-007, OWSER No. 9355.7-03B-P, June 2001.

1.1 Purpose of Review

The purpose of this FYR was to evaluate whether the response actions undertaken at WVOW OU-1, OU-2, OU-3, OU-4, and OU-5 are functioning as intended and remain protective of human health and the environment. An objective was also to identify and provide recommended remedies for any issues of concern associated with implemented responses actions. Section 121(c) of the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) of 1980, as amended by the Superfund Amendments and Reauthorization Act (SARA) of 1986, and Section 300.430(f)(4)(ii) of the National Oil and Hazardous Substances Contingency Plan, mandate that a post SARA remedial action (RA) be reviewed no less often than every five years after initiation of the RA at sites where hazardous substances, pollutants, or contaminants remain at levels above those that allow for

unlimited use and unrestricted exposure. This is the third FYR for the WVOW site; the first FYR report (USEPA, 1995) was finalized during 1995, and the second FYR report (USEPA, 2000) was finalized during June 2000.

1.2 Site Overview

The WVOW site is located on the eastern bank of the Ohio River, approximately 6 miles north of the city of Point Pleasant in Mason County, West Virginia (Figure 1-1). When WVOW was designated as a National Priorities List (NPL) site in 1983, it consisted of 8,323 acres, of which 2,788 acres are currently designated as the Clifton F. McClintic Wildlife Management Area (MWMA) and managed by the West Virginia Division of Natural Resources (WVDNR). In 1994, the USEPA, the USACE, and the West Virginia Department of Environmental Protection (WVDEP) clarified the WVOW NPL site boundary map to delineate areas of known or suspected contamination, which resulted in a NPL boundary encompassing 2,700 acres. Of this area, 512 acres were deleted on December 13, 2002 and 1004 acres were deleted on April 26, 2004, each by notice in the Federal Register. The remaining and current NPL boundary (Figure 1-2) comprises 1184 acres. The locations of the site OUs which are the focus of this FYR are shown relative to the current NPL boundary in Figure 1-3. Most of the WVOW NPL site is within the MWMA, but other property within the NPL boundary is owned by the U.S. Army, private land holders, and state and local agencies.

1.3 Site OUs, ESIs, and AOCs

1.3.1 *Description of OUs, ESIs, and AOCs*

The WVOW site has 13 Operable Units (OUs), ten Expanded Site Investigations (ESIs), and several Areas of Concern (AOCs):

- Operable Unit One (OU-1) includes the Burning Grounds, a portion of the TNT Manufacturing Area, the Former Waste Water Process Lines, and the Former TNT Re-melt Facility.
- Operable Unit Two (OU-2) consists of the activities required to drain, cap, and monitor the Red Water Reservoirs.
- Operable Unit Three (OU-3) consists of the activities required to drain, cap, and monitor the Yellow Water Reservoir, the Barren Area, and vicinity.
- Operable Unit Four (OU-4) consists of the activities associated with the extraction and treatment of nitroaromatics-contaminated groundwater at the Red Water Reservoir, Yellow Water Reservoir and Pond 13/Wet Well areas.
- Operable Unit Five (OU-5) consists of the activities required to remediate and monitor the Pond 13/Wet Well vicinity.
- Environmental Unit Six (ENV-6) consists of the activities required to provide Wetlands Mitigation for OUs 1, 2, 3, and 5. (COMPLETE)
- Operable Unit Seven (OU-7) consists of the activities required to investigate and remediate any identified contamination associated with the Point Pleasant Landfill.
- Operable Unit Eight (OU-8) and Operable Unit Nine (OU-9) consist of all activities associated with the investigation and remediation of the Southeast Area soils and groundwater, respectively.
- Operable Unit Ten (OU-10) consists of the activities associated with the investigation and remediation of the South Acids Area and Toluene Storage Areas. (COMPLETE)
- Operable Unit Eleven (OU-11) consists of the activities required to investigate and remediate the Sellite Plant Area and vicinity. (COMPLETE)

- Operable Unit Twelve (OU-12) consists of the investigations and remediation activities required for the North and South Power Houses and vicinity. (COMPLETE)
- Operable Unit 13 (OU-13) consists of USEPA investigation of trichloroethene plume near the Point Pleasant water supply at the former Acid Dock (currently Pantasote property).

There are 10 ESIs at the WVOW site, which consist of investigations and remediation activities at:

- ESI-1. Magazine Area, excluding the Point Pleasant Landfill area (COMPLETE).
- ESI-2: Acid Dock.
- ESI-3: Tract 21 (COMPLETE).
- ESI-4: Red Water Sewer Outfall. (COMPLETE)
- ESI-5: Refueling Depot (COMPLETE).
- ESI-6: Motorpool/Maintenance Area. (COMPLETE)
- ESI-7: Former Sewage Treatment Plant Outfall (COMPLETE).
- ESI-8: Dump Site Adjacent to the Washout Area. (COMPLETE).
- ESI-9: Classification Yards (COMPLETE).
- ESI-10: Various AOCs (COMPLETE).
- AOC-7: Removal of drum carcasses from an area near Pond 13 (COMPLETE)
- AOC-18: Investigation and removal action required for the Former National Guard Shooting Range (COMPLETE).
- AOC-21: Investigation and removal action required for the area of a puddle of reddish water along the Red Water Process Sewer Line. (COMPLETE)
- AOC-22: Investigation and remediation activities required for the area of an abandoned drum southwest of AOC-21.

1.3.2 Current Status of OUs, ESIs, and AOCs

OU-1 Long Term Monitoring Program (LTMP) – A FYR Report was prepared by the USEPA and approved on June 22, 2000. Following submission of work plans for the 8th sampling event (2001), the Tier II Team delegated review to the WVDEP. A LTMP task group, formed in May 2001, completed a consensus agreement detailing the methodology for making future revisions to the LTMP, which was approved by the Tier I team in April 2002. The Tier I team reached consensus to use portable low-flow pumps and Teflon tubing and discontinue filtering of nitroaromatic groundwater samples for the 2002 sampling event. The Background Study was finalized in September 2002. The draft report for the 2003 event reflected the approved report for the 2002 event and was presented at the Tier I team meeting on March 4, 2004. The contract for the 2004 event was awarded March 22 2004. The report for the 2003 event was finalized during August 2004. Sampling for the 2005 event will be conducted in June.

OU-1 Burning Grounds - The occurrence of explosive components discovered during Long Term Monitoring (LTM) outside the capped areas led to additional sampling for nitroaromatics, asbestos, and PCBs. Samples were collected in June 1999. Agency review of the sampling analyses resulted in a consensus agreement being signed by Tier I on April 19, 2001 to cap the additional area without re-ROD, ROD amendment, or Explanation of Significant Differences (ESD) actions. The capping was completed in December 2001. Newly-capped areas include extensions of existing caps and construction of a few small caps. The final construction completion report was received in June 2002 and accepted by USACE, USEPA, and WVDEP. A site visit was conducted on March 25, 2003 and no asbestos-containing material (ACM) was visible in the area south of the caps. Additional samples were taken as part of the Southeast Area investigation indicated no nitroaromatics detected in the soil. Consensus was given by Tier I to sample the eight LTM wells biennially and to develop a cross section for future discussion of these wells.

OU-2&3 - The only ongoing activities in these areas are LTM of groundwater and operation and maintenance (O&M) of the RCRA soil caps. Efforts by USACE Baltimore and Huntington Districts to lease the PDP property to the Mason County Development Authority are ongoing.

OU-4 – Groundwater extraction and treatment - WVDEP and USEPA granted approval for USACE to discharge effluent from the groundwater treatment plants into wetlands areas for additional treatment before entering Mill Run. Modifications necessary for these discharges were made and the computer hardware and software, the electrical system, and the operating parts were repaired and/or updated as needed. During FY01, a pilot study was conducted which verified the success of this treatment method. The system operated for one year without violation. A first draft OU-4 Operating Properly and Successfully (OP&S) package was distributed to the Tier I team for review in July and CELRH has submitted O&M reports semi-annually thereafter. Consensus Agreement No.9 outlining the O&M procedures was approved by the Tier I team and signed on August 28, 2002. CELRH transmitted the OP&S documentation to USEPA for approval on September 27, 2002. Currently OP&S is on-going with the system operating as designed and additional data/information is being compiled to provide to the regulators for final concurrence. Additional monitoring wells were requested by USEPA, and recommended by the USACE Hazardous, Toxic, and Radiologic Waste Center of Expertise (HTRW-CX), to enhance the OU-4 monitoring network. The wells were installed in August 2004 by the OU-4 O&M contractor. The HTRW-CX completed a Remediation System Evaluation (RSE) Report in January 2004, and the WVOW Tier I team is reviewing optimization options. Five wells have been added to OP&S to better define the capture zone. A task group is currently evaluating other cost reducing options. During installation of two new extraction wells in the Wet Well Area, breaks and holes were found in the lines between Pond 13 and Yellow Water Treatment Plant which must be repaired. The revised OP&S report will be provided to Tier I team in June.

OU-5, Ponds 13/Wet Well Area – The existing ROD requires draining and capping the Pond 13/Wet Well area and pumping and treatment contaminated groundwater under OU-4. A draft sampling report (Revised Alternative Analysis Report) submitted on 14 July 1995 identified a localized "hot spot." This data indicates that the actions specified in the existing ROD may be ineffective and an inefficient use of funds. Consensus Agreement No.1 was signed by USEPA, WVDEP, and USACE on March 8, 2001 proposing the following actions:

- Remove a hot spot of material (approx 200 cubic yards, 5-8 ft deep)
- Add institutional controls to prohibit use of groundwater for drinking
- Not pump OU-4 extraction wells in this area
- Install a source area well to be sampled annually
- Install one or two point of compliance (POC) wells between the source area well and Red Water Sewer Line (RWSL) to be sampled annually
- Cease monitoring after 5 yrs if contamination in the POC well(s) is below action levels
- Determine necessity and quantity of additional sampling events, not necessarily annual sampling events of the source area well(s), and additional source area well sampling shall not exceed 5 sampling events
- Track land use

A scope of work (SOW) for removal of the hotspot as well as soils at AOC 21, excavation of TNT Manufacturing Area Cap #7 and additional contaminated material encountered at the Wet Well Area was awarded by CELRH in FY03. All of the excavated contaminated soil was bioremediated on-site using *ex situ* windrow composting. Composting of the last batch was completed during August 2004. The Tier I team selected two extraction well locations and CELRH awarded a contract in June 2004 for their installation. The extraction wells have been installed, but are not yet operating. Installation

of a monitoring well to be used as a point-of-compliance well was completed in January, and it was decided that existing monitoring well P13GW-023I will be used in lieu of installing a second well.

OU-7, Point Pleasant Landfill – A response to the 104(e) letter from USEPA was prepared by USACE Louisville District (CELRL) Office of Counsel in June 2004 with assistance from CELRH. USACE is awaiting letter to PRPs for future action.

OU-8, Southeast Area Soils and OU-9 Southeast Area Groundwater - A draft work plan incorporating sample selection and recent comments by the USEPA on the ESIs representing revisions to "past" approaches was submitted January 31, 2000. Soil exposure unit descriptions and data sets and surface water and sediment exposure unit descriptions and data sets submitted in May 2000 were accepted by the USEPA, and the work plan was accepted in October 2000. The Final Baseline Human Health Risk Assessment (HHRE BRA) Work Plan was approved by the USEPA on March 28, 2001. A contract reflecting consensus reached at the March/April Tier I meetings was awarded May 4, 2001 to continue HHRE BRA Work Plan development. The consensus for path forward is:

- Revise the APEC 3 issue paper to reflect concerns of mercury hits; completed
- Confirm that the BHHRA for OU-8 may not be required, just screening outside the proposed capped areas, OU-9 groundwater issues to be addressed;
- Prepare consensus agreement; signed September 28, 2001
- Do not conduct baseline Eco Risk Assessment
- Address funding issues.

Capping within OU-8 of the Acid Fume Recovery House foundations at TNT Manufacturing Lines 2, 3, and 4, plus extension of Washer/Flaker House Cap 3 was completed December 2001.

The Tier I team identified a need for further investigation at OU-8b (APEC 4) including the "Southern Swamp Area" (three locations north and three locations south of the culvert below Patrol Road in the areas of toxic water in the 1947 Decontamination Plan); "Washout Area Creek" and Pond 32 to be evaluated for habitat quality; and "Exposed TNT Area" immediately south of the East Burning Ground Cap. Data Quality Objectives (DQOs) for each site were approved by Tier I team members during the January 2003 meeting. The task group visited the site in March to finalize the sampling locations as presented at the April meeting. Sampling was completed in October 2003. The Final Risk Management Screening Report Exposed TNT Area, Old Yellow Water Reservoir Area, Southern Swamp and Washout Creek Area was completed in October 2004. No further action is recommended for the Exposed TNT Area and Old Yellow Water Reservoir Area. The Southern Swamp and Washout Creek Areas will be monitored in LTM for OU 1 and addressed in the Feasibility Study for treating groundwater contamination.

OU-9 groundwater issues (McClintic Area Residential Well Use Scenario) were discussed at the Tier I meeting in October 2001. The path forward is to (1) use the residential scenario in BHHRA, both on and off-site; (2) evaluate options for restoration of the aquifer, including source removal, pumping, and institutional controls; (3) make risk management decisions on whether restoration is practicable. The draft Baseline Human Health Risk Assessment was submitted February 18, 2002 and the final submitted on 26 April with the draft Feasibility Study. Issues currently being considered involve the TNT MFA's relationship to the area covered by the OU-1 ROD as well as defining "beneficial use" or "particular circumstances of the site". Preliminary modeling results indicate that remediation of soil or intermediate groundwater only will not achieve RAOs at point of compliance. Both soil and groundwater remediation will be required. Technologies will be developed based upon volumetric calculations. RAO issues and challenges include beneficial use of groundwater, deep water bearing

zone, and intermediate water bearing zone. RGO issues and challenges currently being addressed by Tier I include the site boundary and within the TNT Mfg area.

The Tier I team approved RAOs using generic language and removing references to facility boundaries in a May 2005 meeting. The EPA will continue to review the intermediate water bearing zone issue prior to completion of the FS. Additional samples will be collected to further define the extent of contamination at the remaining eight lines which have not been been adequately evaluated. The data will be utilized in remedial design.

Previous actions include completion of an "Enhanced Bioremediation Pilot Study" which was identified in the Interim FS as the preferred alternative. The pilot study finalized in March 2004 documented reductions in nitroaromatics.

During an investigation of the southeast area, an open grate at Building 511 was discovered and soil borings (hand auger) were collected for analysis. The data obtained indicates a need to go deeper in the areas northeast of the building. The open grate has been covered by CELRH as a safety measure and potential contamination in the vicinity of Building 511 was investigated in October 2004. Results indicate elevated contamination in both soil and groundwater. Soil contamination is fairly well delineated and groundwater contamination will be further analyzed.

A contract was awarded September 30, 2004 to further investigate a section of the industrial wastewater sewer line extending from the OU 5 wet wells area to area of concern (AOC 21). The scope includes the red water sewer line (RWSL) from the OU 5 wet wells area to just east of the yellow water/red water sewer line (YWSL) split. The section of the RWSL extending from AOC 21 to the Point Pleasant Landfill was also included. Field work began in April 2005 and will continue through mid July. The additional data collected will be included in the modeling effort for the feasibility study for groundwater.

OU-10, South Acids Area & Toluene Storage Areas – A no further action (NFA) ROD was signed in September 2003, and removal from the NPL was effective April 26, 2004.

OU-11, Sellite Area – A NFA ROD was signed in May 2000, and removal from the NPL was effective December 13, 2002.

OU-12, North & South Powerhouses – A NFA ROD was signed in June 2002, and removal from the NPL was effective December 13, 2002.

OU-13, Pantasote Property – No USACE action at this time; investigation of trichloroethene plume by USEPA near the Point Pleasant water supply. For previous USACE action see ESI-2. GenCorp is currently conducting the Engineering Evaluation/Cost Analysis (EE/CA) and has indicated that USACE may be named a Potentially Responsible Party (PRP). A risk evaluation group is currently studying USACE's future action.

ESI-1, Magazine Area – The USEPA evaluated a Polychlorinated Biphenyls (PCBs) hit in the Northern area for human health and ecological risks and agreed to pursuing a No Further Action (NFA) Decision Document (DD) for ESI-1 with the Point Pleasant Landfill (PPLF) excluded. CELRN revised the DD to close out the entire area for Department of Defense (DoD) related contaminants and noting possible presence of PCBs which are not DOD-related. The NFA DD was signed January 22, 2003 and removal from the NPL was effective April 26, 2004.

ESI-2, Acid Dock Area - Based on verbal comments from the USEPA, the draft decision document was written from the Army's perspective as the USEPA is pursuing needed action through the PRP and was submitted on May 22, 1998. A closure letter from the USEPA is needed. The WVDEP has requested that additional sampling be conducted for PCBs in areas suspected of having transformer storage. Rights-of-entry may be difficult to obtain for sampling.

ESI-3, Tract 21 – A NFA DD was signed September 28, 2000, and removal from the NPL was effective December 13, 2002.

ESI-4, Red Water Sewer Line – The NFA DD was signed at USEPA on September 29, 2003 and removal from the NPL was effective April 26, 2004.

ESI-5 Refueling Depot - A NFA DD was signed September 28, 2000, and removal from the NPL was effective December 13, 2002.

ESI-6 Maintenance Area – The Decision Document for no further action, excluding two "oily spots", for the motorpool/maintenance area was signed in June 2003. NPL de-listing was effective April 26, 2004. The removal and composting of the "oily spot" was completed. DPT delineation sampling was conducted in December 2004, with results showing additional contamination above WV LUST levels. However, WVDEP determined that this does not pose an unacceptable risk. A consensus agreement was signed stating that no further excavation is required in this area.

ESI-7 Former Sewage Treatment Plant Outfall – A No Action Decision Document was signed for ESI-7 in September 2000 and NPL removal was effective April 26, 2004.

ESI-8 Dump Adjacent to the Washout Area South of the TNT Manufacturing Area South of the TNT Manufacturing Area - A No Action Decision Document was signed September 2000. Groundwater in this area is being addressed under OU-9.

ESI-9 Classification Yards and Additional Background Samples – A NFA DD was signed for ESI-9 on July 12, 2001, and the site was removed from the NPL, effective December 13, 2002.

ESI-10 Various AOC - The final Data Package was submitted in April 2001. A decision document was signed October 2001 stating that no further action was required for any of the AOCs, except for the following:

- AOC-7 – removal of drum carcasses
- AOC-18 – removal of lead-contaminated soil
- AOC-21 and 22 – address under existing RODs

AOC-7 – A contract to sample and dispose of the drum carcasses was awarded in September 2001. The drum carcasses were sampled in March and removed in April 2002. The final report was completed in July 2002.

AOC-18 – A contract to remove the lead-contaminated soil was awarded in June 2002. Excavation and stabilization began in September and was completed in October 2002. The final report was completed in December 2002 and approved by the WVDEP and USEPA.

AOC-21 – In conjunction with the OU-5 contract, the contaminated surface soil was removed from this area and bioremediated via windrow composting. Any future work will be a corrective action under the OU-1 ROD.

AOC-22 – The LTM Task Group attempted to evaluate whether the existing Pump and Treat system capture zone includes AOC-22 and found that insufficient data is available. Shaw Group has evaluated AOC-22 along with the OU-4 operation analysis and it appears that AOC-21 and AOC-22 plumes are being captured by the Yellow Water Reservoir Treatment Plant extraction wells.

2.0 SITE BACKGROUND

This section provides brief descriptions of the location, history, characteristics, and past studies pertaining to the areas encompassed by the WVOW site. Detailed and comprehensive background information concerning the site is contained in the Site Management Plan (WCC, 1994) and the Site Management Plan Update (IT, 1999), as well as in the project administrative record (AR), and are therefore not repeated herein.

2.1 Site History

The former WVOW manufactured trinitrotoluene (TNT) from October 1942 through August 1945 (USACE, 1944), using toluene, sulfuric acid, and nitric acid as feedstocks. Construction of the plant was authorized on December 13, 1941, and began on March 16, 1942, using the site design prepared by E.B. Badger & Sons Co., Boston, Massachusetts. Acid production began at the WVOW on October 9, 1942, and TNT production commenced on October 21, 1942. Construction of the facility was completed on September 10, 1943. The design capacity of the WVOW was 720,000 pounds of TNT per 24-hour day, utilizing three shifts per day. However, due to shortages in raw materials and varying product demands, the plant never reached full production capacity; maximum attained production was 425,000 pounds of TNT in a 24-hour period.

The generalized process for the production of TNT at WVOW (USACE, 1944) was as follows: nitric acid was manufactured using anhydrous ammonia; nitration-grade toluene was treated (three times) with a mixture of nitric acid, sulfuric acid, and oleum oil to form the explosive TNT in liquid form. Note that the toluene used in TNT production was stored in eight bulk storage tanks located south of the Sellite Manufacturing Plant. The spent acid was recovered and concentrated for reuse in TNT production. Next, the liquid TNT was purified in two steps. First, the TNT was washed in warm water and soda ash, producing waste water called "yellow water"; second, the TNT was washed in a cold water and sellite (sodium sulfite) mixture, producing waste water referred to as "red water". Finally, the crude TNT was sent through a finishing process involving drying, flaking, and packaging. The principal by-product of TNT production was 93 percent sulfuric acid. Neither the loading of munitions nor the testing of ordnance was conducted at WVOW.

At the close of World War II in 1945, WVOW was decontaminated and subsequently declared surplus, and its facilities were either disposed of or salvaged. In August 1945, TNT production was suspended, the work force was reduced, and plant shutdown was initiated. The plant was declared surplus in December 1945. The production of TNT resulted in identified soil contamination in the industrial areas, process facilities, and wastewater disposal facilities by TNT and associated nitroaromatic residue by-products and environmental transformation products (ESE, 1984). During 1946, the facility was surveyed for the purpose of classifying the facility for disposal, by the Surplus Property Administration, Washington DC, the Reconstruction Finance Corporation, Richmond, Virginia, and the Federal Land Bank, Baltimore, Maryland, under the Surplus Property Act of 1944. The property use was classified as follows: 660 acres industrial; 7,600 acres farming; 14 acres on-site housing, and 20 acres West Virginia National Guard (ESE, 1984; Senjalia and Cinquegranna, 1981).

2.1.1 Early Decontamination Efforts

During May 1946, the Harris Board Report (USACE, 1946) was released. The report indicated areas of contamination and recommended that all equipment be dismantled and flashed prior to sale; the ten TNT lines be excavated and removed; the Red Water Reservoir (RWR) and Yellow Water Reservoir (YWR) be unplugged, drained, and flashed; and that contaminated soils be excavated and burned at the Burning Grounds. The report also stated that 100 percent decontamination was unachievable, but

that proper decontamination could be performed to the point at which no significant hazard would remain. By September 1946, 72 partial decontamination certificates had been issued (ESE, 1984; Senjalia and Cinquegranna, 1981). Although the limited decontamination had occurred, TNT manufacturing lines 1 through 10 and associated drainage pipelines were reported to be highly contaminated, and approximately 15,000 tons of acid, 14,000,000 tons of TNT, and 2,000,000 tons of smokeless powder still remained at the facility. In late 1946, the War Assets Administration acquired the property from the War Department, and the USACE was tasked with the protection, maintenance, and custody of the property (ESE, 1991). A chronology of major site events is presented in Table 2-1.

2.1.2 Preliminary Investigations

During 1981, seepage of red water was observed adjacent to Pond 13, located on MWMA property. This pond is located near the former TNT wastewater trunk lines and main pumping station. After investigation, the shallow groundwater discharging into Pond 13 was found to be contaminated by 2,4-dinitrotoluene (2,4-DNT), 2,6-DNT, and 2,4,6-TNT (RFW, 1983). Based on the 1981 investigation, the WVOW site was nominated for the NPL by the State of West Virginia and was listed on the NPL with a ranking number of 84 in 1983 (ESE, 1984). Following that action, the United States Army Toxic and Hazardous Materials Agency (USATHAMA) conducted Remedial Investigation/Feasibility Study (RI/FS) work which led to the development of Records of Decision (RODs) for OU-1 and OU-2 in 1987 and 1988, respectively. Also during this time period, an Interagency Agreement (IAG) was developed and signed by the Army and USEPA to guide development of contamination studies and remedial projects at the WVOW Site. USACE accepted site responsibilities from USATHAMA during 1991 to 1992.

2.2 Site Characteristics

2.2.1 Surface Water and Topography

The WVOW site lies 1.0 to 2.5 miles east of the Ohio River (Figure 1-2), where it is situated on Quaternary alluvial terraces within a broad bend of an abandoned meander belt of the Ohio River. The west side of the site is within the floodplain of the Ohio River. Rising above the valley floor, on the east side of the site, are upland areas underlain by Pennsylvanian age bedrock. Elevations range from 560 feet above mean sea level (msl), along the Ohio River, to 880 feet above msl along the northern boundary of the site. The Ohio River pool elevation is 538 feet above msl near WVOW.

Drainage at WVOW occurs through two major streams, their tributaries, and a number of intermittent streams. The northern half of WVOW, including the Point Pleasant Landfill, Magazine Area, Red Water Reservoir, Yellow Water Reservoir, North Acid Area, and South Acid Area, is drained by Mill Run and a small unnamed tributary of Mill Run. Mill Run is a tributary to the Ohio River and enters the river along the western boundary of the installation. The southern and eastern portions of the site are drained by Oldtown Creek (also a tributary of the Ohio River). Oldtown Creek, along with its tributaries, drains the TNT Manufacturing Area, Burning Grounds, Tract 21, and Pond 13; the creek enters the Ohio River south of the site. After closure of WVOW in 1945, thirty-nine artificial ponds were established by constructing dams and weirs in drainage ways (Tetra Tech, 1992). Natural drainage by Mill Run and Oldtown Creek has remained similar to the previous drainage, except for alteration to a number of tributaries caused by ponds construction. The WVOW area is not an environmentally sensitive habitat (i.e. one having threatened or endangered species).

Topography at WVOW reflects underlying stratigraphy. Deposition of glacial outwash by the Ohio River and re-working of the outwash by recent river migration and flooding resulted in alluvial covered terraces. These alluvial terraces have level or gentle slopes and have maximum elevations of

675 feet above msl. Topographic highs are remnants of an old plateau and are characterized by ridges that have developed on bedrock. Bedrock ridges predominantly consist of sandstones, siltstones, and shales. The sandstones generally form cliffs and steep slopes, the siltstones form gentle slopes, and the shales are poorly exposed. Old river channels and isolated low and high areas resulting from differential erosion characterize the bedrock surface beneath the alluvium cover. The alluvium extends from the surface down to elevations as low as 438 feet above msl. There is no distinct drainage pattern developed in the alluvial terrace areas, but there is a dendritic stream pattern that has developed in the uplands over the flat-lying beds of the Pennsylvanian age bedrock.

2.2.2 Hydrogeologic Setting

The local hydrogeologic setting at WVOW is characterized by unconsolidated and heterogeneous layered (glacio-fluvial origin) materials with ranging grain sizes (i.e. gravels, sands, silts, and clays) and hydraulic properties. In most parts of WVOW, groundwater is under natural (unstressed/uninfluenced by pumping activities) conditions, and its movement is generally towards local discharge locations such as Mill Run, Oldtown Creek, the Ohio River, seeps, and public and private wells. In the western portion of the site, groundwater flow direction in the intermediate and deep water-bearing zones has been influenced by groundwater withdrawals from both the Camp Conley public supply wells and the Point Pleasant Well Field. Fluctuations (seasonal) in the Ohio River stage appear to influence groundwater flow in its vicinity. Groundwater extraction by the RWR and YWR treatment systems also influences groundwater flow in the intermediate and deep water-bearing zones in these regions of the site. Detailed information and maps concerning site hydrogeology exist in the *Sitewide Hydrogeological Study* (IT, 1996) and *10th Annual LTM Report* (Shaw, 2004).

Three water-bearing zones (shallow, intermediate, and deep) and two impermeable/low permeability zones (shallow and deep aquitards) have been identified at WVOW. The shallow water-bearing zone (WBZ) is present in the central portion of the site, extending from the Sellite Manufacturing Area northwest to the vicinity of the inactive Point Pleasant Landfill. Groundwater in this unit is under unconfined conditions with the water table elevation ranging between 609 and 619 feet above msl. The shallow water-bearing zone is comprised of relatively coarse-grained channel deposits that grade both laterally and vertically into point bar sands and overbank silts or clays deposited in meander belt sequences of the ancestral Ohio River. The thickness of the saturated portion of the shallow water-bearing zone, as encountered in monitoring wells, varies from 9 to 15 feet. Normal shallow groundwater levels fluctuate with seasons; the highest water levels occur in the late winter and early spring, and the lowest occur in the late summer and early fall (Wilmoth, 1966). Beneath the shallow WBZ is the (clay/silty clay) shallow aquitard, ranging in thickness from 5 to 20 feet.

The intermediate WBZ is present in most parts of the WVOW site. However, it is absent from the southern TNT Manufacturing Area and Burning Grounds to near the ESI-3/Tract 21 Area. The unit is unconfined throughout the TNT Manufacturing Area and consists of fine to medium grained sand with low to moderate hydraulic conductivity (Shaw, 2003). Throughout the central and southeastern portions of the site, the intermediate WBZ is separated from the deep WBZ by the deep (clay) aquitard, which extends along the east channel with thickness ranging from less than a foot, to more than 95 feet thick in the Point Pleasant Landfill Area. In other portions of the site, specifically the northwestern, southwestern, and western portions, the deep aquitard is absent, and the intermediate and deep water-bearing zones become one hydrogeologic unit (in these areas the two water-bearing zones are referred to as the intermediate/deep water-bearing zone). The intermediate water-bearing zone can be divided into three basins (central, north, and south) based on groundwater divides present near the Sellite Manufacturing Area extending northeast, and a divide that extends from the Sellite Manufacturing Area to the northwest (Shaw, 2004). The depth to the bottom of the intermediate WBZ

ranges from the ground surface to 60 feet below ground surface, and the zone thickness ranges up to 60 feet.

The deep water-bearing zone is present in most parts of the WVOW site, with the exception of the bedrock highs in the central and northern portions of the site. The unit is under confined conditions (confined by the deep aquitard) throughout the central and southern portions of the site and consists of fine to medium sand (interbedded gravelly sands are present near its base) with low to moderate hydraulic conductivity (Shaw, 2003). Throughout the central and southeastern portions of the site, the deep water-bearing zone is separated from the intermediate water-bearing zone by the deep aquitard. In other portions of the site (see above), the intermediate and deep water-bearing zones become one hydrogeologic unit. As with the intermediate water-bearing zone, the deep water-bearing zone can be divided into three basins based on groundwater divides (Shaw, 2004). The approximate locations of the groundwater divides are consistent with those in the intermediate water-bearing zone. The total thickness of the deep water-bearing zone has not been established in many areas of WVOW. However, 45 feet of this unit were encountered in the YWR Area. Underneath the deep water-bearing zone is bedrock. Hydrogeologic features of bedrock and their relationship with the unconsolidated water-bearing materials have not been established, due to a lack of data.

2.2.3 Current and Projected Uses of the Former WVOW and Surrounding Area

The population of Mason County (2000 census) was 25,957, with the population of the city of Point Pleasant being 4,637. The Mason County Commission (MCC) owns portions of the former Maintenance Area and utilizes the property for the annual Mason County Fair, conducted in August of each year. The property also contains a local raccoon hunters club structure. The MCC has indicated that they intend to maintain the current land use for the near future. The Mason County Development Authority (MCDA) has discussed with the USACE the leasing of and future transfer to the MCDA a portion of the former Industrial Park (then owned by Mason County) that the Army purchased as part of the OU-2 ROD, which is referred to as the Power Distribution Products (PDP) property. The USACE conducted an Environmental Baseline Screening (EBS) of the property in November 2001 and prepared an Environmental Assessment (EA) and Findings of No Significant Impact (FONSI) as part of the lease agreement. The county was recently provided the lease agreement for signature, but as of the date of this report, has not approved and signed that agreement. The site would be used as an economic incubator for small business. The lease agreement has property use restrictions to assure the integrity of the OU-4 treatment system, which is adjacent to the former PDP property. The county also owns the former Main Classification Yard (ESI-9), which is operated as the Mason County Airport. The county intends to maintain this property as an airport for the foreseable future. Other commercial activities near the former WVOW include a Christmas tree farm business located northwest of the former Red Water Reservoir and PTI, Inc., a plastics molding company, located adjacent to the Mason County Fairgrounds along Wadsworth Ave. Several residences exist in close proximity of the former WVOW, with portions of the land adjacent to or within the MWMA being farmed or share-cropped.

The State of West Virginia owns a major portion of the former WVOW property, having had the property deeded to the state from the Army in 1948-49 for use as a wildlife management area. This property was transferred with a deed restriction requiring that the land be used for wildlife management, or else ownership will revert to the federal government. The WVDNR currently manages the property for the state, and it is designated as the MWMA. The MWMA occupies 2,788 acres of the 1983 WVOW NPL site, and most of the MWMA is also within the current (2004) NPL boundary. The MWMA is a popular attraction for hunters and fisherman.

The West Virginia Department of Agriculture (WVDA) also owns portions of the former Maintenance Area (ESI-6) and South Acids Areas (OU-10). The West Virginia State Farm Museum operates and maintains this property for the WVDA. The Farm Museum contains interpretative displays, historic farm machinery, and camping areas, which are open to the public year-round. The WVDA signed a Cooperative Agreement for Property Transfer with the United States on June 23, 2000, for the transfer of the 19-acre OU-11 property. The draft Findings of Suitability to Transfer (FOST) is currently being reviewed by the WVDA, WVDEP, and Huntington District USACE, with property transfer currently scheduled to occur in the near future. The State Farm Museum plans to construct an interpretive path (the Old TNT Trail) through the former OU-11 property and incorporate property use and operation with current Farm Museum property. Futher information is available online: *http://www.pointpleasantwv.org/Museums/FarmMuseum/Old_TNT_Trail_1.htm*.

There are no plans for groundwater (i.e. contained in the shallow, intermediate, or deep WBZs) within the MWMA to be used as a source of residential drinking water, due to its location and deed prohibitions restricting the land to wildlife management use only. Nonetheless, groundwater within this region is being cleaned up to "beneficial use" standards (see discussions below concerning groundwater cleanup levels for each OU). Twenty-one off-site residential wells were sampled during 2003 for nitroaromatics, and nitroaromatics were not detected above the reporting limit during analysis in any of the samples (WTI, 2003). It is expected that local off-site residents will continue to use wells for drinking water, watering lawns, washing cars, etc. The Point Pleasant Public Water Supply (PPPWS) is downgradient (west) of the WVOW site and receives a portion of its supply from the central basin (see Section 2.2.2 for discussion concerning site hydrogeology) of the intermediate/deep WBZ. Monitoring wells have been installed as sentry wells (designated AOC-2) for the PPPWS well field to provide an early warning of possible contaminant migration from the WVOW site toards the PPPWS. Sampling of the sentry wells began as part of the LTMP during 1997. During the most recent LTMP event (Shaw, 2004), eleven sentry wells were sampled and analyzed for nitroaromatics; only an estimated, low-level concentration of nitrobenzene was detected in well PPWGW-012. However, nitroaromatics were not detected in upgradient (east) wells PPWGW-004 and PPWGW-005 or cross-gradient (south) wells PWSGW-003 and PPWGW-013. Also, nitroaromatics were not detected in three downgradient (west) hydropunch points sampled during this monitoring event. Therefore, the nitrobenzene detection is considered anomalous. It is concluded, based on previous sampling events and the most recent sampling event, that the PPPWS has not been adversely affected by groundwater from the intermediate/deep WBZ. Contaminant migration is not occurring from WVOW toward the PPPWS.

3.0 PRIOR REVIEW PROTECTIVENESS STATEMENT AND RECOMMENDATIONS

The second FYR report (USEPA, 2000) of the WVOW site was finalized during June 2000. This section provides a brief overview of statements regarding remedial actions' protectiveness and recommendations that were presented in the second FYR report. Detailed discussions concerning the status of recommendations and follow-up actions since the last FYR, and results of actions implemented actions since the last FYR, are contained in subsequent sections of this report.

3.1 Prior FYR Protectiveness Statement

With regard to remedial actions' protectiveness, the last FYR (USEPA, 2000) concluded that "since the Remedial Actions at OU-1, OU-2, and OU-4 are incomplete and not fully functional and are not protective and since remedies for the remainder of the Site have not been chosen or implemented, the Site must be deemed not protective of Human Health & Environment at this time".

3.2 Prior FYR Recommendations

Several general recommendations, for follow-up actions intended to ensure protectiveness, were provided in the last FYR report (USEPA, 2000):

- USEPA will provide oversight to insure the USACE continues to conduct the Long-Term Monitoring/Operations Program at the Site.
- USEPA will support actions designed to resume operation of the OU-4 groundwater pump/treat system and enable the system to meet discharge limits for lead, zinc, and other metals.
- USEPA will support the USACE actions toward expanding the Burning Ground Caps or otherwise assuring compliance with the OU-1 ROD conditions that were developed to prevent direct contact with nitroaromatic-contaminated soil.
- USEPA will continue to work with USACE to complete ongoing remedial investigations, site investigations, and other related studies at the site, including a re-evaluation of the groundwater protectiveness standards.

4.0 REVIEW PROCESS AND FINDINGS

This FYR consisted of the following activities: the notification and involvement of stakeholders, the review of existing and relevant documentation and data, the identification and review of recent and new information, an assessment of site conditions, and the preparation of this report.

4.1 Administrative Components

This five-year review was led by the USACE, Huntington District, Environmental and Remediation Section (CELRH-EC-CE). The following individuals from CELRH-EC-CE conducted technical tasks and report preparation:

Ken Woodard, PE	Environmental Engineer	CELRH-EC-CE
Erich Guy, PhD, PG	Hydrogeologist	CELRH-EC-CE
Frank Albert, PE	Environmental Engineer	CELRH-EC-CE

4.2 Stakeholder and Community Notification and Involvement

A notice regarding the forthcoming FYR was placed in the Point Pleasant Register newspaper in April 2004. No public input was received. The draft-final and final versions of this FYR report will be available in the public repository (PR), which is located at the Mason County Library in Point Pleasant, West Virginia. Copies of documents from the previous year are physically located at the PR, while the entire AR is maintained on the WVOW Restoration Advisory Board (RAB) web site: http://www.lrh.usace.army.mil/projects/current/derp-fuds/wvow/. The PR is kept up to date and maintained by the USACE Huntington District. The final version of the report will also be available in the project AR and will be available for download from this website. Notice of the draft five-year review report completion, announcement of a 30-day public review and comment period, and announcement of a public meeting to discuss findings of the FYR, will be published in a local newspaper. The public meeting, at which USACE representatives will make presentations and discuss FYR conclusions and recommendations, will be held at a location within close proximity to the WVOW site. Subsequent to the 30-day public review and comment period, a Responsiveness Summary will be prepared to discuss any significant public comments received on the report and the actions taken to address any such comments; the Responsiveness Summary is located in Appendix D.

4.3 Documentation and Data Reviews

Reviews of relevant documents including RODs, ROD Amendments, Explanations of Significant Difference (ESDs), Operations and Maintenance (O&M) records, previous FYR reports, a Remediation System Evaluation (RSE) report, and monitoring data reports were conducted as part of this FYR. Remediation levels identified in RODs were also reviewed, and Applicable or Relevant and Appropriate Requirements (ARARs) and toxicity factors were checked for updates.

4.4 Interviews

Interviews were conducted with the following people as part of this FYR to obtain additional information and insight concerning the site:

- Mr. Lloyd Akers, Director, WV State Farm Museum
- Mr. George Carico, Environmental Specialist, Marshall University Center for Environmental, Geotechnical, and Applied Science (Restoration Advisory Board support contractor)
- Mr. Pete Costello, Project Manager, WVDEP

- Mr. David McClung, Wildlife Manager, McClintic Wildlife Management Area, WVDNR
- Mr. Joe Wheeler, former Project Manager, WTI (Remedial Action contractor)
- Mr. Jamie Wolfe, GIS Manager Marshall University Center for Environmental, Geotechnical, and Applied Science (Restoration Advisory Board support contractor)

Records which detail the interviews that were conducted are contained in Appendix B.

4.5 Site Conditions Inspection

Each quarter, the USACE inspects the remedies at OUs-1, 2, and 3 (e.g. RCRA soil caps, protective soil covers, protective warning signs, and drainage structures) in accordance with the approved *Operation and Maintenance Plan* (USACE, May 1994). The inspection results are forwarded to the USACE Project Manager (PM) at that time, and the quarterly inspection results are compiled and sent to the USEPA Remedial Project Manager (RPM) and WVDEP PM in an annual summary report. The USACE also administers O&M and corrective action contracts to maintain the remedies in accordance with the approved O&M Plan. During the most recent quarterly O&M inspection (March 21, 2005), the remedies were reported to be functioning as intended, with only minor deficiencies noted. Repair of minor soil cover damage, regarding and re-seeding, replacement of protective warning signs, and replacement of a damaged gate are being accomplished through recently awarded corrective actions contracts. Work has been hindered somewhat due to weather delays.

The USACE has a recurring (weekly to monthly) presence at OUs-4 and 5 through the O&M of the OU-4 groundwater treatment remedy and oversight of remedial actions at the site. During the site visits to inspect these facilities, USACE representatives also inspect the conditions of other OUs and portions of the WVOW site. The USACE OU-4 O&M contractor conducts weekly inspections and O&M of the OU-4 facilities in accordance with the O&M work order that USACE administers for that remedy.

On August 6, 2004, representatives from the Huntington District inspected OUs 1, 2, 3, 4, and 5 for this FYR. The Site Inspection Checklist and photographs of each OU are located in Appendix A.

5.0 OPERABLE UNIT 1

5.1 Site Description

OU-1 consists of these four major areas of the WVOW property: the former Burning Grounds, the former TNT Manufacturing Area (TNT MfA), and the former Industrial Wastewater Sewer Lines (Main Trunk Sewer and Red and Yellow Water Sewer Lines). Much of the area was agricultural prior to acquisition for WVOW (USATHAMA, 1979; ESE, 1984). The area was deeded to the State of West Virginia in 1948-49 for wildlife conservation after DoD declared that it could not be decontaminated for private ownership use. OU-1 is located within the boundaries of the MWMA, and onsite activities are managed for the state by the WVDNR. The site is open for public hunting and fishing. The current status of OU-1 is further described in 1.3.1.

5.1.1 Former Burning Grounds

The former Burning Grounds are located in the southwest portion of the WVOW property, about 500 feet west of the southern portion of the TNT MfA, and include the East and West Burning Grounds and the Y-Cap Area. The Army destroyed off-specification TNT products in this area through burning and also used the site to dispose of sulfur and asbestos-containing materials (USATHAMA, 1979) According to Table 1 in the OU-1 ROD (USACE, 1987), maximum detected concentrations (MDCs) of contaminants of concern (COCs) attributed to former WVOW activities include nitroaromatics (MDC=2%), PAHs (MDC=100 µg/g), lead (MDC=1400 µg/g), and friable asbestos in soils; lead (MDC=20.5 µg/L) and asbestos (MDC=2.6E6 fibers/L) in surface water; and lead (MDC=31 µg/g) in sediments. However, elsewhere in the OU-1 ROD, it is stated that up to 4% total nitroaromatics were detected at the Burning Grounds. The Endangerment Assessment (ESE, 1986) clarifies that total nitroaromatic concentrations in soils ranged up to 40,000 ppm (4%) in the East Burning Grounds and 20,000 ppm (2%) in the West Burning Grounds. The possible sources of the lead and PAH have not been identified. PAH contamination could be attributed to former WVOW burning activities, or possibly burning that may have been conducted by subsequent property owners adjacent to or within the Burning Grounds. Cleanup levels are media-specific, were developed only for nitroaromatic compounds, and are shown in Table 5-2.

Initial investigations at the Burning Grounds (ESE, 1986a) determined that surface soils, surface water, and sediments were contaminated from former DoD activities. Pieces of crystalline TNT existed at both the East and West Burning Grounds areas. West Burning Ground soils also contained PAH contamination (benzo(a)pyrene) at 100 µg/g, large pieces of friable asbestos, deposits of elemental sulfur, and lead concentrations up to 1,400 µg/g.

No nitroaromatic compounds or priority pollutant organics were observed in the surface water or groundwater at the Burning Grounds. Low levels of 1,3-DNB (0.2 µg/g) were detected in one downgradient sediment sample, and lead was detected at 31 µg/g. Asbestos (2.6 x 10^6 fibers/L) and lead (20.5 µg/L) were detected in surface water downgradient of the Burning Grounds.

The East and West Burning Grounds and Y-Cap are approximately 50 acres in size, bounded to the south by the Patrol Road/Camp Conley Road, and on the east by Ponds 30, 31, 32, and 33a. The East Burning Grounds are located in the southeast portion of the area, the West Burning Grounds are located northwest of the East Burning Grounds, and the Y-Cap Area is located east of the West Burning Grounds.

5.1.2 Former TNT Manufacturing Area

The former TNT MfA is located east of the former Burning Grounds. The area is roughly "rectangular" in shape, approximately 415 acres in size, oriented in a southwest to northeast direction, and bounded on the south and east by the Patrol Road.

Originally, twelve (12) TNT process lines were constructed at the TNT MfA; however, it is reported that only Lines 1-10 were used (ESE 1984; USACE 1945). Remnants of building foundations are all that remains from the former TNT production. The Old Yellow Water Reservoir (OYWR) area (present day Pond 10) was located at the southern end of the TNT MfA, to the north of the Patrol Road. The reservoir reportedly held both red and yellow water discharges from TNT Lines 1 through 4 and discharged to Oldtown Creek, which is located south of the Patrol Road (ESE 1984). The reservoir reportedly failed at one time and wastewater discharged into Oldtown Creek.

The Washout Area, located at the southwest end of the TNT MfA in a tributary to Oldtown Creek, was reportedly used for the disposal of used containers, trash, and possibly contaminated soil (OHM, 1994).

According to Table 1 in the OU-1 ROD, COCs include nitroaromatics in soil (MDC=3%), surface water (MDC=1 µg/L, Pond 34 only), sediments (MDC=0.4 µg/g), and groundwater (MDC=14,000 µg/L) and lead in soils (MDC=320 µg/g) and groundwater (MDC=20 µg/L). Nitroaromatic residues, up to 20,000 µg/g, were present in surface soil within 16 to 32 feet of the foundations of the nitrating and Washer/Flaker building foundations, with the primary nitroaromatic contaminants in the surface soil being 2,4,6-TNT, 2,4-DNT, and 1,3-DNB. Cleanup levels are media-specific, were developed only for nitroaromatic compounds, and are shown in Table 5-2. The ROD required only the capping of the former Washer/Flaker house foundations at manufacturing lines 1 through 10. Later corrective action (Section 5.5) added capping of the Acid/Fume Recovery House foundations at manufacturing Lines 2, 3, and 4 only.

Groundwater, seeps, and surface water at the TNT Manufacturing Area contained nitroaromatic contamination. The highest levels of groundwater contamination (nitroaromatics up to 14,000 µg/L and lead up to 20 µg/L) were observed in shallow groundwater near the Red and Yellow Wastewater Sewer lines in the TNT production area, and are attributed to leakage from the underground sewers or to infiltration from contaminated soils. Nitroaromatics were discovered in Pond 34 surface water (2,4-DNT at 0.8 µg/L and 2,4,6-TNT at 0.4 µg/L), and sediments contained nitroaromatics at up to 0.4 µg/g.

The investigation and remediation of soil and groundwater contamination at the TNT MfA is being conducted under OUs 8 and 9, respectively. The intermediate and deep WBZs have historically been monitored in the vicinity of the OYWR by wells TNTGW-021 and TNTGW-021D; the shallow WBZ is not present in this area of the WVOW site. TNTGW-021 is no longer included in the LTMP, although TNTGW-021D is still sampled under the LTMP. The intermediate WBZ pinches out near the northern edge of Pond 10, and is thus not present underlying the OYWR area except perhaps in the vicinity of the large washout area. Groundwater samples were acquired from wells TNTGW-021 and TNTGW-021D (IT, 1995); and analytical results indicated groundwater had not been impacted by nitroaromatics, VOCs, SVOCs, or pesticides/PCBs. Investigation and remediation of soil contamination at the OYWR area is being addressed under OU-8.

5.1.3 Former Industrial Wastewater Sewer Lines

The former Industrial Wastewater Sewer Lines transferred the waste wash waters from the ten TNT process lines to the Wastewater Pumping Station at the Pond 13/Wet Well Area. The Red Water Sewer Line (RWSL) traversed the central WVOW from the TNT MfA to the RWR and continued off-site to the Ohio River. The entire sewer line was approximately four miles long, with about one mile of the RWSL located beneath private property. Investigation of the RWSL from the RWR, beneath the private property locations, and to the Ohio River, was conducted under ESI-4.

The main trunk sewer line (MTSL) ran the entire length of the TNT MfA and collected wastewater from sewer lines that were connected to the mono-nitrating, tri-nitrating, acid/fume recovery, bi-fortifier, and Washer/Flaker houses. The MTSL carried the red and yellow wastewaters by gravity feed north to the Wastewater Pumping Station located at the current Pond 13/Wet Well Area. From this location, red wastewater was pumped to the RWR and yellow wastewater was pumped to the YWR. The sewers were constructed of steel, vitrified clay, or wood stave pipe (ESE, 1984). From the YWR, yellow wastewater was pumped to a neutralization station and then discharged to Mill Run (ESE, 1984). Red wastewater was held in the RWR until adequate flow in the Ohio River would allow the waste to be pumped to the river for disposal.

According to Table 1 in the OU-1 ROD, nitroaromatics were the only COC identified within the sewer lines and were present in the portion of the sewer lines within the TNT MFA, the Acids Area, the YWR, and the RWR. Crystalline TNT residues containing up to approximately 70 percent nitroaromatics were detected in the excavated industrial sewer lines at the TNT MfA. Soil beneath the sewer lines contained nitroaromatic contamination from 10 to 500 µg/g. Soils surrounding the sewer lines at the Yellow Water Reservoir area contained nitroaromatics at 400 µg/g, and at 0.2 percent in soils at the Red Water Reservoir. Cleanup levels were developed only for nitroaromatic compounds, and are shown in Table 5-2.

5.2 Remedial Objectives

The objective of the selected alternative was complete removal of all contaminated soil that contains nitroaromatic concentrations above the 10^{-6} risk levels. To achieve a 10^{-6} risk level for soils in OU-1, the following remedial objectives were established:

1. To eliminate safety hazards associated with reactive wastes: remove or render non-reactive all reactive wastes;
2. To achieve less than 10^{-6} individual lifetime, excess cancer risk for avid hunters and their families or friends who consume meat from game that feed in contaminated areas: remove or cover the upper two feet of soil if total nitroaromatic contamination exceeds 500 µg/g; and
3. To achieve less than 10^{-6} individual lifetime excess cancer risk for frequent visitors to the McClintic Wildlife Station who come into direct contact with surficial soils: remove or cover the upper 6 inches of soil if total nitroaromatic contamination exceeds 50 µg/g.

The remedial actions for addressing these objectives were to flame reactive TNT residue on the ground surface at the Burning Grounds; dispose of loose asbestos at the Burning Grounds at an offsite sanitary landfill; excavate, flame, and backfill the reactive sewer lines; install 2-foot thick protective soil covers over areas of greater than 50 ppm nitroaromatics at the Burning Grounds and TNT MfA; and conduct a wetlands assessment prior to construction activities to identify and avoid potential wetlands impacts, as practical. Groundwater was vaguely addressed in the ROD, stating only that monitoring

would be required. No cleanup of groundwater was required under the OU-1, nor was monitoring defined in any way. The RAOs are shown in Table 5-2.

Note that these ROs were developed only to protect human health, and do not address ecological concerns. A screening level ecological risk assessment (SLERA) was performed for all areas within the NPL boundary and the site divided into five areas of potential environmental concern (APECs). The OU-1 process wastewater lines pass through APECs 1, 2, and 4. The TNT MfA is located within APEC 3 and the Burning Grounds within APEC 4. No further action was recommended for APECs 1 or 2. Additional capping actions were completed to address ecological concern for APECs 3 and 4, as discussed in Section 5.5.

5.3 Remedy Selection

The basic remedial objectives for OU-1 were defined in the Endangerment Assessment (EA) report (ESE, 1986). Remedial investigation data were interpreted to assess actual and/or potential threats to human health and the environment. Several factors associated with OU-1 affected the exposure assessment, these being:

- The contaminants were restricted to the MWMA;
- No residences would be constructed on the MWMA;
- Contaminated groundwater resources were not used for potable supply (the MWMA is served by public water and there are on-site restrictions concerning groundwater use); and
- The original deed transferring the property from the Department of the Army to the state of West Virginia requires that the property be maintained as a wildlife management area.

Based upon the findings from EA, the remedial objectives discussed in Section 5.2 were developed.

The objectives for remedial actions to be taken at WVOW were to prevent or reduce the following:

- Contaminant infiltration through source areas;
- Direct contact with contaminated soils;
- Future contamination of groundwater; and
- Degradation of surface waters.

Using best engineering judgment, a group of remedial action alternative technologies that would best address the protection of human health and the environment were developed and screened, and the following five action categories were developed to provide flexibility in final remedy selection:

- Alternatives for treatment or disposal in an offsite facility (1A1, 1A2, 1B1, and 1B2);
- Alternatives which attain public health and environmental standards, per CERCLA (2A, 2B, and 2C);
- Alternatives which exceed public health and environmental standards, per CERCLA (3A, 3B, and 3C);
- Alternatives which do not attain public health and environmental standards, but will reduce the likelihood of present or future threat (4A); and
- No action (5A).

Consistent with the National Contingency Plan (NCP), the alternatives were developed, screened, and evaluated in accordance with sections 300.68(g) through (i) of the NCP. The screening criteria consisted of the following: cost, public health concerns, environmental concerns, technical concerns, community response concerns, and operation and maintenance (O&M). All alternatives, except for

the No Action Alternative, met or exceeded the remedial action criteria and the objectives established in the EA, which were to:

- Remove or render non-reactive all reactive wastes; and
- Remove or cover the upper 2 feet of soil where total nitroaromatics exceed 50 ppm, to achieve less than 10^{-6} individual lifetime excess cancer risk.

The OU-1 ROD was signed by the Department of the Army and the USEPA in April and May 1987, respectively, and later gained the acceptance of the WVDEP. The ROD consisted of the following remedies for source control, based upon the recommended Alternative 4A, that satisfy the OU-1 remedial objectives:

- To eliminate safety hazards associated with reactive wastes: remove or render non-reactive, all reactive wastes.
    - In situ flaming of the reactive TNT residue on the surface of the Burning Grounds; and
    - Excavation, flaming, and backfilling of reactive wastewater sewer lines.

- To achieve less than 10^{-6} individual lifetime excess cancer risk: remove or cover the upper 2 feet of soil where total nitroaromatics exceed 50 ppm.
    - Installation of a two-foot soil cover over areas in the Burning Grounds with greater than 50 ppm total nitroaromatics contamination.
    - Installation of two-foot soil covers over areas in the TNT MfA with greater than 50 ppm total nitroaromatics contamination.

Since the OU-1 remedy included the placement of soil covers to satisfy the remedial objectives, periodic O&M inspection, maintenance, and repair of the covers is required to assure that exposure to contaminated surface soils and contaminant migration to groundwater was being achieved. Additionally, a groundwater monitoring plan was developed for conducting post-closure long-term groundwater monitoring, consistent with RCRA requirements.

The OU-1 ROD also required that a wetlands assessment be conducted prior to construction activities, and that mitigation be conducted for wetlands impacts, as necessary. Additionally, ACM at the Burning Grounds were to be removed and disposed of at an off-site sanitary landfill. Long-term monitoring was also a component of the ROD, although it was not described in detail.

5.4 Remedy Implementation

Remedial action at the First Operable Unit (per OU-1 ROD recommendations) was initiated on February 17, 1988 and was accomplished in two phases at the TNT MfA: sewer line excavation, in-situ flaming of the sewer and contaminated surface soil, and backfilling, followed by development of a borrow pit, and placing soil covers over the contaminated soils. Remediation in the TNT MfA included the lateral sewer lines and the main trunk sewer line.

Minimum two-foot thick protective soil covers, with five inches of topsoil vegetated with native grasses, were placed over the Washer/Flaker building foundations at manufacturing Lines 1 through 10. The covers were constructed from clay soil found on MWMA, southwest of the burning grounds. The sites to be capped were thoroughly searched for visible TNT, and any pieces were burned or placed in a holding area for later burning, prior to soil cover placement. Soil samples were taken around the Washer/Flaker buildings to determine the outside boundaries of the soil covers and the perimeters were marked with stakes. The soil covers were completed in early June 1988. Restrictive

signs, warning of the potential TNT hazard associated with digging/excavation, were then placed around the perimeters of the soil covers.

Remedial Actions at the East and West Burning Grounds (EBG, WBG) were also completed in 1988 (ESE 1989). Activities included in-situ flaming of TNT residue on the ground surface, followed by installation of a two-foot protective soil covers. Asbestos-contaminated soils were disposed offsite The soil cover material came from the same on-site borrow area (see above), and construction methods were similar to the TNT MfA soil covers. Construction of the EBG soil cover commenced in May 1988 and was completed by June 1988. Topsoil had to be imported to complete the project, due to depletion of onsite material.

WBG soil cover operations began the first week of June 1988. Preliminary clearing work at the WBG exposed other sources of asbestos contamination that were far more extensive than investigations had suggested. An estimated three to four acres of asbestos-contaminated soils, one to two feet thick on average, was discovered adjacent to the WBG. Due to the extremely high cost to dispose all of this asbestos-contaminated material offsite, discussions were held with USEPA. It was decided that only loose asbestos would be double-bagged and disposed offsite, and that remaining asbestos-contaminated soil would be covered with a two-foot thick soil cover. Because the area was next to the WBG, the soil cover was merely extended from the WBG to cover the asbestos-contaminated soil. Restrictive warning signs were placed around the perimeter of the site, due to the nitroaromatic and asbestos contamination that remained under the soil covers.

5.5 Follow Up Actions

The remedial actions for OU-1 were completed in December 1988. A Close-Out Interim Inspection was conducted by USEPA, USACE, and WVDEP on October 9 and 10, 1991. This inspection was initiated due to the lack of a closeout report at the time of construction completion of OU-1. The first FYR included completing the closeout report and inspecting the caps. Results of that initial inspection and the subsequent follow-up inspection are included in Appendix A of the first FYR Report (USEPA, 1995). The initial inspection identified numerous concerns and deficiencies. Due to excessive growth in and around the soil covers, a thorough inspection was not completed until April 1992, after the area had been made accessible by removing the excessive growth. Several required actions were listed for this area in order for a final close-out inspection to be conducted (note that these items were conducted for the deficiencies noted at that time):

- Regular mowing of the caps to prevent establishment of trees and brush on the soil covers;
- Repair of erosion-damaged parts of the caps;
- Repair of warning signs in the area; and
- Approval of an O&M plan for the area.

The USACE undertook several actions in response to the findings and recommendations from the close-out interim inspection of OU-1. A supplementary investigation was conducted at the OYWR in 1992. Sediment and core samples were collected and a dump was identified in the Washout Area.

In 1992, the USACE contracted with Advanced Science, Inc., for preparation of the long-term monitoring plan. The draft plan was revised and completed in January 1993 by Tetra Tech to incorporate USACE and USEPA review comments. IT Corporation (currently Shaw Environmental) was contracted to conduct the initial sampling of the OU-1 LTMP in March 1993, and has conducted all LTMP sampling events since that time. In 1996, the sampling of OUs-1, 2, and 3 was combined into one event, and the LTM plan was revised in May 1996 for the combined OUs. The LTM plan

was revised in November 1997 to incorporate regulator review comments and to add OU-11 to the LTMP (Shaw, 2004).

In January 1993, USACE Omaha District issued a contract to OHM Remediation Services (OHM) for remedial services at the Washout Area, which is located at the southern end of the TNT MfA. This area had historically received such wastes as drums, paint cans, glass bottles, and other trash; contaminated soil was also reported to have been deposited at the site. Previous investigations had indicated that contaminated soil was dumped in this area, and was assumed to contain nitroaromatics. The area was littered with decayed drums and paint cans, broken glass bottles, and miscellaneous household and construction debris. The delivery order required sampling and analysis for disposal (RCRA characteristics, PCBs, VOCs, and SVOCs), site waste characterization, and excavation and disposal of all of the waste and debris present. Initial disposal sampling and analysis determined that the site contained PCB and lead contamination at hazardous concentrations; therefore, the area was gridded off to determine the locations of hazardous and non-hazardous wastes. Four areas were determined to contain hazardous constituents, exhibiting PCBs above 50 ppm and/or lead above 5 mg/L. The hazardous waste was excavated and disposed of at an offsite hazardous waste facility, and the remaining waste was removed and disposed of at an offsite non-hazardous waste landfill. Approximately 546 tons of hazardous waste and 3,606 tons of non-hazardous waste and debris and contaminated soil were removed from the area (OHM, 1994). Additional sampling was conducted following the removal action, and VOCs, SVOCs, PCBs, and lead (by TCLP) were detected in soil samples; no nitroaromatics were detected (OHM, 1994).

In April 1994, a project was required to repair and re-grade the soil closure caps in the TNT MfA and the Burning Grounds due to a lack of O&M activities, erosion, and vehicular damage. The areas around the caps were re-graded to provide for positive drainage, drainage structures were constructed to channel storm water away from the caps, and vegetative cover was restored. The WBG cap was extended to cover another area of exposed asbestos. Access was provided to the caps for future maintenance activities. OHM completed the corrective actions on August 5, 1994, and the USEPA conducted a final inspection of the repairs on August 9, 1994 (OHM, 1995).

During a 1994 site walkover by USEPA, WVDEP, and USACE personnel, approximately 1.5 acres of open-dump debris, including household wastes, automotive parts, and potential ACM, was discovered south of the Washout Area; the area was designated ESI-8. During the fall of 1995, an expanded site investigation was performed and soil and product samples were analyzed for VOCs, SVOCs, metals, pesticides/PCBs, explosives, and asbestos. Surface water samples were also taken from the creek at the northern boundary. Trace concentrations of all contaminants analyzed, except nitroaromatics, were detected. Product samples indicated up to 50 percent chrysotile asbestos in weathered product and shingle samples, and up to 30 percent chrysotile asbestos in soil samples. A human health risk assessment was conducted, and none of the COPC concentrations exceeded health-based criteria; however, remedial action was required to address the ACM. In June 1999, the USACE awarded a contract for the removal of loose ACM and the placement of a three-foot protective soil cover over the approximate 0.35-acre asbestos dump along the ridgeline. The establishment of an asbestos landfill, and the protective soil cover requirements, were coordinated with and approved by the WVDEP. Site work commenced on September 22, 1999 and was completed September 30, 1999 (Chippewa, October 1999). The USACE later surveyed the boundary of the asbestos dump and incorporated it into the deed for the tract upon which the ESI-8 Area is situated. The USEPA and WVDEP approved and signed a Decision Document for the ESI-8 Area on September 28, 2000 that declared the site required no further action to protect human health and the environment.

In November 2001, following the recommendations contained in Consensus Agreement No. 2 (CA2, 2001) and Consensus Agreement No. 3 (CA3, 2001), construction of new soil covers and extensions

of existing covers was initiated at the WBG and TNT MfA. This action was required due to nitroaromatic contamination above the OU-1 ROD level of 50 ppm that had been found during a recent long-term monitoring soil sampling event. Subsequent investigation revealed that zinc and nitroaromatic compounds were detected at levels that posed ecological concerns. As stated in CA3, capping of the areas that contained mercury and nitroaromatics removed the unacceptable risks to potential ecological receptors in APEC3, and eliminated the need to conduct a baseline ecological risk assessment (BERA) in the area. Also, an issue paper (IT, August 7, 2001), concluded that construction of the soil covers in lieu of completing the BERA would conservatively save the Government $150,000 and approximately two to three years on the schedule. The Biological Technical Assistance Group (BTAG) of USEPA agreed with this recommendation and the elimination of additional ecological assessments at APEC 3. Therefore, portions of the existing WBG and EBG soil covers were extended, and two new, small soil covers were constructed. The two WBG extensions covered areas exhibiting zinc at up to 525 mg/kg and 2,4-DNT at 0.51 mg/kg. The EBG extension covered an area of total nitroaromatic contamination at 1137 mg/kg. The two new soil covers covered areas of total nitroaromatic contamination at 4,511 mg/kg and 7,744 mg/kg. The team had agreed that the two areas where chromium was detected would not be addressed due to their small areal extents. Nitroaromatic compounds and mercury were discovered at levels that posed ecological risks at Lines 2, 3, and 4 in the TNT MfA, and high TNT concentrations were detected adjacent to the existing Washer/Flaker House cap at Line 3. New soil caps were constructed at these areas (foundations of the former acid/fume recovery houses at Lines 2, 3, and 4) and the existing Washer/Flaker House cap on Line #3 was extended (WTI, July 2002).

5.6 System Operations/O&M

As previously stated, USACE Huntington District developed an O&M plan for the protective soil covers, and submitted it to USEPA Region III for review in 1993; comments were received from the USEPA in April 1993. The comments were addressed, and the O&M plan was finalized in May 1994. USACE initialized quarterly closure cap inspection in August 1993. The closure caps are inspected for signs of vandalism, erosion, or failure, and vent risers were monitored for methane gas. In 1999, the USACE requested and received approval from USEPA for cessation of methane monitoring, following three years of non-detect results.

The results from each quarterly inspection are reported to the WVOW PM, who in turn provides a copy of the inspection report to the USEPA Region 3 RPM and WVDEP PM. Minor deficiencies, such as missing or damaged warning signs, damaged locks, or other vandalism are typically repaired by USACE in-house forces. Typically, major repairs, such as slope failure, drainage repair, etc., that require use of construction equipment or purchase of materials, are conducted through Corrective Measures contracts administered by USACE. Since the initiation of the quarterly O&M inspection program, there have been no major failures of the soil covers, and all required repairs have been accomplished in a timely manner to avoid further damage.

USACE Huntington District operates and maintains OU-1 in accordance with the WVOW O&M Plan (USACE, 1994). O&M activities include regular mowing of the protective soil covers, clearing of ditches and drainage structures (to prevent erosion or ponding of water), and maintenance of the protective warning signs (to notify the public that only surficial use of the site is permitted).

The Huntington District programs and awards an annual mowing contract for the maintenance of the soil covers, ditches, drainage structures, and monitoring wells. Mowing is conducted between May and September of each year. Minor repair work, which has been identified from previous quarterly site inspections as being required to maintain the covers, is typically included in the mowing contract. More extensive repair work is typically performed with a Corrective Measures contract. This work is

either programmed for the next fiscal year (FY), if it is identified early enough in the previous FY, or the work is scoped and awarded subject to the availability of funds in the 4th quarter of the FY.

O&M costs since the last FYR follow:

OU-1 O&M Costs ($1,000s)

	FY99	FY00	FY01	FY02	FY03	FY04
In-house labor	$11.6	$10	$27.5	$9.5	$9.3	$11.5
Contract	N/A *	N/A *	$4.1	$4.7	$18.1	$12.2

* O&M contract costs for FY99 and FY00 are not adequately reflected in the FUDSMIS database

Future O&M costs are expected to be similar, with an allowance for escalation due to inflation, unless the source areas are removed.

5.6.1 Quarterly Site Inspections and Corrective Actions Taken

Quarterly inspections of the OU-1 site are conducted in accordance with the WVOW O&M Plan (USACE, 1994). The area is inspected for signs of soil cap failure (e.g. differential settlement, exposed geotextile membrane), soil cap erosion, tire ruts from off-road vehicles, groundhog burrow holes, drainage problems, monitoring well damage, missing or damaged protective warning signs, and general appearance. During the most recent quarterly inspection of OU-1 (March 21, 2004) conducted by USACE Huntington District, no major deficiencies were noted; the next quarterly inspection is scheduled to be completed by June 30, 2005.

The USACE provides copies of each quarterly inspection report to the USEPA Region 3 RPM and the WVDEP PM. Following each calendar year, a summary report of O&M inspections and corrective actions is also provided to these agencies (USACE, O&M Summary Reports, Calendar Years 1999-2003).

5.6.2 Operation and Maintenance Repairs

FY00 O&M Repairs

The following repairs were conducted through a corrective measures contract (Contract No. DACW69-00-D-0021, Task Order No. 2, Aug. 2000):

- An approximate 500 square foot depression near the center of the WBG cap was repaired through stripping the failed soil, placing compacted topsoil to match existing contour, and then re-seeding the disturbed area.
- The dirt access road through the TNT MfA was re-graded and low spots filled in over an approximate 200 linear foot area to remove extensive tire ruts. Aggregate drains were installed in the road to remove ponded water that had contributed to road failure.
- Groundhog burrow holes were repaired at TNT MfA Cap #9, the SW portion of the WBG, and the ESI-8 soil cover through plugging with bentonite and covering with at least six inches of compacted soil cover.
- Numerous ruts were repaired in the EBG and TNT MfA through regarding and seeding.
- Seven new protective warning signs with posts were placed in the BG area and six new signs were placed throughout the TNT MfA, to replace damaged or missing signs.
- Bollards were replaced and painted for three monitoring wells in the TNT MfA.

- The inlets and outlets of several drainage culverts at the TNT MfA were repaired by removing debris that had blocked the culverts and replacing the stone protection pads.
- Additional ACM that had been discovered at the ESI-8 area was removed and disposed offsite at a licensed landfill.
- Two guardrail gates were installed at the ESI-8 area to control access to the area.

FY03 O&M Repairs

The following repairs were conducted through a corrective measures contract (Contract No. DACW69-03-D-0007, Task Order No. 10, Sep. 2003):

- Numerous protective warning signs were replaced at the BG area.
- A culvert was repaired at TNT MfA Cap #6 through removal of debris and replacement of the stone protection pads.
- Rutted areas were repaired near the new caps at the Acid Fume Recovery House Caps near Lines 2, 3, and 4, through regarding and placement of compacted soil. Aggregate drains were also installed to relieve ponded water.
- Re-grading of the ditch at the WBG cap to alleviate a persistent standing water problem.

5.7 Current Site Conditions

During the most recent quarterly O&M inspection (March 21, 2005), and the FYR site inspection (August 6, 2004), no major deficiencies were noted. Repair work that was awarded in a FY03 contract was on-going during the FYR site inspection and had been delayed due to access problems. The corrective actions have since been completed and addressed tire rutting, minor erosion, sparse grass growth, and standing water problems that were noted during the FY03 inspection program.

During the tenth annual OU-1 LTMP investigation conducted during 2003 (Shaw, 2004), the intermediate and deep WBZs were sampled in the vicinity of the TNT MfA. Twelve wells were sampled; eight are screened in the intermediate WBZ and four are screened in the deep WBZ. Groundwater samples were analyzed for nitroaromatics only. Analysis of these data and data acquired during previous LTMP events, indicates that the intermediate WBZ has consistently exhibited levels of nitroaromatics exceeding the risk-based screening concentrations (RBSCs). The highest detected concentrations have been present in wells TNTGW-037 and TNTGW-016 (both are screened in the intermediate WBZ). Low level concentrations of nitroaromatics, below RBSCs, have been detected in all of the deep water-bearing zone wells, with some higher concentrations detected in TNTGW-036D. Further research is required to determine if nitroaromatics in the deep WBZ of the TNT MfA are the result of cross-contamination between the otherwise isolated (by confining media) aquifers. It is suspected that this may have occurred as a result of (early to mid 1980's) well construction techniques that may not have utilized isolation casing.

5.8 Technical Assessment

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

In order to answer this question, the three RAOs listed in Section 5.2 must be addressed to determine if they are being met by the remedial actions and subsequent actions taken.

1. RAO#1: To eliminate safety hazards associated with reactive wastes: remove or render non-reactive all reactive wastes - Yes: Gross contamination was removed or rendered non-reactive.

2. RAO#2: To achieve less than 10^{-6} individual lifetime, excess cancer risk for avid hunters and their families or friends who consume meat from game that feed in contaminated areas: remove or cover the upper 2 ft of soil if total nitroaromatic contamination exceeds 500 µg/g - Yes: Nitroaromatic compounds do not bioaccumulate in edible deer tissue or plants. If eating the secondary source (deer or other prey) does not present a complete pathway, then RAO#2 is met or moot. "Because of rapid excretion and lack of bioaccumulation in animals, it is unlikely that nitroaromatic compounds could be transferred between predator and prey animal species. Noting that the consumption of game is essentially a transfer of absorbed materials between trophic levels (biomagnification) and the lack of TNT accumulation in edible plant tissue and minimal potential for transfer to game species, it is clear that TNT exposure in humans via the food chain is exceedingly unlikely." (USACHPPM, March 2002).
3. RAO#3: To achieve less than 10^{-6} individual lifetime excess cancer risk for frequent visitors to the McClintic Wildlife Station who come into direct contact with surficial soils: remove or cover the upper 6 inches of soil if total nitroaromatic contamination exceeds 50 µg/g: The answer to this question is discussed in the answer to Question B (Section 5.8.2). The key words in this RAO are direct contact by a visitor - The risk ratio approach in these areas is for the maintenance worker, and that exposure level is assumed to be greater than or worst case of a visitor's exposure level. So, if the risk-ratio approach for untreated or uncapped COCs is less than 10^{-6}, then this RAO is met.

The remedy appears to be functioning as intended by the OU-1 ROD. However, groundwater was only vaguely addressed in the ROD and there may be impacts to groundwater due to waste being left in place rather than removed and treated or disposed. Additional capping was required to address areas of nitroaromatic contamination above ROD levels and areas of ecological concern, and was completed in 2001 (see section 5.5). Caps are maintained, mowed, and inspected as described previously. Institutional controls consist of a deed restriction that requires that the land only be used for wildlife management purposes and warning signs that prevent digging on each soil cover. Quarterly inspections of the soil covers allow sufficient time to detect and repair the covers prior to any type of catastrophic failure of the protective measures.

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

During this review, it was necessary to consider the four following types of assumptions made in the OU-1 ROD (USACE, 1987) and how those assumptions may differ at the present time:

- Standards and "to be considereds" (TBCs);
- Cleanup levels;
- Exposure pathways; and
- Toxicity and other contaminant characteristics.

Standards and TBCs

The RAOs table included in the OU-1 Feasibility Study (ESE, 1986b) and in the ROD is included as Table 5-2. However, the Feasibility Study (FS) states that Category 1 remedial alternatives were developed to meet Resource Conservation and Recovery Act (RCRA) requirements, Category 2 remedial alternatives complied with "laws, regulations, and criteria (which) may include RCRA, Safe Drinking Water Act (SDWA), Clean Air Act (CAA), Clean Water Act (CWA), Department of Transportation (DOT) Hazardous Materials Transport Rules, USEPA Ground Water Protection Strategy, and appropriate Federal public health and environmental requirements" (ESE, 1986b), and Category 3 alternatives exceeded the same standards. No ARARs are listed for Category 4 or 5

alternatives. The remedial alternatives were primarily evaluated on the bases of "environmental, public health, and cost criteria" (ESE, 1986b) and ability to achieve acceptable risk levels. Based on this evaluation, the alternative selected in the OU-1 ROD is the remedy described in Section 5.4. No changes to any of the standards shown in Table 5-1 were found that would change the selected alternative.

The WVOW Tier 1 team agreed that groundwater must be returned to its beneficial use, in accordance with USEPA's groundwater policy. This requires cleanup of groundwater where there is no plan for it to be a source of residential drinking water, due to its location on the MWMA and deed prohibitions restricting that land to wildlife management use only.

A RI/FS of the Southeast Area Soils and Groundwater, designated as OUs-8 and 9, respectively, is ongoing. The results of the RI/FS are expected to apply to much, if not all, of OU-1. This includes determining soil-to-groundwater leaching characteristics that may drive cleanup of contaminated soil that was left in place under the OU-1 ROD and treatment of groundwater not explicitly addressed in the OU-1 ROD.

Cleanup Levels

According to the OU-1 Endangerment Assessment (ESE, 1986c), cleanup levels identified in the OU-1 ROD (USACE, 1987) were calculated by the Preliminary Pollutant Limit Value (PPLV) method in which each significant source-to-receptor pathway was quantified and the effects combined to ensure that an exposed individual would not receive an unacceptably large dose. The PPLVs were then used as remedial objectives for OU-1. The PPLV methodology is very different from USEPA's Risk Assessment Guidance for Superfund (RAGS), (USEPA, 1989). Also, risk-based concentrations (RBCs), reference doses (RfDs), and slope factors (SFs) have been created or changed since the preparation of the OU-1 ROD.

Ecological screening evaluations for APECs have been conducted using USEPA ecological screening and assessment guidance that became available after the OU-1 ROD was signed. Corrective actions performed to address ecological and human health concerns within the TNT MfA portion of APEC 3 and the BG portion of APEC 4 are discussed in Section 5.5. The risk assessors recommended no additional consideration of potential ecological risks within APEC 4 (IT, 1998c).

All incremental lifetime cancer risks (ILCRs) and hazard indices (HIs) were recalculated in accordance with RAGS using assumptions previously accepted by USEPA in the Baseline Human Health Risk Assessment (BHHRA) for the former TNT MfA (IT, 2002). RAOs were substituted for maximum detected concentrations (MDCs) in the risk-ratio screening process. The results of this human health risk evaluation are shown in Tables 5-3 through 5-14. The receptors evaluated were a construction worker and a maintenance worker, as accepted for the TNT MfA BHHRA. As in the OU-1 ROD, the compounds evaluated for the FYR follow:

- 2,4,6-TNT
- 1,3,5-TNB
- 1,3-DNB
- 2,4-DNT
- 2,6-DNT
- Total nitroaromatics

Also as performed for the OU-1 ROD, the following media were evaluated:

- McClintic soils (0.5-2 ft)
- Pond waters
- Pond sediments
- Surficial soils

For the FYR, each compound's effect for each medium on each receptor (i.e. construction worker and maintenance worker) was evaluated. The frequent site visitor was addressed in the OU-1 ROD by developing surficial soil levels for nitroaromatic compounds, however the maintenance worker scenario would be more conservative. That is, levels protective of the maintenance worker in the FYR evaluation would also be overly protective of a frequent site visitor. In order to evaluate the total nitroaromatics cleanup levels, each parameter singly was assumed to be present at that total concentration (i.e. a single nitroaromatic compound comprised 100% of the total nitroaromatics). For example, for the McClintic soils level of 500 ppm total nitroaromatics in the ROD, TNT and total DNT were each evaluated at a level of 500 ppm for cancer risk. Remedial objectives for total nitroaromatics in pond water and pond sediments were not included in the ROD, and therefore could not be evaluated during this review. Protectiveness is assumed when ILCRs are less than $5x10^{-5}$ and HIs are not greater than 1 Based on the technical analysis that was conducted for the FYR as described above, it was determined that not all of the ROD cleanup levels are protective of human health.

All of the OU-1 ROD levels are protective with respect to cancer risks for a construction worker (Tables 5-3 through 5-8). For a maintenance worker, the ROD levels for 2,4,6-TNT in McClintic soils and total DNT nitroaromatics of 500 µg/g in McClintic soils exhibit ILCRs of $8x10^{-5}$ (Table 5-9) and $2x10^{-6}$ (Table 5-10), respectively, and are therefore not protective for cancer risks. All other ROD levels are protective for cancer risks for a maintenance worker (Tables 5-10 through 5-14).

For non-cancer risks for an exposed construction worker, only the pond water (Table 5-5) and pond sediment (Table 5-6) ROD levels are protective. HIs for the other media (Tables 5-3, 5-4, 5-7, and 5-8) range from 2 for 50 ppm total nitroaromatics in surface soil (primarily due to 1,3-DNB; Table 5-8) to 181 for McClintic soils (primarily due to TNT at 7,300 ppm; Table 5-3). It is noted that the HI for pond water is 1.2 (Table 5-6), but was rounded to 1 to achieve one significant figure during this evaluation. For non-cancer risks for an exposed construction worker, the ROD levels for McClintic soil (Table 5-9), 500 ppm total nitroaromatics in McClintic soil (Table 5-10), and surficial soils (Table 5-13) are not protective. The ROD levels for pond sediments (Table 5-11), pond water (Table 5-12), and 50 ppm total nitroaromatics in surficial soils (Table 5-14) are protective for non-cancer risks posed to construction workers, as the HIs are less than 1.

Exposure Pathways

Most of the exposure pathway assumptions included in the OU-1 ROD are still accurate and valid. All of the OU-1 area is included in the MWMA boundary, and was deeded to the State of WV with the stipulation that the land only be used for wildlife management purposes or else ownership reverts back to the federal government. Land use has not changed significantly, nor have any new human health or ecological routes of exposure been discovered. However, ecological exposure was not adequately addressed in the ROD (USACE, 1987), as no ecologically-protective values for remediation were derived. Nitroaromatic levels in groundwater are not included in the ROD, although a vague requirement for monitoring of groundwater is mentioned. In the Endangerment Assessment (ESE, 1986c) and in the ROD (USACE, 1987), migration from soil to groundwater was dismissed because no residents may build in the area of contaminated groundwater. However, USEPA policy now states that all groundwater shall be returned to beneficial use, although "beneficial use" needs to be clearly defined. Soil contamination leaching to groundwater used for potable water as a beneficial use is still

a hypothetically-complete exposure pathway. Groundwater migration into surface water was not addressed by the OU-1 ROD, for human health or ecological receptors. The industrial wastewater sewer line (IWSL) was excavated and flashed in accordance with the ROD to eliminate reactive wastes, but soil below the IWSL that may have been impacted by leaks from the line was not addressed. Lastly, only a limited number of nitroaromatic compounds are addressed in the ROD. Additional nitroaromatic compounds that are presumably linked to the TNT production process have been detected at the site and may be at levels that cause unacceptable risks.

Toxicity and Other Contaminant Characteristics

The current RfDs and SFs were retrieved from USEPA Integrated Risk Information System (IRIS) Database for Risk Assessment (http.//www.epa.gov/IRIS); these values were used in the risk assessments discussed above.

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

Yes. As discussed in the response to Question B, the definition of "beneficial use" of groundwater needs to be clearly defined. No other information has come to light that calls into question the protectiveness of the remedy.

5.9 OU-1 Protectiveness Statement

The remedy at OU-1 may not protect human health and the environment in the short-term or in the long-term, based on the risk evaluation discussed in Section 5.8.2. Specifically, ROD levels for McClintic soils and surficial soils are not protective. The remedial action taken at OU-1 may have been protective based on what was known at that time, but new ROD levels should be calculated in order to determine if those actions would still be considered protective.

Risk evaluation aside, it appears that the actions taken were otherwise protective in the short-term because two-foot thick soil covers have been placed over areas in the BG and TNT MfA to prevent direct contact with nitroaromatic-contaminated soil, per the OU-1 ROD determinations. Reactive TNT residue on the ground surface and within the industrial sewer lines has been flamed, which eliminated the reactivity hazard. Furthermore, asbestos-contaminated soils within the WBG have been covered with two-foot protective soil covers to prevent exposure to humans and the environment. For the remedy to remain protective in the long-term, however, continued O&M of the soil covers and protective warning signs is required to prevent human and ecological exposure to the contaminated soil that remains in place. Remedies which eliminate the need for the protective soil covers, i.e., source removal, *in situ* bioremediation, and/or *ex situ* composting of the nitroaromatic-contaminated soil, would also help achieve long-term protectiveness and could provide for unrestricted site use. To achieve this goal, the asbestos-contaminated soil would have to be removed from beneath the WBG area protective soil cover. This removal action may be too costly to propose or fund in the near term. Given the relatively low O&M costs involved with soil cover maintenance, a cost comparative analysis would have to be performed and a management decision made regarding the disposition of the ACM beneath the WBG cover.

6.0 OPERABLE UNIT 2

6.1 Site Description

OU-2 currently consists of the Red Water Reservoir (RWR) and vicinity. However, the OU-2 ROD addresses the RWR, the Yellow Water Reservoir (now designated OU-3), the Groundwater Pump & Treat System (OU-4), and the Pond 13/Wet Well Area (OU-5). Each of these was formerly part of OU-2, which was divided into these four OUs for administrative purposes a few years after the ROD was signed. The RWR area is located in the northwest corner of the MWMA, south of Potter Creek Road (County Road 11), and west of the Magazine Area. The three former reservoirs had a combined capacity of 30 million gallons and occupied approximately 17 acres. Private residences and a Christmas tree farm operation are located within 2,500 feet west of the former RWR area (WCC, 1994). Like most of the former WVOW property, the RWR area's use was agricultural prior to acquisition.

The RWRs were constructed for WVOW operations to provide temporary storage of the "red water" wastes when flow in the Ohio River was too low to provide adequate dilution of the wastewater. When river flow increased, the red wastewater was pumped to the river for disposal. A 1:20,000 dilution was required for discharge to the Ohio River. The red wastewater was pumped from the Wastewater Pumping Station at the current Pond 13 to RWR No. 2 (Pond 2; the center reservoir). The wastewater was eventually discharged from the southeast corner of RWR No. 3 (Pond 1; the southern-most reservoir) via a sewer to the Ohio River. The portion of the discharge line approximately 1,250 feet west of RWR No. 3 traverses under private property. Records indicate that RWR No. 1 was not used; it may have been unable to hold water, or could have been used as an overflow reservoir for RWR Nos. 2 and 3 (ESE 1986).

The only COCs identified for the RWR in OU-2 ROD Table 1 were nitroaromatic compounds. Pond sediments exhibited total nitroaromatics up to 2210 µg/g and groundwater had total nitroaromatics up to 100 µg/L.

6.2 Remedial Objectives

Following the detailed analysis of the five alternatives, the preferred remedy for OU-2 (RWR Area) was Alternative 4A, which was chosen to satisfy the RAOs as excerpted from the OU-2 ROD, Section F·

> "The major objectives of remedial action to be taken at the West Virginia Ordnance Works Site include the removal of soil contaminants to protective levels; the minimization of the amount of hazardous substances leaching into the groundwater and the treatment of groundwater to protective levels. The levels that were developed are based on standards that were available for the specific chemical, or developed with respect to the 10-6 cancer risk, that is one person in one million adversely affected."

The RAO addressing groundwater is not further discussed in Section 6.2, but in Section 8.2 which covers OU-4, the system which treats groundwater from OU-2. Table 6-2 presents the remedial objectives for the second operable unit, per Table 4 from the OU-2 Record of Decision.

Note that these ROs were developed only to protect human health, and do not address ecological concerns. A SLERA was performed for all areas within the NPL boundary and the site divided into five APECs. OU-2 falls within APEC 1, for which no further action was recommended (IT, 1998a).

6.3 Remedy Selection

The major objectives of the remedial action include the following:

1. the removal of soil contaminants to protective levels;
2. the minimization of the amount of hazardous substances leaching into the groundwater; and
3. the treatment of groundwater to protective levels.

Technologies that were evaluated to achieve the RAOs for OU-2 were grouped into the following four categories and were applicable to each area defined in OU-2 (RWR, YWR, and Pond 13/Wet Well Area):

- Excavation and Incineration;
- Excavation and Landfilling;
- Containment and Institutional Controls; and
- No Action

As specified by USEPA policy and interim guidance on compliance with the NCP and CERCLA, as amended by SARA, remedial action alternatives that were developed ranged from alternatives that eliminated the need for long-term O&M to alternatives that involved treatment to reduce toxicity, mobility, or volume. A containment option, which involved little to no treatment, was also developed.

The alternatives that were developed and analyzed for the RWR Area of OU-2 were:

- Alternative 2A – excavation of contaminated soils for onsite incineration and activated carbon treatment of groundwater removed by extraction wells, with direct discharge to Mill Run.
- Alternative 3A – Excavation of contaminated sediments from the former RWR with disposal in an onsite landfill and activated carbon treatment of groundwater removed by extraction wells, with direct discharge to Mill Run.
- Alternative 4A – Placement of a RCRA cover over contaminated RWR sediments and activated carbon treatment of groundwater removed by extraction wells, with direct discharge to Mill Run.
- Alternative 5A – No action, with long-term groundwater monitoring.

SARA and the NCP established various requirements pertaining to the evaluation of remedial action alternatives under CERCLA. The following nine criteria were used in the evaluation of the remedial action alternatives for OU-2:

- Overall protection of human health and the environment
- Compliance with ARARs
- Long-term effectiveness and permanence
- Short-term effectiveness
- Implementability
- Cost
- State acceptance
- Community acceptance

The OU-2 ROD was signed by the USEPA in September 1988 and contained recommended remedial actions for the YWR, Pond 13/Wet Well Area, and the RWR. Between November 1992 and March 1993, the YWR and the Pond 13/Wet Well areas were re-designated as OUs-3 and 5, respectively, and

the RWR remained as OU-2. Remedial actions for the current OU-2 are addressed under the OU-2 ROD, OU-4, and OU-6 (re-designated as Environmental Unit 6, ENV-6). OU-4 is the groundwater extraction and treatment component of the OU-2 ROD. ENV-6 is the wetlands mitigation component for the OU-1, 2, and 3 remedial actions.

The USEPA determined that the preferred alternative provided the best balance of tradeoff with respect to the nine evaluation criteria, and that they anticipated the preferred alternative would meet the following statutory requirements:

- Protect human health and the environment
- Attain ARARs
- Be cost-effective
- Utilize permanent solutions and alternative treatment (or resource recovery) technologies to the maximum extent practicable.

The preferred remedy for OU-2 (RWR Area) was Alternative 4A, which contained the following remedial actions to satisfy the RAOs, as excerpted from the OU-2 ROD, Section J.2.b (USACE, 1988):

> "This alternative will provide protection of human health and the environment by containing sediment contamination and eliminating further contamination of the ground water aquifer via the sediments in the ponds. Not only will the ground water contamination pathway be mitigated, but exposure to the sediments will also be prevented once the ponds are filled with clean fill. The extraction system will remove contaminants from the ground water and act to improve the quality of the aquifer. This alternative is also beneficial as new ponds will be created to provide recreation and wildlife activities.
>
> This alternative will achieve the contaminant-specific ARARS by mitigating the contamination pathway and treating the ground water until the standard is achieved. The effluent from the treatment system will meet the surface water criteria and will be operated and monitored to maintain compliance. The site-specific ARARs will be achieved through the replacement of the ponds and the eventual use of the ponds for recreation and the promotion of wildlife.
>
> This alternative is cost-effective in that it meets the ARARs and response objectives for about one-sixth the capital cost of the next least costly acceptable alternative. The long-term O&M cost is similar to that for the other alternatives.
>
> Although this alternative does not provide destruction or removal of the contaminants in the sediments, it does provide protection and the reduction of further aquifer contamination. The extraction and treatment of the ground water is a permanent treatment remedy and will eventually act to restore the ground water."

Since the OU-2 remedy consisted of the placement of protective soil covers and the construction and operation of a groundwater treatment system to satisfy the RAOs, periodic O&M inspection of the soil cover, and long-term O&M of the groundwater treatment system (including groundwater water monitoring) were required to assure that no exposure to contaminated soils and groundwater occurred, that contaminants did not migrate, and that groundwater remediation goals are eventually met.

6.4 Remedy Implementation

The protective soil and clay covers (closure caps) were designed and constructed by OHM through contracts administered by the USACE Omaha and Huntington Districts. Design and construction work plans were prepared by OHM, and reviewed and approved by USACE and USEPA between June 1991 and May 1992. The covers were designed in accordance with RCRA closure cap requirements, and were designed so as to minimize the amount of hazardous substances leaching into the groundwater (e.g. a 24-inch thick clay cap, permeability of 1 x 10^{-7} cm/sec).

USACE provided the notice to proceed for construction of the protective soil covers in February 1991. Sampling was conducted to determine the extent of the cap, and the concentration of contaminants in Pond 1 water. Chemical and geotechnical testing was conducted on the clay borrow material, which was obtained from within the MWMA area but outside any known former WVOW manufacturing areas. RWR Pond No. 1 was dewatered prior to construction; RWR Pond No. 2 was dry. Following stabilization of the sediments, the closure caps were constructed. Final walkthrough inspection of the closure caps was conducted by representatives of the USACE and OHM on September 24, 1992. Minor erosion problems were noted and repaired by OHM. The construction contractor demobilized from the site on September 30, 1992. The final as-built report (OHM, 1993) for the RWR closure cap construction was submitted March 1993.

6.5 Follow-up Actions

No follow up actions (e.g. supplemental investigation, corrective actions, etc.) other than routine O&M of the caps (as discussed in Section 6.6.2) has been performed for OU-2.

6.6 System Operations/O&M

Refer to section 5.6 for discussion concerning system operations/O&M. O&M costs since the last FYR follow:

OU-2 O&M Costs ($1,000s)

	FY99	FY00	FY01	FY02	FY03	FY04
In-house labor	$18.9	$19.6	$17.5	$9.5	$7.9	$11.1
Contract	N/A *	N/A *	$4.7	$8.6	$5.8	$7.6

* O&M contract costs for FY99 and FY00 are not adequately reflected in the FUDSMIS database

Future O&M costs are expected to be similar, with an allowance for escalation due to inflation, unless the source areas are removed.

6.6.1 Quarterly Site Inspections and Corrective Actions Taken

Refer to section 5.6.1 for discussion of quarterly site inspections and corrective actions taken.

6.6.2 Operation and Maintenance Repairs

FY00 O&M Repairs

The following repairs were conducted through a corrective measures contract (Contract No. DACW69-00-D-0021, Task Order No. 2, Aug. 2000):

- Five groundhog burrow holes in the Pond 1 soil cap were repaired by "plugging" the holes with a bentonite clay slurry, covering with one foot of compacted soil, and seeding and mulching following bentonite setup.
- Three groundhog burrow holes in the Pond 2 soil cap were repaired as discussed above
- Vent Riser D on Pond 2 soil cap was repaired to replace the vent that had been broken off above grade.
- Two protective warning signs were replaced.

FY03 O&M Repairs

The following repairs were conducted through a corrective measures contract (Contract No. DACW69-03-D-0007, Task Order No. 10, Sep. 2003):

- Three groundhog burrow holes in the Pond 2 soil cap were repaired by "plugging" the holes with bentonite clay slurry, covering with one foot of compacted soil, and seeding and mulching following bentonite setup.
- An approximate 100 square foot area on Pond 1 soil cap was repaired to remove depressions and "pock marks". Vegetation was stripped, the area was filled and graded to the existing contour with clean soil borrow material, compacted with a rubber-tired roller, and then seeded and mulched.
- All eight protective warning signs were replaced (four on each soil cap).

6.7 Current Site Conditions

During the most recent quarterly O&M inspection (March 12, 2005), and the FYR site inspection (August 6, 2004), no major deficiencies were noted in the OU-2 caps.

6.8 Technical Assessment

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

In order to answer this question, the ROs listed in Section 6.2 must be addressed to determine if they are being met by the remedial actions and subsequent actions taken.

1. RO#1: The removal of soil contaminants to protective levels – Yes: Soil contaminants have been covered by RCRA caps.
2. RO#2: The minimization of the amount of hazardous substances leaching into the groundwater – Inconclusive: This cannot be determined by the results of the long-term monitoring program (LTMP), at this time. LTMP monitoring will assist to continue to evaluate this RO.
3. RO#3: The treatment of groundwater to protective levels – Discussed in Section 8.8.1.

The remedy appears to be functioning as intended by the OU-2 ROD. Caps are maintained, mowed, and inspected as described previously in this section. Institutional controls consist of a deed restriction that requires that the land only be used for wildlife management purposes and warning signs located

on each soil cover. Quarterly inspections of the caps allow sufficient time to detect and repair the covers prior to any type of catastrophic failure of the protective measures.

Using information gained from the recently-completed composting pilot project, the feasibility of excavating and composting nitroaromatic-contaminated material from beneath the caps will be evaluated as a potential permanent remedy (i.e. remove and treat the source). During the eighth annual LTMP sampling event (Shaw, 2004), no surface water or sediment samples were collected in the RWR area. This is because analytical results from sediment and surface water samples collected during the four previous events and supplementary investigations indicated no detectable nitroaromatic compounds. Fourteen wells were sampled as part of the 2003 LTMP (Shaw, 2004) at OU-2; four of these monitor the deep WBZ, while ten of these monitor the intermediate WBZ. The shallow WBZ is present in the RWR area. Nitroaromatic compounds were not detected in the deep wells sampled. Nitroaromatics were detected in seven of the intermediate WBZ wells (six are down gradient of the RWR) at concentrations exceeding RBSCs or ROD criteria; groundwater is being extracted and treated via the OU-4 system.

Most of the nitroaromatic concentrations in ground water in this area have remained fairly stable with no overall increasing or decreasing trend observed throughout the eight LTMP events Due to the chemical properties of the nitroaromatic compounds, (see the fate and transport analysis performed in the RSE, HTRW CX, 2004), these contaminants will move much more slowly than ground water. Consequently, decreasing contaminant trends are expected to occur well into the future (or if the RSE predicted a contaminant flow rate use this prediction here as to when we should start seeing a decrease in contaminant concentrations), making it premature to interpret whether the caps adequately minimize the leaching of contaminants from soils to ground water and draw a definitive conclusion with respect to their protectiveness of groundwater, at this time. Irrespective, the stringent RCRA standards that the cap's design and construction were required to meet and quarterly inspections which verify that the structural integrity of the cap is maintained, would suggest that the cap is minimizing infiltration of precipitation and leaching of contaminants to ground water.

6.8.2 Question B: Are the exposure assumptions, toxicity data, cleanup levels, and RAOs used at the time of the remedy still valid?

During this review, it was necessary to consider the four following types of assumptions made in the OU-2 ROD (USACE, 1988) and how those assumptions may differ may differ at the present time:

- Standards and "to be considereds" (TBCs);
- Cleanup levels;
- Exposure pathways; and
- Toxicity and other contaminant characteristics

Standards and TBCs

The Applicable or Relevant and Appropriate Requirements (ARARs) table included in the OU-2 ROD (USACE, 1988) is included as Table 6-1. No changes to any of the standards were found that would change the OU-2 remedial objectives, as shown in Table 6-2.

As stated in Section 6.2, only soil RAOs are addressed in this section. The groundwater RAO is discussed in Section 8.2.

Cleanup Levels

According to the OU-2 Endangerment Assessment (ESE, 1987), remedial objectives identified in the OU-2 ROD (USACE, 1988) were calculated by the PPLV method, in which each significant source-to-receptor pathway was quantified and the effects combined to ensure that an exposed individual would not receive an unacceptably large dose. The PPLVs were then used as remedial objectives for OU-2, unless other ARAR-driven values were more stringent. The PPLV methodology is very different from USEPA's RAGS (USEPA, 1989). RfDs and SFs have been created and/or changed since preparation of the OU-2 ROD. The OU-2 ROD mentions that MCLs (specific to human potable water supply) are ARARs for the RWR, but there are currently no MCLs for the nitroaromatics addressed in the ROD (i.e. TNT, 2,4-DNT, 2-6-DNT, 1,3-DNB, and 1,3,5-TNB).

Ecological screening evaluations for APECs have been conducted using USEPA ecological screening and assessment guidance that became available after the OU-2 ROD was signed. APEC 1 includes the RWR. Given the evidence that concentrations and potential risks of APEC 1 inorganic analytes identified in the 1998 SLERA addendum as being of ecological concern were within or similar to WVOW background levels and risks, it was recommended that no further ecological studies were recommended for at APEC-1 (IT, 1998a). Since ecologically-protective cleanup levels were not developed, they could not be re-evaluated as part of this review.

All remedial objectives were recalculated in accordance with RAGS using assumptions previously accepted by USEPA in the Baseline Human Health Risk Assessment for the Former TNT Manufacturing Area (IT, 2002). RAOs were substituted for MDCs in the risk-ratio screening process. The results of this human health risk assessment are shown in Tables 6-3 through 6-8. The receptors evaluated were a construction worker, a maintenance worker, and an on-site resident. The last receptor was evaluated only for groundwater used for drinking water. As in the OU-2 ROD, the compounds evaluated for the FYR follow:

- 2,4,6-TNT
- 1,3-DNB
- 1,3,5-TNB
- 2,4-DNT
- 2,6-DNT
- Total nitroaromatics

Also as performed for the OU-2 ROD, the following media were evaluated:

- Ground water used as drinking water (on-site resident only)
- Soils, industrial land use (maintenance worker and construction worker only)
- Surface water, McClintic (maintenance worker and construction worker only)

For the FYR, each compound's effect for each medium on each receptor (i.e. construction worker, maintenance worker, and on-site resident using groundwater as drinking water) was evaluated In order to evaluate the total nitroaromatics cleanup levels, each parameter singly was assumed to be present at that total concentration (i.e. a single nitroaromatic compound comprised 100% of the total nitroaromatics). For example, for the soils level for industrial land use of 200 ppm total nitroaromatics in the ROD, TNT and total DNT were each evaluated at a level of 200 ppm for cancer risk. Protectiveness is assumed when ILCRs are less than $5x10^{-5}$ and HIs are not greater than 1. Based on the technical analysis that was conducted for the FYR as described above, it was determined that some of the ROD cleanup levels may not be protective of human health.

All of the OU-2 ROD levels are protective with respect to cancer risks for a construction worker (Tables 6-3 through 6-5) and a maintenance worker (Tables 6-6 through 6-8). It is noted that the ILCR for a maintenance worker for soils for industrial land use appears as $5x10^{-5}$ in Table 6-6, but was rounded up from $4.6x10^{-5}$. Evaluation of the ROD levels for an on-site resident using groundwater as drinking water is discussed under OU-4 in Section 8.8.2.

For non-cancer risks for an exposed construction worker and maintenance worker, individual nitroaromatic (Tables 6-3 and 6-9, respectively) and total nitroaromatic (Table 6-4 and 6-10, respectively) ROD levels for soil for industrial land use are not protective. It is noted that the ILCR for both receptors for surface water is 1.3, but was rounded to 1 for purposes of this evaluation (Table 6-5). Non-cancer risks associated with groundwater used for drinking are discussed under OU-4 in Section 8.8.2.

Exposure Pathways

The assumptions seem to be correct at this time. Capping of the RWR in accordance with the OU-2 ROD eliminated human health and ecological exposure pathways to contaminated surface water and sediments. Groundwater is discussed in Section 8.8.2. Land use has not changed significantly, nor have any new human health or ecological routes of exposure been discovered.

Toxicity and Other Contaminant Characteristics

The current RfDs and SFs were retrieved from IRIS (http://www.epa.gov/IRIS); these values were used in the risk assessments discussed above.

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

No additional information has come to light that calls into question the protectiveness of the remedy

6.9 OU-2 Protectiveness Statement

The remedy at OU-2 may not protect human health and the environment in the short-term or in the long-term, based on the risk evaluation discussed in Section 6.8.2. Specifically, ROD levels for soils for industrial land use are not protective for non-cancer risks. The remedial action taken at OU-2 may have been protective based on what was known at that time, but new ROD levels should be calculated in order to determine if those actions are still protective.

Risk evaluation aside, it appears that the actions taken were otherwise protective in the short-term because the remedy (RCRA soil caps) has been found to be well-maintained and functioning in accordance with the OU-2 ROD, and is therefore preventing human and ecological exposure to the contaminated sediments that lie beneath the caps. In order for the remedy to be protective in the long-term, however, inspection, maintenance, and repair of the protective RCRA soil caps and warning signs, in conjunction with long-term groundwater monitoring, must continue for as long as the caps are in place. Remedies which eliminate the need for the protective soil caps (i.e., source removal, in-situ bioremediation, and/or composting of the nitroaromatic-contaminated soil) could also help achieve long-term protectiveness and provide for unrestricted site use. The protectiveness statement concerning the groundwater remedy at OU-2 (i.e. the OU-4 groundwater extraction and treatment system) is contained in Section 8.9.

7.0 OPERABLE UNIT 3

7.1 Site Description

OU-3 consists of the YWR, the Barren Area, and vicinity. The OU-2 ROD addresses this area, but OU-2 was later administratively divided into OUs-2, 3, 4, and 5. The YWR area is located in the central region of the former WVOW. The area is bounded to the east by the former PDP property and the MWMA boundary, to the south by Wadsworth Road (County Road 12) and the former industrial park area (current Army property), and to the west by the former North Acids Area. The YWR had a capacity of 5 million gallons and occupied approximately 3.5 acres. Like most of the former WVOW property, the YWR area's use was agricultural prior to acquisition (USATHAMA, 1979; ESE, 1984). The West Virginia State Farm Museum and Mason County Fairgrounds are located within 2,500 to 3,500 feet northwest of the former YWR. The WVDNR office for MWMA management personnel is located approximately 1,500 feet northeast of the YWR, with one residence present. Water is provided to these locations from the Point Pleasant Public Water Supply. There are no other residences located at or within close proximity of the YWR area.

The YWR was constructed in 1942 to provide temporary storage of "yellow water" that was produced as a by-product of the TNT manufacturing process. The yellow wastewater was pumped to the YWR from the Wastewater Pumping Station at the current Pond 13, neutralized with lime, and discharged via an underground sewer to Mill Run, a tributary of the Ohio River. Neutralized yellow wastewater was discharged so that dilution would not be less than 1:10,000 (ESE, 1984).

In 1960, the YWR Area was sold to private owners, and the site was later developed into an industrial park (ESE, 1984). The US Army purchased the industrial park in 1989 as part of the OU-2 ROD requirements. A cooperative agreement was signed in December 1988 between the Army and the State of West Virginia for transfer of the property to the state, and incorporation into the MWMA boundary, following successful completion of the remedial action.

The COCs identified for the YWR in OU-2 ROD Table 1 included nitroaromatic compounds and lead. TNT was found in soil at 1% in one small area. Lead was found at a maximum of 100 µg/g in soil. Total nitroaromatics were detected in groundwater as high as 60 µg/L.

7.2 Remedial Objectives

Following the detailed analysis of the alternatives, the preferred remedy for OU-3 (YWR area) was Alternative 4A, which was chosen to satisfy the RAOs as excerpted from the OU-2 ROD, Section F:

> "The major objectives of remedial action to be taken at the West Virginia Ordnance Works Site include the removal of soil contaminants to protective levels; the minimization of the amount of hazardous substances leaching into the groundwater and the treatment of groundwater to protective levels. The levels that were developed are based on standards that were available for the specific chemical, or developed with respect to the 10^{-6} cancer risk, that is one person in one million adversely affected."

Table 6-2 presents the remedial objectives for the third operable unit, per Table 4 from the OU-2 Record of Decision.

Note that these ROs were developed only to protect human health, and do not address ecological concerns. A SLERA was performed for all areas within the NPL boundary and the site divided into five APECs. OU-3 falls within APEC 2, for which no further action was recommended (IT, 1997b).

7.3 Remedy Selection

The major objectives of remedial action taken included:

1. the removal of soil contaminants to protective levels;
2. the minimization of the amount of hazardous substances leaching into the groundwater; and
3. the treatment of groundwater to protective levels.

The OU-2 ROD included remedial actions for the YWR Area. After ROD approval, the YWR area was designated as OU-3. The groundwater remedy for the OU-3 area is designated as OU-4. The remedial alternatives' objectives and technologies that were evaluated to achieve the RAOs for OU-3 were the same as for OU-2. Refer to Section 6.3 for discussion.

The remedial alternatives that were developed and analyzed for the YWR Area of OU-3 included:

- Alternative 1A – Excavation of contaminated soils/sediments for offsite incineration and activated carbon treatment of groundwater removed by extraction wells, with direct discharge to Mill Creek.
- Alternative 2A – Excavation of contaminated soils/sediments for onsite incineration and activated carbon treatment of groundwater removed by extraction wells, with direct discharge to Mill Creek.
- Alternative 3A – Excavation of contaminated soils/sediments and disposal in an offsite landfill and activated carbon treatment of groundwater removed by extraction wells, with direct discharge to Mill Creek.
- Alternative 4A – Purchase of the industrial park area (which encompasses the area of contamination), placement of a protective RCRA soil (clay cap) cover over contaminated YWR sediments, incorporation of the former industrial park area into the existing MWMA, and activated carbon treatment of groundwater removed by extraction wells, with direct discharge to Mill (Run) Creek.
- Alternative 5A – No Action, with long-term groundwater monitoring.

The same nine evaluation criteria were used in the evaluation of the remedial action alternatives for OU-3 as were used for OU-2 Refer to Section 6.3 for discussion.

Following the detailed analysis of the five alternatives, the preferred remedy for OU-3 (YWR Area) was Alternative 4A, which contained the following remedial actions to satisfy the RAOs, as excerpted from the OU-2 ROD, Section J.2.a:

> "...the purchase of lands within the area encompassing the contamination, placing 1 2-ft soil cover over the contaminated area, incorporating the area into existing wildlife preserve, and extracting and treating ground water.
>
> This alternative provides protection of human health and the environment by containing the nitroaromatic contaminants in soil therefore protecting against exposure. Although residual contamination will remain in the soils, as long as the soil cover remains intact, exposures to humans via the inhalation, skin contact, and ingestion pathways will be mitigated. Further protection is provided through the purchase of the land and the control of the use of the land by incorporating it as part of the wildlife preserve.

Through these institutional actions, development of the lands for industrial or residential use will be prohibited, and the contaminants will remain undisturbed.

The extraction and treatment of the ground water will mitigate this migration pathway and reduce the contamination in the aquifer. Potable water supplies will be protected through this action, and the local ground water will eventually be restored.

This alternative meets the contaminant, site, and action specific ARARs. Although contaminants are left in place, the redesignation of land use and the soil cover will meet the health-based criteria developed for nitroaromatics in soil. The ground water will be treated until the criteria for nitroaromatics are attained. Discharge from the ground water treatment system will achieve the stream standard and will be monitored to assure compliance.

This alternative is cost effective in comparison to the other alternatives evaluated. The capital cost of the alternatives is about two-thirds of the cost of the next least costly acceptable alternative and had about the same annaual (sic) O&M cost.

This alternative, however, does not provide permanent removal or destruction of the contaminants that remain in the soils. Although, through institutional controls and the soil cover, protection against a release which could be an endangerment is provided. The ground water treatment system, however, will provide permanent removal of the contaminant and restore the ground water resource over time."

Since the OU-3 remedy consisted of the placement of protective soil covers and the construction and operation of a groundwater treatment system to satisfy the RAOs, periodic O&M inspection of the soil covers and long-term O&M of the groundwater treatment system (including groundwater monitoring) was required to assure that no exposure to contaminated soils and groundwater occurred, that contaminants did not migrate, and that groundwater remediation goals are eventually met.

7.4 Remedy Implementation

The protective soil and clay covers (closure caps) were designed and constructed by OHM, through contracts administered by USACE Omaha and Huntington Districts. Design and construction work plans were prepared by OHM and reviewed and approved by USACE and USEPA between June 1991 and May 1992. The covers were designed in accordance with RCRA closure cap requirements, and were designed so as to minimize the amount of hazardous substances leaching into the groundwater (e.g. a 24-inch thick clay cap, permeability of 1×10^{-7} cm/sec).

USACE provided the notice to proceed for construction of the protective soil covers in February 1991. Chemical and geotechnical testing was conducted on the clay borrow material, which was obtained from within the MWMA area but outside any known former manufacturing areas.

The YWR was dewatered prior to construction. Following stabilization of the sediments, closure caps were constructed on the former YWR and on the Barren Area. Final walkthrough inspection of the closure caps was conducted by representatives of the USACE and OHM on September 24, 1992. Minor erosion problems were noted and repaired by OHM. The construction contractor demobilized from the site on September 30, 1992. The final as-built report for the YWR closure cap construction was submitted in March 1993.

7.5 Follow-Up Actions

No follow-up actions (e.g. supplemental investigation, corrective actions, etc.) other than routine O&M of the caps (as discussed in Section 7.6.2) has been performed for OU-3.

7.6 System Operations/O&M

Refer to section 5.6 for discussion concerning system operations/O&M. O&M costs since the last FYR follow:

OU-3 O&M Costs ($1,000s)

	FY99	FY00	FY01	FY02	FY03	FY04
In-house labor	$10.8	$7.2	$17.5	$9.5	$5.6	$10 9
Contract	N/A *	N/A *	$4.4	$2.6	$9.1	$5.6

* O&M contract costs for FY99 and FY00 are not adequately reflected in the FUDSMIS database

Future O&M costs are expected to be similar, with an allowance for escalation due to inflation, unless the source areas are removed.

7.6.1 Quarterly Site Inspections and Corrective Actions Taken

Refer to section 5.6.1 for discussion concerning quarterly site inspections and corrective actions taken.

7.6.2 O&M Repairs

FY00 O&M Repairs

The following repairs were conducted through a corrective measures contract (Contract No DACW69-00-D-0021, Task Order No. 2, Aug. 2000):

- Yellow Water Cap
  - two burrow holes repaired with bentonite plug
  - screen cap for gas venting Riser K replaced
  - one protective warning sign replaced
  - one ground depression repaired by stripping the grass cover and placing one foot of compacted soil cover and reseeding
- Barren Area Cap
  - one burrow hole repaired with bentonite plug
  - one protective warning sign replaced

FY03 O&M Repairs

The following repairs were conducted through a corrective measures contract (Contract No. DACW69-03-D-0007, Task Order No. 10, Sep. 2003):

- Yellow Water Cap:
  - A ground depression was repaired by stripping the grass cover and placing one foot of compacted soil. The area was then seeded and mulched.
  - A large burrow behind the 2nd vent riser was repaired by "plugging" the hole with bentonite, covering with one foot of compacted soil, and reseeding.
- Barren Area Cap - One burrow hole was repaired.
- Yellow Water Cap and Barren Area Cap - A protective warning sign was replaced at each area.

7.7 Current Site Conditions

No major deficiencies were noted in the OU-3 remedies during the most recent quarterly O&M inspection (March 12, 2005), or the FYR site inspection (August 6, 2004).

7.8 Technical Assessment

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

In order to answer this question, the ROs listed in Section 7.2 must be addressed to determine if they are being met by the remedial actions and subsequent actions taken.

1. RO#1: The removal of soil contaminants to protective levels – Yes: Soil contaminants have been covered by RCRA caps.
2. RO#2: The minimization of the amount of hazardous substances leaching into the groundwater – Inconclusive: This cannot be determined by the results of the long-term monitoring program (LTMP) at this time. LTMP monitoring will assist to continue to evaluate this RO.
3. RO#3: The treatment of groundwater to protective levels – Discussed in Section 8.8.1.

The remedy appears to be functioning as intended by the OU-2 ROD. YWR caps are maintained, mowed, and inspected as described previously in this section. Institutional controls consist of a deed restriction that requires that the land only be used for wildlife management purposes and warning signs on each soil cover. Quarterly inspections of the caps allow sufficient time to detect and repair the covers prior to any type of catastrophic failure of the protective measures.

Using information gained from the recently-completed composting pilot project, the feasibility of excavating and composting nitroaromatic-contaminated material from beneath the caps will be evaluated as a potential permanent remedy (i.e. remove and treat the source). During the eighth annual LTMP sampling event (Shaw, 2004), ten monitoring wells (six intermediate WBZ and four deep WBZ) were sampled near the YWR area. Nitroaromatics have shown generally stable concentrations in impacted wells over the LTMP investigations (Shaw, 2004). Groundwater is being extracted and treated via the OU-4 system.

Most of the nitroaromatic concentrations in ground water in this area have remained fairly stable with no overall increasing or decreasing trend observed throughout the eight LTMP events Due to the chemical properties of the nitroaromatic compounds, (see the fate and transport analysis performed in the RSE, HTRW CX, 2004), these contaminants will move much more slowly than ground water. Consequently, decreasing contaminant trends are expected to occur well into the future (or if the RSE predicted a contaminant flow rate use this prediction here as to when we should start seeing a decrease in contaminant concentrations), making it premature to interpret whether the caps adequately minimize the leaching of contaminants from soils to ground water and draw a definitive conclusion with respect

to their protectiveness of groundwater, at this time. Irrespective, the stringent RCRA standards that the cap's design and construction were required to meet and quarterly inspections which verify that the structural integrity of the cap is maintained, would suggest that the cap is minimizing infiltration of precipitation and leaching of contaminants to ground water.

7.8.2 Question B: Are the exposure assumptions, toxicity data, cleanup levels, and RAOs used at the time of the remedy still valid?

During this review, it was necessary to consider the four following types of assumptions made in the OU-2 ROD (USACE, 1987) and how those assumptions may differ may differ at the present time:

- Standards and TBCs
- Cleanup levels
- Exposure pathways
- Toxicity and other contaminant characteristics

Standards and TBCs

Since the OU-3 Yellow Water Reservoir was addressed in the OU-2 ROD, see the technical assessment section (7.8.2) for OU-2 for a discussion of standards and TBCs.

Cleanup Levels

Since the OU-3 Yellow Water Reservoir was addressed in the OU-2 ROD, see the technical assessment section (7.8.2) for OU-2 for a discussion of cleanup levels.

Ecological screening evaluations for APECs have been conducted using USEPA ecological screening and assessment guidance that became available after the OU-2 ROD was signed. YWR is included in APEC-2. A few CPECs (namely zinc within surface soils as associated with the American robin, antimony within sediment as associated with the belted kingfisher, and zinc within surface water as associated with the chironomid) exhibited elevated toxicity quotient (TQ) values. But, with use of a weight-of-evidence approach and best professional judgment, it seemed clear that given the CPEC concentrations and their apparent bioavailability to surrounding biota, they were not sufficiently elevated to significantly impair or disrupt the viability of APEC-2's natural biotic systems. The risk assessors therefore recommended that no further consideration of potential ecological risks be considered within APEC-2 of WVOW (IT, 1997b). Since ecologically-protective cleanup levels were not developed, they could not be re-evaluated as part of this review.

Exposure Pathways

The exposure pathway assumptions for OU-3 as stated in the OU-2 ROD are still accurate. All of the OU-3 YWR area is currently owned by the federal government. After OU-4 is declared Operating Properly & Successfully (OP&S), most of OU-3 will be deeded to the state of WV with the stipulation that the land only be used for wildlife management purposes or else ownership will revert back to the federal government. A portion of OU-3, the PDP building, is in the process of being transferred to the Mason County Development Authority (MCDA) for use as an economic incubator for new businesses. Restrictions within their lease and transfer agreements will preclude use of groundwater, and no areas of known soil contamination will be leased or transferred to the MCDA. Other than this, land use has not changed significantly nor has any new human health or ecological route of exposure been discovered. Groundwater is further discussed in Section 8.8.2.

Toxicity and Other Contaminant Characteristics

Since the OU-3 Yellow Water Reservoir was addressed in the OU-2 ROD, see the technical assessment section for OU-2 (Section 6.8.2) for a discussion of toxicity and other contaminant characteristics.

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

No additional information has come to light that calls into question the protectiveness of the remedy.

7.9 OU-3 Protectiveness Statement

The remedy at OU-3 may not protect human health and the environment in the short-term or in the long-term, based on the risk evaluation discussed in Section 7.8.2. Specifically, ROD levels for soils for industrial land use are not protective for non-cancer risks. The remedial action taken at OU-3 may have been protective based on what was known at that time, but new ROD levels should be calculated in order to determine if those actions are still protective.

Risk evaluation aside, it appears that the actions taken were otherwise protective in the short-term because the remedy (RCRA soil caps) has been found to be well-maintained and functioning in accordance with the OU-2 ROD, and is therefore preventing human and ecological exposure to the contaminated sediments that lie beneath the caps. In order for the remedy to be protective in the long-term, inspection, maintenance, and repair of the protective RCRA soil caps and warning signs and long-term groundwater monitoring must continue for as long as the caps are in place. Remedies which eliminate the need for the protective soil caps, i.e., source removal, in-situ bioremediation, and/or composting of the nitroaromatic-contaminated soil, could also help achieve long-term protectiveness and provide for unrestricted site use. The protectiveness statement concerning the groundwater remedy at OU-3 (i.e. the OU-4 groundwater extraction and treatment system) is contained in Section 8.9.

8.0 OPERABLE UNIT 4

8.1 Site Description

OU-4 consists of the RWR and YWR groundwater extraction and treatment systems. OU-4 also includes the Pond 13/Wet Well Area (P13/WWA), but the extraction wells in this area are not currently operating. The P13/WWA extraction wells discharge into the YWR Treatment Plant (YWRTP). The treatment buildings and groundwater extraction wells are located in close proximity to the former wastewater holding reservoirs. The RWR Treatment Plant (RWRTP) is located approximately 1,800 feet east of State Route 62, south of Potters Creek Road (County Road 11), and the YWRTP is located approximately 1 mile east of SR 62, just north of Wadsworth Road (CR 12).

Both plants utilize granular activated carbon treatment units to adsorb nitroaromatics from the extracted groundwater. The RWRTP currently utilizes five groundwater extraction wells (Figure 8-1), extracting groundwater from the intermediate WBZ. Another five extraction wells had been installed in the deep WBZ, paired with the intermediate extraction wells; however, they are not being utilized per recommendations contained in the Sitewide Hydrogeological Study (IT, 1996). That study determined that the deeper extraction wells could pull contamination from the upper aquifer to the lower zone, that nitroaromatic contamination was minimal in the deep WBZ, and that the upper extraction wells could pull any nitroaromatic contamination from the deep WBZ. For these reasons, the study recommended that the deep extraction wells should not be operated.

The YWRTP currently utilizes four groundwater extraction wells (Figure 8-2); two pairs of wells are placed in couplets, extracting from the intermediate and deep WBZs. Two extraction wells were installed at the OU-5 site for the OU-4 remedy, one screened in the intermediate aquifer and one screened in the deep aquifer. The groundwater extraction wells in the OU-5 area were operated from February 1997 through July 1997, until the WVDEP Office of Water Resources (OWR) directed the shutdown of the OU-4 system due to violations of water quality criteria. During this brief operational period, the extraction wells at OU-5 did not produce the desired design flow and did not extract nitroaromatics from the groundwater to any measurable extent; as a result they have not been subsequently operated. They are presently being replaced with two new extraction wells located in one of the former wet wells.

The RWRTP discharges treated water to the Sedimentation Basin, located below (southeast of) the RWR RCRA caps, which then discharges into a smaller wetlands area. The YWRTP discharges to a "wet weather ditch" (wetlands) located to the northeast of the plant. Both wetland areas then discharge to Mill Run, which is a tributary to the Ohio River. Monthly effluent compliance samples are taken from the wetlands discharge and results are reported to the WVDEP in a Discharge Monitoring Report (DMR). The current status of this OU is further described in Section 1.3.1

The COCs identified for OU-4 groundwater (i.e. OUs-2, 3, and 5) in OU-2 ROD Table 1 included only total nitroaromatic compounds.

8.2 Remedial Objectives

Since groundwater at the RWR, YWR, and P13/WWA was not addressed as a separate entity in the ROD, ROs were not specifically developed for OU-4. As per the OU-2 ROD, the groundwater remedy requirements were:

- Extracting and treating the ground water until nitroaromatics' criteria are attained.

- Treated effluent from the OU-4 system will meet the State of West Virginia Surface Water Quality Standards and be monitored for compliance.

Table 6-2 presents the remedial objectives for the fourth operable unit, per Table 4 from the OU-2 Record of Decision. However, the OU-2 ROD is unclear on whether Table 4 or Table 14 should apply to groundwater in the P13/WWA when operation of the new extraction wells begins. Table 4 is titled "Remedial Objectives for Second Operable Unit" and Table 14 is titled "Ground Water Criteria for Pond 13/Wet Well Area." Alternative 4A, which was selected for the Pond 13/Wet Well Area, does not specify which of these tables should apply to groundwater treatment for that area. Therefore, groundwater was evaluated using values from both of these tables. It is recommended that the WVOW Tier 1 team determine which set of values should apply to groundwater in the Pond 13/Wet Well Area.

Note that these ROs were developed only to protect human health, and do not address ecological concerns. A SLERA was performed for all areas within the NPL boundary and the site divided into five APECs. OU-4 falls within APECs 1, 2, and 4. No further action was recommended for APECs 1 (IT, 1998a) and 2 (IT, 1997b). Additional capping actions were required to address ecological concern for APEC 4, as discussed in 5.4.

8.3 Remedy Selection

As previously stated, the OU-2 ROD contained groundwater remedial action remedies for the YWR (OU-3), Pond 13/Wet Well (OU-5), and RWR (OU-2) areas. The groundwater treatment remedy has since been designated as OU-4. The RGOs for OU-4 are listed in Table 6-2.

8.4 Remedy Implementation

8.4.1 Design and Construction of Groundwater Extraction and Treatment System

Fieldwork, treatability studies, design analysis, and the construction plans and specifications were conducted and prepared by Woodward-Clyde Consultants through contracts administered by the Omaha District USACE. Initial work began in 1991. Granular activated carbon (GAC) adsorption and ion exchange treatment were analyzed, and GAC treatment was chosen as the most economical remedy. Discharge of the effluent was initially designed for the Ohio River; however, the discharge location was later changed to Mill Run, an on-site stream that is a tributary to the Ohio River.

The construction contract was awarded in June 1995 and several modifications were subsequently issued. The final construction inspection was conducted by representatives of the construction and design contractors, USEPA, WVDEP, and USACE on February 5, 1997. The Huntington District USACE prepared and submitted a Remedial Action Report (USACE, 1997) for the OU-4 construction project to the USEPA in April 1997. The report stated that the groundwater treatment system was "Operational and Functional". The USACE requested and received USEPA's concurrence that the Remedial Action had been completed and was operating as designed. A copy of the Remedial Action Report is available in the Administrative Record.

8.4.2 Initial System Operation and Maintenance

Following one week of successful operation, per the construction contract specifications, OU-4 system operation officially commenced February 7, 1997. The construction contract required the construction contractor to operate the treatment plants for one year. It was previously noted that the original effluent discharge point was to be the Ohio River, but due to anticipated delays in obtaining rights-of-

entry to construct the discharge line, the USACE and WVDEP mutually agreed to a six-month trial discharge to Mill Run to evaluate the "marginal" levels of metals that were anticipated in the extracted and treated groundwater.

The plants were operated from February 1997 through July 1997. During that time period, the plants were effective in removing nitroaromatic contamination from the groundwater but both treatment plants experienced continued high levels of metals in the effluent. The RWRTP effluent exceeded discharge limits for seven different metals: most frequently lead and zinc and occasionally beryllium (IT, 1999). The YWRTP effluent also exceeded discharge limits for seven different metals during the trial discharge, with the most frequent exceedances again being lead and zinc, and occasionally manganese. The AAR determined that the influent concentrations of these metals were greater than those that were estimated during the design of the OU-4 system.

Due to the continued violations of surface water quality discharge criteria (specifically lead and zinc), the WVDEP OWR directed the USACE to shutdown OU-4 in July 1997. The USACE met with representatives of WVDEP OWR on August 8, 1997 to discuss their evaluation of the OU-4 system, and discuss a new proposal for system restart and continued operation and evaluation. The proposal detailed the continuation of the pilot discharge to Mill Run and a study of treatment alternatives. The final proposal was provided to the OWR on August 15, 1997, and OWR acceptance was received in October 1997, contingent upon recommended changes to the plan. USACE accepted the changes, prepared a scope of work for the alternatives analysis, and issued a delivery order to IT Corporation in 1998 to perform the study.

8.5 Follow-up Actions

8.5.1 Alternative Analysis Study

The draft second five-year review report (USACE, 2000) stated that the OU-4 system was currently shutdown and undergoing an alternatives analysis study to determine the most cost effective measure(s) to bring the system into compliance with state discharge standards. The study, documented in the AAR (IT, 1999), evaluated the following seven (7) alternatives:

1. Chemical Precipitation;
2 Ion Exchange;
3. Wetlands Treatment;
4. Optimization of Existing Treatment System;
5. Groundwater Re-injection;
6. Ohio River Discharge; and
7. Site-Specific Water Quality Criteria.

Following alternative screening and detailed analyses, the selected alternatives, in order of preference were:

- Alternative No. 4, Optimization of the Existing System;
- Alternative No. 7, Site-Specific Water Quality Criteria; and
- Alternative No. 6, Ohio River Discharge.

The AAR estimated that Alternative No. 7 could take from 18 to 30 months to implement due to state legislative action that would be required. The USACE decided to implement Alternative No. 4, and if that alternative proved unsuccessful, planned to pursue site-specific discharge criteria, and then construct the discharge line to the Ohio River, as a last resort.

In the fall of 1998, a meeting was held at the OU-4 project with representatives from the WVDEP, West Virginia University (WVU), and USACE for the purpose of evaluating existing onsite wetlands for the treatment of the effluent discharge. The WVU researchers determined that the existing wetlands (the Sedimentation Basin, at the RWRTP and a "wet weather ditch" at the YWRTP) could be effective in reducing metals' concentrations in the effluent. Based upon that determination, the Huntington District issued a work order to WasteTron, Inc., in March 1999, which detailed the requirements to restart the OU-4 system and implement the wetlands discharge study. The USACE subsequently revised their August 1997 proposal to OWR to include a study of the effectiveness of effluent discharge to the wetlands. OWR received the revised proposal in July 1999 and approved implementation of the plan in August 1999.

Since the OU-4 treatment facilities had sat dormant since their shutdown in July 1997 (GAC units had been drained and heating systems were left on in the buildings), the first order of business was to clean the interior of the treatment buildings and then inspect and test all extraction wells, the treatment systems' process equipment, and the computerized monitoring system. Electric power lines and signal lines to the extraction wells did not work properly, and they had to be replaced for both systems. It was discovered that some of the original equipment was incompatible with other system components, and many faults-to-ground were present in the power and control lines. The repairs at the RWRTP were determined to be less extensive; therefore, USACE decided to repair the RWRTP first, and from lessons learned, perform similar repairs to the YWRTP. Following repairs at the RWRTP, and a successful one-week trial operation period, the plant restarted on September 5, 2000 and the contractor implemented the wetlands discharge study. Following repairs and similar operations' testing, the YWRTP restarted on December 5, 2000, and the effluent discharge study commenced.

The effluent discharge study consisted of a systematic approach of weekly sampling and reporting of "system" and "wetlands" effluent, evaluation of analyses' results after every three rounds of sampling, providing recommendations for system adjustments, and then a continuation of the sampling, analysis, adjustment, and recommendation cycle for a minimum of twelve weeks. The study determined that the wetlands discharge was effective at both wetland locations in reducing metals and also in removing ammonia that had been discovered in some wetlands samples. It was later determined that the ammonia was present due to surface water runoff in the spring and fall, from recently-fertilized fields and possibly also due to nearby animal containment structures. USACE reported the study results to the WVDEP in the spring of 2001, and they in turn granted permission to continue operation of OU-4 with wetlands discharge.

8.5.2 System Monitoring and Reporting Requirements

In August 2002, the WVOW Tier I Consensus Team members (remedial and project managers from USEPA, WVDEP, and USACE) signed Consensus Agreement No. 9 (CA9, 2002). This agreement defined the operation, maintenance, and monitoring requirements for the OU-4 system. The agreement detailed requirements of the treatment plant O&M contractor for system sampling and analysis, reporting, and O&M requirements. The agreement further detailed the requirements of the LTMP contractor for incorporating system monitoring and reporting data into the LTMP to evaluate system performance, determine if ROs are being achieved, etc. (Consensus Agreement No. 9, 28 August 2002). USACE Huntington District included the requirements of CA9 in the scope of work beginning with the FY03 OU-4 O&M work order.

8.5.3 Remediation System Evaluation Study

At the request of USACE Huntington District, HTRW-CX conducted a RSE of OU-4 between July 2003 and January 2004 (USACE, 2004). The request was made because no formal system evaluation had yet been conducted, the plants had been operating since September 2000, and the recommended timeframe for such evaluation was two to three years. The HTRW-CX developed the RSE process, which is intended to be an independent and holistic evaluation of remediation systems, serving four major purposes:

1) assess system performance and effectiveness to achieve remediation objectives;
2) identify opportunities to reduce O&M costs;
3) verify that a clear and realistic exit strategy exists; and
4) confirm that the system is being adequately maintained.

In addition, the HTRW-CX evaluated the format and content of current O&M reports and system monitoring, and recommended changes as appropriate. General recommendations from the RSE report are summarized subsequently in this report (see OU-4 recommendations Section 10.4).

8.6 System Operations/O&M

The initial O&M work order that was issued in 1999 was awarded for approximately $465,000. That work order included the additional costs to conduct the wetlands discharge study and the costs for repair and replacement of extraction well power and signal cables, as well as other required replacement parts. The "basic" O&M contract, not including the repair costs was approximately $370,000, which is comparable to the annual O&M cost of $357,075, as estimated by Woodward-Clyde (WCC, 1993).

Since that time, O&M work order awards for one-year operation periods have included costs for monthly system O&M, system utilities, system sampling and analysis, GAC replacement, repairs and parts replacement, and semi-annual evaluation reports. Due to fluctuations in parts and repair needs, some work orders have been extended beyond the one-year operation period through "no-cost" modifications. This has led to the issuance of three work orders over the past five fiscal years (FY00-FY04). USACE in-house and O&M contract costs since FY99 are as follows:

Operable Unit 4 Costs ($1,000)

	FY99	FY00	FY01	FY02	FY03	FY04
In-house labor	$44.6	$76.5	$76.4	$65	$62.6	$62.5
Contract	$465.5	$42.9	$382.1	$23.9	$531.6*	$369.9

* Reflects modification for the installation of additional (twelve) groundwater monitoring wells per USEPA, HTRW-CX, and WVOW OU-4 Task Group recommendations to improve monitoring at the RWRTP and YWRTP. Initial O&M award was $368,253.35.

As previously stated, extensive repairs to electrical power and extraction well system controls were required to bring the RWRTP and YWRTP into operation following the three-year shutdown. In addition, the computer system and system control software that had been initially installed in 1997 were not Year 2000 (Y2K) compliant and had to be replaced. The original system computer programmer was retained by the O&M contractor to perform this task.

Extraction well pumps are controlled by a programmable logic controller (PLC) based on signals from transducers that are in the wells. The original transducers were replaced with more reliable transducers, and only two have required replacement due to lightning strikes. During plant restart in September 2000, many problems were encountered with blown fuses for the signal lines from the pressure transducers. USACE Huntington District recommended replacements for the transformers, fuses, and amplifiers, which proved to be more reliable and there have been no further control problems (USACE, 2004).

Previously, treatment plant shutdowns did not trigger an alarm and the system's auto-dialer did not notify the plant operator. Since the plants are controlled by an onsite computer and the computer is on an uninterruptible power supply (battery backup unit), the plants "sensed" no power loss Automatic restart capabilities were added to the PLCs in April 2003 to fix this problem. Following a power loss, the PLC now "senses" when power has been restored for at least one minute, and automatically restarts the extraction wells. This change greatly decreased the amount of downtime, and has led to the plants operating over 99.8% of the time (USACE, 2004).

Various meters within the plants have also been replaced due to age and the fact that certain replacement parts were no longer available. Following several months of operation, excess particulate matter was discovered in the particulate filters at both treatment plants, and pump production rates had decreased. The plant operator found that the galvanized steel that had been used for the extraction wells' discharge pipes had corroded due to reaction with the metal in the pumps. The operator replaced the pipes with stainless steel. Pumps that were not being used in the deep extraction wells at the RWRTP were removed and used for replacements in other extraction wells.

The GAC in the lead vessel in the YWRTP was replaced in November 2002 after nitroaromatic detection between the GAC units were noted for a few months, until breakthrough was observed in the lag GAC vessel. The under drain system in the YWRTP GAC vessel was found to be damaged at that time and was repaired. It is believed that the under drain had been damaged during construction of OU-4. The lead unit was then switched to be the lag unit in the treatment train. The lead GAC vessels were also changed out at both treatment plants in December 2003, and the vessels were again switched from the lead to lag position.

General RWTP and YWTP groundwater and contaminant extraction trends are shown in Figures 8-3, 8-4, and 8-5 for the period of August 2002 through November 2003 (WTI, 2004a; WTI, 2004b). Figures 8-3 and 8-4 show graphs of extraction well flow rate measurements by month, and extraction flow rate measurements by month respectively, for the RWTP and YWTP. Figure 8-5 shows nitroaromatic compounds mass removed from the treatment plants by month. During the 16-month period represented in Figures 8-3 and 8-4, over 87 million gallons were processed through the RWTP, and over 93 million gallons were processed through the YWTP. Over 26 pounds and over 66 pounds of nitroaromatic compounds were removed from the RWTP and YWTP, respectively, during this same 16-month period. Information concerning recent (i.e. subsequent to November 2003) groundwater and contaminant mass extraction trends is currently being compiled into subsequent Systems Evaluation Reports by WTI.

8.7 Current Site Conditions

Since restart in late 2000, the OU-4 system has consistently met water quality discharge criteria and has only been shutdown due to minor power failures or required system repairs. Subsequent to the initial O&M work order that was issued in March 1999, the Huntington District has issued three additional O&M work orders to WasteTron, Inc. Table 8-1, as taken from the RSE (USACE, 2004), compares the OU-2 ROD cleanup levels, the West Virginia Water Quality discharge standards, and the

average concentration of nitroaromatics in the extraction wells at the RWRTP and YWRTP, for the period August 2002 through May 2003.

The RSE (USACE, 2004) stated that there were no known impacts to existing active water supply wells near the RWRTP and YWRTP. The Marshall University Center for Environmental, Geotchnical, and Applied Science (MUCEGAS) performed a residential water well survey (MUCEGAS, 2002) for USACE in April 2002 and sent letters to 302 residences in the vicinity of WVOW. Twenty residents responded that they had active wells on their property, with nine using them for private consumption. These 20 wells plus one additional well were sampled and no nitroaromatics were detected (Shaw, 2004). Results of the survey were furnished to USEPA and WVDEP in August 2003.

During the eighth annual OU-2 LTMP investigation conducted during 2003, fourteen wells (four screened in the deep WBZ and ten screened in the intermediate WBZ) were sampled in the vicinity of the RWR (Shaw, 2004). Of the deep wells, nitroaromatic compounds were only detected in extraction well RWREW-102. Concentrations in this well have been decreasing since the deep extraction wells were deactivated This indicates that contaminants had previously been drawn into the deep zone by the deep extraction wells, and that the deep WBZ in the vicinity of the RWR has generally not been otherwise impacted by nitroaromatics. Analytical data acquired from seven of the intermediate wells in the RWR area during 2003 indicated nitroaromatics at concentrations exceeding RBSCs or ROD criteria. Since the highest concentrations are between the RWR area and the extraction wells, the extraction wells appear to have been properly placed to intercept the contaminant plume. Most of the nitroaromatics have been fairly stable or otherwise have shown no overall increasing or decreasing trend throughout the LTMP annual investigations. This suggests that natural attenuation and of the intermediate WBZ contaminants is minimal in the RWR area. Monitoring well RWRGW-004 (intermediate WBZ) is located directly north of the extraction wells, and has never yielded a nitroaromatic detection. This indicates that the extraction wells are effectively preventing northward contaminant plume migration in the intermediate WBZ.

Tables 8-2 through 8-8 compare the concentrations of nitroaromatics in the five RWRTP extraction wells to the OU-2 ROD levels for the period June 2003 through September 2004. The sampling and analysis was performed by the OU-4 O&M contractor, WTI (formerly WasteTron, Inc.). Tables 8-4 and 8-5 show that two nitroaromatics have been detected in excess of ROD levels: 2,4-DNT and 2,6-DNT. RWRTP extraction well RWR-101 shows consistently high levels of 2,4-DNT, with levels ranging from 1.91 µg/L, initially in June 2003, to a peak of 30.1 µg/L in December 2003, and remaining at high levels throughout the monitoring period. 2,4-DNT was detected in RWR-101 in 15 of the 16 months during the monitoring period. Extraction well RWR-103 has also shown consistent levels of 2,4-DNT (detections in 14 of the 16-month monitoring period), but not at the level of concentrations noted in well RWR-101. The average concentration of 2,4-DNT in RWR-101 was approximately 19 µg/L, and was approximately 4.6 µg/L in RWR-103, as compared to the OU-2 ROD level of 0.11 µg/L. The other three extraction wells, RWR-105, RWR-107, and RWR-109, each had one detection (between August and September 2003) of 2,4-DNT during the monitoring period, but not of the magnitude noted in RWR-101 or RWR-103.

Extraction well RWR-101 had detections of 2,6-DNT in 9 months of the 16-month monitoring period, with a fairly consistent detection from May 2004 through August 2004. RWR-103 has shown detections of 2,6-DNT in 12 of the 16 months, with consistent detections from November 2003 through September 2004. The average concentration of 2,6-DNT in RWR-101 was approximately 6 µg/L, and 4 µg/L in RWR-103, as compared to the OU-2 ROD level of 0.022 µg/L.

Table 8-16 contains data from the semi-annual groundwater monitoring that was performed by the

OU-4 O&M contractor, WTI, during the period May 2002 through May 2004. The data that is shown is only for the groundwater monitoring wells that showed nitroaromatic concentrations in excess of the OU-2 ROD levels. Year 2003 data for well RWRGW-030, which is upgradient of well RWRPT-001, showed a slight decrease in the concentration of 2,4-DNT with a corresponding increase in well RWRPT-001 observed during this same period. This could be an indication that the RWR extraction wells have been effective in drawing the contaminant plume towards the groundwater extraction system. Well RWRGW-004D had no detections of nitroaromatics from May 2002 through November 2003, then 2,4-DNT was detected at a concentration of 2.3 µg/L in May 2004. This could be an indication that the intermediate extraction wells have also been effective at drawing nitroaromatic contamination from the deep aquifer towards the extraction system; it is noted that well RWRGW-004D is located down gradient of the extraction system. A similar comparison could be made for well RWRGW-002, which is west of the extraction system, and upgradient of the extraction system due to the system's influence on local groundwater flow direction. Nitroaromatics were not detected in this well from May 2002 to November 2002, then 2,4-DNT and 2,6-DNT were detected in May 2003 and November 2003, respectively. It is noted that neither contaminant was detected in May 2004 sampling. Monitoring wells RWRGW-045, RWRGW-046, and RWRGW-047 have shown a great increase in the levels of both 2,4-DNT and 2,6-DNT during the sampling period. These three wells are located between the former RWR and the groundwater extraction system, and they are immediately upgradient of the extraction system. The initial level of 2,4-DNT noted in RWRGW-045 was 0.447 µg/L in May 2002, and in May 2004, the level had increased to 31.80 µg/L. Similarly, the level of 2,4-DNT detected in RWRGW-047 in November 2002 was 1.90 µg/L, and the May 2004 sampling showed a marked increase to 56.10 µg/L. The levels of 2,4-DNT in RWRGW-046 also showed an increase, but not of this magnitude Well RWRGW-046 is not as directly downgradient of the RWRs as wells RWRGW-045 and RWRGW-047.

During the eighth annual OU-3 LTMP investigation conducted during 2003, ten wells (six screened in the intermediate WBZ and four screened in the deep WBZ) were sampled in the vicinity of the YWR (Shaw, 2004). Acquired analytical data show that nitroaromatic constituent concentrations have been stable in impacted intermediate and deep WBZ wells during LTMP investigations. An exception is monitoring well YWRGW-002 (screened in the deep WBZ) where decreasing concentrations are observed. Monitoring well data suggest that natural attenuation and migration of nitroaromatic constituents are minimal in the YWR area. Nitroaromatics have not been detected in the well NPHGW-002 located downgradient (i.e. northwest) of impacted wells in the YWR area. This, along with data acquired semi-annually as part of the OU-4 O&M program, indicates that the downgradient extent of groundwater contamination has been defined in the YWR area, and suggests that the YWR extraction wells are effectively capturing nitroaromatic-contaminated groundwater and preventing its downgradient migration.

Tables 8-9 through 8-15 compare the concentrations of nitroaromatics in the four YWRTP extraction wells to the OU-2 ROD levels for the period June 2003 through September 2004. The sampling and analysis was performed by the OU-4 O&M contractor, WTI. OU-2 ROD analyte detections are similar to that of the RWRTP extraction wells, with the exception that 2,4,6-TNT was detected slightly above the ROD limit during three months (February 2004, April 2004, and July 2004) in YWR-501A. It is noted that the extraction well designation "A" denotes a well in the intermediate WBZ, and that "B" denotes a well in the deep WBZ. All four wells have had detections of 2,4-DNT and 2,6-DNT above the respective ROD limits at various periods during the 16-month monitoring period. Wells 501A and 502A have had the most consistent detections of 2,4-DNT, 11 and 14 months, respectively, during the 16-month monitoring period. Although wells 501B and 502B have been out of service during certain months for repair during the monitoring period, it is noted that they did have detections of 2,4-DNT. The average concentration of 2,4-DNT in well 501A was approximately 2.2 µg/L, and in well 501B, approximately 12.4 µg/L, as compared to the ROD level of 0.11 µg/L.

Extraction well 502A had less frequent but higher detections of 2,6-DNT than well 501A. 2,6-DNT was detected in well 502A in 5 of the 16 months during the monitoring period, whereas detections were noted in 10 of the 16 months for well 501A. The average concentration of 2,6-DNT in well 502A was approximately 14.1 µg/L versus an average of 3.8 µg/L in well 501A, as compared with the 0.022 OU-2 ROD limit. It is noted that in 8 of the 13 months that well 501B operated, 2,6-DNT was detected as an average concentration of approximately 2.9 µg/L. Well 502B had one detection in one of the five months it operated, at a concentration of 1.04 µg/L. The data show that although well 502B has had detections of various nitroaromatics, the levels were very low to non-detect during the operational period.

Table 8-17 contains data from the semi-annual groundwater monitoring that was performed by the OU-4 O&M contractor, WTI, during the period May 2002 through May 2004. The data that is shown is only for the groundwater monitoring wells that showed nitroaromatic concentrations in excess of the OU-2 ROD levels. Groundwater monitoring wells YWMRGW-027 and YWMRGW-027D, a pair of wells in the intermediate and deep WBZs, respectively, located upgradient of the YWR extraction wells, both had detections of 2, 6-DNT above the ROD limits during November 2002 and May 2003. Well YWRGW-027 also had detections above the ROD limits during November 2003 and May 2004; this well showed a general increasing trend during the period of November 2002 to May 2004. These wells are hydraulically located between the former YWR and extraction wells 501A and 501B, and these data indicate that the groundwater contamination is migrating from upgradient of the monitoring wells towards the extraction wells. The contaminant levels in each monitoring well were similar, with average concentrations between 3 and 4.4 µg/L. Groundwater monitoring well YWRGW-041, which is located near extraction wells 502A and 502B, has shown sporadic but increasing levels of 2,4-DNT. These trends tend to suggest that the extraction wells have been effective at drawing in and containing contaminated groundwater.

8.8 Technical Assessment

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

Only one remedial objective (RO#3: The treatment of groundwater to protective levels) from the OU-2 ROD addressed groundwater, which is covered by OU-4. The remedy at OU-4 is currently functioning as intended because the groundwater extraction and treatment system appears to be capturing the nitroaromatic-contaminated plume and the system is removing nitroaromatics from the groundwater. The treatment system has been consistently discharging treated water below the established surface water discharge criteria, based on monthly sampling.

The extraction wells originally installed at the P13/WWA have not been operated since system operation resumed in 2000. They were never developed properly and the design flow could not be achieved. It was later determined that they are not in an optimal location to adequately capture the plume. Instead, it was decided to excavate and compost contaminated soil from this area in order to remove the source of the groundwater contamination. Two new extraction wells are being installed (contract awarded by CELRH in June 04) in the P13/WWA in order to capture the plume.

8.8.2 Question B: Are the exposure assumptions, toxicity data, cleanup levels, and RAOs used at the time of the remedy still valid?

During this review, it was necessary to consider the four following types of assumptions made in the OU-2 ROD (USACE, 1987) and how those assumptions may differ at the present time.

- Standards and TBCs
- Cleanup levels
- Exposure pathways
- Toxicity and other contaminant characteristics

Standards and TBCs

The Applicable or Relevant and Appropriate Requirements (ARARs) table included in the OU-2 ROD (USACE, 1988) is included as Table 6-1. No changes to any of the standards were found that would change the OU-2 remedial objectives or groundwater criteria for P13/WWA, as shown in Table 6-2.

It may be appropriate to compare Life-Time Health Advisories (USEPA, 1999) and RBCs for Tap Water (USEPA Region 3, April 2005) as a comparison to RGOs. Of the COCs, life-time health advisories exist only for 2,4,6-TNT (0.002 µg/L) and 1,3-DNB (0.0001 µg/L), and both are exceeded by the OU-2 ROD Table 4 RGOs, as shown in Table 6-2. The RBSC for 2,4,6-TNT is exceeded by the OU-2 ROD Table 4 RGOs. The RBSCs for 2,4-DNT, 2,6-DNT, 1,3,5-TNB, and 1,3-DNB are more stringent than the ROD Table 4 RGOs (Table 6-2), but less than the Table 14 P13/WWA groundwater criteria. Based on this, the Table 4 RGOs and Table 14 P13/WWA groundwater criteria do not appear to be protective if groundwater is used as a potable water source.

Cleanup Levels

According to the OU-2 Endangerment Assessment (ESE, 1987), remedial objectives identified in the OU-2 ROD (USACE, 1988) were calculated by the PPLV method in which each significant source-to-receptor pathway was quantified and the effects combined to ensure that an exposed individual would not receive an unacceptably large dose. The PPLVs were then used as remedial objectives for OU-2, unless other ARAR-driven values were more stringent. The PPLV methodology is very different from USEPA's RAGS, (USEPA, 1989). RfDs and SFs have been created and/or changed since the preparation of the OU-2 ROD. The OU-2 ROD mentions that MCLs (specific to human potable water supply) are ARARs for the RWR, but there are currently no MCLs listed for 2,4,6-TNT, 2,4-DNT, 2-6-DNT, 1,3-DNB, or 1,3,5-TNB.

The only receptor whose risk was evaluated was an on-site resident who uses groundwater as their sole drinking water supply. Based on this evaluation, the remedial objectives for OU-2 appear to be protective of both an adult resident (Table 6-9) and child resident (Table 6-10) for cancer risks. However, the remedial objectives for OU-2 do not appear to be protective for either an adult resident (Table 6-9) or child resident (Table 6-10) for non-cancer risks, exhibiting HIs of 7 and 17, respectively. These large HI values are driven predominantly by 2,4,6-TNT and 1,3-DNB, with 1,3,5-TNB, 2,4-DNT, and 2,6-DNT contributing very little to HI values. This is expected, since the ROs for 2,4,6-TNT and 1,3-DNB exceed the USEPA Region 3 RBSCs (USEPA, 2005).

Additionally, the groundwater criteria for the P13/WWA are not protective of the child or adult residents for cancer or non-cancer risks. They are from 30 to 2300 times greater than the OU-2 groundwater RGOs. The sums of the ILCRs for P13/WWA groundwater criteria for the child and adult residents are $3x10^{-5}$ (Table 6-11) and $2x10^{-3}$ (Table 6-12), respectively. The total HI for the adult resident is over 2000 (Table 6-11), while the total HI for the child resident exceeds 4800 (Table 6-12). As stated above, it is recommended that the Tier 1 team determine what values should apply to groundwater remediation in the P13/WWA.

Exposure Pathways

Most of the exposure pathway assumptions included in the OU-2 ROD for OU-4 are still accurate. All of the OU-4 Groundwater Extraction and Treatment extraction wells for OUs 2 and 5 area are included in the MWMA boundary, and that land was deeded to the State of WV with the stipulation that it only be used for wildlife management purposes or else ownership reverts back to the federal government. The OU-3 extraction wells are located on property owned by the federal government that will eventually be transferred to WVDNR and incorporated into the MWMA, with the same restrictions. However, the OU-2 extraction wells are located adjacent to private property. Groundwater use beyond the MWMA boundary by private owners is not restricted, although public water is available to and used by most residents located between the RWR and the Ohio River. Based on the residential well survey (MUCEGAS, 2002), there is at least one potable water well in that area. That well was tested along with 20 others, and nitroaromatic compounds were not detected in any of those wells (WTI, 2003). Treated groundwater is eventually discharged to Mill Run, and the YW "wet weather ditch" and RW "sedimentation basin" present exposure pathways not addressed in the OU-2 ROD. USEPA now states that all groundwater shall be returned to beneficial use, although "beneficial use" needs to be clearly defined. Soil contamination leaching to groundwater used for potable water as a beneficial use is still a hypothetically-complete exposure pathway. Groundwater migration into surface water was not addressed by the OU-2 ROD for human health or ecological receptors. Since OU-4 addresses only groundwater, the exposure pathways for ecological receptors are incomplete.

Toxicity and Other Contaminant Characteristics

Since the OU-5 Pond 13 and Wet Well Area were addressed in the OU-2 ROD, see the technical assessment section (6.8.2) for OU-2 for a discussion of toxicity and other contaminant characteristics.

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

No additional information has come to light that calls into question the protectiveness of the remedy.

8.9 OU-4 Protectiveness Statement

The remedy at OU-4 may not protect human health and the environment in the short-term or in the long-term, based on the risk evaluation discussed in Section 8.8. Specifically, ROD levels for groundwater used as drinking water are not protective for non-cancer risks. New, protective ROD levels should be calculated, and could easily be implemented since the system is still operating (i.e. the remedial action is ongoing).

Based upon the evaluation of recent groundwater modeling, and on-site and off-site sampling and analysis data, the OU-4 groundwater extraction and treatment system appears to effectively capture the nitroaromatic-contaminated plume and the system is removing nitroaromatics from the groundwater. The OU-4 system has consistently discharged treated effluent per OU-2 ROD requirements and below established surface water criteria since the system was re-started in the fall of 2000. There is no current exposure to groundwater because the site is a wildlife management area, with restrictions that prohibit both groundwater use and residential development.

Data (Tables 8-2 through 8-17) from groundwater monitoring wells and sampling points throughout the OU-4 system indicate that groundwater contamination still exists above the OU-2 RAOs. However, the selected remedy is working and continued implementation is necessary to achieve the final cleanup goals as specified in the OU-2 ROD. The USACE is taking the necessary steps to ensure

that the remedy is protective, such as expanding the monitoring network around the OU-4 system (see Figures 8-1 and 8-2) to further define the plume and capture zone.

9.0 OPERABLE UNIT 5

9.1 Site Description

OU-5 consists of the Pond 13 and the former Wet Well Area. The site is located on the east-central side of the former WVOW, north of TNT MfA Line 10 and Wadsworth Road. The former wastewater pumping station and wet wells were located in this area and the red and yellow wastewater lines ran directly through the current Pond 13 site. The pump station no longer exists, but remnants of the building foundation and wet wells remain.

The former pump station and wet wells were part of the wastewater handling system for the former TNT manufacturing facility. The pump station diverted red and yellow Water from the TNT MfA Lines to the RWR and YWR. The red and yellow Water wastes entered into two wet wells for flow control. Two additional, larger wet wells were available as emergency storage/temporary reservoirs during times when maintenance was required or when waste flow was greater than the facility's capacity (USACE, 1944).

A red water seep was identified during 1981, and then four soil borings were made with four monitoring wells were installed (EPA-1 through EPA-4) (ESE, 1984). Nitroaromatic contamination was found in soils and groundwater at the location of the former pumping station. During the remedial investigation, seven monitoring wells were installed in the Pond 13 area. Groundwater and soil samples indicated nitroaromatic contamination, which was attributed to the former IWSL that was still present beneath the ground surface (Tetra Tech 1992). Additional investigations were performed by Woodward-Clyde in 1992, during which two additional monitoring wells, four observation wells, and one pump test well were installed. The current status of this OU is further described in Section 1.3.1.

The only COCs identified for the P13/WWA in OU-2 ROD Table 1 are nitroaromatic compounds. Total nitroaromatic compounds were detected in surface water (MDC=68 µg/L), sediment (MDC=4240 µg/g), and groundwater (MDC=50,000 µg/L).

9.2 Remedial Objectives

Following the detailed analysis of the five alternatives, the preferred remedy for OU-5 (P13/WWA) was Alternative 4A, which was chosen to satisfy the RAOs as excerpted from the OU-2 ROD, Section F:

> "The major objectives of remedial action to be taken at the West Virginia Ordnance Works Site include the removal of soil contaminants to protective levels; the minimization of the amount of hazardous substances leaching into the groundwater and the treatment of groundwater to protective levels. The levels that were developed are based on standards that were available for the specific chemical, or developed with respect to the 10^{-6} cancer risk, that is one person in one million adversely affected."

This remedial action was selected in order to "provide protection of human health and the environment by cutting off the contamination pathway to (Pond 13). This will prevent further contamination pathway to the pond. This will prevent further contamination of the pond and the exposure to humans and biota from contaminated water and sediment. Although contaminated materials will remain in the wet wells, the cover will protect against direct contact and the inflow of contaminated ground water." However, according to the APEC 4 SLERA (IT, 1998c), nitroaromatic compounds in surface water did not cause a toxicity quotient greater than 1 for aquatic organisms. ROs for OU-2 are listed in Section 6.2 and in Table 6-2.

Note that these ROs were developed only to protect human health, and do not address ecological concerns. A SLERA was performed for all areas within the NPL boundary and the site divided into five APECs. OU-5 falls within APEC 4. Additional capping actions within OU-1 were required to address ecological concerns for APEC 4, as discussed in Section 5.5. The risk assessors recommended no additional consideration of potential ecological risks within APEC 4 (IT, 1998c).

9.3 Remedy Selection

The OU-2 ROD included remedial action remedies for the P13/WWA. Subsequent to the ROD signing, the P13/WWA was designated as OU-5. The groundwater remedy for the OU-5 area is designated as OU-4.

The remedial alternatives' objectives and technologies that were evaluated to achieve the RAOs for OU-5 were the same as for OU-2. Refer to Sections 6.2 and 6.3 for discussion.

The remedial alternatives that were developed and analyzed for Pond 13/Wet Well (OU-5) included:

- Alternative 1B – Excavation of contaminated soils/sediments for onsite incineration, and activated carbon treatment of groundwater removed by extraction wells, with direct discharge to Mill Run.
- Alternative 2C– Excavation of contaminated soils/sediments for onsite incineration and disposal in an onsite landfill, and activated carbon treatment of groundwater removed by extraction wells, with direct discharge to Mill Run.
- Alternative 3A – Excavation of contaminated soils/sediments and disposal in an onsite landfill, and activated carbon treatment of groundwater removed by extraction wells, with direct discharge to Mill Run.
- Alternative 3B – Excavation of contaminated soils/sediments with disposal in an offsite landfill, and activated carbon treatment of groundwater removed by extraction wells, with direct discharge to Mill Run.
- Alternative 4A – Covering the wet wells with protective soil covers, and activated carbon treatment of groundwater removed by extraction wells, with direct discharge to Pond 13.
- Alternative 4B – Relocation of Pond 13, and activated carbon treatment of groundwater removed by extraction wells, with direct discharge to Pond 13.
- Alternative 5A – No Action, with long-term groundwater monitoring.

The same nine evaluation criteria were used in the evaluation of the remedial action alternatives for OU-5 as were used for OU-2. Refer to Section 6.3 for discussion.

Following the detailed analysis of the five alternatives, the preferred remedy for OU-5 (P13/WWA) was Alternative 4A, which contained the following remedial actions to satisfy the RAOs:

> "This alternative will provide protection of human health and the environment by cutting off the contamination pathway to the pond. This will prevent further contamination pathway to the pond. This will prevent further contamination of the pond and the exposure to humans and biota from contaminated water and sediment. Although contaminated materials will remain in the wet wells, the cover will protect against direct contact and the inflow of contaminated ground water. The extraction and treatment system will remove the contaminants from the ground water as well as control the migration pathway.

The ARARs associated with this site will be attained including the action-specific ARARs associated with the discharge of the treated effluent into the pond.

The capital and operating cost of this alternative is in the same range of other alternatives evaluated, but is at least as effective or more effective in protecting against exposure and in restoring the pond and the aquifer.

Although this alternative does not provide permanent destruction or removal of the contaminants in the wet wells, it does provide control of the release and does prevent exposure to the contaminants. The pond and the ground water resources will be protected and restored through this alternative. Because this remedy will result in hazardous substances remaining on-site, the five year facility review, pursuant to CERCLA Section 121(c) will (be) implemented."

Since the OU-5 remedy originally included the placement of a protective soil cover and the construction and operation of a groundwater treatment system to satisfy the RAOs, periodic O&M inspection of the soil covers and long-term O&M of the groundwater treatment system (including groundwater monitoring), would have been required to assure that no exposure to contaminated soils and groundwater occurred, that contaminants did not migrate, and that groundwater remediation goals are eventually met.

9.4 Remedy Implementation

In 1994, USACE contracted for the investigation of the wet wells and sediments of the Pond 13 area. This investigation indicated that contamination above soil action levels was not present in the wet well areas. Therefore, it was not necessary to install the soil cover in this area per the OU-2 ROD. Additionally, the investigation indicated that gross soil contamination was present at depth, but was confined to a narrow strip of material located along the trace of the former main-trunk sewer line.

Refer to Section 8.0 for general discussion of the design, construction, and initial operation and maintenance of the OU-4 groundwater extraction and treatment facility.

9.5 Follow-up Actions

In February 1995, IT Corporation conducted a focused investigation (FI) of soils and sediments at Ponds 12 and 13 and the Wet Well Area, and in September 1998, IT conducted sampling of tissue from fish living in Pond 13. These investigations are summarized in the report *Data Package, Focused Investigation of the Ponds 12 and 13/Wet Wells Area, Operable Unit 5, West Virginia Ordnance Works, Mason County, West Virginia*, IT Corporation, March 1999.

The objective of the 1995 FI was to determine the nature and extent of soil and sediment contamination in and around Ponds 12 and 13, the Wet Wells, and the former Wastewater Pump Station. The primary objective of 1998 fish tissue sampling was to determine whether nitroaromatic compounds were being bioaccumulated by fish residing in Pond 13, and if so, if there was a potential risk to humans through the consumption of Pond 13 fish.

The 1995 FI determined that soil contamination was limited to the area around Wet Well No. 1 and along the trace of the former red and yellow water sewer lines, from approximately four to eight feet bgs. Total nitroaromatics and 2,4,6-TNT in the sediments at Wet Well No. 1 exceeded OU-2 RAOs. However, none of the detected nitroaromatics exceeded RBCs; therefore, these nitroaromatic constituents did not pose an unacceptable risk to human health. The report recommended that the

protective soil cover remedy for OU-5 be amended to No Further Action. The FI also determined that contaminated groundwater was only present within the intermediate water-bearing zone, and recommended that the OU-4 remedy be used to remove this contamination; groundwater would be monitored under the LTMP. The fish tissue sampling investigation determined that nitroaromatic compounds were not detected in the five samples that were collected from Pond 13.

Based upon the findings of the 1995 FI of OU-5, the USACE, USEPA, and WVDEP signed Consensus Agreement No. 1 (CA1) on March 8, 2001, for the removal of approximately 200 cubic yards (CY) of nitroaromatic-contaminated soil from the Wet Well Area. The removal action would be undertaken to protect groundwater resources in the area. Following the removal of this material, confirmation samples were to be taken to confirm the removal of all nitroaromatic-contaminated soil. CA1 stated that the USACE would contract for the treatment of the soils that would require treatment for disposal. The agreement also included requirements for installation of groundwater monitoring wells and long-term monitoring to determine the effectiveness of the removal action. Sampling of the point-of-compliance well could cease depending upon the results from five years of groundwater monitoring. The agreement stated that if monitoring data showed an increasing trend of contamination, the extraction system, either the current OU-4 extraction wells or a redesigned system, would be activated.

Subsequent to CA1, the USACE issued a work order in February 2002 for the removal and treatment of the soil at Wet Well Area adjacent to Pond 13. The work order detailed the limits of excavation and stipulated that the contaminated soil, along with material that would be removed from Area of Concern 21 (AOC-21) and TNT MfA Cap #7, would be treated via windrow composting. The removal at Cap #7 was being conducted to demonstrate the viability of removing and treating nitroaromatic-contaminated soil that had been left in place from the OU-1 soil cover remedy. A larger volume nitroaromatic-contaminated soil than anticipated was encountered at the Wet Well Area during excavation, and the contract was modified so that an additional 800 CY could be excavated and composted. Additionally, the groundwater appeared to be much more contaminated than expected, so USACE elected to install new groundwater extraction wells in this area after excavation was completed. Approximately 1000 CY of nitroaromatic-contaminated soil was excavated from the Wet Well Area, and approximately 20 CY excavated from AOC-21. Excavation and composting of approximately 900 CY of soil from TNT MFA Cap #7 was completed last. All soil was composted in a building constructed within the TNT MfA that is underlain by an HDPE liner, as agreed to with WVDEP Office of Compliance. After composting, all treated material from these areas was placed into a field within the TNT MfA that was selected by WVDNR.

Between March and April 2004, groundwater modeling was performed for the P13/WWA to determine the potential location(s) of groundwater extraction well(s) to reverse the groundwater gradient to prevent nitroaromatic contamination from spreading to Pond 13. The evaluation determined that two extraction wells, pumping at approximately eight gallons per minute (GPM), could reverse the flow while causing no adverse drawdown of the pond. CELRH-EC-CE prepared a scope of work for design, construction, and installation of the wells, and awarded the work, as a separate contract in conjunction with the FY04 O&M work order for the OU-4 system, on June 24, 2004. Installation of the wells should be completed during summer 2005.

9.6 System Operations/O&M

CA1 required the removal of a limited "hot spot" of nitroaromatic-contaminated soil in lieu of draining and capping the wet well area. Excavation and composting of this material is complete The excavation has been backfilled and a monitoring well installed in this area as part of OU-4. Two extraction wells are being installed. Since the RA is not complete, no O&M costs have been incurred.

It is not anticipated that future O&M costs will be funded under OU-5, since groundwater treatment costs will be programmed under OU-4 and no cap will be constructed.

9.7 Current Site Conditions

As mentioned previously, excavation and composting of nitroaromatic-contaminated soil from this area was recently completed. Results of samples from the OU-5 remedial investigation conducted by IT and the pre-excavation conducted by WTI are shown in Figures 9-1 and 9-2, respectively. Pre-excavation sampling showed a trend of increasing nitroaromatic concentration from the eastern wet well toward the western wet well. The purpose of the removal action was to excavate a small area of subsurface contamination that is not addressed by the OU-2 ROD in order to prevent leaching to groundwater. Therefore, most of the excavation was performed in and around the western wet well in an attempt to remove the most-contaminated soil. No sampling was performed after excavation. Excavated soil was composted in batches of approximately 240 CY each, and averaged four to six weeks of treatment time. Treatment time was sometimes extended while awaiting laboratory results. In this time frame, soil was treated to less than 50 ppm total nitroaromatics. For each of the five batches that included Wet Well Area soil, an increase then a decrease in amino-DNTs was apparent. Additional evaluation of the composting effort will be included in the forthcoming Remedial Action Report, anticipated to be completed in June 2005.

9.8 Technical Assessment

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

In order to answer this question, the ROs listed in Section 9.2 must be addressed to determine if they are being met by the remedial actions and subsequent actions taken.

1. RO#1 The removal of soil contaminants to protective levels – No: Contaminated soil has been removed, but only because it is a source of groundwater contamination. Future groundwater sampling results alone will determine if this RO is being met.
2. RO#2 The minimization of the amount of hazardous substances leaching into the groundwater – No: Previous sampling under the LTMP showed nitroaromatic contamination in this area, and the assumed source is leaching from soil. An additional monitoring well was installed in this area and added to the LTMP.
3. RO#3 The treatment of groundwater to protective levels – No: Groundwater from this area is not currently being treated. However, installation of two extraction wells will be completed during summer 2005 and treatment of groundwater from the Wet Well Area initiated

The OU-5 remedy has not been installed per the recommendations contained in the OU-2 ROD, and is therefore not functioning as intended. It was technically infeasible to install the protective soil cover over the Wet Well and seep areas due to the high groundwater table in the area. The Tier 1 team agreed in principle to an Explanation of Significant Differences (ESD) that would change the remedy from a soil cover to removal action that has been completed, but retaining the groundwater treatment component. It is anticipated that that ESD will be signed by all parties by June 2005. The initial extraction and treatment of nitroaromatic-contaminated groundwater in the area (February-July 1997, using extraction wells GW-401A and GW-401B) did not produce the design flow and did not remove any appreciable amounts of nitroaromatic contamination.

9.8.2 Question B: Are the exposure assumptions, toxicity data, cleanup levels, and RAOs used at the time of the remedy still valid?

During this review, it was necessary to consider the four following types of assumptions made in the OU-2 ROD (USACE, 1987) and how those assumptions may differ today:

- Standards and TBCs
- Cleanup levels
- Exposure pathways
- Toxicity and other contaminant characteristics

The evaluation of each of these is described below.

Standards and TBCs

Since the OU-5 P13/WWA was addressed in the OU-2 ROD, see the technical assessment section (6.8.2) for OU-2 for a discussion of standards and TBCs.

Cleanup Levels

Since the OU-5 P13/WWA was addressed in the OU-2 ROD, see the technical assessment section (6.8.2) for OU-2 for a discussion of cleanup levels.

Ecological screening evaluations for APECs have been conducted using USEPA ecological screening and assessment guidance that became available after the OU-2 ROD was signed. Corrective actions performed to address ecological and human health concerns within the Burning Grounds portion of APEC 4 are discussed in Section 5.5. The risk assessors recommended no additional consideration of potential ecological risks within APEC 4 (IT, 1998c).

Exposure Pathways

Most of the exposure pathway assumptions included in the OU-2 ROD for OU-5 are still accurate. All of the OU-5 P13/WWA is included in the MWMA boundary, and was deeded to the State of WV with the stipulation that the land only be used for wildlife management purposes or else ownership reverts back to the federal government. Land use has not changed significantly, nor has any new human health or ecological route of exposure been discovered. The treated compost was be placed in fields within the TNT MfA. The goal of composting is to reduce total nitroaromatics to 50 ppm and risk-based level that were developed by a WVOW Tier 1 team task group; therefore, the final compost will have nitroaromatics below this level. Groundwater is further discussed in Section 8.8.2.

Toxicity and Other Contaminant Characteristics

Since the OU-5 P13/WWA was addressed in the OU-2 ROD, see the technical assessment section (6.8.2) for OU-2 for a discussion of toxicity and other contaminant characteristics.

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

The OU-5 remedy has not been implemented; therefore, the protectiveness of the remedy cannot be evaluated. As previously stated, the USACE conducted additional investigations in 1995 and 1998 in an effort to determine a more feasible solution for remediation of the OU-5 Area. The investigations

concluded that the protective soil cover was not necessary, but that nitroaromatic-contaminated soil did exist below the ground surface and was a source for groundwater contamination at OU-5. Subsequently, the WVDEP, USEPA, and USACE signed CA1 in March 2001 to address the contaminated soil, and the USACE awarded a contract in June 2004 to install two groundwater extraction wells to remove and treat the contaminated groundwater via the OU-4 remedy. It is also noted that the original assumption and selected alternative stated in the OU-2 ROD appear to be incorrect, based on more recent knowledge. Direct contact only appeared to be a concern while the WWA excavation was open. This area was backfilled prior to the end of 2004, eliminating that exposure pathway. Groundwater is the primary exposure pathway in this area, and will be addressed by installation of two new extraction wells.

9.9 OU-5 Protectiveness Statement

The remedy at OU-5 must be deemed not protective at this time because the OU-2 ROD remedy has not yet been implemented. The OU-4 system has not operated at Pond 13 since system shutdown in July 1997, and groundwater contamination exists above the RAOs. The soil cover has not been installed on the Wet Well and seep areas, but subsequent investigations have shown that installation of the soil cover was not required. A consensus agreement for OU-5 (CA1, March 2001) has been entered into by the USACE, USEPA, and WVDEP. Contaminated soil has been removed, to the extent feasible, to eliminate the continued source of groundwater contamination. In conjunction with the consensus agreement, USACE Huntington District awarded a contract for the installation of two groundwater extraction wells at Pond 13 to remove the residual groundwater contamination.

Approximate extents of excavation at OU-5 were determined based on prior investigations. It was initially believed that approximately 200 cubic yards of nitroaromatic-contaminated soil would be excavated from five to eight feet below ground surface (bgs) between the former wet wells. However, pre-excavation sampling found that contamination levels increased moving westward toward and into the western wet well. Excavation showed that contamination was present at other depths, too. This was primarily evident due to the strong odor of DNT and the reddish discoloration of water that entered the excavation. A second work order was awarded to require the excavation of an additional 800 cubic yards of soil from the wet well area. All excavation planned for this area has been completed. The excavation was backfilled and two extraction wells are being installed for the collection and treatment of groundwater through the Yellow Water Treatment Plant. A monitoring well was also installed to monitor the effectiveness of that operation.

USACE is taking, or plans to take, the following actions to ensure protectiveness:

- Installation of two groundwater extraction wells in the intermediate water-bearing zone and installation of new extraction well power and signal control lines;
- Resumption of the OU-4 system at P13/WWA;
- Extraction of the groundwater until the RAOs of the OU-2 ROD or the P13/WWA groundwater criteria (depending on Tier 1 team decision) are met;
- Discharge of treated effluent shall meet WV water quality discharge criteria; and
- Completion of an ESD which details the current objectives of OU-5, in relation to the OU-2 ROD.

10.0 RECOMMENDATIONS

Recommendations provided in this section are based upon the results obtained and the conclusions drawn from the FYR process. USACE and other involved agencies should attempt to execute responsibilities associated with these recommendations in accordance with overall fiscal responsibilities and the receipt of appropriate funding. These recommendations do not commit USACE or other involved agencies to any activity for which funding is not made available through their respective budgetary processes. The recommendations described in this section are summarized in the FYR Summary Form following the Executive Summary; the FYR Summary Form also contains information concerning the party responsible to implement the recommendations, oversight agency, milestone date, and whether the follow-up action affects either current or future protectiveness.

10.1 Operable Unit 1 Recommendations

To assure the protectiveness of the OU-1 remedy in the long-term, inspection and maintenance of the soil covers, drainage structures, and protective warning signs must continue, and corrective measures contracts shall be administered by the USACE for any repairs that are necessary to maintain the remedy. Long-term groundwater monitoring should continue, and revisions to the LTMP for OU-1 should be conducted in accordance with Consensus Agreement No. 6, *Methodology for Future Revisions to the Long-Term Monitoring Program* (CA6, 2002) Using information gained from the recently-completed composting pilot project,, the possibility of excavating and composting nitroaromatic-contaminated material beneath the soil covers should be evaluated as a potential permanent remedy (i.e. remove and treat the source). However, due to the inclusion of asbestos-containing material beneath the WBG soil cover, composting may not be viable option for contaminated soil in that area. RAOs which address ecological risks could be developed and added to the OU-1 ROD via an ESD. Revised, protective ROs for human health risks and ROs for other nitroaromatic compounds detected at the site should be calculated. These could be incorporated into an ESD, also. These new levels could be applied to a removal action for nitroaromatic-contaminated soil along/beneath the IWSL. The investigations at OUs-8 and 9 should be completed to determine how to address nitroaromatic-contaminated soil and groundwater within OU-1 This includes a determination of whether the capped materials need to be remediated in order to restore groundwater.

10.2 Operable Unit 2 Recommendations

Long-term inspection and maintenance of the RCRA soil covers, drainage structures, and protective warning signs must continue, and repair contracts should be awarded, as necessary, to maintain, and assure the protectiveness of, the OU-2 remedy. The LTMP for OU-2 should continue, and be revised as recommended for OU-1. As suggested for OU-1, the feasibility of composting the contaminated sediments beneath the OU-2 RCRA cap should be evaluated upon the completion of the OU-5 composting project. This proposed remedy could permanently remove a potential source of groundwater contamination that has to be treated by the OU-4 groundwater treatment system, which would help expedite the OU-4 groundwater cleanup objectives. Source removal would eliminate the requirement (and costs) for inspection, maintenance, and repair of the RCRA caps. Additionally, RAOs which address ecological risks could be developed and added to the OU-2 ROD via an ESD. This ESD could also be used to document the division of OU-2 into OU-2 RWR, OU-3 YWR, OU-4 Groundwater Pump & Treat, and OU-5 Pond 13/Wet Well Areas. A typographical error in Table 12 of the ROD should also be addressed in an ESD, revising the units from mg/L to µg/L in order to correspond with Table 4 (It is presumed that µg/L should be the correct units for ROD Tables 4 & 12, because values in the mg/L range probably would not have been noted as being below detection limits). Revised, protective ROs for human health risks and ROs for other nitroaromatic compounds detected at the site should be calculated. These could be incorporated into an ESD, also.

10.3 Operable Unit 3 Recommendations

The feasibility of composting the contaminated sediments beneath the OU-3 cap should be evaluated, along with OU-1 and OU-2 evaluations. Source removal could expedite the OU-4 groundwater remediation and eliminate the O&M costs for inspection, maintenance, and repair of the RCRA cap. Long-term inspection, maintenance, and repair of the OU-3 RCRA soil covers should continue as recommended for OUs-1 and 2, to assure that the remedy remains protective. Likewise, the LTMP for OU-3 should continue and should be revised per CA6. Additionally, RAOs which address ecological risks could be developed and added to the OU-2 ROD via an ESD. Revised, protective ROs for human health risks and ROs for other nitroaromatic compounds detected at the site should be calculated. These could be incorporated into an OU-2 ESD, also.

10.4 Operable Unit 4 Recommendations

10.4.1 Groundwater Plume Capture

The USEPA, in their review of the draft report *Demonstration that the Operable Unit 4 Groundwater Extraction and Treatment System is Operating Properly and Successfully* (USACE, 2002), stated that additional monitoring wells were needed for the OU-4 system to define plume capture and determine drawdown to prove that OU-4 was "OP&S". The USEPA recommended locations for monitoring wells at both the RWRTP and YWRTP areas (USEPA, 2003). The RSE (USACE, 2004) stated that the plumes appeared to be adequately defined and that the remedy appeared to be protective, but recommended the installation of additional monitoring wells at both RWRTP and YWRTP to also define the capture zone and perform additional site characterization. An OU-4 task group was subsequently formed with representatives from all of the WVOW team's agencies to evaluate the HTRW-CX and USEPA recommendations, and determine the locations for new monitoring wells that would satisfy both agencies' recommendations. The recommendations were compiled and reviewed by task group members, and on March 29, 2004, a conference call was held among the task group members to discuss the recommendations. The group agreed upon the locations for thirteen new monitoring wells: six intermediate wells at the RWR area and five intermediate and two deep monitoring wells at the YWR area. The deep wells at the YWR area will be paired with two of the intermediate wells. A modification was issued to the FY03 O&M work order to install the wells, and twelve new wells were installed during August 2004 (Figures 8-1 and 8-2); a planned 13th well could not be installed because a necessary right-of-entry could not be obtained. Task group work to optimize OU-4 groundwater treatment and further pursue the topic of plume capture should be conducted.

10.4.2 Groundwater Remediation Goals

For the RSE, the HTRW-CX compared the OU-2 ROD groundwater remediation goals (RGs) for 2,4-DNT and 2,6-DNT to ecotoxicity and screening levels (USACE, 2004). The evaluation determined that the calculated nitroaromatic influent concentrations at both plants were well below the ecotoxicity screening levels, USEPA Region III RBCs, USEPA Region IX PRGs, and MCLs, with the exception of the combined toxicity of 2,4-DNT, 2,6-DNT and 2,4,6-TNT. The report stated that the values represented an excess cancer risk of 10^{-6}, and concluded that the OU-2 groundwater RGs appeared to be quite conservative and should probably be re-evaluated given the land use at WVOW. This recommendation is valid and should be given further consideration by the WVOW OU-4 task group, although the OU-2 ROD assumes that groundwater may be used as a drinking water source and USEPA policy requires that groundwater be treated in order to achieve "beneficial use". The revised ROs would also have to be protective of residential receptors who may use this aquifer for drinking water, in accordance with USEPA policy. Revised, protective ROs for human health risks and ROs

for other nitroaromatic compounds detected at the site should be calculated, if groundwater is assumed to be a potential source of drinking water. These could be incorporated into an OU-2 ESD.

10.4.3 System O&M Cost Reduction

The RSE team reported that the influent concentrations of primary COCs (2,4 DNT; 2,6 DNT; 2,4,6 TNT; 1,3,5 TNB; and 1,3 DNB) at the RWRTP were below the discharge standards, and recommended considering taking the GAC out of service and discharging the extracted groundwater directly to the Sedimentation Basin. Costs for analyses, electric power, particulate filters, and GAC replacement could be greatly reduced or eliminated. Extraction well pumping rates could possibly be increased due to the decreased head pressure from bypassing the GAC vessels, in an effort to reduce the remediation time. The report noted that although groundwater concentrations are below the effluent discharge standards, the levels still exceed OU-2 ROD RAOs (USACE, 2004). This topic should undergo further evaluation by the OU-4 task group. Although the observed levels of COCs and other groundwater constituents have consistently been below the discharge criteria, it is believed that the WVDEP OWR would still require effluent analysis and monthly reporting via a DMR

For the YWRTP, the RSE team observed that nitroaromatic concentrations in the deep aquifer were significantly lower than those in the intermediate aquifer, and referred to the hydraulic communication between both aquifers that had been confirmed through previous pump tests at the YWR site. For these reasons, they recommended cessation of pumping the deep extraction wells due to the likelihood that these wells could be drawing nitroaromatics from the upper aquifer into the deep aquifer. It was also noted that pumping cessation could increase the drawdown available to the upper extraction wells, thus inducing an upward gradient The upward gradient could prevent the migration of nitroaromatics into and within the deep aquifer. Significant O&M cost savings would result through the adoption of this recommendation. This recommendation could be easily implemented through a modification to the current (FY04) OU-4 O&M work order. The OU-4 task group should conduct further evaluation of this recommendation.

10.4.4 Consideration of Monitored Natural Attenuation

Due to the relatively low concentrations and minimal spread of nitroaromatic contamination, the limited human and ecological exposure, and the evidence of nitroaromatic degradation products, the RSE recommended that a monitored natural attenuation (MNA) remedy be investigated and evaluated as an option to replace the groundwater extraction and treatment system. Such a remedy would greatly reduce the annual and lifetime costs for OU-4. Implementation of this plan would require amendment of the OU-2 ROD and the development of a decision matrix to identify under what circumstances the extraction and treatment systems would be restarted. This recommendation appears to have merit, given the low RAOs of the OU-2 ROD, and the potential to achieve those levels without great expense through the current groundwater extraction system. The OU-4 task group is tasked to evaluate this proposal, but no additional studies have yet been conducted. It is recommended that such an evaluation be conducted during FY06.

10.4.5 Removal of Nitroaromatic Sources to Groundwater

The capped areas at the former RWR and YWR are potential long-term sources of nitroaromatic contamination to groundwater, since the contaminated sediments were not removed when the remedy was implemented. Removal of these sources could reduce the OU-4 life-cycle cost. Remedial actions could include excavation and treatment (e.g. composting, incineration, off-site disposal, etc.), in-situ bioremediation, or in-situ chemical oxidation. Given the estimated quantity of soil, any remedial action would likely be very expensive, and could cost upwards of $12-15 million. Cap and source

removal would reduce annual O&M costs and could also reduce long-term groundwater monitoring in these areas. Removal of the RCRA caps and removal and treatment of the contaminated soil and sediment beneath these caps would be limited to available funds and is a managerial decision beyond the scope of this report. This recommendation should be given additional consideration after higher priority projects have been addressed.

10.4.6 Potential Accumulation of Metals in Sediment

During the review of the draft report, USEPA BTAG raised the issue of whether metals are accumulating in sediments due to discharge from the RWRTP and causing an unacceptable risk to ecological receptors. Other related issues became apparent during subsequent discussion, such as whether the RWR sedimentation basin into which the RWRTP discharges is a mitigation wetland or a treatment unit. It is recommended that the WVOW Tier 1 team discuss these issues and determine if and how to address the possibility of metals accumulating in these sediments and what course of action should be taken if an unacceptable ecological risk exists.

10.4.7 Selection of Pond 13/Wet Well Area Remedial Objectives

As stated in Section 8.2, the OU-2 ROD is unclear on whether Table 2 (Remedial Objectives for Second Operable Unit) or Table 14 (Ground Water Criteria for Pond 13/Wet Well Area) should apply to groundwater treatment in the P13/WWA. It is recommended that the WVOW Tier 1 team further research this issue and reach consensus on whether these levels or some other levels should apply. The team should also determine how to document this decision (e.g. CA, ESD, or ROD amendment). However, this issue would be moot if the team follows the recommendation of calculating new ROs, which would supersede the values in both of these tables, if adopted.

10.4.8 Applicability of OU-9 Pilot Study

The results of the enhanced in situ bioremediation pilot study performed for OU-9 groundwater should be evaluated for its applicability to groundwater in other areas of the site (e.g. OUs-2 and 3). This evaluation should include a comparison to OU-4 in terms of, at a minimum, cost, treatment time, and effectiveness.

10.5 Operable Unit 5 Recommendations

Currently, the ROD for the P13/WWA stipulates the placement of a soil cover over the Wet Well and seep areas, with extraction of groundwater until the criteria for nitroaromatics is attained. Based upon investigations that were conducted in 1995 and the agreements contained in CA1, an ESD was prepared and is currently being routed for signature. Installation of the two new extraction wells and resumption of the extraction system at OU-5 will satisfy part of the OU-2 ROD requirements. Additionally, RAOs which address ecological risks could be developed and added to the OU-2 ROD via an ESD. Revised, protective ROs for human health risks and ROs for other nitroaromatic compounds detected at the site should be calculated. These could be incorporated into an OU-2 ESD or ROD amendment, also.

10.6 General Recommendations

10.6.1 LTM Program Review

The WVOW Tier I team formed a LTMP Task Group (TG) in 2001, which drafted a methodology for revisions to the program That methodology was presented to the WVOW team in February 2002, and

was agreed upon by consensus members in CA6. The *Long-Term Monitoring Report, Tenth Annual OU-1 Investigation and Eighth Annual OU-2 and OU-3 Investigation, West Virginia Ordnance Works, Mason County, West Virginia* (Shaw, 2004b) and the previous LTMP report (*Long-Term Monitoring Report, Ninth Annual OU-1 Investigation, Seventh Annual OU-2 and OU-3 Investigation, and Fifth OU-11 Investigation, West Virginia Ordnance Works, Mason County, West Virginia* (Shaw, 2004a), were prepared in accordance with the recommendations and methodology contained in CA6.

A new LTMP TG was assembled during July 2004 to conduct a through review of the data contained in the final 2004 LTMP report (2003 investigation) and data from the previous LTMP investigation report in order to provide the following:

- Assure that long-term monitoring is being conducted per ROD requirements and that data needs are still being met for the various OUs.
- Ensure that there is no redundancy or excess sampling and analysis efforts between what is being conducted for the LTMP and other projects; e.g., LTMP sampling vs. OU-4 O&M sampling efforts. Coordinate any duplicate efforts between the projects.
- Determine that the LTMP provides adequate monitoring to assure that the remedies remain protective and are functioning per ROD requirements.
- Determine that Tier I team review comments to the LTMP reports have been adequately addressed to assure that their data needs are being satisfied.
- Conduct a review of existing groundwater monitoring wells and recommend decreases in sampling frequency where applicable, or the permanent abandonment of wells that no longer serve the needs of the LTMP.

The LTMP TG should continue their work and meet the above objectives, and should provide recommendations for revisions to the LTM program to the WVOW Tier I team for discussion and consensus. Final recommendations should then be provided to USACE Nashville District, sometime near the end of each calendar year, so that they can be incorporated into the scope of work for the LTMP sampling event to be conducted during the following calendar year.

10.6.2 Public Information Needs Service

Current project-related information should continue to be provided to the public through the PR which is located at the Mason County Library in Point Pleasant, West Virginia, and the AR which is located at the USACE Huntington District and on the USACE Huntington District's website. The USACE's annual Formerly Used Defense Sites (FUDS) Newsletter, which contains project-related articles, should also continue to be produced and provided to the public. The USACE should continue to hold Restoration Advisory Board (RAB) and public meetings, as necessary, to keep the public informed and solicit stakeholders' input regarding project activities and developments.

10.6.3 GIS Development and Application

The project Geographic Information System (GIS) should continue to be updated, applied, and further developed by USACE and its contractors. This will allow a current database of project information to be maintained, and will facilitate future project management, site monitoring, and reviews. Methods that will allow a web-based exchange of information between the project team members should be evaluated for possible development and implementation.

11.0 STATEMENT OF PROTECTIVENESS

The USACE has implemented the remedies at OUs-1, 2, 3, and 4 in accordance with the remedial action objectives of the OU-1 and OU-2 Records of Decision, and they are currently functioning as intended. However, contamination remains in place. Also, some of the ROD levels do not appear to be protective.

For the remedies to be protective of human health and the environment in the long-term, continued O&M of the remedies must continue until RAOs have been met. Also, revised, protective ROD levels for human health and ecological risks should be developed. The USACE, as the lead agency for environmental restoration of the WVOW property, is taking necessary measures to assure that the remedies are protective and is conducting additional studies to address wastes that remain in place. Actions that the USACE is taking, or plans to take, to assure that the remedies are protective of human health and the environment, are as follows:

- Continuation of the O&M of the RCRA soil caps and protective soil covers at OUs 1, 2, and 3;
- Completion of the investigations at OUs-8 and 9, to determine remedies for nitroaromatic-contaminated soil and groundwater within OU-1;
- Enhancement of the groundwater monitoring network at OU-4 and continuation of groundwater treatment until the OU-2 ROD RAOs are met;
- Evaluation of the soil removal action at OU-5, installation of groundwater extraction wells, and extracting and treating nitroaromatic-contaminated groundwater until OU-2 ROD RAOs are met;
- Continuation of the long-term groundwater monitoring requirements for all OUs;
- Completion of the remedial investigations for the remaining OUs and areas of concern on Site.

The Records of Decision for OUs-10, 11, and 12 required that no remedial actions or institutional controls in order to protect human health and the environment; therefore, a five-year review of the remedies for these OUs was not required. Since the remedies for these OUs have been implemented per the RODS for the respective OU, the remedies for OUs-10, 11, and 12 are determined to be protective of human health and the environment.

12.0 NEXT REVIEW

The next (i.e. fourth) five-year review of remedial actions implemented at the WVOW site should occur within five years of the completion date on the cover of the final version of this report.

13.0 REFERENCES

Chippewa Hazardous Waste, Inc., 1999, Site Restoration Report, Removal of Asbestos/Mixed Debris and Placement of Soil Cover, Expanded Site Investigation 8 (ESI-8) Area, West Virginia Ordnance Works, Point Pleasant, West Virginia, Contract No. DACW69-98-D-0001, Work Order No. 0017.

Consensus Agreement #1, March 8, 2001, West Virginia Ordnance Works.

Consensus Agreement #2, April 19, 2001, West Virginia Ordnance Works Consensus Agreement for OU-1 Burning Grounds.

Consensus Agreement #3, September 28 2001, West Virginia Ordnance Works Consensus Agreement for Area of Potential Ecological Concern 3, TNT Manufacturing Area, Operable Unit 8.

Environmental Science and Engineering, Inc. (ESE), 1984, Archives Search Report of the Former West Virginia Ordnance Works, Point Pleasant, West Virginia. U.S. Army Toxic and Hazardous Materials Agency, Assessment Division, Aberdeen Proving Ground, Maryland.

Environmental Science and Engineering, Inc . (ESE), 1986a . West Virginia Ordnance Works Remedial Investigation. Revised Final Report.

ESE, 1986b, West Virginia Ordnance Works Feasibility Study for the TNT Manufacturing Area, the Burning Grounds, and the Industrial Sewer Lines Final Report (Volumes I and II)

ESE, 1986c, West Virginia Ordnance Works Endangerment Assessment for Sewer Lines.

ESE, 1987, West Virginia Ordnance Works: Endangerment Assessment for Acids Area / Yellow Water Reservoir, Red Water Reservoirs, and the Pond - 13 / Wet Well Area.

ESE, 1991, Supplemental Investigation, West Virginia Ordnance Works, Final Report, U.S. Army Toxic and Hazardous Materials Agency, Aberdeen Proving Ground, Maryland.

IT Corporation (IT), 1995, Supplemental Investigation of the TNT Manufacturing Area, Operable Unit 8B, West Virginia Ordnance Works, Mason County, West Virginia, June.

IT, 1996, Sitewide Hydrogeological Study, West Virginia Ordnance Works, Mason County, West Virginia.

IT, 1997a, Human Health Risk Evaluation, Baseline Risk Assessment, Former Sellite Manufacturing Area, Operable Unit 11, West Virginia Ordnance Works, Mason County, West Virginia.

IT, 1997b, Ecological Risk Assessment Screening Report, Exposure Assessment and Analysis, Area of Potential Environmental Concern (APEC) 1, West Virginia Ordnance Works.

IT, 1998a, Ecological Risk Assessment Screening Report, Exposure Assessment and Analysis, Area of Potential Environmental Concern (APEC) 1, West Virginia Ordnance Works.

IT, 1998b, Ecological Risk Assessment Screening Report, Exposure Assessment and Analysis, Area of Potential Environmental Concern (APEC) 3, West Virginia Ordnance Works.

IT, 1998c, Ecological Risk Assessment Screening Report, Exposure Assessment and Analysis, Area of Potential Environmental Concern (APEC) 4, West Virginia Ordnance Works.

IT, 1999, Final Alternative Analysis Report (AAR) Groundwater Extraction and Treatment System Operable Unit 4 West Virginia Ordnance Works, Point Pleasant, West Virginia.

IT, 1999, West Virginia Ordnance Works Site Management Plan Update, West Virginia Ordnance Works, West Virginia.

IT, August 7, 2001, Issue Paper, Completion of the BERA Process for APEC-3 vs "Hot Spot" Remediation, West Virginia Ordnance Works, Mason County, West Virginia.

IT, 2002, Baseline Human Health Risk Assessment for the Former TNT Manufacturing Area.

Marshall University Center for Environmental, Geotechnical, and Applied Science (MUCEGAS), 2002, Community Water Well Survey Report at the West Virginia Ordnance Works.

OHM Remediation Services Corp., March 22, 1993, Final As-Built Report for the Yellow Water Reservoir and Barren Area Closure Caps, Former West Virginia Ordnance Works, Point Pleasant, West Virginia.

OHM Remediation Services Corp., March 26, 1993, Final As-Built Report for the Red Water Reservoir Closure Caps, Former West Virginia Ordnance Works, Point Pleasant, West Virginia.

OHM Remediation Services Corp, October 14, 1994, Final Report, Washout Area Removal Action, Former West Virginia Ordnance Works, Point Pleasant, West Virginia, Rapid Response Contract No. DACW45-94-D-0005.

OHM Remediation Services Corp., March 1, 1995, Final Report, Operable Unit One, Cap Repair and Replacement, Former West Virginia Ordnance Works, Point Pleasant, West Virginia.

Roy F. Weston, Inc. (RFW), 1983, Extent of Contamination Study, McClintic Wildlife Refuge, Point Pleasant, West Virginia, Pennsauken, New Jersey, WVOW-119.

Senjalia, N. and M. Cinquegranna, 1981, Ground Water/Hazardous Waste Section, Division of Water Resources, Preliminary Investigation of West Virginia Ordnance Works at Point Pleasant, West Virginia.

Shaw Environmental, Inc. (Shaw), 2003, Long-Term Monitoring Report: Eighth Annual OU-1 Investigation, Sixth Annual OU-2 and OU-3 Investigation, and Fourth Annual OU-11 Investigation, West Virginia Ordnance Works, Mason County, West Virginia.

Shaw, 2004a, Long-Term Monitoring Report: Ninth Annual OU-1 Investigation and Seventh Annual OU-2 and OU-3 Investigation, West Virginia Ordnance Works, Mason County, West Virginia.

Shaw, 2004b, Long-Term Monitoring Report: Tenth Annual OU-1 Investigation and Eighth Annual OU-2 and OU-3 Investigation, West Virginia Ordnance Works, Mason County, West Virginia.

Tetra Tech, Inc., 1992, Field Summary Report: Groundwater, Surface Water, Soil/Sediment Investigation, West Virginia Ordnance Works, Mason County, West Virginia.

U.S. Army Center for Health Promotion and Preventive Medicine, May 2000 - March 2002, Bioconcentration, Bioaccumulation and Biomagnification of Nitroaromatic and Nitramine Explosives and their Breakdown Products, Toxicology Study No. 87-874677-01.

U.S. Army Corps of Engineers (USACE), 1944, Industrial Facilities Inventory, West Virginia Ordnance Works, Mason County, West Virginia.

USACE, 1946, Harris Board Report.

USACE, 1987, Record of Decision Remedial Alternative Selection for First Operable Unit.

USACE, 1988, Record of Decision Remedial Alternative Selection for Second Operable Unit.

USACE, 1994, West Virginia Ordnance Works Operation and Maintenance Plan.

USACE, 2002, Demonstration that the Operable Unit 4 Groundwater Extraction and Treatment System is Operating Properly and Successfully, prepared by USACE Huntington District

USACE, 2004, Remedial System Evaluation: Red and Yellow Water Reservoirs, Groundwater Extraction and Treatment Systems, Former West Virginia Ordnance Works, report prepared by USACE HTRW-CX; final version of report dated January 2004.

U.S. Environmental Protection Agency (USEPA), 1989, Risk Assessment Guidance for Superfund: Human Health Evaluation Manual, EPA/540/1-89/002.

USEPA, 1995, Five-Year Review Report, West Virginia Ordnance Works, Point Pleasant, West Virginia.

USEPA, 1995, USEPA Region III Risk Based Concentration Table.

USEPA, 1999, Primary Drinking Water Standards and Health Advisories (http://www.epa.gov/safewater/uic/classv/pdfs/appd pdf).

USEPA, 2000, Five-Year Review Report: Operable Units 1, 2, 3, 4, and 5, West Virginia Ordnance Works NPL Site, Mason County, West Virginia.

USEPA, 2001, Comprehensive Five-Year Review Guidance, EPA 540-R-01-007, June 2001.

USEPA, 2003, EPA Recommendations concerning locations for monitoring wells at both the RWRTP and YWRTP areas (provided by Bernice Pasquini via email communication, January 2003).

USEPA Region 3, April 2005, USEPA Region III Risk Based Concentration Table (http://www.epa.gov/reg3hwmd/risk/human/).

Woodward-Clyde Consultants (WCC), 1993, West Virginia Ordnance Works Treatment System, Concept Design Analysis.

Woodward-Clyde Consultants (WCC), 1994, West Virginia Ordnance Works Site Management Plan, West Virginia Ordnance Works, West Virginia.

Wilmoth, B. M., 1966, Groundwater in Mason and Putnam Counties, West Virginia, Bulletin 32, by U.S. Geological Survey in Cooperation with the West Virginia Geological and Economic Survey.

WTI, 2003, Residential Well Sampling Report, West Virginia Ordnance Works, Point Pleasant, West Virginia.

WTI, 2004a, Systems Evaluation Report· from July 31, 2002 through May 28, 2003, Operable Unit 4, West Virginia Ordnance Works, West Virginia.

WTI, 2004b, Draft Systems Evaluation Report: from May 2003 through December 2003, Operable Unit 4, West Virginia Ordnance Works, West Virginia.

Tables

Table 2-1. Chronology of major site events through April 2004.

(page 1 of 2)

Event	*Date*
WVOW plant construction authorized	1941
WVOW manufactured TNT	1942 to 1945
Construction of WVOW plant completed	1943
TNT production was suspended and plant shutdown was initiated	1945
Harris Board Report was released and indicated area of contamination	1946
72 partial decontamination certificates had been released	1946
USACE tasked with the protection, maintenance, and custody of property	1946
State of West Virginia Conservation Commission (now WVDNR) acquired a large portion of WVOW land at no cost, provided the land was to be used as a wildlife management area	1949
Inspection reported dangerous TNT contamination on the MWMA property	1954
Red Water seepage discovered at Pond 13	1981
Site added to NPL (ranked number 84) by the State of WV	1983
Memorandum of Understanding between USEPA and DoD	1983
Began initial RI/FS	1984
First two operable units (OUs) identified	1986
ROD and IAG signed for OU-1	1987
OU-1 Remedial Action completed	1988
ROD and IAG signed for OU-2	1988 and 1989
OU-2 Remedial Action completed	1992
USACE accepts site responsibilities from USATHAMA	1991-92
OU-1 groundwater LTM initiated	1993
Technical Review Committee formed; powerhouses demolished at OU-12; NPL boundary reduced from ~8,300 acres to 2,700 acres through partnering with TRC, state of WV, and USEPA.	1994
Completed OU-1 Corrective Action to repair and replace soil covers; sentry wells installed to monitor public water supply; OU-2 groundwater LTM initiated; OU-4 Remedial Action contract awarded and Remedial Design commences; First Five-year Review Report completed	1995
OU-5 RI initiated; OUs 8, 9, and 11 risk assessments and RIs completed; Baseline risk assessments initiated for OUs 10 and 12; OU-3 Corrective Action completed; OU-4 RA construction commences.	1996

Table 2-1. Chronology of major site events through April 2004.

Event	*Date*
OU-4 RA completed, initiated 6-month O&M, OU-4 pump and treat plant shutdown due to metals' discharge noncompliance; Final risk assessments submitted for OUs 10, 11, and 12; draft FS OU-10 submitted; OU-11 draft Proposed Plan submitted; OU-5 final alternative analysis report submitted	1997
TRC converted to RAB; sitewide groundwater model completed, draft FS Alternative Analysis completed for OU-4; OUs 10 and 12 draft Proposed Plans completed	1998
Second Five-year review process completed; Completed response to public comments for OUs 10 and 12 RODs; supplemental sampling at OU-1; Project Management Plan signed	1999
OU-11 ROD signed; Second Five-year Review Report signed by USEPA; Successful re-start of OU-4 pump and treat following Alternatives Analysis and effluent discharge to wetlands; OU-9 aquifer pump test completed; Supplemental sampling at OUs 10 and 12; PMP updated	2000
Soil cover extensions and new soil cover construction at OU-1; repair of RCRA soil caps at OUs 2 and 3; Demolition of unsafe structures and asbestos removal at OU-11; Consensus Agreements signed for OUs1, 5, and 9	2001
OU-12 NFA ROD signed; First NPL partial delisting of 512 acres; OU-9 interim FS completed; background study completed; supplemental sampling for OU-10 PP/ROD; Consensus Agreements signed for OU-4 OM&M and LTM program revision methodology	2002
Implemented composting of nitroaromatic-contaminated soil OU-5 and draft ESD completed; OU-10 PP/ROD signed; residential well sampling performed	2003
Remediation System Evaluation of OU-4 completed; Signed Consensus Agreement and initiated HRC injection treatability study for OU-9; Second NPL partial deletion of 1,004 acres (remaining NPL comprises 1184 acres)	2004

Table 5-1 - OU-1 ARARs

ARAR	Feasibility Study Analysis (ESE, 1986a)	Five-Year Review Analysis (2004)
Federal		
RCRA	Treatment and disposal of materials removed from WVOW to an offsite facility will be in compliance with current RCRA regulations issued in the HSWA of 1984 Onsite treatment and disposal operations will be in accordance with the substantive technical requirements of RCRA	No additional offsite treatment or disposal from OU-1 is planned at this time Future onsite treatment and disposal of any material, such as composting of capped soil contaminated with nitroaromatics, will comply with the technical requirements of RCRA
National Ambient Air Quality Standards (NAAQS)	Implementation of alternatives that include onsite incineration will result in the emission of pollutants into the air The use of air pollution control equipment will minimize the effect of incinerator emissions on existing air quality Incinerator performance standards will be attained, but permits will not be required Because the emissions from surface flashing are largely uncontrollable, air quality standards may not be met during flashing operations Particulate emissions during excavation will occur, although dust palliatives will be used to minimize fugitive dust Onsite personnel, however, will be adequately protected	No incineration or flashing within OU-1 is ongoing or planned
DOT Hazardous Materials Transport Rules	The transport of hazardous materials to off-site facilities will be in compliance with these rules, including use of properly constructed and marked transport vehicles, a licensed transporter, and hazardous waste manifests	No additional offsite treatment or disposal from OU-1 is ongoing or planned
Federal Water Quality Criteria (FWQC)	*During the implementation of alternatives, the substantive* requirements and standards of FWQC in creeks that drain the site and other downgradient surface water will be attained	2,4-DNT and 2,6-DNT are included in the current list of FWQC, but have not been exceeded in any surface water sample taken during long-term monitoring of OU-1
Asbestos Disposal Rule (40 CFR, Part 61, Subpart M)	Since asbestos is present in the Burning Grounds Area, alternatives for asbestos disposal will meet or exceed this rule Offsite alternatives will be in full compliance, onsite alternatives will meet technical requirements	No additional asbestos disposal from OU-1 is ongoing or planned All known asbestos-containing materials (ACM) have been covered in accordance with this rule or disposed offsite
State		
State of West Virginia Water Quality Standards (WVWQS)	In implementing alternatives, WVWQS in creeks that drain the site and other down-gradient surface water will be considered The substantive requirements will be complied with and the standards attained	2,4-DNT is the only nitroaromatic included in the current list of WVWQS (effective 1 July 2004), and has not been exceeded in any surface water sample taken during long-term monitoring of OU-1 for any surface water use category
West Virginia Solid Waste Regulations	Implementation of alternatives will consider West Virginia regulations for noncontaminated materials taken to offsite sanitary landfills	No additional offsite treatment or disposal from OU-1 is ongoing or planned
West Virginia Hazardous Waste Regulations	Implementation of alternatives will consider the requirements of current regulations, including manifest requirements	No additional offsite treatment or disposal from OU-1 is ongoing or planned
West Virginia Air Pollution Control Commission (WVAPCC) Administrative Regulations	The substantive technical requirements of these regulations will be considered, and the standards and criteria of New Source Performance Standards (NSPS) will be considered	No incineration or flashing within OU-1 is ongoing or planned
West Virginia Pollution Discharge Elimination System (WVPDES) Regulations	The substantive technical requirements of these regulations will be considered, and the standards and criteria of New Source Performance Standards (NSPS) will be considered, the standards and criteria for point source discharges will be considered in implementation of the alternative	No surface water discharge within OU-1 is ongoing or planned

Table 5-2 - OU-1 ROD - Acceptable Soil, Sediment, and Water Contamination Levels

Compound	McClintic Soils (0.5 to 2 ft*) (µg/g)	Pond Waters† (µg/L)	Pond Sediments† (µg/g)	Surficial Soils** (to 0.5 ft) (µg/g)
2,4,6-TNT	7,300	60	4	680
1,3,5-TNB	72,000	80	8	2,800
1,3-DNB	3,400	160	16	190
2,4-DNT				
10-6 risk	15	3 4	0 22	1 5
10-5 risk	150	34	2 2	15
2,6-DNT				
10-6 risk	3 1	0 67	0 53	0 31
10-5 risk	31	6 7	5 3	3 1
Total Nitroaromatics				
10-6 risk	500	N/A	N/A	50
10-5 risk	N/A††	N/A	N/A	300

* Protects hunters from exposure by the plant-to-game pathway

† Protects aquatic life and fishermen

** Protects frequent McClintic Wildlife Station visitors from exposure by direct contact and inhalation of dust

†† Plants do not grow in soils containing total nitroaromatic contamination at concentrations that would result in 10-5 cancer risk

TABLE 5-3

SUMMARY OF RECEPTOR RISKS AND HAZARDS FOR COPCs

WVOW OU-1 Record of Decision Remedial Action Objectives

Scenario Timeframe	Current
Receptor Population	Construction Worker
Receptor Age	Adult

Medium	Exposure Medium	Exposure Point	Chemical of Potential Concern	Carcinogenic Risk					Non-Carcinogenic Hazard Quotient				
				Ingestion	Inhalation	Dermal	External (Radiation)	Exposure Routes Total	Primary Target Organ(s)	Ingestion	Inhalation	Dermal	Exposure Routes Total
McClintic Soil	Soil (0 5-2 0 ft)	Direct contact	2,4,6-TNT	6E-06	--	--	--	6E-06	Erythrocytes	*41*	0 5	*11*	**52**
			1,3,5-TNB	--	--	--	--	--	Liver; erythrocytes	*7*	0 00000003	*2*	**8**
			1,3-DNB	--	--	--	--	--	Erythrocytes	*95*	*1*	*25*	**121**
			2,4-DNT	--	--	--	--	--	CNS, erythrocyte liver	0 02	0 0003	0 005	0 03
			2,6-DNT	--	--	--	--	--	CNS, erythrocyte, kidney, liver	0 009	0 0001	0 002	0 01
			Total DNT	3E-07	--	9E-08	--	4E-07	--	--	--	--	--
			Chemical Total	6 3E-06	--	8 8E-08	--	6 4E-06		142	2	37	181
		Exposure Point Total						6 4E-06					181
	Exposure Medium Total							6 4E-06					181
Medium Total								6 4E-06					181

Total HI Across All Media =	**181**
Total Erythrocyte HI Across All Media =	**181**
Total Liver HI Across All Media =	**8**
Total CNS HI Across All Media =	0 04
Total Kidney HI Across All Media =	0 01

TABLE 5-4

SUMMARY OF RECEPTOR RISKS AND HAZARDS FOR COPCs

WVOW OU-1 Record of Decision Remedial Action Objectives

Scenario Timeframe	Current
Receptor Population	Construction Worker
Receptor Age	Adult

Medium	Exposure Medium	Exposure Point	Chemical of Potential Concern	Carcinogenic Risk					Non-Carcinogenic Hazard Quotient				
				Ingestion	Inhalation	Dermal	External (Radiation)	Exposure Routes Total	Primary Target Organ(s)	Ingestion	Inhalation	Dermal	Exposure Routes Total
McClintic Soil	Soil (0 5-2 0 ft)	Direct contact	2,4 6-TNT	4E-07	--	--	--	4E-07	Erythrocytes	*3*	0 03	0 7	**4**
500 ppm total nitroaromatics			1,3,5-TNB	--	--	--	--	--	Liver; erythrocytes	0 05	0 0006	0 01	0 1
			1,3-DNB	--	--	--	--	--	Erythrocytes	*14*	0 2	*4*	**18**
			2,4-DNT	--	--	--	--	--	CNS, erythrocyte, liver	0 7	0 008	0 2	0 9
			2,6-DNT	--	--	--	--	--	CNS, erythrocyte, kidney, liver	*1*	0 02	0 4	**2**
			Total DNT	9E-06	--	2E-06	--	1E-05	--	--	--	--	
			Chemical Total	--	--	--	--	--		19	0 2	5	--
		Exposure Point Total						--					--
	Exposure Medium Total							--					--
Medium Total								--					--

Maximum HI Across All Media =	**18**
Maximum Erythrocyte HI Across All Media =	**18**
Maximum Liver HI Across All Media =	**2**
Maximum CNS HI Across All Media =	**18**
Maximum Kidney HI Across All Media =	**2**

TABLE 5-5

SUMMARY OF RECEPTOR RISKS AND HAZARDS FOR COPCs

WVOW OU-1 Record of Decision Remedial Action Objectives

Scenario Timeframe	Current
Receptor Population	Construction Worker
Receptor Age	Adult

Medium	Exposure Medium	Exposure Point	Chemical of Potential Concern	Carcinogenic Risk					Non-Carcinogenic Hazard Quotient				
				Ingestion	Inhalation	Dermal	External (Radiation)	Exposure Routes Total	Primary Target Organ(s)	Ingestion	Inhalation	Dermal	Exposure Routes Total
Pond Sediments	Pond Sediments	Direct contact	2,4,6-TNT	3E-10	--	--	--	3E-10	Erythrocytes	0 02	--	0 006	0 03
			1,3,5-TNB	--	--	--	--	--	Liver; erythrocytes	0 0007	--	0 0002	0 0009
			1,3-DNB	--	--	--	--	--	Erythrocytes	0 4	--	0 1	0 6
			2,4-DNT	--	--	--	--	--	CNS, erythrocyte, liver	0 0003	--	0 00008	0 0004
			2,6-DNT	--	--	--	--	--	CNS, erythrocyte, kidney, liver	0 001	--	0 0002	0 002
			Total DNT	1E-09	--	4E-10	--	2E-09	--	--	--	--	
			Chemical Total	2E-09	--	4E-10	--	2E-09		0 5	0	0 1	0 6
		Exposure Point Total						2E-09					0 6
	Exposure Medium Total							2E-09					0 6
Medium Total								2E-09					0 6

Total HI Across All Media =	0 6
Total Erythrocyte HI Across All Media =	0 6
Total Liver HI Across All Media =	0 003
Total CNS HI Across All Media =	0 002
Total Kidney HI Across All Media =	0 002

TABLE 5-8

SUMMARY OF RECEPTOR RISKS AND HAZARDS FOR COPCs

WVOW OU-1 Record of Decision Remedial Action Objectives

Scenario Timeframe	Current
Receptor Population	Construction Worker
Receptor Age	Adult

Medium	Exposure Medium	Exposure Point	Chemical of Potential Concern	Carcinogenic Risk					Non-Carcinogenic Hazard Quotient				
				Ingestion	Inhalation	Dermal	External (Radiation)	Exposure Routes Total	Primary Target Organ(s)	Ingestion	Inhalation	Dermal	Exposure Routes Total
Pond Waters	Pond Waters	Direct contact	2,4,6-TNT	4E-10	--	--	--	4E-10	Erythrocytes	0 02	--	0 06	0 09
			1,3,5-TNB	--	--	--	--	--	Liver; erythrocytes	0 0005	--	0 001	0 002
			1,3-DNB	--	--	--	--	--	Erythrocytes	0 3	--	0 9	1
			2,4-DNT	--	--	--	--	--	CNS, erythrocyte, liver	0 0003	--	0 0009	0 001
			2,6-DNT	--	--	--	--	--	CNS, erythrocyte, kidney, liver	0 0001	--	0 0004	0 0005
			Total DNT	5E-10	--	1E-09	--	2E-09	--	--	--	--	
			Chemical Total	9E-10	--	1E-09	--	2E-09		0 3	0	0 9	1
		Exposure Point Total						2E-09					1
	Exposure Medium Total							2E-09					1
Medium Total								2E-09					1

Total HI Across All Media =	1
Total Erythrocyte HI Across All Media =	1
Total Liver HI Across All Media =	0 004
Total CNS HI Across All Media =	0 002
Total Kidney HI Across All Media =	0 0005

TABLE 5-7

SUMMARY OF RECEPTOR RISKS AND HAZARDS FOR COPCs

WVOW OU-1 Record of Decision Remedial Action Objectives

Scenario Timeframe	Current
Receptor Population	Construction Worker
Receptor Age	Adult

Medium	Exposure Medium	Exposure Point	Chemical of Potential Concern	Carcinogenic Risk					Non-Carcinogenic Hazard Quotient				
				Ingestion	Inhalation	Dermal	External (Radiation)	Exposure Routes Total	Primary Target Organ(s)	Ingestion	Inhalation	Dermal	Exposure Routes Total
Surficial Soils	(to 0 5 ft)	Direct contact	2,4 6-TNT	6E-07	--	--	--	6E-07	Erythrocytes	4	0 05	1	5
			1 3,5-TNB	--	--	--	--	--	Liver; erythrocytes	0 3	0 003	0 07	0 3
			1,3-DNB	--	--	--	--	--	Erythrocytes	5	0 06	1	7
			2,4-DNT	--	--	--	--	--	CNS, erythrocyte, liver	0 002	0 00003	0 0005	0 003
			2,6-DNT	--	--	--	--	--	CNS, erythrocyte, kidney liver	0 0009	0 00001	0 0002	0 001
			Total DNT	3E-08	--	9E-09	--	4E-08	--	--	--	--	--
			Chemical Total	6E-07	--	9E-09	--	6E-07		9	0 1	2	12
		Exposure Point Total						6E-07					12
	Exposure Medium Total							6E-07					12
Medium Total								6E-07					12

Total HI Across All Media =	12
Total Erythrocyte HI Across All Media =	12
Total Liver HI Across All Media =	0 3
Total CNS HI Across All Media =	0 004
Total Kidney HI Across All Media =	0 001

TABLE 5-8

SUMMARY OF RECEPTOR RISKS AND HAZARDS FOR COPCs

WVOW OU-1 Record of Decision Remedial Action Objectives

Scenario Timeframe: Current
Receptor Population: Construction Worker
Receptor Age: Adult

Medium	Exposure Medium	Exposure Point	Chemical of Potential Concern	Carcinogenic Risk					Non-Carcinogenic Hazard Quotient				
				Ingestion	Inhalation	Dermal	External (Radiation)	Exposure Routes Total	Primary Target Organ(s)	Ingestion	Inhalation	Dermal	Exposure Routes Total
Surficial Soil	Surficial soil (to 0.5 ft)	Direct contact	2,4,6-TNT	4E-08	--	--	--	4E-08	Erythrocytes	0.3	0.003	0.07	0.4
50 ppm total nitroaromatics			1,3,5-TNB	--	--	--	--	--	Liver; erythrocytes	0.005	0.00006	0.001	0.01
			1,3-DNB	--	--	--	--	--	Erythrocytes	1	0.02	0.4	**2**
			2,4-DNT	--	--	--	--	--	CNS, erythrocyte, liver	0.07	0.0008	0.02	0.09
			2,6-DNT	--	--	--	--	--	CNS, erythrocyte, kidney, liver	0.1	0.002	0.04	0.2
			Total DNT	9E-07	--	2E-07	--	1E-06	--	--	--	--	
			Chemical Total	--	--	--	--	--		2	0.02	0.5	--
		Exposure Point Total						--					--
	Exposure Medium Total							--					--
Medium Total								--					--

Maximum HI Across All Media = **2**

Maximum Erythrocyte HI Across All Media = **2**
Maximum Liver HI Across All Media = 0.2
Maximum CNS HI Across All Media = **2**
Maximum Kidney HI Across All Media = 0.2

TABLE 5-9

SUMMARY OF RECEPTOR RISKS AND HAZARDS FOR COPCs

WVOW OU-1 Record of Decision Remedial Action Objectives

Maintenance Worker\[Risk Asmnt-HI, Maint

Scenario Timeframe	Current
Receptor Population	Maintenance Worker
Receptor Age	Adult

Medium	Exposure Medium	Exposure Point	Chemical of Potential Concern	Carcinogenic Risk					Non-Carcinogenic Hazard Quotient				
				Ingestion	Inhalation	Dermal	External (Radiation)	Exposure Routes Total	Primary Target Organ(s)	Ingestion	Inhalation	Dermal	Exposure Routes Total
McClintic Soil	Soil (0 5-2 0 ft)	Direct contact	2 4,6-TNT	8E-05	--	--	--	8E-05	Erythrocytes	*21*	0 5	*11*	**32**
			1,3 5-TNB	--	--	--	--	--	Liver; erythrocytes	*3*	0 00000003	*2*	**5**
			1,3-DNB	--	--	--	--	--	Erythrocytes	*49*	*1*	*25*	**74**
			2,4-DNT	--	--	--	--	--	CNS, erythrocyte, liver	0 01	0 0003	0 005	0 02
			2,6-DNT	--	--	--	--	--	CNS, erythrocyte, kidney, liver	0 004	0 0001	0 002	0 01
			Total DNT	4E-06	--	2E-06	--	6E-06	--	--	--	--	
			Chemical Total	8 1E-05	--	2 2E-06	--	**8 3E-05**		73	2	37	112
		Exposure Point Total						8 3E-05					112
	Exposure Medium Total							8 3E-05					112
Medium Total								**8 3E-05**					112

Total HI Across All Media =	**112**
Total Erythrocyte HI Across All Media =	**112**
Total Liver HI Across All Media =	**5**
Total CNS HI Across All Media =	0 02
Total Kidney HI Across All Media =	0 01

TABLE 5-10

SUMMARY OF RECEPTOR RISKS AND HAZARDS FOR COPCs

WVOW OU-1 Record of Decision Remedial Action Objectives

Scenario Timeframe	Current
Receptor Population	Maintenance Worker
Receptor Age	Adult

Medium	Exposure Medium	Exposure Point	Chemical of Potential Concern	Carcinogenic Risk					Non-Carcinogenic Hazard Quotient				
				Ingestion	Inhalation	Dermal	External (Radiation)	Exposure Routes Total	Primary Target Organ(s)	Ingestion	Inhalation	Dermal	Exposure Routes Total
McClintic Soil	Soil (0 5-2 0 ft)	Direct contact	2 4,6-TNT	5E-06	--	--	--	5E-06	Erythrocytes	1	0 03	0 7	**2**
500 ppm total nitroaromatics			1,3,5-TNB	--	--	--	--	--	Liver; erythrocytes	0 02	0 00000003	0 01	0 0
			1,3-DNB	--	--	--	--	--	Erythrocytes	*7*	0 2	*4*	**11**
			2,4-DNT	--	--	--	--	--	CNS, erythrocyte, liver	0 4	0 008	0 2	0 5
			2 6-DNT	--	--	--	--	--	CNS, erythrocyte, kidney, liver	0 7	0 02	0 4	1
			Total DNT	*1E-04*	--	*6E-05*	--	**2E-04**	--	--	--	--	
			Chemical Total	--	--	--	--	--		--	--	--	--
		Exposure Point Total						--					--
	Exposure Medium Total							--					--
Medium Total								--					--

Maximum HI Across All Media =	**11**
Maximum Erythrocyte HI Across All Media =	**11**
Maximum Liver HI Across All Media =	1
Maximum CNS HI Across All Media =	**11**
Maximum Kidney HI Across All Media =	1

TABLE 5-11
SUMMARY OF RECEPTOR RISKS AND HAZARDS FOR COPCs
WVOW OU-1 Record of Decision Remedial Action Objectives

Scenario Timeframe: Current
Receptor Population: Maintenance Worker
Receptor Age: Adult

Medium	Exposure Medium	Exposure Point	Chemical of Potential Concern	Carcinogenic Risk					Non-Carcinogenic Hazard Quotient				
				Ingestion	Inhalation	Dermal	External (Radiation)	Exposure Routes Total	Primary Target Organ(s)	Ingestion	Inhalation	Dermal	Exposure Routes Total
Pond Sediments	Pond Sediments	Direct contact	2,4,6-TNT	4E-09	--	--	--	4E-09	Erythrocytes	0 01	--	0 006	0 02
			1,3 5-TNB	--	--	--	--	--	Liver; erythrocytes	0 0004	--	0 0002	0 0006
			1,3-DNB	--	--	--	--	--	Erythrocytes	0 2	--	0 1	0 3
			2 4-DNT	--	--	--	--	--	CNS, erythrocyte, liver	0 0002	--	0 00008	0 0002
			2 6-DNT	--	--	--	--	--	CNS, erythrocyte kidney, liver	0 0008	--	0 0004	0 001
			Total DNT	2E-08	--	9E-09	--	3E-08	--	--	--	--	
			Chemical Total	2E-08	--	9E-09	--	3E-08		0	0	0	0 4
		Exposure Point Total						3E-08					0 4
	Exposure Medium Total							3E-08					0 4
Medium Total								3E-08					0 4

Total HI Across All Media = 0 4

Total Erythrocyte HI Across All Media = 0 4
Total Liver HI Across All Media = 0 002
Total CNS HI Across All Media = 0 001
Total Kidney HI Across All Media = 0 001

TABLE 5-12

SUMMARY OF RECEPTOR RISKS AND HAZARDS FOR COPCs

WVOW OU-1 Record of Decision Remedial Action Objectives

Scenario Timeframe	Current
Receptor Population	Maintenance Worker
Receptor Age	Adult

Medium	Exposure Medium	Exposure Point	Chemical of Potential Concern	Carcinogenic Risk					Non-Carcinogenic Hazard Quotient				
				Ingestion	Inhalation	Dermal	External (Radiation)	Exposure Routes Total	Primary Target Organ(s)	Ingestion	Inhalation	Dermal	Exposure Routes Total
Pond Waters	Pond Waters	Direct contact	2,4,6-TNT	9E-09	–	–	–	9E-09	Erythrocytes	0 02	–	0 06	0 09
			1,3,5-TNB	–	–	–	–	–	Liver; erythrocytes	0 0005	–	0 001	0 002
			1,3-DNB	–	–	–	–	–	Erythrocytes	0 3	–	0 9	1
			2,4-DNT	–	–	–	–	–	CNS, erythrocyte, liver	0 0003	–	0 0009	0 001
			2 6-DNT	–	–	–	–	–	CNS, erythrocyte, kidney, liver	0 0001	–	0 0004	0 0005
			Total DNT	1E-08	–	4E-08	–	5E-08	–	–	–	–	
			Chemical Total	2E-08	–	4E-08	–	6E-08		0 3	–	0 9	1
		Exposure Point Total						6E-08					1
	Exposure Medium Total							6E-08					1
Medium Total								6E-08					1

Total HI Across All Media =	1
Total Erythrocyte HI Across All Media =	1
Total Liver HI Across All Media =	0 004
Total CNS HI Across All Media =	0 002
Total Kidney HI Across All Media =	0 0005

TABLE 5-13

SUMMARY OF RECEPTOR RISKS AND HAZARDS FOR COPCs

WVOW OU-1 Record of Decision Remedial Action Objectives

Scenario Timeframe	Current
Receptor Population	Maintenance Worker
Receptor Age	Adult

Medium	Exposure Medium	Exposure Point	Chemical of Potential Concern	Carcinogenic Risk					Non-Carcinogenic Hazard Quotient				
				Ingestion	Inhalation	Dermal	External (Radiation)	Exposure Routes Total	Primary Target Organ(s)	Ingestion	Inhalation	Dermal	Exposure Routes Total
Surficial Soils	(to 0 5 ft)	Direct contact	2,4 6-TNT	7E-06	--	--	--	7E-06	Erythrocytes	2	0 05	1	**3**
			1,3,5-TNB	--	--	--	--	--	Liver; erythrocytes	0 1	0 00000003	0 07	0 2
			1,3-DNB	--	--	--	--	--	Erythrocytes	3	0 06	1	**4**
			2,4-DNT	--	--	--	--	--	CNS, erythrocyte, liver	0 001	0 00003	0 0005	0 002
			2,6-DNT	--	--	--	--	--	CNS, erythrocyte, kidney, liver	0 0004	0 00001	0 0002	0 0007
			Total DNT	4E-07	--	2E-07	--	6E-07	--	--	--	--	
			Chemical Total	8E-06	--	2E-07	--	8E-06		5	0 1	2	7
		Exposure Point Total						8E-06					7
	Exposure Medium Total							8E-06					7
Medium Total								8E-06					7

Total HI Across All Media =	7
Total Erythrocyte HI Across All Media =	7
Total Liver HI Across All Media =	0 2
Total CNS HI Across All Media =	0 002
Total Kidney HI Across All Media =	0 001

TABLE 5-14

SUMMARY OF RECEPTOR RISKS AND HAZARDS FOR COPCs

WVOW OU-1 Record of Decision Remedial Action Objectives

Scenario Timeframe	Current
Receptor Population	Maintenance Worker
Receptor Age	Adult

Medium	Exposure Medium	Exposure Point	Chemical of Potential Concern	Carcinogenic Risk					Non-Carcinogenic Hazard Quotient				
				Ingestion	Inhalation	Dermal	External (Radiation)	Exposure Routes Total	Primary Target Organ(s)	Ingestion	Inhalation	Dermal	Exposure Routes Total
Surficial Soil	Surficial soil (to 0 5 ft)	Direct contact	2,4 6-TNT	4E-08	--	--	--	4E-08	Erythrocytes	0 1	0 003	0 07	0 2
50 ppm total nitroaromatics			1,3,5-TNB	--	--	--	--	--	Liver; erythrocytes	0 002	0 00000003	0 001	0 00
			1,3-DNB	--	--	--	--	--	Erythrocytes	0 7	0 02	0 4	1
			2,4-DNT	--	--	--	--	--	CNS, erythrocyte, liver	0 04	0 0008	0 02	0 05
			2 6-DNT	--	--	--	--	--	CNS, erythrocyte, kidney, liver	0 07	0 002	0 04	0 1
			Total DNT	9E-07	--	2E-07	--	1E-06	--	--	--	--	
			Chemical Total	--	--	--	--	--		1	0	0 5	--
		Exposure Point Total						--					--
	Exposure Medium Total							--					--
Medium Total								--					--

Maximum HI Across All Media =	1
Maximum Erythrocyte HI Across All Media =	1
Maximum Liver HI Across All Media =	0 1
Maximum CNS HI Across All Media =	1
Maximum Kidney HI Across All Media =	0 1

Table 6-1 - OU-2 ARARs

ARAR	OU-2 ROD Analysis (USACE, 1988)	Five-Year Review Analysis (2004)
Federal-Major		
Clean Water Act (CWA)	- Wetlands Impact - Differential Groundwater Policy - Ambient Water Quality Criteria - Pretreatment Standards for Explosives Manufacturing Point Source Category - EPA National Pollutant Discharge Elimination System requirements	OU-4 continues to meet the substantive NPDES requirements, and will be continue to be monitored for them on a monthly basis
Resource Conservation and Recovery Act (RCRA)	Groundwater Protection Standards	The LTMP was evaluated with respect to these standards, and a recommendation is included in the FYR that this type of evaluation be performed on an annual basis to ensure continued compliance
Federal-Other		
Toxic Subtances Control Act (ToSCA)		No excavation, treatment, and/or disposal of ToSCA waste in ongoing or planned
Safe Drinking Water Act (SDWA)	Maximum contaminant levels (MCLs) and maximum contaminant level goals (MCLGs)	No MCLs or MCLGs exist for nitroaromatic compounds
Clean Air Act (CAA)	National Ambient Air Quality Standards (NAAQS)	N/A
Clean Water Act (CWA)	Ambient water quality criteria (AWQC)	N/A
Marine Protection, Research, and Sanctuaries Act (MPRSA)		N/A
Solid Waste Disposal Act (SWDA)		All composted material disposed on-site will continue to meet any applicable substantive requirements of the SWDA
State		
West Virginia Hazardous Waste Management Regulations	- Closure and Post Closure Standards - Standards for Owners and Operators of Hazardous Waste Treatment, Storage, and Disposal Facilities - Performance Standards for Incinerators - Groundwater protection standards	Nitroaromatic-contaminated soil is being composted and disposed on-site in accordance with all State regulations and meets all substantive requirements of those regulations

Table 6-2 - OU-2 ROD Remedial Objectives

Compound	Groundwater Used as Drinking Water [1] (ug/L)	Soils, Industrial Land Use [1] (mg/kg)	Surface Water, McClintic [1] (ug/L)	Groundwater Criteria for Pond 13/Wet Well Area [2] (ug/L)	Drinking Water Lifetime Health Advisory [3] (ug/L)	Tap Water Risk-Based Screening Concentration [4] (ug/L)
2,4,6-TNT	50	4,000	60	4,600	0 002	2 2
1,3-DNB	14	1,200	180	12,000	0 001	3 7
1,3,5-TNB	200	18,000	80	6,200	N/A	1100
2,4-DNT					N/A	7 3
10-6 risk	0 11	10	3 4	260		
10-5 risk	1 1	100	34	2,600		
2,6-DNT					N/A	3 7
10-6 risk	0 022	2	0 67	52		
10-5 risk	0 22	20	6 7	520		
Total Nitroaromatics					N/A	N/A
10-6 risk	N/A	200	N/A	N/A		
10-5 risk	N/A	2,000	N/A	N/A		

1 - Source OU-2 ROD, Table 4, Remedial Objectives for Second Operable Unit

2 - Source OU-2 ROD, Table 14, Ground Water Criteria for Pond 13/Wet Well Area

3 - Source. Primary Drinking Water Standards and Health Advisories (http //www epa gov/safewater/uic/classv/pdfs/appd pdf)

4 - Source USEPA Region 3 Risk Based Concentration Table, April 2004 (http //www epa gov/reg3hwmd/risk/human/)

TABLE 6-3

SUMMARY OF RECEPTOR RISKS AND HAZARDS FOR COPCs

WVOW OU-2 Record of Decision Remedial Action Objectives

Scenario Timeframe	Current
Receptor Population	Construction Worker
Receptor Age	Adult

Medium	Exposure Medium	Exposure Point	Chemical of Potential Concern	Carcinogenic Risk					Non-Carcinogenic Hazard Quotient				
				Ingestion	Inhalation	Dermal	External (Radiation)	Exposure Routes Total	Primary Target Organ(s)	Ingestion	Inhalation	Dermal	Exposure Routes Total
Soils Industrial Land Use	Soil	Direct contact	2,4,6-TNT	3E-06	--	--	--	3E-06	Erythrocytes	*22*	0 3	*6*	**28**
			1,3,5-TNB	--	--	--	--	--	Liver; erythrocytes	*2*	0 02	0 4	**2**
			1,3-DNB	--	--	--	--	--	Erythrocytes	*33*	0 4	*9*	**43**
			2,4-DNT	--	--	--	--	--	CNS, erythrocyte, liver	0 01	0 0002	0 004	0 02
			2,6-DNT	--	--	--	--	--	CNS, erythrocyte, kidney, liver	0 006	0 00007	0 001	0 01
			Total DNT	2E-07	--	6E-08	--	3E-07	--	--	--	--	
			Chemical Total	3E-06	--	6E-08	--	4E-06		57	0 7	15	73
		Exposure Point Total						4E-06					73
	Exposure Medium Total							4E-06					73
Medium Total								4E-06					73

Total HI Across All Media =	**73**
Total Erythrocyte HI Across All Media =	**73**
Total Liver HI Across All Media =	**2**
Total CNS HI Across All Media =	0 02
Total Kidney HI Across All Media =	0 01

TABLE 6-4

SUMMARY OF RECEPTOR RISKS AND HAZARDS FOR COPCs

WVOW OU-2 Record of Decision Remedial Action Objectives

Scenario Timeframe	Current
Receptor Population	Construction Worker
Receptor Age	Adult

Medium	Exposure Medium	Exposure Point	Chemical of Potential Concern	Carcinogenic Risk					Non-Carcinogenic Hazard Quotient				
				Ingestion	Inhalation	Dermal	External (Radiation)	Exposure Routes Total	Primary Target Organ(s)	Ingestion	Inhalation	Dermal	Exposure Routes Total
Soils, Industrial Land Use, 200 ppm total nitroaromatics	Soil	Direct contact	2,4,6-TNT	2E-07	--	--	--	2E-07	Erythrocytes	1	0 01	0 3	1
			1,3,5-TNB	--	--	--	--	--	Liver; erythrocytes	0 02	0 0002	0 005	0 02
			1 3-DNB	--	--	--	--	--	Erythrocytes	6	0 07	1	7
			2,4-DNT	--	--	--	--	--	CNS, erythrocyte, liver	0 3	0 003	0 07	0 4
			2,6-DNT	--	--	--	--	--	CNS, erythrocyte, kidney, liver	0 6	0 007	0 1	0 7
			Total DNT	4E-06	--	1E-06	--	5E-06	--	--	--	--	
			Chemical Total	--	--	--	--	5E-06		8	0 09	2	10
		Exposure Point Total						5E-06					10
	Exposure Medium Total							5E-06					10
Medium Total								5E-06					10

Maximum HI Across All Media =	7

Maximum Erythrocyte HI Across All Media =	7
Maximum Liver HI Across All Media =	1
Maximum CNS HI Across All Media =	7
Maximum Kidney HI Across All Media =	1

TABLE 8-5

SUMMARY OF RECEPTOR RISKS AND HAZARDS FOR COPCs

WVOW OU-2 Record of Decision Remedial Action Objectives

Scenario Timeframe	Current
Receptor Population	Construction Worker
Receptor Age	Adult

Medium	Exposure Medium	Exposure Point	Chemical of Potential Concern	Carcinogenic Risk					Non-Carcinogenic Hazard Quotient				
				Ingestion	Inhalation	Dermal	External (Radiation)	Exposure Routes Total	Primary Target Organ(s)	Ingestion	Inhalation	Dermal	Exposure Routes Total
Surface Water, McClintic	Pond Waters	Direct contact	2,4,6-TNT	4E-10	--	--	--	4E-10	Erythrocytes	0 02	N/A	0 06	0 09
			1 3,5-TNB	--	--	--	--	--	Liver; erythrocytes	0 0005	N/A	0 001	0 002
			1,3-DNB	--	--	--	--	--	Erythrocytes	0 3	N/A	0 9	1
			2,4-DNT	--	--	--	--	--	CNS, erythrocyte, liver	0 0003	N/A	0 0009	0 001
			2,6-DNT	--	--	--	--	--	CNS, erythrocyte, kidney, liver	0 0001	N/A	0 0004	0 0005
			Total DNT	5E-10	--	1E-09	--	2E-09	--	--	--	--	
			Chemical Total	9E-10	--	1E-09	--	2E-09		0 3	0	0 9	1
		Exposure Point Total						2E-09					1
	Exposure Medium Total							2E-09					1
Medium Total								2E-09					1

Total HI Across All Media =	1
Total Erythrocyte HI Across All Media =	1
Total Liver HI Across All Media =	0 004
Total CNS HI Across All Media =	0 002
Total Kidney HI Across All Media =	0 0005

TABLE 6-6

SUMMARY OF RECEPTOR RISKS AND HAZARDS FOR COPCs

WVOW OU-2 Record of Decision Remedial Action Objectives

Scenario Timeframe	Current
Receptor Population	Maintenance Worker
Receptor Age	Adult

Medium	Exposure Medium	Exposure Point	Chemical of Potential Concern	Carcinogenic Risk					Non-Carcinogenic Hazard Quotient				
				Ingestion	Inhalation	Dermal	External (Radiation)	Exposure Routes Total	Primary Target Organ(s)	Ingestion	Inhalation	Dermal	Exposure Routes Total
Soils, Industrial Land Use	Soil	Direct contact	2,4,6-TNT	4E-05	--	--	--	4E-05	Erythrocytes	*11*	0 3	*6*	**18**
			1,3,5-TNB	--	--	--	--	--	Liver; erythrocytes	0 9	0 02	0 4	1
			1 3-DNB	--	--	--	--	--	Erythrocytes	*17*	0 4	*9*	**26**
			2,4-DNT	--	--	--	--	--	CNS, erythrocyte liver	0 007	0 0002	0 004	0 01
			2,6-DNT	--	--	--	--	--	CNS, erythrocyte, kidney, liver	0 003	0 00007	0 001	0 00
			Total DNT	3E-06	--	1E-06	--	4E-06	--	--	--	--	
			Chemical Total	4E-05	--	1E-06	--	5E-05		29	1	15	45
		Exposure Point Total						5E-05					45
	Exposure Medium Total							5E-05					45
Medium Total								5E-05					45

Total HI Across All Media =	**45**
Total Erythrocyte HI Across All Media =	**45**
Total Liver HI Across All Media =	1
Total CNS HI Across All Media =	0 02
Total Kidney HI Across All Media =	0 00

TABLE 6-7

SUMMARY OF RECEPTOR RISKS AND HAZARDS FOR COPCs

WVOW OU-2 Record of Decision Remedial Action Objectives

Scenario Timeframe	Current
Receptor Population	Maintenance Worker
Receptor Age	Adult

Medium	Exposure Medium	Exposure Point	Chemical of Potential Concern	Carcinogenic Risk					Non-Carcinogenic Hazard Quotient				
				Ingestion	Inhalation	Dermal	External (Radiation)	Exposure Routes Total	Primary Target Organ(s)	Ingestion	Inhalation	Dermal	Exposure Routes Total
Soils, Industrial Land Use, 200 ppm total nitroaromatics	Soil	Direct contact	2,4,6-TNT	2E-07	--	--	--	2E-07	Erythrocytes	0 6	0 01	0 3	1
			1 3,5-TNB	--	--	--	--	--	Liver; erythrocytes	0 01	0 0002	0 005	0 01
			1,3-DNB	--	--	--	--	--	Erythrocytes	*3*	0 07	1	**4**
			2 4-DNT	--	--	--	--	--	CNS, erythrocyte, liver	0 1	0 003	0 07	0 2
			2,6-DNT	--	--	--	--	--	CNS, erythrocyte, kidney, liver	0 3	0 007	0 1	0 4
			Total DNT	4E-06	--	1E-06	--	5E-06	--	--	--	--	
			Chemical Total	--	--	--	--	5E-06		4	0 09	2	6
		Exposure Point Total						5E-06					6
	Exposure Medium Total							5E-06					6
Medium Total								5E-06					6

Maximum HI Across All Media =	**4**
Maximum Erythrocyte HI Across All Media =	**4**
Maximum Liver HI Across All Media =	0 4
Maximum CNS HI Across All Media =	**4**
Maximum Kidney HI Across All Media =	0 4

TABLE 6-8

SUMMARY OF RECEPTOR RISKS AND HAZARDS FOR COPCs

WVOW OU-2 Record of Decision Remedial Action Objectives

Scenario Timeframe	Current
Receptor Population	Maintenance Worker
Receptor Age	Adult

Medium	Exposure Medium	Exposure Point	Chemical of Potential Concern	Carcinogenic Risk					Non-Carcinogenic Hazard Quotient				
				Ingestion	Inhalation	Dermal	External (Radiation)	Exposure Routes Total	Primary Target Organ(s)	Ingestion	Inhalation	Dermal	Exposure Routes Total
Surface Water McClintic	Pond Waters	Direct contact	2,4,6-TNT	4E-10	--	--	--	4E-10	Erythrocytes	0 02	N/A	0 06	0 09
			1,3,5-TNB	--	--	--	--	--	Liver; erythrocytes	0 0005	N/A	0 001	0 002
			1,3-DNB	--	--	--	--	--	Erythrocytes	0 3	N/A	0 9	1
			2,4-DNT	--	--	--	--	--	CNS, erythrocyte, liver	0 0003	N/A	0 0009	0 001
			2,6-DNT	--	--	--	--	--	CNS, erythrocyte, kidney, liver	0 0001	N/A	0 0004	0 0005
			Total DNT	5E-10	--	1E-09	--	2E-09	--	--	--	--	
			Chemical Total	9E-10	--	1E-09	--	2E-09		0 3	0	0 9	1
		Exposure Point Total						2E-09					1
	Exposure Medium Total							2E-09					1
Medium Total								2E-09					1

Total HI Across All Media =	1
Total Erythrocyte HI Across All Media =	1
Total Liver HI Across All Media =	0 004
Total CNS HI Across All Media =	0 002
Total Kidney HI Across All Media =	0 0005

TABLE 6-9

SUMMARY OF RECEPTOR RISKS AND HAZARDS FOR COPCs

WVOW OU-2 Record of Decision Remedial Action Objectives

Scenario Timeframe	Current
Receptor Population	Resident
Receptor Age	Adult

Medium	Exposure Medium	Exposure Point	Chemical of Potential Concern	Carcinogenic Risk					Non-Carcinogenic Hazard Quotient				
				Ingestion	Inhalation	Dermal	External (Radiation)	Exposure Routes Total	Primary Target Organ(s)	Ingestion	Inhalation	Dermal	Exposure Routes Total
Groundwater Used as Drinking Water Supply	Groundwater	Tap water	2,4,6-TNT	1E-05	--	--	--	1E-05	Erythrocytes	*3*	--	0 008	**3**
			1,3,5-TNB	--	--	--	--	--	Liver; erythrocytes	0 2	--	0 0005	0 2
			1,3-DNB	--	--	--	--	--	Erythrocytes	*4*	--	0 01	**4**
			2,4-DNT	--	--	--	--	--	CNS, erythrocyte, liver	0 002	--	0 000004	0 002
			2,6-DNT	--	--	--	--	--	CNS, erythrocyte, kidney, liver	0 0006	--	0 000002	0 001
			Total DNT	8E-07	--	2E-09	--	8E-07	--	--	--	--	
			Chemical Total	1E-05	--	2E-09	--	1E-05		7	0 00	0	7
		Exposure Point Total						1E-05					7
	Exposure Medium Total							1E-05					7
Medium Total								1E-05					7

Total HI Across All Media =	7
Total Erythrocyte HI Across All Media =	7
Total Liver HI Across All Media =	0 2
Total CNS HI Across All Media =	0 002
Total Kidney HI Across All Media =	0 001

TABLE 6-10

SUMMARY OF RECEPTOR RISKS AND HAZARDS FOR COPCs

WVOW OU-2 Record of Decision Remedial Action Objectives

Scenario Timeframe	Current
Receptor Population	Resident
Receptor Age	Child

Medium	Exposure Medium	Exposure Point	Chemical of Potential Concern	Carcinogenic Risk					Non-Carcinogenic Hazard Quotient				
				Ingestion	Inhalation	Dermal	External (Radiation)	Exposure Routes Total	Primary Target Organ(s)	Ingestion	Inhalation	Dermal	Exposure Routes Total
Groundwater Used as Drinking Water Supply	Groundwater	Tap water	2,4,6-TNT	8E-06	--	--	--	8E-06	Erythrocytes	7	--	0 02	**7**
			1,3,5-TNB	--	--	--	--	--	Liver; erythrocytes	0 4	--	0 002	0 4
			1,3-DNB	--	--	--	--	--	Erythrocytes	9	--	0 03	**9**
			2,4-DNT	--	--	--	--	--	CNS, erythrocyte, liver	0 004	--	0 00001	0 004
			2,6-DNT	--	--	--	--	--	CNS, erythrocyte, kidney, liver	0 001	--	0 000005	0 001
			Total DNT	5E-07	--	2E-09	--	5E-07	--	--	--	--	
			Chemical Total	9E-06	--	2E-09	--	9E-06		16	0	0	17
		Exposure Point Total						9E-06					17
	Exposure Medium Total							9E-06					17
Medium Total								9E-06					17

Total HI Across All Media =	**17**
Total Erythrocyte HI Across All Media =	**17**
Total Liver HI Across All Media =	0 5
Total CNS HI Across All Media =	0 005
Total Kidney HI Across All Media =	0 001

TABLE 6-11

SUMMARY OF RECEPTOR RISKS AND HAZARDS FOR COPCs

WVOW OU-2 Record of Decision Groundwater Criteria for Pond 13/Wet Well Area

Scenario Timeframe	Current
Receptor Population	Resident
Receptor Age	Adult

Medium	Exposure Medium	Exposure Point	Chemical of Potential Concern	Carcinogenic Risk					Non-Carcinogenic Hazard Quotient				
				Ingestion	Inhalation	Dermal	External (Radiation)	Exposure Routes Total	Primary Target Organ(s)	Ingestion	Inhalation	Dermal	Exposure Routes Total
Groundwater Used as Drinking Water Supply	Groundwater	Tap water	2,4,6-TNT	*8E-04*	–	–	–	**8E-04**	Erythrocytes	*263*	–	0 7	**264**
			1,3,5-TNB	–	–	–	–	–	Liver erythrocytes	*11*	–	0 03	**11**
			1,3-DNB	–	–	–	–	–	Erythrocytes	*1771*	–	5	**1776**
			2,4-DNT	–	–	–	–	–	CNS erythrocyte, liver	*4*	–	0 01	**4**
			2 6-DNT	–	–	–	–	–	CNS, erythrocyte, kidney, liver	1	–	0 004	**1**
			Total DNT	*2E-03*	–	6E-06	–	**2E-03**	–	–	–	–	
			Chemical Total	3E-03	–	6E-06	–	**3E-03**		2051	0 00	6	2057
		Exposure Point Total						**3E-03**					2057
	Exposure Medium Total							**3E-03**					2057
Medium Total								**3E-03**					2057

Total HI Across All Media =	**2057**
Total Erythrocyte HI Across All Media =	**2057**
Total Liver HI Across All Media =	**17**
Total CNS HI Across All Media =	**5**
Total Kidney HI Across All Media =	1

TABLE 6-12

SUMMARY OF RECEPTOR RISKS AND HAZARDS FOR COPCs

WVOW OU-2 Record of Decision Groundwater Criteria for Pond 13/Wet Well Area

Scenario Timeframe	Current
Receptor Population	Resident
Receptor Age	Child

Medium	Exposure Medium	Exposure Point	Chemical of Potential Concern	Carcinogenic Risk					Non-Carcinogenic Hazard Quotient				
				Ingestion	Inhalation	Dermal	External (Radiation)	Exposure Routes Total	Primary Target Organ(s)	Ingestion	Inhalation	Dermal	Exposure Routes Total
Groundwater Used as Drinking Water Supply	Groundwater	Tap water	2,4,6-TNT	*8E-04*	--	--	--	**8E-04**	Erythrocytes	*613*	--	*2*	**616**
			1,3,5-TNB	--	--	--	--	--	Liver; erythrocytes	*27*	--	0 1	**27**
			1,3-DNB	--	--	--	--	--	Erythrocytes	*4133*	--	*15*	**4149**
			2,4-DNT	--	--	--	--	--	CNS, erythrocyte, liver	*9*	--	0 03	**9**
			2,6-DNT	--	--	--	--	--	CNS, erythrocyte, kidney liver	*3*	--	0 01	**3**
			Total DNT	*1E-03*	--	4E-06	--	**1E-03**	--	--	--	--	
			Chemical Total	2E-03	--	4E-06	--	**2E-03**		4785	0 00	18	4803
		Exposure Point Total						**2E-03**					4803
	Exposure Medium Total							**2E-03**					4803
Medium Total								**2E-03**					4803

Total HI Across All Media =	**4803**
Total Erythrocyte HI Across All Media =	**4803**
Total Liver HI Across All Media =	**39**
Total CNS HI Across All Media =	**12**
Total Kidney HI Across All Media =	**3**

Table 8-1
OU-4 Treatment Plant Influent and Effluent Criteria[1]

Parameter	Cleanup Levels OU-2 ROD (µg/L)	West Virginia Water Quality Criteria (µg/L)	Concentration in Extracted Groundwater[2] (µg/L) Red Water Area	Concentration in Extracted Groundwater[2] (µg/L) Yellow Water Area
2, 4 Dinitrotoluene	0 11	3.4	2.2	9 6
2, 6 Dinitrotoluene	0.022	0.67	0 2	3.0
2, 4, 6 TNT	50	60	2 8	23
1, 3, 5 TNB	200	80	2.1	9.1
1, 3 DNB	14	160	1 5	0 9
Arsenic	-	190	0	0
Beryllium	-	0.117	0	0.02
Cadmium	-	1.1	0	0
Chromium	-	10	0	0
Copper	-	11	0	0
Iron	-	1500	0	730
Lead	-	3.2	0	1
Manganese	-	1000	75	200
Mercury	-	0 012	0	0
Nickel	-	160	-	-
Selenium	-	5	-	-
Silver	-	4	-	-
Zinc	-	90	1.7	6
TSS	-	-	<5	<5
pH	-	6 - 9	6 7 $\pm$ .5	6.7 $\pm$ 5
TOC	-	-	<5	<5
Ammonia	-	50	*	*

[1] Final Design Specifications, Sec. 01800, Tables 2 & 7, Woodward Clyde Consultants, January 1995
[2] Avg. Well Concentrations 8/02 – 5/03. Concentrations based on largest blended plant influent concentration from extraction well sampling results on 9/02, 3/03, and 8/03.
* Data indicate the ammonia concentrations meet effluent standards for all but 1 – 2 months/year Outside influences appear to be the cause for standards not being met such as run off from animal containment areas and farmer fertilizer application.

Reference: USACE, 2004, *Remedial System Evaluation. Red and Yellow Water Reservoirs, Groundwater Extraction and Treatment Systems, Former West Virginia Ordnance Works*, prepared by USACE HTRW-CX, January 2004.

Table 8-2 - Red Water Treatment Plant
Concentration of 1,3,5-Trinitrobenzene in Extraction Wells

Well Description	June 2003	July 2003	August 2003	September 2003	October 2003	November 2003	December 2003	January 2004
	(µg/l)	(µg/l)	(µg/l)	(µg/l)	(µg/l)	(µg/l)	(µg/l)	(µg/l)
RWR101[2]	3.34	11.9	4 34	15.5	0.25	23 6	27.4	25.2
RWR103[2]	1 93	4.06	4.1	4 98	3.1	9 18	7 92	10.9
RWR105[2]	N/A[1]	0.25	0.717	0.25	0.25	0 25	0.25	0.25
RWR107[2]	0.25	0.25	0 25	0.25	0.25	0.25	0.25	0 25
RWR109[2]	0.25	0.25	0 25	0.25	0.25	0.25	0.25	0 25
ROD Limit	200	200	200	200	200	200	200	200

Well Description	February 2004	March 2004	April 2004	May 2004	June 2004	July 2004	August 2004	September 2004
	(µg/l)	(µg/l)	(µg/l)	(µg/l)	(µg/l)	(µg/l)	(µg/l)	(µg/l)
RWR101[2]	16.1	18.6	19 3	8.3	14.0	14.7	14.7	12.6
RWR103[2]	8.33	9 27	14.8	4.88	8 34	5 57	4 6	3 66
RWR105[2]	0.25	0.25	0.25	2 36	0 25	0.25	0.25	0.25
RWR107[2]	0 25	0.25	0.25	0.25	0 25	0 25	0 25	0.25
RWR109[2]	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25
ROD Limit	200	200	200	200	200	200	200	200

Table 8-3 - Red Water Treatment Plant
Concentration of 1,3-Dinitrobenzene in Extraction Wells

Well Description	June 2003	July 2003	August 2003	September 2003	October 2003	November 2003	December 2003	January 2004
	(µg/l)	(µg/l)	(µg/l)	(µg/l)	(µg/l)	(µg/l)	(µg/l)	(µg/l)
RWR101[2]	3.34	3 51	1.51	4.06	0.25	8 02	8.72	7.31
RWR103[2]	1.13	1.51	4.1	2.03	3 44	4 28	4 26	4.58
RWR105[2]	N/A[1]	0.25	0 717	0 25	0.25	0 25	0 25	0 25
RWR107[2]	0 25	0.25	0 25	0 25	0 25	0 25	0 25	0 25
RWR109[2]	0.25	0.25	0 25	0 25	0 25	0 25	0 25	0.25
ROD Limit	14	14	14	14	14	14	14	14

Well Description	February 2004	March 2004	April 2004	May 2004	June 2004	July 2004	August 2004	September 2004
	(µg/l)	(µg/l)	(µg/l)	(µg/l)	(µg/l)	(µg/l)	(µg/l)	(µg/l)
RWR101[2]	6.34	8.47	6.82	4.92	6.0	7.41	4.87	1 8
RWR103[2]	4 7	6.3	6.28	4 46	5.83	5 0	2 26	1.73
RWR105[2]	0.25	0 25	0 25	3.54	0 25	0.25	0.25	0 25
RWR107[2]	0 25	0.25	0.25	0 25	0.25	0 25	0.25	0 25
RWR109[2]	0.25	0 25	0 25	0 25	0.25	0.25	0.25	0 25
ROD Limit	14	14	14	14	14	14	14	14

[1] Not Applicable, the pump in well RWR105 stopped working in late May 2003 and was not operational until after the June 2003 sampling event
[2] The Laboratory Practical Quantitation Limit of 0 25 µg/l is reported when the laboratory indicted a parameter was "Not Detected "
ROD exceedances (in excess of laboratory PQL) are indicated by shaded values

Table 8-4 - Red Water Treatment Plant
Concentration of 2,4,6-Trinitrotoluene in Extraction Wells

Well Description	June 2003 (µg/l)	July 2003 (µg/l)	August 2003 (µg/l)	September 2003 (µg/l)	October 2003 (µg/l)	November 2003 (µg/l)	December 2003 (µg/l)	January 2004 (µg/l)
RWR101[2]	2.78	6.2	3.8	7.77	0.25	11.8	11.8	11.5
RWR103[2]	2.4	4 62	5.51	4.68	0.25	7.56	7 27	6.88
RWR105[2]	N/A[1]	2 07	0 25	2 22	0.25	0 25	0.25	0.25
RWR107[2]	0.25	0 25	2.17	0.25	0.25	0.25	0 25	0.25
RWR109[2]	0.25	0 25	2 16	0 25	0.25	0 25	0.25	4 22
ROD Limit	50	50	50	50	50	50	50	50

Well Description	February 2004 (µg/l)	March 2004 (µg/l)	April 2004 (µg/l)	May 2004 (µg/l)	June 2004 (µg/l)	July 2004 (µg/l)	August 2004 (µg/l)	September 2004 (µg/l)
RWR101[2]	9.38	13.5	14.7	8 21	11.7	11.9	6 9	6.93
RWR103[2]	8.25	9.66	8.7	6.71	8.98	8 74	3.71	3.96
RWR105[2]	0.25	0 25	0 25	0 25	0.25	0.25	0 25	1.02
RWR107[2]	0.25	0 25	0 25	0.25	0.25	0.25	0 25	0 25
RWR109[2]	0 25	0 25	0.25	0 25	0.25	0 25	0 25	0.25
ROD Limit	50	50	50	50	50	50	50	50

Table 8-5 - Red Water Treatment Plant
Concentration of 2,4-Dinitrotoluene in Extraction Wells

Well Description	June 2003 (µg/l)	July 2003 (µg/l)	August 2003 (µg/l)	September 2003 (µg/l)	October 2003 (µg/l)	November 2003 (µg/l)	December 2003 (µg/l)	January 2004 (µg/l)
RWR101[2]	**1.91**	**8.34**	**4.3**	**9.74**	0.25	**26.6**	**30.1**	**28.7**
RWR103[2]	**1.08**	**3.44**	**4.04**	**2.33**	0 25	**3.13**	**2.92**	**3.36**
RWR105[2]	N/A[1]	0 25	0 25	**1.35**	0 25	0.25	0 25	0.25
RWR107[2]	0 25	0 25	**1.26**	0 25	0 25	0 25	0 25	0 25
RWR109[2]	0 25	0.25	**1.19**	0.25	0.25	0 25	0 25	0.25
ROD Limit	0.11	0 11	0.11	0.11	0.11	0 11	0 11	0 11

Well Description	February 2004 (µg/l)	March 2004 (µg/l)	April 2004 (µg/l)	May 2004 (µg/l)	June 2004 (µg/l)	July 2004 (µg/l)	August 2004 (µg/l)	September 2004 (µg/l)
RWR101[2]	**20.0**	**20.3**	**20.0**	**17.2**	**29.7**	**29.1**	**28.0**	**18.2**
RWR103[2]	0.25	**4.96**	**4.82**	**2.91**	**3.37**	**3.69**	**19.3**	**1.45**
RWR105[2]	0.25	0.25	0.25	0.25	0.25	0 25	0.25	0 25
RWR107[2]	0 25	0.25	0.25	0.25	0.25	0.25	0.25	0 25
RWR109[2]	0 25	0.25	0.25	0.25	0 25	0.25	0.25	0.25
ROD Limit	0.11	0.11	0.11	0 11	0.11	0.11	0.11	0 11

[1] Not Applicable, the pump in well RWR105 stopped working in late May 2003 and was not operational until after the June 2003 sampling event
[2] The Laboratory Practical Quantitation Limit of 0 25 µg/l is reported when the laboratory indicted a parameter was "Not Detected "
ROD exceedances (in excess of laboratory PQL) are indicated by shaded values

Table 8-6 - Red Water Treatment Plant
Concentration of 2,6-Dinitrotoluene in Extraction Wells

Well Description	June 2003	July 2003	August 2003	September 2003	October 2003	November 2003	December 2003	January 2004
	(µg/l)	(µg/l)	(µg/l)	(µg/l)	(µg/l)	(µg/l)	(µg/l)	(µg/l)
RWR101[2]	**1.77**	**2.1**	0.25	**3.69**	0.25	**12**	**10.3**	0 25
RWR103[2]	0.25	0.25	**0.772**	0.25	0.25	**4.2**	**4.33**	**5.25**
RWR105[2]	N/A[1]	0.25	0.25	0.25	0.25	0.25	0 25	0 25
RWR107[2]	0.25	0 25	0.25	0 25	0.25	0.25	0 25	0 25
RWR109[2]	0.25	0 25	0.25	0.25	0.25	0.25	0 25	0 25
ROD Limit	0.022	0.022	0 022	0.022	0 022	0.022	0 022	0.022

Well Description	February 2004	March 2004	April 2004	May 2004	June 2004	July 2004	August 2004	September 2004
	(µg/l)	(µg/l)	(µg/l)	(µg/l)	(µg/l)	(µg/l)	(µg/l)	(µg/l)
RWR101[2]	0 25	0 25	0.25	**4.99**	**8.73**	**8.03**	**5.97**	0 25
RWR103[2]	**6.74**	**4.89**	**5.32**	**5.73**	**5.57**	**4.97**	**1.89**	**1.8**
RWR105[2]	0.25	0 25	0.25	0 25	0.25	0.25	0.25	0 25
RWR107[2]	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0 25
RWR109[2]	0.25	0.25	0 25	0.25	0.25	0.25	0.25	0 25
ROD Limit	0 022	0 022	0 022	0.022	0 022	0 022	0 022	0 022

Table 8-7 - Red Water Treatment Plant
Concentration of 2-Amino-4,6-Dinitrotoluene in Extraction Wells

Well Description	June 2003	July 2003	August 2003	September 2003	October 2003	November 2003	December 2003	January 2004
	(µg/l)	(µg/l)	(µg/l)	(µg/l)	(µg/l)	(µg/l)	(µg/l)	(µg/l)
RWR101[2]	0.845	3.4	0.25	2.9	0 25	5.76	4 08	9 92
RWR103[2]	0 357	0 432	0.405	0.25	0.25	0.972	1 24	3.12
RWR105[2]	N/A[1]	0 25	0.25	0 25	0.25	0 25	0 25	0 25
RWR107[2]	0.25	0.25	0.25	0.25	0.25	0 25	0 25	0.25
RWR109[2]	0.25	0.25	0.25	0 25	0 25	0 25	0 25	0 25
ROD Limit[3]	---	---	---	---	---	---	---	---

Well Description	February 2004	March 2004	April 2004	May 2004	June 2004	July 2004	August 2004	September 2004
	(µg/l)	(µg/l)	(µg/l)	(µg/l)	(µg/l)	(µg/l)	(µg/l)	(µg/l)
RWR101[2]	0.25	5.83	5 11	0 25	5.35	1.87	1 08	0.25
RWR103[2]	0.25	4.13	1 94	0 25	5 25	0.25	0 682	0 36
RWR105[2]	0 25	0 25	0.25	1.4	0.25	0 25	0.25	0 25
RWR107[2]	0.25	0.25	0.25	0 25	0.25	0.25	0 25	0 25
RWR109[2]	0 25	0 25	0.25	0.25	0.25	0.25	0 25	0 25
ROD Limit[3]	---	---	---	---	---	---	---	---

[1] Not Applicable, the pump in well RWR105 stopped working in late May 2003 and was not operational until after the June 2003 sampling event
[2] The Laboratory Practical Quantitation Limit of 0 25 µg/l is reported when the laboratory indicted a parameter was "Not Detected"
ROD exceedances (in excess of laboratory PQL) are indicated by shaded values
[3] A ROD limit has not been set for this parameter

Table 8-8 - Red Water Treatment Plant
Concentration of 4-Amino-2,6-Dinitrotoluene in Extraction Wells

Well Description	June 2003	July 2003	August 2003	September 2003	October 2003	November 2003	December 2003	January 2004
	(µg/l)	(µg/l)	(µg/l)	(µg/l)	(µg/l)	(µg/l)	(µg/l)	(µg/l)
RWR101[2]	0.25	1.73	0 25	1.55	0.25	2.76	2.42	0.25
RWR103[2]	0.25	1.49	1.43	1.32	0.25	1.96	2.09	0.25
RWR105[2]	N/A[1]	0 25	0.25	0 25	0 25	0 25	0.25	0.25
RWR107[2]	0 25	0.25	0 25	0 25	0 25	0.25	0.25	0 25
RWR109[2]	0.25	0.25	0.25	0.25	0 25	0.25	0.25	1 62
ROD Limit[4]	---	---	---	---	---	---	---	---

Well Description	February 2004	March 2004	April 2004	May 2004	June 2004	July 2004	August 2004	September 2004
	(µg/l)	(µg/l)	(µg/l)	(µg/l)	(µg/l)	(µg/l)	(µg/l)	(µg/l)
RWR101[2]	0 25	0.25	0.25	0.25	6.28	2.61	1 1	0.25
RWR103[2]	0 25	0.25	3.15	0.25	6.08	2.28	0 25	0.455
RWR105[2]	0.25	0.25	0.25	2.21	0 25	0.25	0.25	0.25
RWR107[2]	0.25	0.25	0.25	0.25	0.25	0.25	0 25	0.25
RWR109[2]	0.25	0.25	0.25	0.25	0.25	0 25	0 25	0 25
ROD Limit[4]	---	---	---	---	---	---	---	---

[1] Not Applicable, the pump in well RWR105 stopped working in late May 2003 and was not operational until after the June 2003 sampling event
[2] The Laboratory Practical Quantitation Limit of 0 25 µg/l is reported when the laboratory indicted a parameter was "Not Detected "
ROD exceedances (in excess of laboratory PQL) are indicated by shaded values
[3] A ROD limit has not been set for this parameter

Table 8-9 - Yellow Water Treatment Plant
Concentration of 1,3,5-Trinitrobenzene in Extraction Wells

Well Description	June 2003	July 2003	August 2003	September 2003	October 2003	November 2003	December 2003	January 2004
	(µg/l)	(µg/l)	(µg/l)	(µg/l)	(µg/l)	(µg/l)	(µg/l)	(µg/l)
501A[2]	11.8	13.2	12 2	0 25	7.83	17.2	16 5	25.0
501B[2]	3.3	2.76	0.83	0.25	5 47	0.25	6.22	11.1
502A[2]	14.9	5.46	0.25	27.5	7.86	27.6	18 9	26 1
502B[2]	0.25	0.25	0.25	0 25	0.25	N/A[1]	N/A[1]	N/A[1]
ROD Limit	200	200	200	200	200	200	200	200

Well Description	February 2004	March 2004	April 2004	May 2004	June 2004	July 2004	August 2004	September 2004
	(µg/l)	(µg/l)	(µg/l)	(µg/l)	(µg/l)	(µg/l)	(µg/l)	(µg/l)
501A[2]	19.7	8.96	13 4	12.9	13 2	15.5	20 2	12.8
501B[2]	N/A[1]	N/A[1]	N/A[1]	0.25	6.58	3.2	2 48	1 06
502A[2]	19 1	26 1	22.2	14 2	17 4	22.4	14.2	16.9
502B[2]	N/A[1]	N/A[1]	N/A[1]	N/A[1]	N/A[1]	N/A[1]	N/A[1]	N/A[1]
ROD Limit	200	200	200	200	200	200	200	200

Table 8-10 - Yellow Water Treatment Plant
Concentration of 1,3-Dinitrobenzene in Extraction Wells

Well Description	June 2003	July 2003	August 2003	September 2003	October 2003	November 2003	December 2003	January 2004
	(µg/l)	(µg/l)	(µg/l)	(µg/l)	(µg/l)	(µg/l)	(µg/l)	(µg/l)
501A[2]	1.53	1 9	1 74	0 8	0.25	0 25	0 25	0.25
501B[2]	1 81	1 98	0 935	0.635	0.25	0.25	0 25	2.18
502A[2]	2.79	0.995	0 25	8.14	3 82	5.5	2 82	3.88
502B[2]	1 23	0.592	0.25	0 25	0.25	N/A[1]	N/A[1]	N/A[1]
ROD Limit	14	14	14	14	14	14	14	14

Well Description	February 2004	March 2004	April 2004	May 2004	June 2004	July 2004	August 2004	September 2004
	(µg/l)	(µg/l)	(µg/l)	(µg/l)	(µg/l)	(µg/l)	(µg/l)	(µg/l)
501A[2]	0 25	0.25	0 25	0.25	0.25	0.25	0 915	1 14
501B[2]	N/A[1]	N/A[1]	N/A[1]	0 25	4 98	0 25	0.738	1 31
502A[2]	4.39	6.58	6.33	0.25	5 86	6 95	1.26	1.68
502B[2]	N/A[1]	N/A[1]	N/A[1]	N/A[1]	N/A[1]	N/A[1]	N/A[1]	N/A[1]
ROD Limit	14	14	14	14	14	14	14	14

[1] Not Applicable, the pump in well 502B stopped working in late October 2003 , and could not be repaired until September 2004 due to site accessibility problems (very wet conditions) Well 501B was offline for repairs from Feb 2004 until May 2004
[2] The Laboratory Practical Quantitation Limit of 0 25 µg/l is reported when the laboratory indicted a parameter was "Not Detected "
ROD exceedances (in excess of laboratory PQL) are indicated by shaded values

Table 8-11 - Yellow Water Treatment Plant
Concentration of 2,4,6-Trinitrotoluene in Extraction Wells

Well Description	June 2003	July 2003	August 2003	September 2003	October 2003	November 2003	December 2003	January 2004
	(µg/l)	(µg/l)	(µg/l)	(µg/l)	(µg/l)	(µg/l)	(µg/l)	(µg/l)
501A[2]	18.8	18 8	15	2.8	12	24.8	18.6	19 9
501B[2]	2.02	2.63	0.25	0.25	5.6	4 5	0.25	0 25
502A[2]	27.6	13 3	43.8	9 5	12 6	49.4	43.9	29 5
502B[2]	1.89	2.21	2.36	2.24	0 25	N/A[1]	N/A[1]	N/A[1]
ROD Limit	50	50	50	50	50	50	50	50

Well Description	February 2004	March 2004	April 2004	May 2004	June 2004	July 2004	August 2004	September 2004
	(µg/l)	(µg/l)	(µg/l)	(µg/l)	(µg/l)	(µg/l)	(µg/l)	(µg/l)
501A[2]	24 1	14.8	19 6	19 3	16 1	26.5	24 9	15 9
501B[2]	N/A[1]	N/A[1]	N/A[1]	0.25	6.56	0.25	1.43	1.19
502A[2]	**51.3**	46 0	**51.3**	30.4	31.1	**54.6**	38.3	49.0
502B[2]	N/A[1]	N/A[1]	N/A[1]	N/A[1]	N/A[1]	N/A[1]	N/A[1]	N/A[1]
ROD Limit	50	50	50	50	50	50	50	50

Table 8-12 - Yellow Water Treatment Plant
Concentration of 2,4-Dinitrotoluene in Extraction Wells

Well Description	June 2003	July 2003	August 2003	September 2003	October 2003	November 2003	December 2003	January 2004
	(µg/l)	(µg/l)	(µg/l)	(µg/l)	(µg/l)	(µg/l)	(µg/l)	(µg/l)
501A[2]	0.25	**1.76**	**1.88**	**1.32**	**3.1**	**1.8**	0.25	**2.14**
501B[2]	0.25	**1.41**	0 25	**1.32**	**3.26**	**1.1**	**0.98**	**1.26**
502A[2]	0 25	**3.21**	**14.2**	**2.88**	**5**	**19.8**	**19.8**	**13.4**
502B[2]	0 25	**1.19**	**1.22**	0.25	0 25	N/A[1]	N/A[1]	N/A[1]
ROD Limit	0 11	0.11	0.11	0.11	0 11	0 11	0 11	0 11

Well Description	February 2004	March 2004	April 2004	May 2004	June 2004	July 2004	August 2004	September 2004
	(µg/l)	(µg/l)	(µg/l)	(µg/l)	(µg/l)	(µg/l)	(µg/l)	(µg/l)
501A[2]	**2.93**	0.25	0 25	**2.78**	**3.17**	0 25	**1.71**	**1.65**
501B[2]	N/A[1]	N/A[1]	N/A[1]	0.25	**3.44**	0.25	**0.962**	**1.08**
502A[2]	**14.4**	**16.1**	**19.9**	0 25	**11.0**	**15.6**	**6.84**	**11.9**
502B[2]	N/A[1]	N/A[1]	N/A[1]	N/A[1]	N/A[1]	N/A[1]	N/A[1]	N/A[1]
ROD Limit	0 11	0.11	0.11	0.11	0.11	0 11	0 11	0.11

[1] Not Applicable, the pump in well 502B stopped working in late October 2003 , and could not be repaired until September 2004 due to site accessibility problems (very wet conditions) Well 501B was offline for repairs from Feb 2004 until May 2004
[2] The Laboratory Practical Quantitation Limit of 0 25 µg/l is reported when the laboratory indicted a parameter was "Not Detected "
ROD exceedances (in excess of laboratory PQL) are indicated by shaded values

Table 8-13 - Yellow Water Treatment Plant
Concentration of 2,6-Dinitrotoluene in Extraction Wells

Well Description	June 2003	July 2003	August 2003	September 2003	October 2003	November 2003	December 2003	January 2004
	(µg/l)	(µg/l)	(µg/l)	(µg/l)	(µg/l)	(µg/l)	(µg/l)	(µg/l)
501A[2]	**2.64**	0.25	0.25	0 25	**3.64**	**4.55**	0.25	**5.52**
501B[2]	**1.33**	0.25	0.25	0.25	**4.47**	**4.05**	**3.42**	**3.98**
502A[2]	**28.5**	0 25	**8.03**	0 25	**4.79**	0.25	**18.0**	0.25
502B[2]	**1.04**	0.25	0.25	0 25	0.25	N/A[1]	N/A[1]	N/A[1]
ROD Limit	0.022	0.022	0.022	0 022	0.022	0.022	0.022	0.022

Well Description	February 2004	March 2004	April 2004	May 2004	June 2004	July 2004	August 2004	September 2004
	(µg/l)	(µg/l)	(µg/l)	(µg/l)	(µg/l)	(µg/l)	(µg/l)	(µg/l)
501A[2]	**5.28**	0.25	0.25	**4.98**	**4.14**	**6.11**	**1.21**	**0.41**
501B[2]	N/A[1]	N/A[1]	N/A[1]	0.25	**4.64**	0.25	**0.452**	**0.74**
502A[2]	0.25	0.25	0.25	0.25	0.25	**11.0**	0 25	0.25
502B[2]	N/A[1]	N/A[1]	N/A[1]	N/A[1]	N/A[1]	N/A[1]	N/A[1]	N/A[1]
ROD Limit	0 022	0.022	0.022	0 022	0.022	0 022	0 022	0.022

Table 8-14 - Yellow Water Treatment Plant
Concentration of 2-Amino-4,6-Dinitrotoluene in Extraction Wells

Well Description	June 2003	July 2003	August 2003	September 2003	October 2003	November 2003	December 2003	January 2004
	(µg/l)	(µg/l)	(µg/l)	(µg/l)	(µg/l)	(µg/l)	(µg/l)	(µg/l)
501A[2]	4.8	2.42	2.43	0.25	3 91	3 6	5 95	8 15
501B[2]	1.99	3.07	0.25	0 25	8 52	3 19	3.78	6 48
502A[2]	0.25	2.82	8.79	0 25	2.73	5.13	8 62	10 1
502B[2]	0.25	0.25	0.25	0.25	0.25	N/A[1]	N/A[1]	N/A[1]
ROD Limit[3]	---	---	---	---	---	---	---	---

Well Description	February 2004	March 2004	April 2004	May 2004	June 2004	July 2004	August 2004	September 2004
	(µg/l)	(µg/l)	(µg/l)	(µg/l)	(µg/l)	(µg/l)	(µg/l)	(µg/l)
501A[2]	5.87	0 25	3 77	0 25	6.46	0 25	3 97	2.42
501B[2]	N/A[1]	N/A[1]	N/A[1]	0.25	7 53	0 25	1.64	1 7
502A[2]	0.25	0.25	5.77	24.6	8 2	0 25	22.1	44.4
502B[2]	N/A[1]	N/A[1]	N/A[1]	N/A[1]	N/A[1]	N/A[1]	N/A[1]	N/A[1]
ROD Limit[3]	---	---	---	---	---	---	---	---

[1] Not Applicable, the pump in well 502B stopped working in late October 2003 , and could not be repaired until September 2004 due to site accessibility problems (very wet conditions) Well 501B was offline for repairs from Feb 2004 until May 2004

[2] The Laboratory Practical Quantitation Limit of 0 25 µg/l is reported when the laboratory indicted a parameter was "Not Detected " ROD exceedances (in excess of laboratory PQL) are indicated by shaded values

[3] A record of decision (ROD) limit has not been set for this parameter

Table 8-15 - Yellow Water Treatment Plant
Concentration of 4-Amino-2,6-Dinitrotoluene in Extraction Wells

Well Description	June 2003 (µg/l)	July 2003 (µg/l)	August 2003 (µg/l)	September 2003 (µg/l)	October 2003 (µg/l)	November 2003 (µg/l)	December 2003 (µg/l)	January 2004 (µg/l)
501A[2]	3.53	3 54	2.95	1.36	4.52	4.46	3.92	6.04
501B[2]	1.66	1.91	0.25	1.19	5.29	2.69	2.9	4.08
502A[2]	19.2	8.7	27	36.2	9.59	32 8	22 5	25 5
502B[2]	1.34	1 1	1.14	0.25	0.25	N/A[1]	N/A[1]	N/A[1]
ROD Limit[3]	---	---	---	---	---	---	---	---

Well Description	February 2004 (µg/l)	March 2004 (µg/l)	April 2004 (µg/l)	May 2004 (µg/l)	June 2004 (µg/l)	July 2004 (µg/l)	August 2004 (µg/l)	September 2004 (µg/l)
501A[2]	6 32	0.25	3.74	0.25	7.43	0 25	2 58	1.64
501B[2]	N/A[1]	N/A[1]	N/A[1]	0.25	7.02	2.6	4.04	2 41
502A[2]	25.8	24.9	33 6	12.1	23.0	27.9	0.25	0 25
502B[2]	N/A[1]	N/A[1]	N/A[1]	N/A[1]	N/A[1]	N/A[1]	N/A[1]	N/A[1]
ROD Limit[3]	---	---	---	---	---	---	---	---

[1] Not Applicable, the pump in well 502B stopped working in late October 2003 , and could not be repaired until September 2004 due to site accessibility problems (very wet conditions) Well 501B was offline for repairs from Feb 2004 until May 2004

[2] The Laboratory Practical Quantitation Limit of 0 25 µg/l is reported when the laboratory indicted a parameter was "Not Detected " ROD exceedances (in excess of laboratory PQL) are indicated by shaded values

[3] A record of decision (ROD) limit has not been set for this parameter

TABLE 8-16
Red Water Reservoir Area -
Semi-annual OU-4 Groundwater Monitoring Well Data
Nitroaromatics Above ROD Levels
May 2002 - May 2004

Parameter (µg/l)	OU-2 RAO 1	RWRGW-002 5/20/02	RWRGW-002 11/14/02	RWRGW-002 5/7/03	RWRGW-002 11/10/03	RWRGW-002 5/19/04
1,3,5-trinitrobenzene	200 0	ND	ND	1 30	3 08	ND
1,3-dinitrobenzene	14 0	ND	ND	ND	1 19	ND
2,4,6-trinitrotoluene	50 0	ND	ND	ND	3 58	ND
2,4-dinitrotoluene	0 1100	ND	ND	**1.14**	ND	ND
2,6-dinitrotoluene	0 0220	ND	ND	ND	**2.33**	ND
2-Amino-4,6-dinitrotoluene	NA	ND	ND	ND	ND	ND
4-amino-2,6-dinitrotoluene	NA	ND	ND	ND	1 53	ND

Parameter (µg/l)	OU-2 RAO 1	RWRGW-004D 5/16/02	RWRGW-004D 11/14/02	RWRGW-004D 5/7/03	RWRGW-004D 11/10/03	RWRGW-004D 5/18/04
1,3,5-trinitrobenzene	200 0	0 305	ND	ND	ND	ND
1,3-dinitrobenzene	14 0	ND	ND	ND	ND	3 34
2,4,6-trinitrotoluene	50 0	ND	ND	ND	ND	ND
2,4-dinitrotoluene	0 1100	ND	ND	ND	ND	**2.30**
2,6-dinitrotoluene	0 0220	ND	ND	ND	ND	ND
2-Amino-4,6-dinitrotoluene	NA	ND	ND	ND	ND	ND
4-amino-2,6-dinitrotoluene	NA	ND	ND	ND	ND	ND

Parameter (µg/l)	OU-2 RAO 1	RWRGW-005 5/20/02	RWRGW-005 11/13/02	RWRGW-005 5/7/03	RWRGW-005 11/10/03	RWRGW-005 5/19/04
1,3,5-trinitrobenzene	200 0	ND	ND	ND	ND	ND
1,3-dinitrobenzene	14 0	ND	ND	ND	ND	ND
2,4,6-trinitrotoluene	50 0	ND	ND	ND	ND	ND
2,4-dinitrotoluene	0 1100	ND	ND	ND	ND	ND
2,6-dinitrotoluene	0 0220	ND	**0.9850**	ND	ND	ND
2-Amino-4,6-dinitrotoluene	NA	ND	ND	ND	ND	ND
4-amino-2,6-dinitrotoluene	NA	ND	ND	ND	ND	ND

Parameter (µg/l)	OU-2 RAO 1	RWRPT-001 5/20/02	RWRPT-001 11/13/02	RWRPT-001 5/8/03	RWRPT-001 11/10/03	RWRPT-001 5/18/04
1,3,5-trinitrobenzene	200 0	ND	5 65	3 68	ND	22 3
1,3-dinitrobenzene	14 0	0 738	2 68	1 6	ND	7 91
2,4,6-trinitrotoluene	50 0	0 425	9 81	5 62	13 5	14 9
2,4-dinitrotoluene	0 1100	ND	**8.51**	**5.20**	**10.50**	**11.80**
2,6-dinitrotoluene	0 0220	**0.57**	**9.49**	**3.46**	**13.60**	ND
2-Amino-4,6-dinitrotoluene	NA	ND	2 70	2 62	6 03	5 97
4-amino-2,6-dinitrotoluene	NA	ND	2 24	2 18	4 64	ND

Parameter (µg/l)	OU-2 RAO 1	RWRGW-030 5/20/02	RWRGW-030 11/14/02	RWRGW-030 5/8/03	RWRGW-030 11/7/03	RWRGW-030 5/18/04
1,3,5-trinitrobenzene	200 0	ND	0 25	2 16	ND	ND
1,3-dinitrobenzene	14 0	ND	ND	1 02	ND	ND
2,4,6-trinitrotoluene	50 0	ND	0 50	2 22	3 70	ND
2,4-dinitrotoluene	0 1100	ND	ND	**1.90**	**0.958**	ND
2,6-dinitrotoluene	0 0220	ND	ND	ND	ND	ND
2-Amino-4,6-dinitrotoluene	NA	ND	ND	0 458	ND	ND
4-amino-2,6-dinitrotoluene	NA	ND	0 478	1 94	1 72	ND

Highlighted entries denote OU-2 ROD exceedances

TABLE 8-16
Red Water Reservoir Area -
Semi-annual OU-4 Groundwater Monitoring Well Data
Nitroaromatics Above ROD Levels
May 2002 - May 2004

Parameter (µg/l)	OU-2 RAO 1	RWRGW-045 5/20/02	RWRGW-045 11/14/02	RWRGW-045 5/8/03	RWRGW-045 11/7/03	RWRGW-045 5/18/04
1,3,5-trinitrobenzene	200 0	ND	ND	ND	ND	24 60
1,3-dinitrobenzene	14 0	ND	ND	ND	ND	ND
2,4,6-trinitrotoluene	50 0	0 662	5 03	8 97	1 05	ND
2,4-dinitrotoluene	0 1100	**0.447**	**2.42**	**8.450**	ND	**31.80**
2,6-dinitrotoluene	0 0220	ND	**2.95**	ND	ND	ND
2-Amino-4,6-dinitrotoluene	NA	ND	ND	5 05	4 9	ND
4-amino-2,6-dinitrotoluene	NA	ND	1 25	4 9	5 08	6 42

Parameter (µg/l)	OU-2 RAO 1	RWRGW-046 5/22/02	RWRGW-046 11/13/02	RWRGW-046 5/8/03	RWRGW-046 11/10/03	RWRGW-046 5/5/04
1,3,5-trinitrobenzene	200 0	ND	ND	3 34	ND	ND
1,3-dinitrobenzene	14 0	ND	ND	2 76	ND	ND
2,4,6-trinitrotoluene	50 0	ND	1 98	3 46	5 34	6 18
2,4-dinitrotoluene	0 1100	ND	**0.542**	**2.07**	**1.620**	**3.34**
2,6-dinitrotoluene	0 0220	ND	**0.437**	**2.32**	**2.960**	ND
2-Amino-4,6-dinitrotoluene	NA	ND	ND	1 03	0 438	1 73
4-amino-2,6-dinitrotoluene	NA	ND	0 515	2 06	2 96	3 7

Parameter (µg/l)	OU-2 RAO 1	RWRGW-047 5/20/02	RWRGW-047 11/14/02	RWRGW-047 5/7/03	RWRGW-047 11/10/03	RWRGW-047 5/18/04
1,3,5-trinitrobenzene	200 0	ND	ND	3 25	ND	30 3
1,3-dinitrobenzene	14 0	ND	ND	ND	ND	15 9
2,4,6-trinitrotoluene	50 0	0 362	4 16	3 15	11 1	17 6
2,4-dinitrotoluene	0 1100	ND	**1.90**	ND	ND	**56.10**
2,6-dinitrotoluene	0 0220	ND	**0.76**	ND	**15.40**	**26.90**
2-Amino-4,6-dinitrotoluene	NA	ND	0 30	1 27	1 86	3 58
4-amino-2,6-dinitrotoluene	NA	ND	ND	1 48	7 16	ND

Parameter (µg/l)	OU-2 RAO 1	PPLGW-032 5/20/02	PPLGW-032 11/14/02	PPLGW-032 5/8/03	PPLGW-032 11/10/03	PPLGW-032 5/18/04
1,3,5-trinitrobenzene	200 0	ND	ND	ND	ND	ND
1,3-dinitrobenzene	14 0	ND	ND	ND	ND	ND
2,4,6-trinitrotoluene	50 0	ND	ND	ND	ND	ND
2,4-dinitrotoluene	0 1100	ND	ND	ND	ND	ND
2,6-dinitrotoluene	0 0220	ND	ND	ND	ND	**3.04**
2-Amino-4,6-dinitrotoluene	NA	ND	ND	ND	ND	ND
4-amino-2,6-dinitrotoluene	NA	ND	ND	ND	ND	ND

Parameter (µg/l)	OU-2 RAO 1	PPLGW-032D 5/20/02	PPLGW-032D 11/14/02	PPLGW-032D 5/8/03	PPLGW-032D 11/10/03	PPLGW-032D 5/18/04
1,3,5-trinitrobenzene	200 0	ND	ND	ND	ND	ND
1,3-dinitrobenzene	14 0	ND	ND	ND	ND	ND
2,4,6-trinitrotoluene	50 0	ND	ND	ND	ND	ND
2,4-dinitrotoluene	0 1100	**0.402**	ND	ND	ND	ND
2,6-dinitrotoluene	0 0220	ND	ND	ND	ND	ND
2-Amino-4,6-dinitrotoluene	NA	ND	ND	ND	ND	ND
4-amino-2,6-dinitrotoluene	NA	ND	ND	ND	ND	ND

Highlighted entries denote OU-2 ROD exceedances

TABLE 8-17
Yellow Water Reservoir Area
Semi-annual OU-4 Groundwater Monitoring Well Data
Nitroaromatics Above ROD Levels
May 2002 - May 2004

Parameter (µg/l)	OU-2 RAO 1	YWRGW-002D 5/15/02	YWRGW-002D 11/11/02	YWRGW-002D 5/6/03	YWRGW-002D 11/11/03	YWRGW-002D 5/20/04
1,3,5-trinitrobenzene	200 0	ND	2 75	3 36	1 4	10 00
1,3-dinitrobenzene	14 0	ND	ND	1 04	ND	ND
2,4,6-trinitrotoluene	50 0	ND	2 45	2 62	3 63	7 81
2,4-dinitrotoluene	0 1100	ND	ND	ND	ND	2.32
2,6-dinitrotoluene	0 0220	ND	ND	ND	ND	3.62
2-Amino-4,6-dinitrotoluene	NA	ND	ND	ND	ND	1 46
4-amino-2,6-dinitrotoluene	NA	0 65	ND	ND	ND	2 81

Parameter (µg/l)	OU-2 RAO 1	YWRGW-027 5/15/02	YWRGW-027 11/11/02	YWRGW-027 5/6/03	YWRGW-027 11/11/03	YWRGW-027 5/5/04
1,3,5-trinitrobenzene	200 0	ND	1 83	1 32	3 42	8 6
1,3-dinitrobenzene	14 0	ND	0 922	1 02	1 65	4 93
2,4,6-trinitrotoluene	50 0	ND	5 9	2 11	6 14	10 8
2,4-dinitrotoluene	0 1100	ND	ND	0.86	ND	ND
2,6-dinitrotoluene	0 0220	ND	4.36	1.05	4.6	7.68
2-Amino-4,6-dinitrotoluene	NA	ND	0 528	0 472	ND	ND
4-amino-2,6-dinitrotoluene	NA	ND	3 49	1 4	2 22	3 68

Parameter (µg/l)	OU-2 RAO 1	YWRGW-027D 5/15/02	YWRGW-027D 11/11/02	YWRGW-027D 5/6/03	YWRGW-027D 11/11/03	YWRGW-027D 5/5/04
1,3,5-trinitrobenzene	200 0	ND	21	20 4	25 00	35 00
1,3-dinitrobenzene	14 0	ND	0 348	1 55	2 98	5 29
2,4,6-trinitrotoluene	50 0	ND	4 01	4 18	7 77	11 3
2,4-dinitrotoluene	0 1100	0.742	ND	ND	ND	ND
2,6-dinitrotoluene	0 0220	ND	1.84	4.29	ND	ND
2-Amino-4,6-dinitrotoluene	NA	ND	ND	1 76	ND	ND
4-amino-2,6-dinitrotoluene	NA	ND	5 12	5 61	ND	11 9

Parameter (µg/l)	OU-2 RAO 1	YWRGW-041 5/16/02	YWRGW-041 11/12/02	YWRGW-041 5/6/03	YWRGW-041 11/11/03	YWRGW-041 5/20/04
1,3,5-trinitrobenzene	200 0	1 78	ND	1 54	7 74	11 2
1,3-dinitrobenzene	14 0	0 653	ND	1 21	3 16	4 66
2,4,6-trinitrotoluene	50 0	0 825	1 45	2 23	7 23	8 02
2,4-dinitrotoluene	0 1100	0.25	ND	1.03	ND	2.94
2,6-dinitrotoluene	0 0220	0.993	ND	ND	ND	4.3
2-Amino-4,6-dinitrotoluene	NA	ND	ND	0 722	ND	2 28
4-amino-2,6-dinitrotoluene	NA	ND	0 52	2 09	ND	4 51

Parameter (µg/l)	OU-2 RAO 1	YWRMW-001A 5/15/02	YWRMW-001A 11/11/02	YWRMW-001A 5/6/03	YWRMW-001A 11/17/03	YWRMW-001A 5/5/04
1,3,5-trinitrobenzene	200 0	0 398	ND	ND	ND	6 48
1,3-dinitrobenzene	14 0	ND	ND	ND	ND	ND
2,4,6-trinitrotoluene	50 0	ND	1 78	3 07	6 4	6 49
2,4-dinitrotoluene	0 1100	ND	ND	ND	ND	ND
2,6-dinitrotoluene	0 0220	0.34	ND	ND	ND	ND
2-Amino-4,6-dinitrotoluene	NA	ND	ND	2 9	ND	ND
4-amino-2,6-dinitrotoluene	NA	ND	ND	2 23	ND	ND

Highlighted entries denote OU-2 ROD exceedances

TABLE 8-17
Yellow Water Reservoir Area
Semi-annual OU-4 Groundwater Monitoring Well Data
Nitroaromatics Above ROD Levels
May 2002 - May 2004

Parameter (µg/l)	OU-2 RAO 1	YWRPT-001 5/16/02	YWRPT-001 11/12/02	YWRPT-001 5/6/03	YWRPT-001 11/11/03	YWRPT-001 5/20/04
1,3,5-trinitrobenzene	200 0	ND	ND	ND	5 84	ND
1,3-dinitrobenzene	14 0	ND	ND	ND	4 15	ND
2,4,6-trinitrotoluene	50 0	ND	ND	ND	4 33	ND
2,4-dinitrotoluene	0 1100	ND	ND	ND	ND	2 27
2,6-dinitrotoluene	0 0220	ND	ND	ND	ND	ND
2-Amino-4,6-dinitrotoluene	NA	ND	ND	ND	ND	1 32
4-amino-2,6-dinitrotoluene	NA	ND	ND	ND	ND	2 32

Highlighted entries denote OU-2 ROD exceedances

Figures

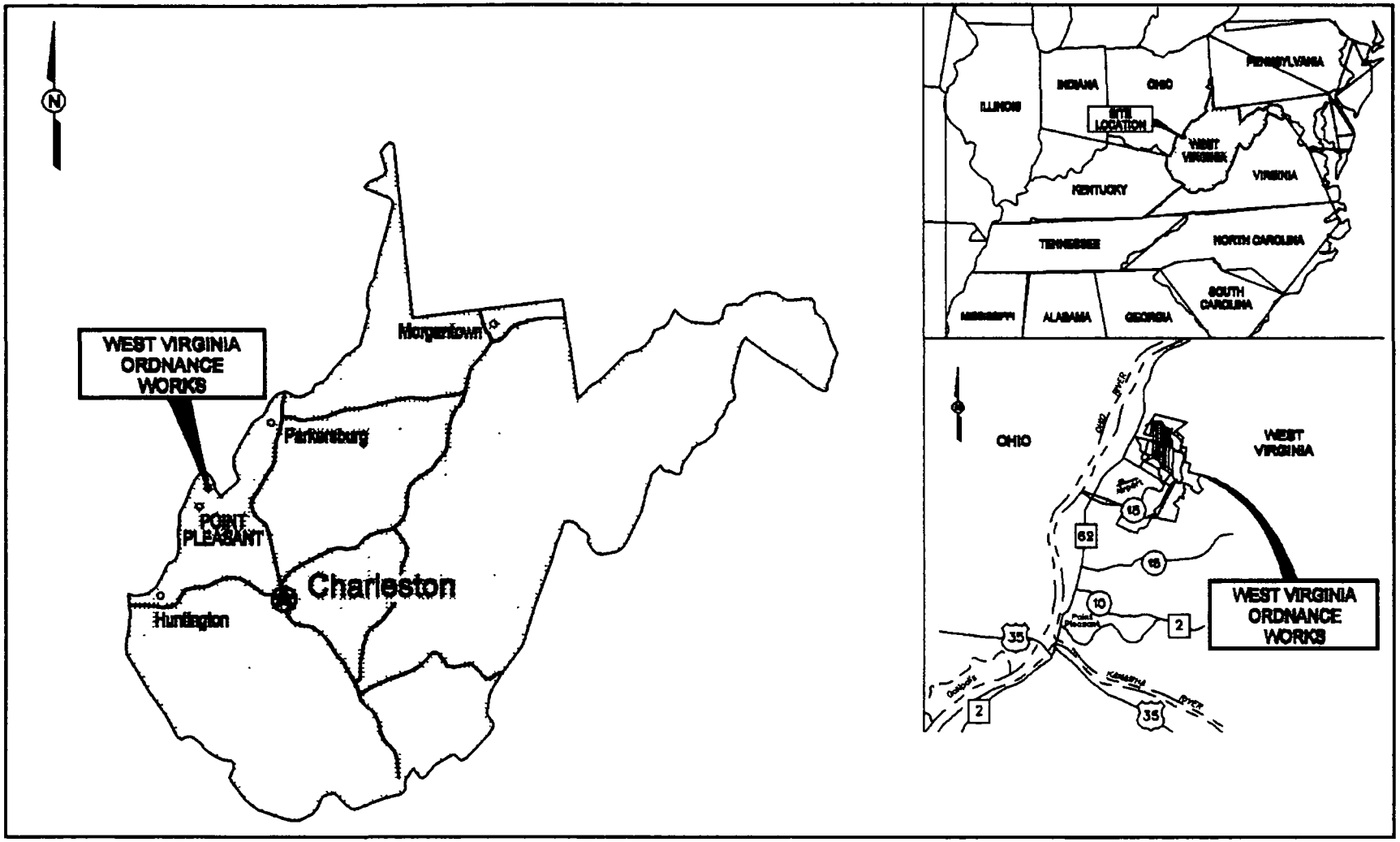


Figure 1-1. Location of the former West Virginia Ordnance Works.

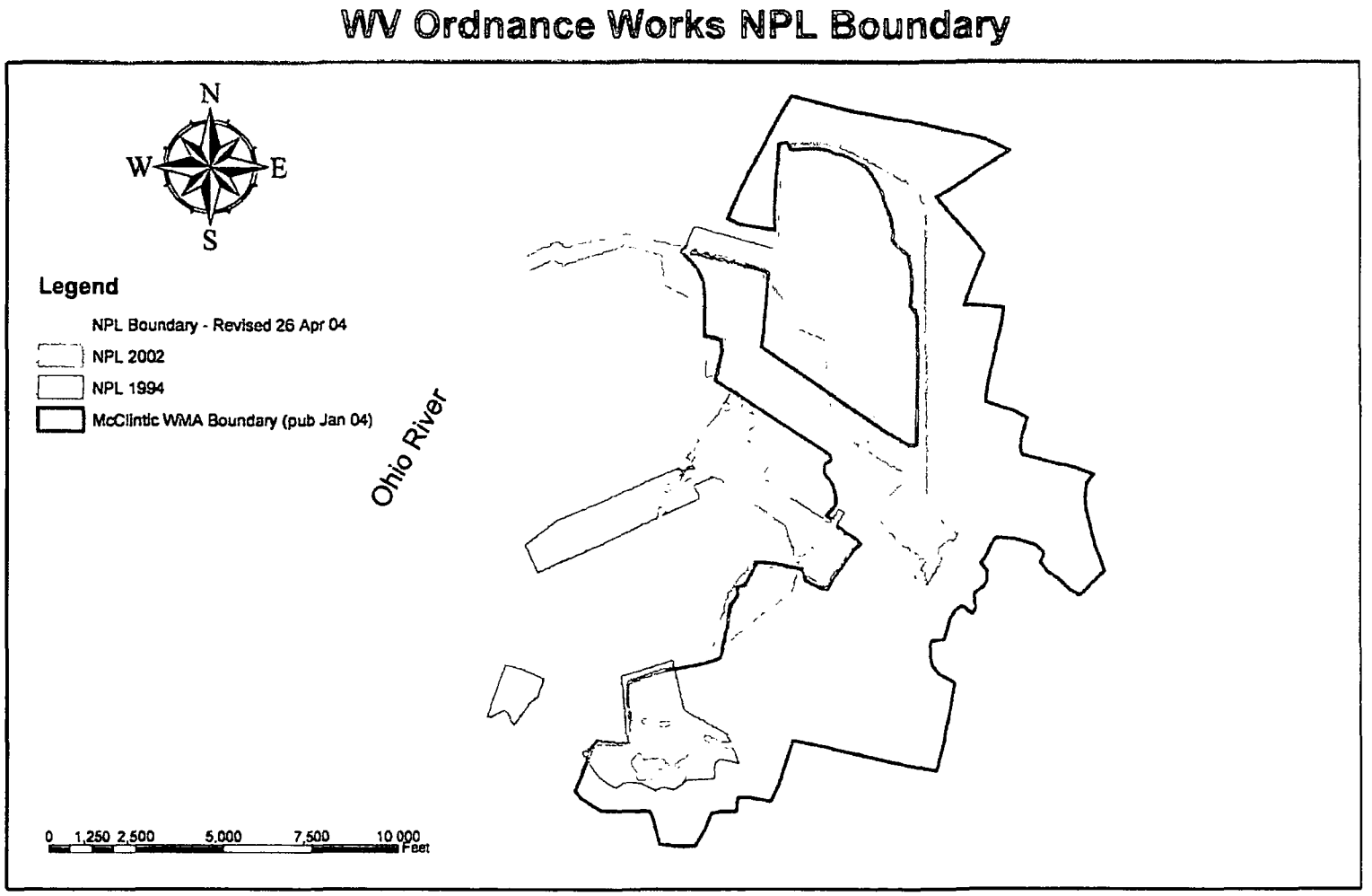


Figure 1-2. West Virginia Ordnance Works National Priorities List (NPL) boundary During 1994, 2,700 acres comprised the site NPL boundary The current NPL boundary (as of 26 April 2004) comprises 1184 acres as a result of 512 acres being delisted during December 2002 and an additional 1004 acres being delisted during April 2004.

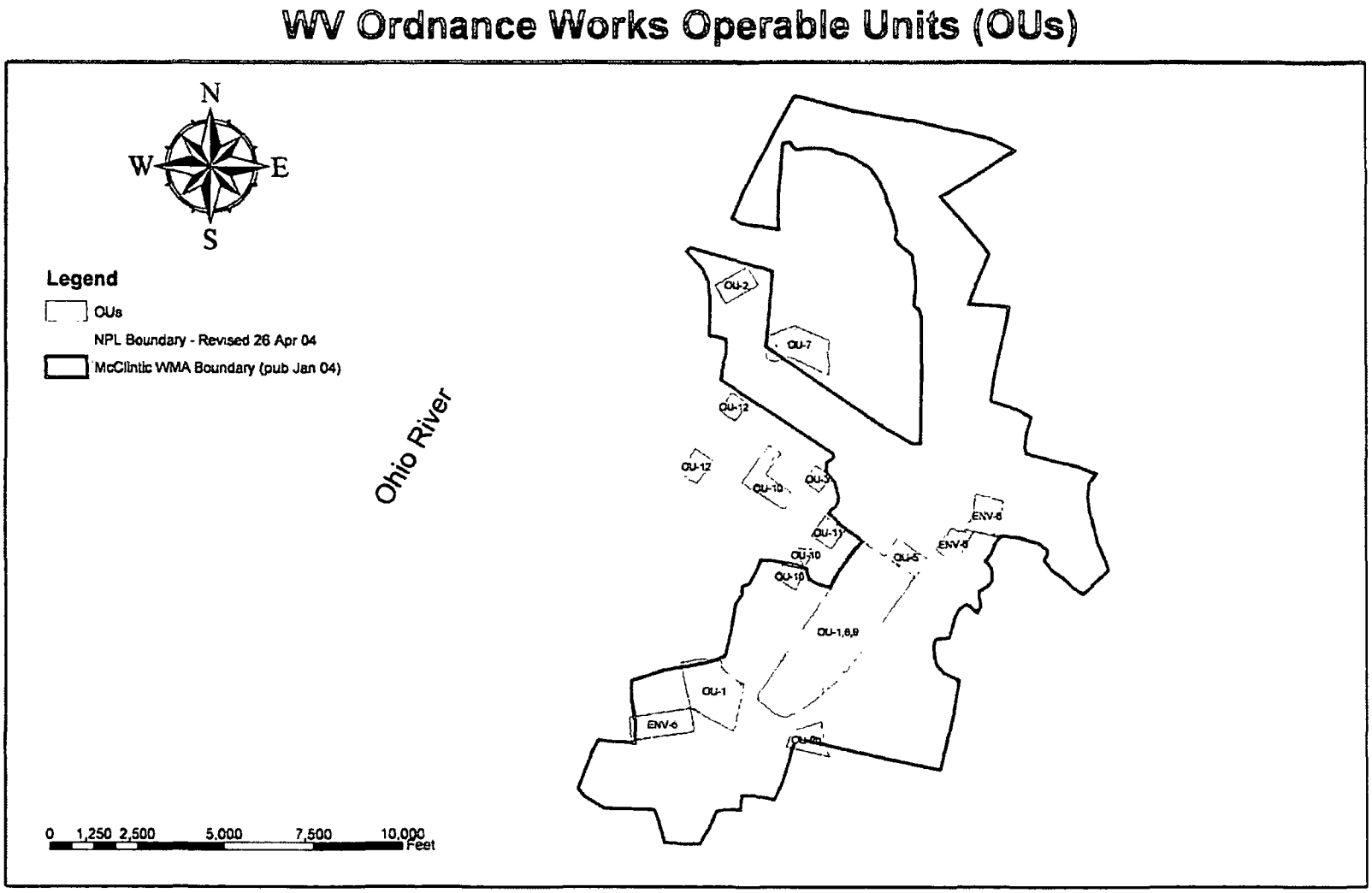
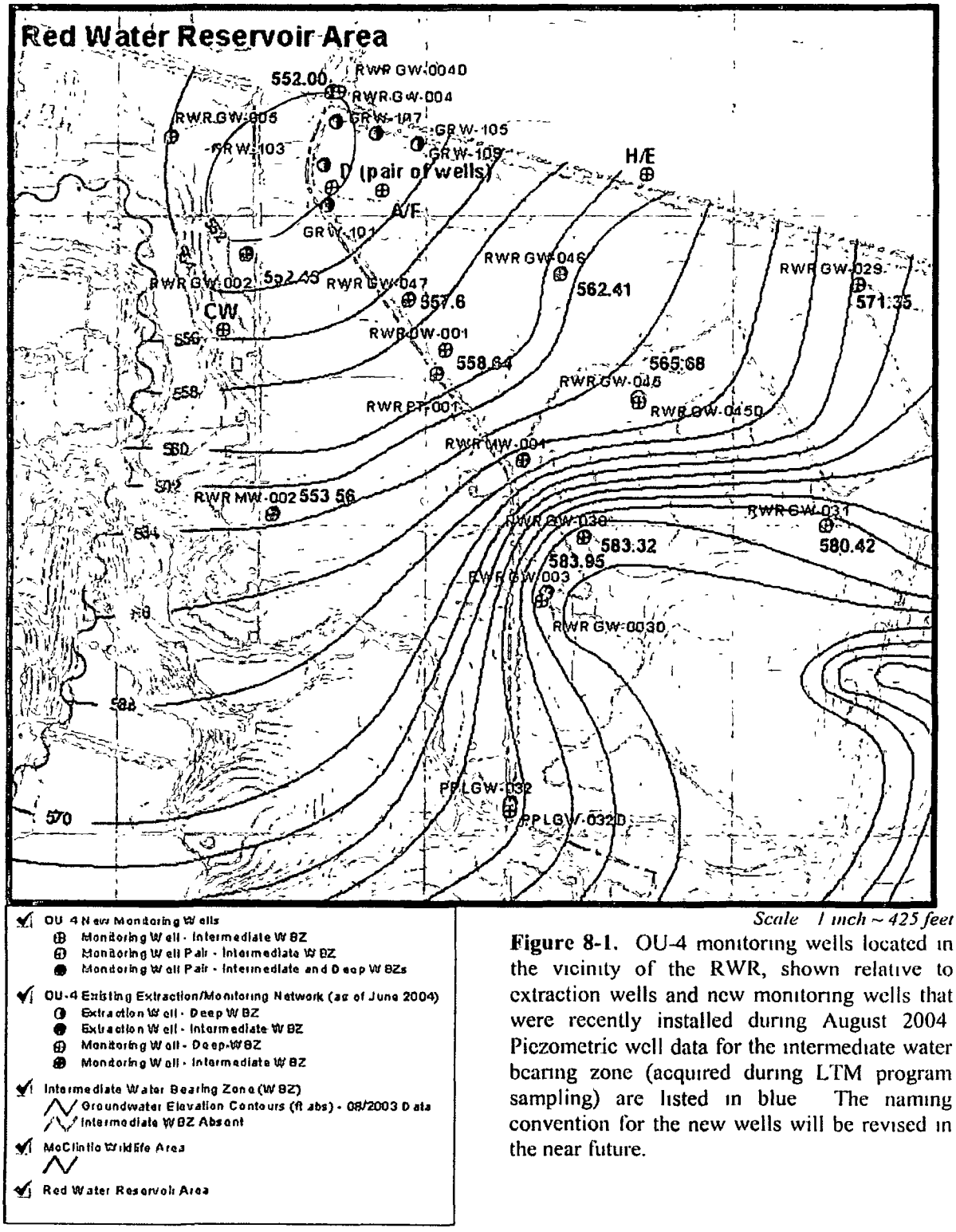


Figure 1-3. West Virginia Ordnance Works Operable Units (OUs) Note that OU-4, which is not shown on the map, addresses the pumping and treating of groundwater contamination at OU-2, OU-3, and OU-5



Scale 1 inch ~ 425 feet

Figure 8-1. OU-4 monitoring wells located in the vicinity of the RWR, shown relative to extraction wells and new monitoring wells that were recently installed during August 2004. Piezometric well data for the intermediate water bearing zone (acquired during LTM program sampling) are listed in blue. The naming convention for the new wells will be revised in the near future.

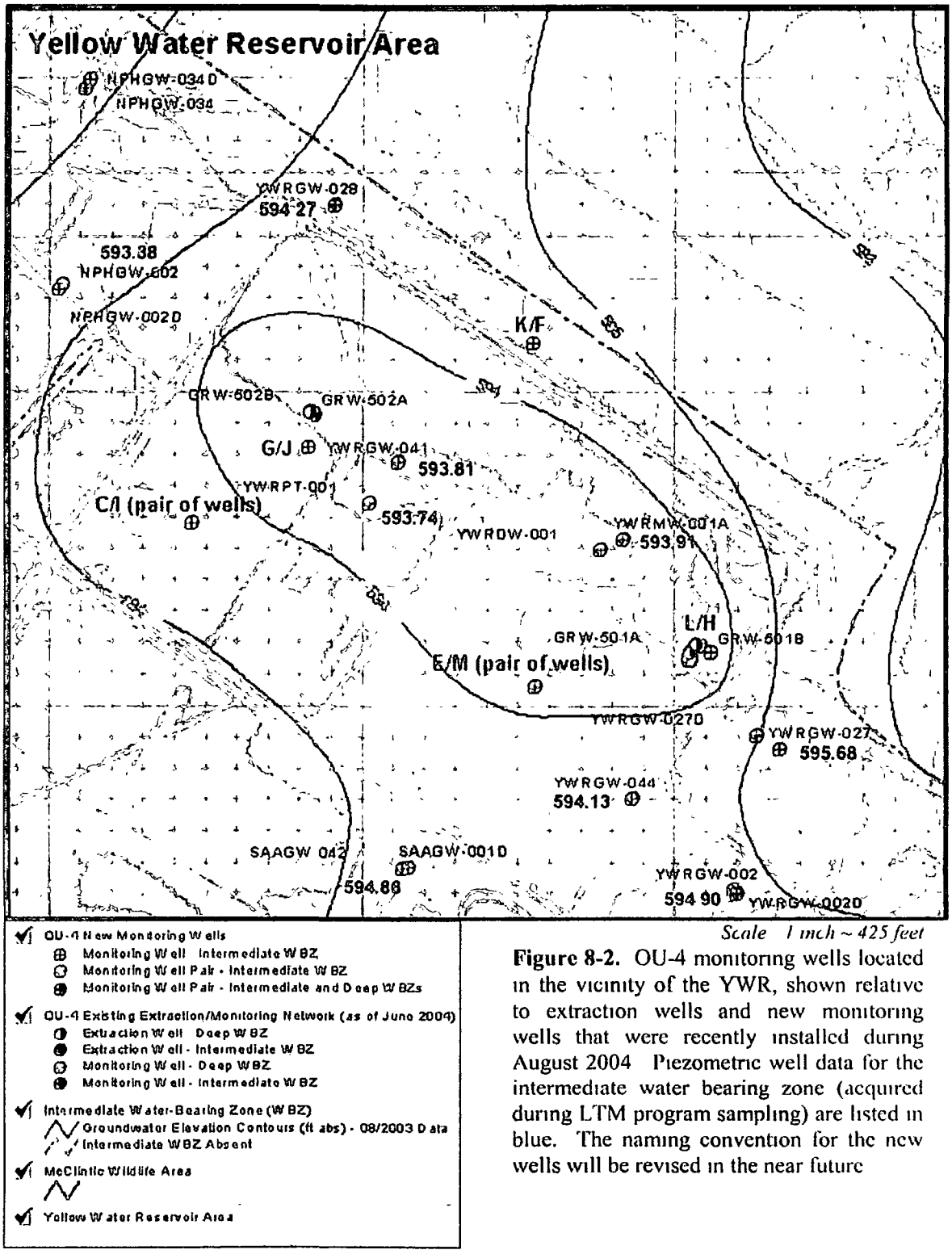
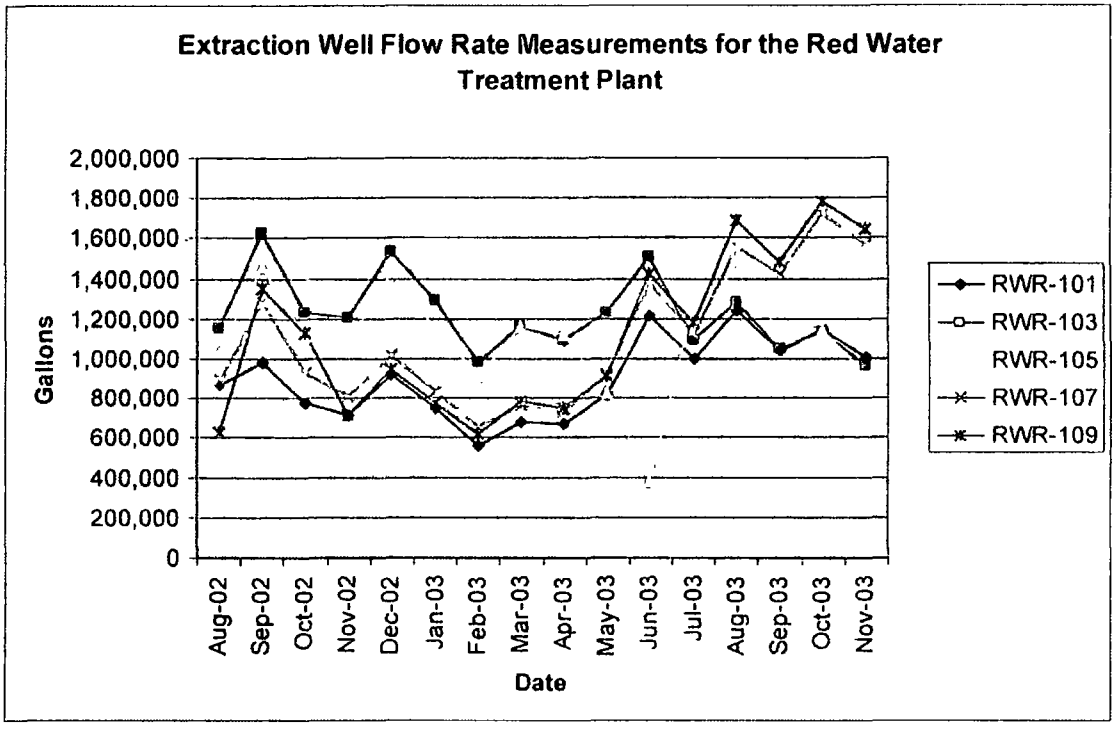
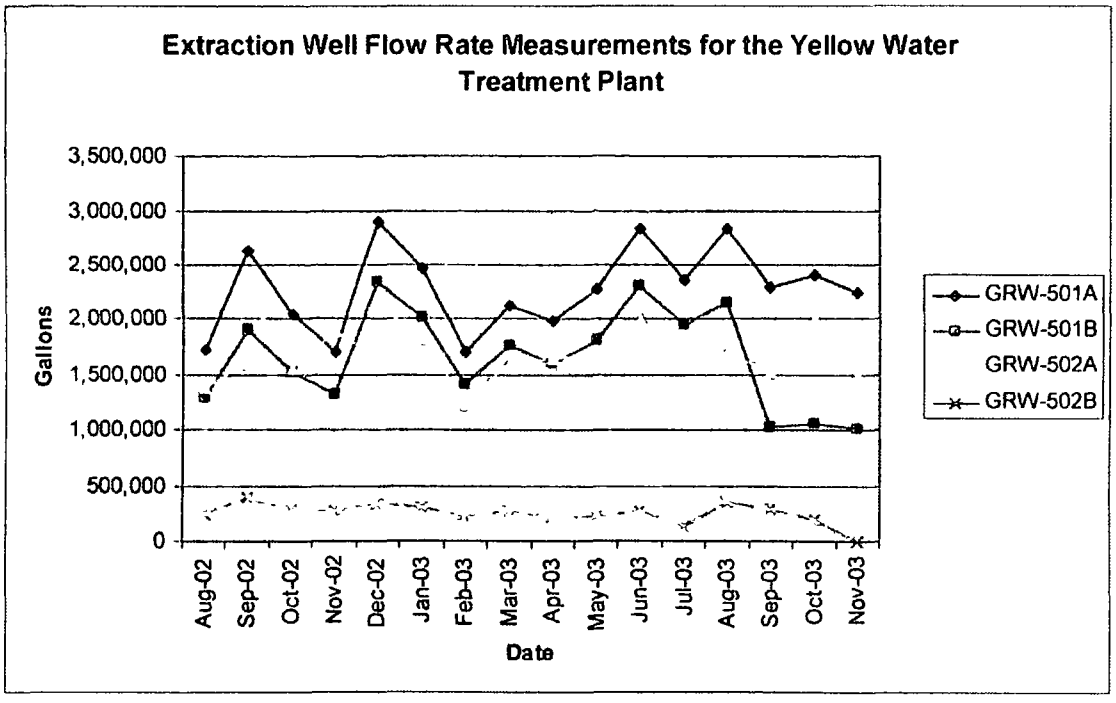


Figure 8-2. OU-4 monitoring wells located in the vicinity of the YWR, shown relative to extraction wells and new monitoring wells that were recently installed during August 2004. Piezometric well data for the intermediate water bearing zone (acquired during LTM program sampling) are listed in blue. The naming convention for the new wells will be revised in the near future.

Figure 8-3. Extraction Well Flow Rate Measurements for the Red Water and Yellow Water Treatment Plants (August 2002 through November 2003).



*The pump in well RWR105 stopped working in late May 2003 and was not operational until after the June 2003 sampling event



* The pump in well 502B stopped working in late October 2003 and was not operational until after the November 2003 sampling event

Figure 8-4. Extraction Flow Rate Measurements for the Red Water and Yellow Water Treatment Plants (August 2002 through November 2003).

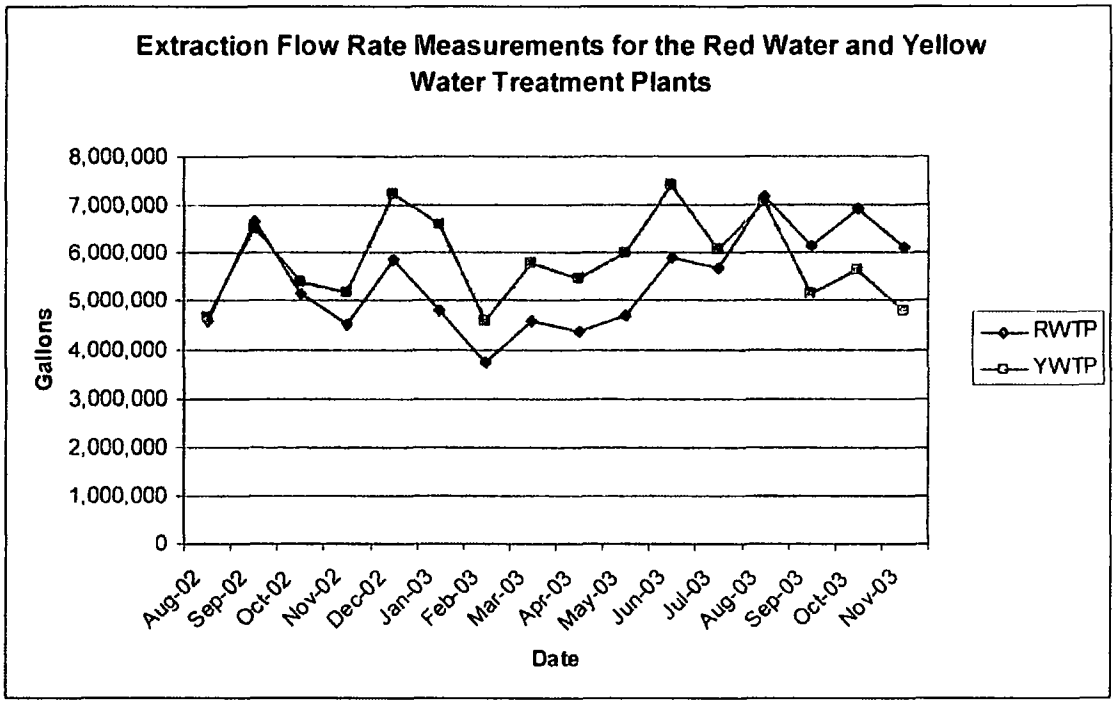


Figure 8-5. Nitroaromatic Compounds Mass Removed from the Red Water and Yellow Water Treatment Plants (August 2002 through November 2003)

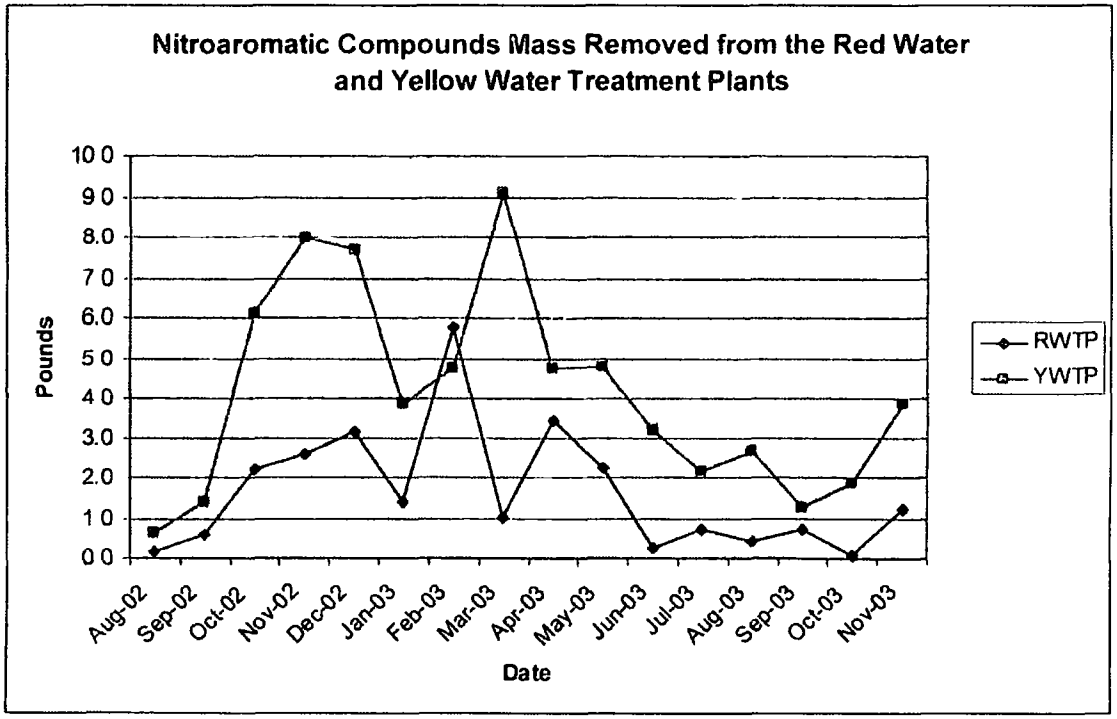
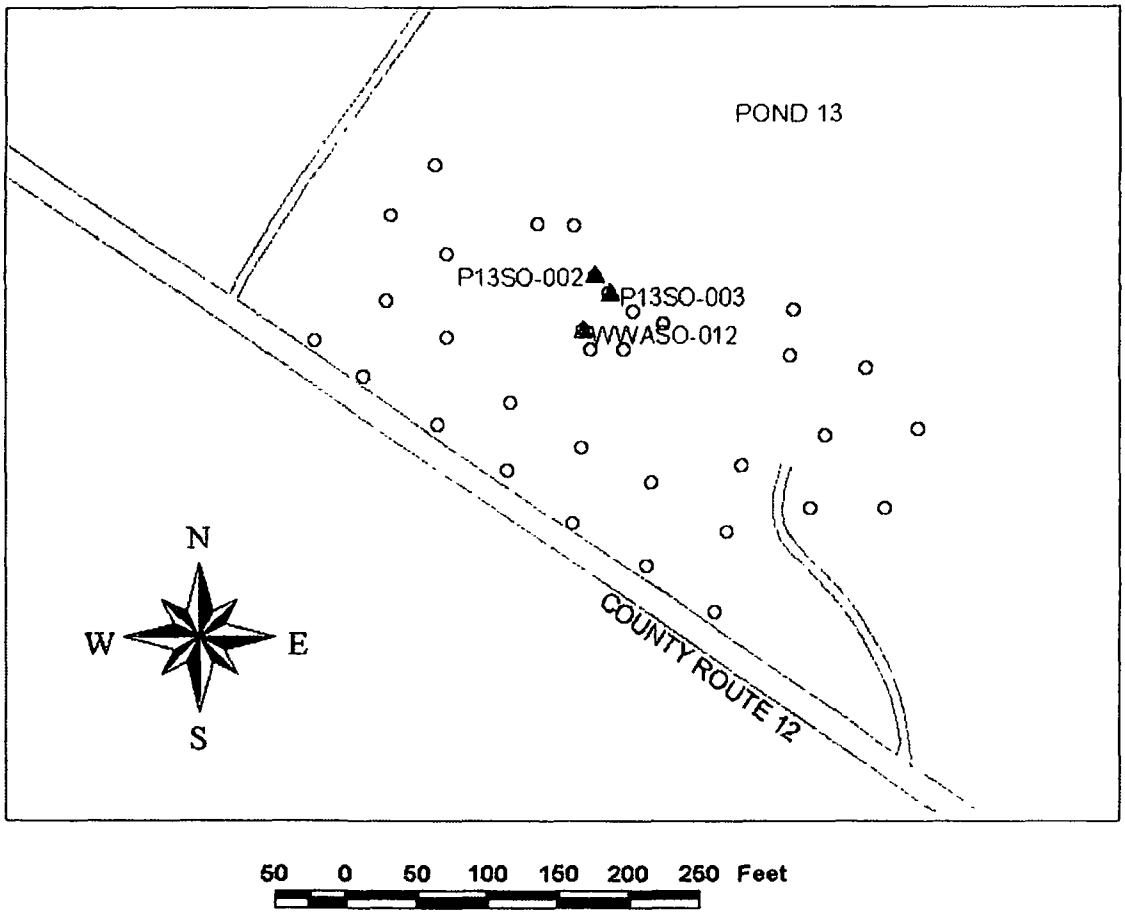


Figure 9-1 - OU-5 Pond 13/Wet Well Area Remedial Investigation Sample Locations



▲ OU-5 Known hot spots

o OU-5 Clean samples at depth

N

LEGEND

TOTAL NITROAROMATICS

- SAMPLE - NOT DETECTED
- SAMPLE - <5.0 mg/kg
- SAMPLE - >5.0 mg/kg <50.0 mg/kg
- SAMPLE - >50 mg/kg <150 mg/kg
- SAMPLE 736 88

Figure 9-2
OU-5 Wet Well Area
Pre-Excavation Samples

I THE UNDERSIGNED HEREBY CERTIFY THAT THIS MAP IS CORRECT AND SHOWS TO THE BEST OF MY KNOWLEDGE AND BELIEF ALL THE INFORMATION REQUIRED BY THE SURFACE MINING LAWS OF THIS STATE

PS 747 SU

STATE OF WEST VIRGINIA
COUNTY OF KANAWHA
TAKEN SUBSCRIBED AND SWORN TO BEFORE ME THIS_____DAY OF _____ 2002

MY COMMISSION EXPIRES _____

WASTETRON, INC
POCA, WEST VIRGINIA

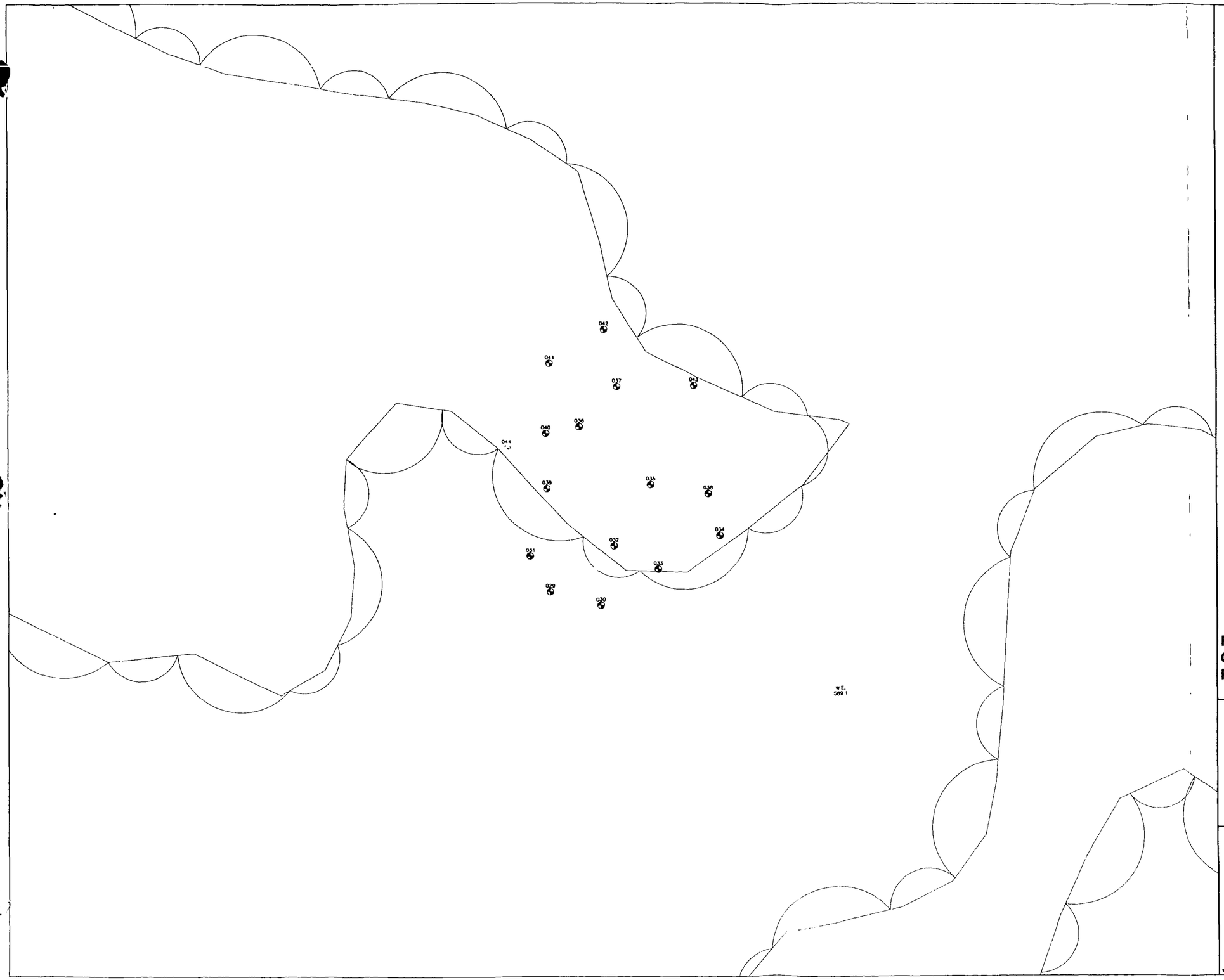
POINT PLEASANT ORDNANCE WORKS

WET WELL AREA

SCALE 1" = 10
CONTOUR INTERVAL 5
DATE PREPARED DECEMBER 2002
DATE REVISED

PREPARED BY
Mountain State Company
P.O. BOX 0 CEDAR GROVE, WV 25039
3318 E. DuPONT AVE. BELLE, WEST VIRGINIA
PHONE (304) 949-4762 FAX (304) 949-4764

WET-WELL-PLAN



N

LEGEND

TOTAL NITROAROMATICS

- SAMPLE - NOT DETECTED
- SAMPLE - <5 0 mg/kg
- SAMPLE - >5 0 mg/kg <50 0 mg/kg
- SAMPLE - >50 mg/kg <150 mg/kg
- SAMPLE 7 36 68

Figure 9-2
OU-5 Wet Well Area
Pre-Excavation Samples

I THE UNDERSIGNED HEREBY CERTIFY THAT THIS MAP IS CORRECT AND SHOWS TO THE BEST OF MY KNOWLEDGE AND BELIEF ALL THE INFORMATION REQUIRED BY THE SURFACE MINING LAWS OF THIS STATE

PS 747 SU

STATE OF WEST VIRGINIA
COUNTY OF KANAWHA
TAKEN SUBSCRIBED AND SWORN TO BEFORE ME THIS_____DAY OF _____ 2002

MY COMMISSION EXPIRES _____

WASTETRON, INC
POCA, WEST VIRGINIA

POINT PLEASANT ORDNANCE WORKS

WET WELL AREA

SCALE 1" = 10
CONTOUR INTERVAL 5
DATE PREPARED DECEMBER 2002
DATE REVISED

PREPARED BY
Mountain State Company
P.O. BOX 0 CEDAR GROVE, WV 25039
5218 E. DUPONT AVE. BELLE, WEST VIRGINIA
PHONE (304) 949-5782 FAX (304) 949-4784

WET-WELL-PLAN

Appendix A: SITE INSPECTION CHECKLIST AND PHOTOGRAPHS

APPENDIX A
Site Inspection Checklist

I. SITE INFORMATION	
Site name: *West Virginia Ordnance Works*	**Date of inspection:** *8/6/04*
Location and Region: *Point Pleasant, WV, Region 3*	**EPA ID:** *WVD 980713036*
Agency, office, or company leading the five-year review: *USACE, Huntington District* *Ken Woodard, Erich Guy, Frank Albert*	**Weather/temperature:** clear, mild

Remedy Includes: (Check all that apply)

- ☒ Landfill cover/containment
- ☒ Access controls
- ☒ Institutional controls
- ☒ Groundwater pump and treatment
- ☐ Surface water collection and treatment
- ☐ Other _____
- ☐ Monitored natural attenuation
- ☐ Groundwater containment
- ☐ Vertical barrier walls

Attachments: ☐ Inspection team roster attached (See Report) ☐ Site map attached

II. INTERVIEWS (Check all that apply)

1. **O&M site manager** Ray McCallister, WTI, groundwater treatment plant operator, 8/6/2004

Interviewed ☒ at site ☐ at office ☐ by phone Phone no *office (304) 755-8448/cell (304) 549-2096*
Problems, suggestions;
Mr. McCallister is in periodic contact with the Huntington District to discuss the O&M of the groundwater treatment facility. He is currently preparing an System Evaluation Report for OU-4, based upon the O&M period from June 2003 through June 2004. He does not know of any current major problems with the OU-4 treatment facility. Mr McCallister recently installed 12 groundwater monitoring wells in the Red and Yellow Water Reservoir Areas, per direction of the Huntington District, based upon recommendations from the WV Ordnance Works Tier I Team, to better define the plume and help to better evaluate the system's performance

2. **O&M staff:** See above (II 1)
Interviewed ☐ at site ☐ at office ☐ by phone Phone no
Problems, suggestions; _____

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 WV Department of Environmental Protection
Contact Pete Costello (Name) Project Manager (Title) 29 SEP 04 (Date) 304-558-2508 (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

Lloyd Akers, Director, WV State Farm Museum

George Carico, Environmental Specialist

David McClung, Wildlife Manager, McClintic Wildlife Management Area, WVDNR

Joe Wheeler, former Project Manager, WTI

Jamie Wolfe, GIS Manager, Marshall University

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
O & M well-documented, O & M manual could be updated

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
On file at the Huntington District Office and in the treatment facility

3 **O&M and OSHA Training Records** ☒ Readily available ☒ Up to date ☐ N/A
Remarks
Contractor has 40-hr HAZWOPER training

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

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

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

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

IV. O&M COSTS

1 **O&M Organization**
☐ State in-house ☐ Contractor for State
☐ PRP in-house ☐ Contractor for PRP
☐ Federal Facility in-house ☒ Contractor for Federal Facility
☐ Other

2. **O&M Cost Records**
☒ Readily available ☒ Up to date
☐ Funding mechanism/agreement in place
Original O&M cost estimate *OU-4 only $357,000/year (1994)* ☐ Breakdown attached

Total annual cost by year for review period if available
See Five-Year Review text (Section 8 6)

From_____ To_____ _____ ☐ Breakdown attached
Date Date Total cost

From_____ To_____ _____ ☐ Breakdown attached
Date Date Total cost

From_____ To_____ _____ ☐ Breakdown attached
Date Date Total cost

From_____ To_____ _____ ☐ Breakdown attached
Date Date Total cost

From_____ To_____ _____ ☐ Breakdown attached
Date Date Total cost

3. **Unanticipated or Unusually High O&M Costs During Review Period**
Describe costs and reasons. *See Five-Year Review text (Section 8 6)*

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

A. Fencing

1 **Fencing damaged** ☐ Location shown on site map ☐ Gates secured ☒ N/A
Remarks

B. Other Access Restrictions

1. **Signs and other security measures** ☐ Location shown on site map ☐ N/A
Remarks
Signs posted Prohibit digging within capped areas. The signs are located as follows
OU-1 TNT Manufacturing Area – on the caps' perimeters on all 4 sides (52 signs)
OU-1 Burning Grounds
West Burning Ground - 6 signs around perimeter
Y-cap – 4 signs around perimeter
East Burning Ground – 4 signs around perimeter
Three small caps - on the caps' perimeters on all 4 sides (12 signs)
OU-2 Red Water Reservoirs - on the caps' perimeters on all 4 sides (8 signs)
OU-3 Yellow Water Reservoir and Barren Area - on the caps' perimeters on all 4 sides (8 signs)
OU-5 Pond 13 – 1 sign in Wet Well Area (near Wadsworth Road) and 1 sign near gravel road between Ponds 13 and 14 – prohibit fishing in Pond 13

C. Institutional Controls (ICs)

1. **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) Self-reporting
Frequency As needed
Responsible party/agency WV Division of Natural Resources, McClintic Wildlife Management Area
Contact David McClung (Name) Wildlife Manager (Title) 304-675-0871 (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 Some trespassing

2 **Land use changes on site**
Remarks N/A

3. **Land use changes off site**
Remarks N/A

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. SOIL COVERS ☒ Applicable ☐ N/A

A. Landfill Surface

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

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

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
Minor erosion present on most caps, small riffles, need to be repaired before they become worse

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 No longer sampled

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 Needs repair, erosion around the structure has led to short-circuiting _____

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_____

IX. GROUNDWATER/SURFACE WATER REMEDIES ☒ Applicable ☐ N/A

A. Groundwater Extraction Wells, Pumps, and Pipelines ☒ Applicable ☐ N/A

1. **Pumps, Wellhead Plumbing, and Electrical**
☒ Good condition ☐ All required wells properly operating ☐ Needs Maintenance ☐ N/A
Remarks Well 502B not operating at this time

2. **Extraction System Pipelines, Valves, Valve Boxes, and Other Appurtenances**
☒ Good condition ☐ Needs Maintenance
Remarks_____

3. **Spare Parts and Equipment**
☒ Readily available ☒ Good condition ☐ Requires upgrade ☐ Needs to be provided
Remarks_____

B. Surface Water Collection Structures, Pumps, and Pipelines ☐ Applicable ☒ N/A

1 **Collection Structures, Pumps, and Electrical**
☐ Good condition ☐ Needs Maintenance
Remarks_____

2. **Surface Water Collection System Pipelines, Valves, Valve Boxes, and Other Appurtenances**
☐ Good condition ☐ Needs Maintenance
Remarks_____

3 **Spare Parts and Equipment**
☐ Readily available ☐ Good condition ☐ Requires upgrade ☐ Needs to be provided
Remarks
See above

C. Treatment System ☒ Applicable ☐ N/A

1. **Treatment Train** (Check components that apply)
☐ Metals removal ☐ Oil/water separation ☒ Bioremediation
☐ Air stripping ☒ Carbon adsorbers
☐ Filters

☐ Additive (*e g* , chelation agent, flocculent) *biocide*
☐ 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 147,459,890 gallons (6 Aug 2003-27 Aug 04)
☐ Quantity of surface water treated annually _____
Remarks _____

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 _____

D. Monitoring Data

☒ Monitoring Data ☒ Is routinely submitted on time ☒ Is of acceptable quality

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.) *See text of five year review report – Sections 5 4, 6 4, 7 4, 8 4, and 9 4*
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 *See text of five year review report – Sections 5 6, 5 7, 6 6, 6 7, 7 6, 7 7, 8 6, 8 7, 9 6, and 9 7*
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 None
D.	**Opportunities for Optimization**
	Describe possible opportunities for optimization in monitoring tasks or the operation of the remedy *See text of five year review report – Section 10 0 Recommendations*

OU-1 Burning Grounds
Soil Covers

East Burning Grounds Soil Cover (photograph taken August 6, 2004)

West Burning Grounds Soil Cover (photograph taken August 6, 2004)

Appendix B: INTERVIEW RECORDS

INTERVIEW RECORD

Site Name: West Virginia Ordnance Works
Subject: Third Five-Year Review Interview
Time: 0830 **Date:** 9/30/04 **Type:** Telephone

Contact Made By: Frank Albert, Environmental Engineer, USACE-Huntington District

Individual Contacted: Lloyd Akers, Director, West Virginia State Farm Museum
Telephone No: 304-675-5737 **E-Mail Address:** N/A
Street Address: Route 1, Box 479, Point Pleasant, WV 25550

The West Virginia State Farm Museum is located adjacent to, and also on, land that was formerly used for operation of the West Virginia Ordnance Works.

Summary of Conversation, Questions:

1. What is your overall impression of the project? (general sentiment)

Mr. Akers said that the group has done a good job. He said that the cleanup work had to be done, and now that progress has been made, it has improved the land so that it can finally get some use by others.

2. Are you aware of any complaints from the public regarding the investigation or cleanup?

No; Mr. Akers has heard no negative comments; everything he has heard has been positive.

3. Do you feel well informed about the site's activities and progress?

Yes; he said that he and the public have always received information regarding site activities.

4. Are you aware of any vandalism or other incidents at the site?

He said that back in the 1970's, there were incidents where stolen property had been stored in the igloos. He was aware of this because he is a retired WV State Trooper and had worked in the area. Other than that, he was not aware of any other cases of vandalism at the site.

5. Do you have any comments, suggestions, or recommendations regarding the site's management or operation?

Mr. Akers had no additional comments, other than to say that everyone has done a good job.

INTERVIEW RECORD

Site Name: West Virginia Ordnance Works
Subject: Third Five-Year Review Interview
Time: 0918 **Date:** 9/29/04 **Type:** Telephone

Contact Made By: Erich Guy, Hydrogeologist, USACE-Huntington District

Individual Contacted: Pete Costello, Office of Environmental Remediation, WVDEP
Telephone No: 304-558-2508 **E-Mail Address:** pcostello@dep.state.wv.us
Street Address: 1356 Hansford Street, Charleston , WV 25301

Summary of Conversation, Questions:

1. What is your overall impression of the project? (general sentiment)

Pete had been part of the project team in the past and recently rejoined the team in July 2004. His perception of the project since he has been back on the team is that the system is pretty good and efficient at getting things done (e.g. team task groups are working well). He noted no deficiencies.

2. Have there been routine communications or activities (site visits, inspections, reporting activities, etc.) conducted by your office regarding the site? If so, please give purpose and results.

Yes. Pete has not made site visits since rejoining the project team, but has received reports on site activities during this time. Pete noted that he was aware that Warren Knotts, the WVDEP representative that Pete is currently taking the place of, had visited the site numerous times throughout recent years.

3. Have there been any complaints, violations, or other incidents related to the site requiring a response by your office?

None that he was aware of during the period he has been back on the project team (since 7/04).

4. Do you feel well informed about the site's activities and progress?

Yes.

5. Do you have any comments, suggestions, or recommendations regarding the site's management or operation?

Pete suggested that the idea of composting capped soil in the TNT Mfg, YWR, and RWR areas should be further explored. Provided recent composting will be deemed to have worked well upon further evaluation, then composting capped soils may be a cost-effective solution when compared to extended years of monitoring and reviews. Pete suggested a cost-analysis be done to compare costs of leaving capped soil in place versus treating capped soil via composting.

Pete also indicated that he would like to have a closer look at the effectiveness of the OU-4 pump and treat system. Clearer documentation as to how well the system is working (i.e. as a true remedial measure) is desired. He suggested that the potential effectiveness of monitored natural attenuation versus the pump and treat system remedy be researched.

INTERVIEW RECORD

Site Name: West Virginia Ordnance Works
Subject: Third Five-Year Review Interview
Time: 1030 **Date:** 5/17/05 **Type:** Telephone

Contact Made By: Ken Woodard, Environmental Engineer, USACE-Huntington District

Individual Contacted: David McClung, Wildlife Manager, McClintic Wildlife Management Area, WVDNR
Telephone No: 304-675-0871 **E-Mail Address:** N/A
Street Address: District 5 Wildlife Office, Route 1, Box 484, Point Pleasant, WV 25550

The McClintic Wildlife Management Area includes most of the land that was formerly included in WVOW.

Summary of Conversation, Questions:

1. What is your overall impression of the project? (general sentiment)

The government has "spent a lot of money" cleaning up the site. The working relationship between the Corps and WVDNR has been good.

2. Are you aware of any complaints from the public regarding the investigation or cleanup?

No, not at this time.

3. Do you feel well informed about the site's activities and progress?

He believes that he has access to this information if he wants it.

4. Are you aware of any vandalism or other incidents at the site?

No recent incidents that pertain to the environmental project.

5. Do you have any comments, suggestions, or recommendations regarding the site's management or operation?

No.

INTERVIEW RECORD

Site Name: West Virginia Ordnance Works
Subject: Third Five-Year Review Interview
Time: 1045 **Date:** 5/17/05 **Type:** Telephone

Contact Made By: Ken Woodard, Environmental Engineer, USACE-Huntington District

Individual Contacted: Joe Wheeler, former Project Manager, WTI
Telephone No: 304-767-4606 **E-Mail Address:** joe.wheeler@rumpke.com
Street Address: 17 Carter Terrace, Saint Albans, WV 25177

WTI has performed much of the remedial action on the site during the past several years for USACE, including composting of nitroaromatic-contaminated soils. Mr. Wheeler repaired and operated the OU-4 system since early 2000, and was involved with other remediation activities, including composting. He left WTI in June 2004.

Summary of Conversation, Questions:

1. What is your overall impression of the project? (general sentiment)

He believes that it is being worked in the correct direction. Some of the approaches may be a little too "long-term", and could be expedited.

2. Are you aware of any complaints from the public regarding the investigation or cleanup?

No. He dealt quite a bit with the public, and one gentleman asked him in 2000 if the water was safe to drink.

3. Do you feel well informed about the site's activities and progress?

Yes, including other contractor's activities.

4. Are you aware of any vandalism or other incidents at the site?

There were a few. Someone tried to break in to the Yellow Water Treatment Plant in 2002, and a report was filed with the WV State Police. The center pole in the gate at the Red Water Treatment Plant was stolen. Thirdly, the Corps once asked WTI to put a chain on a gate between TNT Manufacturing Area and Burning Grounds because the gate had been damaged such that it could no longer be locked.

5. Do you have any comments, suggestions, or recommendations regarding the site's management or operation?

Source removal would expedite groundwater cleanup. He once got the impression from WVDEP that certain areas of the site still need to be addressed, such as the wastewater sewer lines and the old yellow water reservoir. He thinks that composting will work, but that the operating contractor needs to have good knowledge of the entire process. He thinks that composting could be used to treat the nitroaromatic-contaminated soil so that it can be disposed on-site or treat it to a less stringent level for off-site disposal.

INTERVIEW RECORD

Site Name: West Virginia Ordnance Works
Subject: Third Five-Year Review Interview
Time: 1100 **Date:** 5/17/05 **Type:** Telephone

Contact Made By: Ken Woodard, Environmental Engineer, USACE-Huntington District

Individual Contacted: Jamie Wolfe, GIS Manager Marshall University Center for Environmental, Geotechnical, and Applied Science
Telephone No: 304-696-6042 **E-Mail Address:** jawolfe@marshall.edu
Street Address: CEGAS, 1 John Marshall Drive, Huntington, WV 25755-2585

The Marshall University Center for Environmental, Geotechnical, and Applied Science (CEGAS) has served as prime contractor or subcontractor for Restoration Advisory Board (RAB) Support at WVOW since 1998. Mr. Wolfe has been involved with the site since that time. In this role, they plan and facilitate RAB and public meetings, establish and staff a booth at the annual Mason County Fair, and publish quarterly fact sheets and annual newsletters. They performed a survey of water well users in the vicinity of the site in 2002.

Summary of Conversation, Questions:

1. What is your overall impression of the project? (general sentiment)

The Corps is working with the public as best as it can.

2. Are you aware of any complaints from the public regarding the investigation or cleanup?

Any complaints that he has heard have been at the RAB meetings, and they have been resolved. They have not received any negative feedback at the Mason County Fair.

3. Do you feel well informed about the site's activities and progress?

Yes.

4. Are you aware of any vandalism or other incidents at the site?

The windrow turner at the composting building was damaged once.

5. Do you have any comments, suggestions, or recommendations regarding the site's management or operation?

More funding would allow the Corps to do more on the site.

Appendix C: RESPONSE TO REVIEWER COMMENTS

Responses to USEPA Region 3 Technical Review Comments on the West Virginia Ordnance Works Draft-Final Five Year Review Report (Comments received 6 Dec 04)

Reviewer: *Jack Potosnak, RPM*

1. **General Comment - The WVOW FYR Report appears to be well done and comprehensive and it reflects detailed organizational knowledge of the Site history, current status, and future planned activities.**

   RESPONSE: Thank you.

2. **Page III. The text found on lines 6 and 7 appears to be out of place. Please clarify.**

   RESPONSE: This was due to a formatting error, and will be corrected.

3. **Page IV. The title for Figure 9-1 does not agree with that given on the Figure itself. Also, the Figure furnished us as Figure 9-1 is labeled Figure 1. Please clarify.**

   RESPONSE: The title on page IV will be changed to match that shown on Figure 9-1. Also, we will ensure that the correct Figure 9-1 is included in the final report.

4. **Page 14, Section 4.2. Please place in Appendix D a copy of the newspaper notice published in the Point Pleasant Register in April of 2004.**

   RESPONSE: A copy of the notice will be placed in Appendix D.

5. **Page 60, Section 9.7. Please provide more information in terms of sampling results and figures to support the decision that no further response action is appropriate for the *eastern* wet well basin.**

   RESPONSE: The following will be added after the second sentence: "Pre-excavation sampling showed a trend of increasing nitroaromatic concentration from the eastern wet well toward the western wet well. The purpose of the removal action was to excavate a small area of subsurface contamination that is not addressed by the OU-2 ROD in order to prevent leaching to groundwater. Therefore, most of the excavation was performed in and around the western wet well in an attempt to remove the most-contaminated soil."

6. **Figures 1-2 and 1-3. Some of the text in the Figures is not readable in my copy of the Report.**

   RESPONSE: Legible figures will be included in the final report.

7. **Tables 5-6 and 5-8. My copy of the Report contains two Tables designated 5-6 and no Table 5-8.**

   RESPONSE: The second table 5-6 is actually table 5-8, and the title will be fixed.

8. **Figures 8.3 and 8.4. Time units should be provided for the Figures, such as "gallons/month" and "pounds/month".**

   RESPONSE: The labels appear to be correct, with months shown on the X-axis and gallons (Fig 8-4) or pounds (Fig 8-5) shown on the Y-axis, indicating the quantity of gallons treated (Fig 8-4) or pounds of nitroaromatics removed (Fig 8-5), respectively, during that month.

9. **Table 6-1. Under the column titled "Five Year Review Analysis (2004)", the text needs repair in the block corresponding to "Solid Waste Disposal Act".**

   RESPONSE: This was due to a formatting error, and will be corrected.

10. **Appendix A, Site Inspection Checklist. More effort should be made to complete checklist items II.2 and II.3. Also, for Section V.B.1, provide locations of signs, including any signs that prohibit fishing in Pond 13. In Section XI, "Overall Observations", Parts B, C, and D read, "see text of five year review report". Please provide references to specific page numbers and Sections that are intended.**

    RESPONSE: Attempts to interview additional contractor and WVDNR personnel, at a minimum, will be made and results incorporated into II.2 and II.3, respectively. Locations of Pond 13 fishing prohibition signs will be added to V.B.1. References to specific sections will be made in XI.

11. **Copies of the FYR Report received at EPA had duplicate copies of most of the tables and this caused some confusion. Please utilize tabs in the Final Report to separate the various figures, tables, and Appendices from the main body of the Report.**

    RESPONSE: We apologize for any confusion caused by duplicate tables. Tabs will be used in the final report.

Reviewer: Dr. Kathy Patnode, Biological Technical Assistance Group, US Fish & Wildlife Service

1. **Treated groundwater from the OU4 system was documented to exceed state water quality standards for several metals that prevented discharging the effluent directly to Mill Run Creek. Beginning in 2000, effluent was discharged to the Yellow Water Reservoir's wet weather ditch and the Red Water**

Reservoir's sedimentation basin as a final treatment stage to remove metals before the water reached the creek. Over the four year period of discharge, metals in the effluent could have accumulated in the sediments to concentrations of concern to ecological receptors. The five-year review does not indicate that sediment monitoring in the ditch or basin are part of the operation and maintenance plan for OU4. If sediment has been sampled, a discussion of the results should be included in this review. If data are not available, sampling is needed to demonstrate that discharge to these surface water bodies has not created an unacceptable risk. If data indicate that accumulation is occurring and the effluent will continue to be discharged, these sampling locations should be included in the operation and maintenance plan for OU4.

RESPONSE: Due to this comment and subsequent discussions with Dr. Patnode and the Tier 1 team, a recommendation will be made to determine whether the Red Water Sedimentation Basin is a treatment unit or a mitigation wetland. Based on that answer, sampling of the sediment may or may not be performed.

Reviewer: *Dawn Ioven, Toxicologist*

1. **I reviewed the Third Five -Year Review Report for Operable Units 1, 2, 3, 4 and 5 at West Virginia Ordnance Works. This is a very complex report -- which is not unexpected, given the complicated histories of these sites. The preparers should be commended for organizing and simplifying the report so successfully.**

   RESPONSE: Thank you.

2. **I have just one comment to offer, more as a reiteration of U.S. EPA's position than anything else. In Section 10.4.2, the report indicates that remedial goals for groundwater at OU-2 appear to be quite conservative, and "should probably be re-evaluated given the land use at WVOW." However, as this paragraph of the report later acknowledges, U.S. EPA policy requires that groundwater be treated in order to achieve beneficial use. Almost without exception, beneficial use is interpreted to represent restoration to drinking water quality. Consequently, relaxing drinking water standards (or risk-based clean-up goals) to be less protective of residential receptors would be difficult to justify.**

   RESPONSE: The last two sentences of this paragraph will be added as the next-to-last sentence in the paragraph: "The revised ROs would also have to be protective of residential receptors who may use this aquifer for drinking water, in accordance with USEPA policy."

Reviewer: *Bernice Pasquini, Hydrogeologist*

1. **Five Year Review Summary Form, Site Protectiveness, page XX: Editorial comment. Second paragraph, first statement: Remove "in the long term" as it is written twice. Also remove "continued" as it is redundant.**

   RESPONSE: The second occurrence of this phrase will be deleted.

2. **Section 1.3.2, Current Status of OUs, ESIs, and AOCs, Page 4, first full paragraph, last statement, typo. Remove the word is as it's not necessary.**

   RESPONSE: The sentence will be corrected.

3. **Section 2.2.2, Hydrogeologic Setting, Recommend re-writing the first full paragraph: The following changes to the narrative are recommended.**

   a. **First statement: This sentence should reiterate the geologic depositional environment of the (i.e. glacio-fluvial depositional that has sand, gravel, silt and clay) unconsolidated sediment underlying WVOW as indicated in the previous paragraph, as well as the heterogeneous nature of this type of material that is discussed in WV geologic references.**

   b. **First statement: It is unclear what the two major channel systems are? It appears the two Creeks may be referred to here and not ancient glacial outwash. If these channels are surface water bodies, remove reference to them and the Ohio River from this sentence and refer to these surface water bodies and private and public supply wells as ground water discharge locations in a statement later on in the paragraph. Otherwise, provide clarification in regard to these "major channel systems"**

   c. **Second statement: This statement is unclear. Remove the reference to "groundwater in different water-bearing zones is under natural conditions". The only Aquifer that groundwater flow may be "governed by regional flow gradients" appears to be the deeper portion of this glacio-fluvial outwash aquifer. Otherwise, ground water flow is toward local discharge locations such as Oldtown Creek, Mill Creek, Ohio River, seeps, public and private wells. This statement could indicate this.**

   d. **Third statement: Suggest the following modifications: Groundwater flow direction in the intermediate and deep portion of the glacio-fluvial aquifer is influenced by large groundwater withdrawals from both the Camp Conley public supply wells and the Point Pleasant Well Field. Fluctuations in the Ohio River stage also appears to influence groundwater flow in its vicinity. Note: still refer to cites in this narrative.**

e. **Penultimate statement: It is recommended that the narrative be changed as follows: Groundwater extraction at the RWR and YWR influences groundwater flow in the intermediate and deep water-bearing zones.**

RESPONSE: The first paragraph of Section 2.2.2 has been revised in accordance with each of the above recommendations contained in bulleted items a. through e. The revised paragraph reads: "The local hydrogeologic setting at WVOW is characterized by unconsolidated and heterogeneous layered (glacio-fluvial origin) materials with ranging grain sizes (i.e. gravels, sands, silts, and clays) and hydraulic properties. In most parts of WVOW, groundwater is under natural (unstressed/uninfluenced by pumping activities) conditions, and its movement is generally towards local discharge locations such as Mill Run Creek, Oldtown Creek, the Ohio River, seeps, and public and private wells. In the western portion of the site, groundwater flow direction in the intermediate and deep water-bearing zones has been influenced by groundwater withdrawals from both the Camp Conley public supply wells and the Point Pleasant Well Field. Fluctuations (seasonal) in the Ohio River stage appear to influence groundwater flow in its vicinity. Groundwater extraction by the RWR and YWR treatment systems also influences groundwater flow in the intermediate and deep water-bearing zones in these regions of the site. Detailed information and maps concerning site hydrogeology exist in the *Sitewide Hydrogeological Study* (IT, 1996) and *10th Annual LTM Report* (Shaw, 2004)."

4. **Section 5.1.2 Former TNT Manufacturing Area, Last paragraph, penultimate statement: TNTGW-021 has been dropped from the LTMP and isn't being monitored therefore this narrative should be corrected to reflect this.**

RESPONSE: A sentence stating that TNTGW-021 is no longer sampled under the LTMP will be added.

5. **Sections 6.8.1 and 7.8.1 Question A: Is the remedy functioning as intended by the decision documents? Last statement: A decreasing trend would be an indication that the RWR caps are preventing the further leaching of hazardous substances, however, contaminant concentrations remaining stable over time could indicate that the caps may not be as effective at preventing leaching contaminants to ground water. Please reflect this in this narrative and in other areas that this conclusion is drawn.**

RESPONSE: Section 6.8.1 will be revised as follows. Section 7.8.1 will be revised in a similar manner:

In order to answer this question, the ROs listed in Section 6.2 must be addressed to determine if they are being met by the remedial actions and subsequent actions taken.

1. RO#1: The removal of soil contaminants to protective levels – Yes: Soil contaminants have been covered by RCRA caps.
2. RO#2: The minimization of the amount of hazardous substances leaching into the groundwater – Inconclusive: This cannot be determined by the results of the long-term monitoring program (LTMP), at this time. LTMP monitoring will assist to continue to evaluate this RO.

3. RO#3: The treatment of groundwater to protective levels – Discussed in Section 8.8.1.

The remedy appears to be functioning as intended by the OU-2 ROD. Caps are maintained, mowed, and inspected as described previously in this section. Institutional controls consist of a deed restriction that requires that the land only be used for wildlife management purposes and warning signs located on each soil cover. Quarterly inspections of the caps allow sufficient time to detect and repair the covers prior to any type of catastrophic failure of the protective measures.

When composting of OU-5 is completed, the feasibility of excavating and composting nitroaromatic-contaminated material from beneath the caps will be evaluated as a potential permanent remedy (i.e. remove the source). During the eighth annual LTMP sampling event (Shaw, 2004), no surface water or sediment samples were collected in the RWR area. This is because analytical results from sediment and surface water samples collected during the four previous events and supplementary investigations indicated no detectable nitroaromatic compounds. Fourteen wells were sampled as part of the 2003 LTMP (Shaw, 2004) at OU-2; four of these monitor the deep WBZ, while ten of these monitor the intermediate WBZ. The shallow WBZ is present in the RWR area. Nitroaromatic compounds were not detected in the deep wells sampled. Nitroaromatics were detected in seven of the intermediate WBZ wells (six are down gradient of the RWR) at concentrations exceeding RBSCs or ROD criteria; groundwater is being extracted and treated via the OU-4 system.

Most of the nitroaromatic concentrations in ground water in this area have remained fairly stable with no overall increasing or decreasing trend observed throughout the eight LTMP events Due to the chemical properties of the nitroaromatic compounds, (see the fate and transport analysis performed in the RSE, HTRW CX, 2004), these contaminants will move much more slowly than ground water. Consequently decreasing contaminant trends are expected to occur well into the future (or if the RSE predicted a contaminant flow rate use this prediction here as to when we should start seeing a decrease in contaminant concentrations) making it premature to interpret whether the caps adequately minimize the leaching of contaminants from soils to ground water and draw a definitive conclusion with respect to their protectiveness of groundwater, at this time. Irrespective, the stringent RCRA standards that the cap's design and construction were required to meet and quarterly inspections which verify that the structural integrity of the cap is maintained, would suggest that the cap is minimizing infiltration of precipitation and leaching of contaminants to ground water.

6. **Figures 8-1 and 8-2, The water elevation data for each well used to extrapolate the potentiometric contour should be posted on the figures. Solid line contours should not be used where there is no data to extrapolate between (e.g. closing the 552 contour to the north, north-northeast and north-northwest is not appropriate on figure 8-1).**

RESPONSE: Groundwater elevation data for each well used to generate contours will be posted on the figures. Solid line contours will not be used where there are no data points to extrapolate between.

Responses to USEPA Region 3 Technical Review Comments on the West Virginia Ordnance Works Draft-Final Five Year Review Report (Additional comments received 23 May 05)

Reviewer: *Jack Potosnak, RPM*

1. **On Page 21, the final paragraph discusses ...Capping of the Red and Yellow Water Reservoirs...yet the pages are devoted to a discussion of OU-1. Possibly this paragraph is out of place.**

   RESPONSE: The paragraph has been deleted.

2. **On Page XVII, one of the bullets refers to an amendment to the OU-2 ROD for the new remedy for OU-5. We could delete the reference to a ROD amendment.**

   RESPONSE: Reference to a ROD amendment has been deleted.

3. **Also, could you add a sentence at some point in the OU-4 discussion indication that the WVOW Tier I team is evaluating alternative approaches for collecting sediment samples in the RWR Sedimentation basin.**

   RESPONSE: The following was added in the Recommendations section:

   10.4.6 Potential Accumulation of Metals in Sediment

   During the review of the draft report, EPA BTAG raised the issue of whether metals are accumulating in sediments due to discharge from the RWRTP and causing an unacceptable risk to ecological receptors. Other related issues became apparent during subsequent discussion, such as whether the RW sedimentation basin into which the RWRTP discharges is a mitigation wetland or a treatment unit. It is recommended that the WVOW Tier 1 team discuss these issues and determine if and how to address the possibility of metals accumulating in these sediments and what course of action should be taken if an unacceptable ecological risk exists.

Responses to WVDEP Technical Review Comments on the West Virginia Ordnance Works Draft-Final Five Year Review Report (Comments received 28 Apr 05)

Reviewer: *Pete Costello, Project Manager*

1. **Page 12, Last paragraph - Text: "There is no known DoD contamination that has migrated off of the WVOW site." Several investigation have detected nitro-aromatic compounds along the Red Water sewer line trace in the area west of the McClintic boundary. Does the term "site" refer to the original facility boundary or the current NPL site boundary?**

   RESPONSE: This text "there is no known DoD contamination that has migrated off the site" followed an earlier discussion concerning a 2003 WTI study in which nitroaromatics were non-detect in twenty-one off-site residential wells that were sampled. The intention of the text was to clearly convey to the reader that the sampling event results indicated no impact to the off-site residential wells from DoD contamination. Given that the text is unnecessary and that it potentially causes confusion, it will be deleted from the report.

2. **Page 14. §5.1.1 2nd & 3rd paragraphs – The first paragraph states that nitroaromatics were detected at an "(MDC=2%)" whereas the second paragraph states that "...soils with up to 4 percent (40,000ug/g) nitroaromatics existed at both the East and West Burning Ground areas.**

   RESPONSE: There is a conflict in the OU-1 ROD between Table 1 (MDC = 2%) and p.24 (4% nitroaromatics). Section 4.2.2 of the *Endangerment Assessment* (ESE, 1986) states that "Total nitroaromatic concentrations in soils range up to 40,000 ppm in the East Burning Grounds and 20,000 ppm in the West Burning Grounds." This may have been the source of confusion for the ROD author(s). Therefore, the following sentence will be added after the Table 1 reference in the 2nd paragraph: "However, elsewhere in the OU-1 ROD, it is stated that up to 4% total nitroaromatics were detected at the Burning Grounds. The Endangerment Assessment (ESE, 1986) clarifies that total nitroaromatic concentrations in soils ranged up to 40,000 ppm (4%) in the East Burning Grounds and 20,000 ppm (2%) in the West Burning Grounds." Also, the referenced sentence in the 3rd paragraph will be revised to the following: "Pieces of crystalline TNT existed at both the East and West Burning Grounds."

3. **Page 27, Section 5.8.2 - Text states "All increased lifetime cancer risks (ILCRs)". The acronym ILCR is typically used as an abbreviation for Incremental Lifetime Cancer Risk. List of acronyms also indicates that ILCR stands for increased lifetime cancer risk.**

   RESPONSE: CONCUR. "Increased" will be replaced with "incremental".

4. **Page 27, Section 5.8.2 - Text states "All increased lifetime cancer risks (ILCRs)". The acronym ILCR is typically used as an abbreviation for Incremental Lifetime Cancer Risk. List of acronyms also indicates that ILCR stands for increased lifetime cancer risk.**

   RESPONSE: CONCUR. Only the acronym will be used after the first occurrence.

5. **Page 27, Section 5.8.2, Bulleted list - 1,3,5-DNB should be 1,3-DNB.**

   RESPONSE: CONCUR. The bulleted list will be revised to include 1,3,5-TNB and 1,3-DNB. Calculations using values for both of these COCs were performed.

6. **Page 28, Section 5.8.2 - Discussion of protectiveness for the maintenance worker is based upon a 500ppm threshold. Note that OU-1 ROD discusses nitroaromatic remedial objectives in relation to two scenarios, avid hunters and frequent visitors. The 500 ppm total nitroaromatic level was determined to be protective to the hunter as a result of game consumption. A 50 ppm total nitroaromatic level was determined to be protective to a frequent visitor. I recommend that the evaluation be conducted at the 50 ppm level.**

   The following is an excerpt from the OU-1 ROD:

   > **ALL ALTERNATIVES FOR EACH OF THREE AREAS, EXCEPT THE NO ACTION 5A ALTERNATIVE, MEET OR EXCEED THE REMEDIAL ACTION CRITERIA AND OBJECTIVES ESTABLISHED BY THE ENDANGERMENT ASSESSMENT. THESE CRITERIA AND OBJECTIVES ARE TO:**
   > **1. REMOVE OR RENDER UNREACTIVE ALL REACTIVE WASTES, AND**
   > **2. REMOVE OR COVER THE UPPER 2 FT. OF SOIL IF TOTAL NITROAROMATIC CONTAMINATION EXCEEDS 50 PPM TO ACHIEVE LESS THAN 10-6 INDIVIDUAL LIFETIME CANCER RISK.**

   RESPONSE: The evaluation had already been performed for both the 50 ppm (Tables 5-13 and 5-14) and 500 ppm (Tables 5-9 and 5-10) total and individual nitroaromatics levels for the maintenance worker receptor. For clarification, the following text was added in the subsection titled "Cleanup Levels", in the first paragraph below the bulleted list of media evaluated, after the first sentence: "The frequent site visitor was addressed in the OU-1 ROD by developing surficial soil levels for nitroaromatic compounds, however the maintenance worker scenario would be more conservative. That is, levels protective of the maintenance worker in the FYR evaluation would also be protective of a frequent site visitor."

7. **Page 36, Section 6.8.2, Last paragraph, bottom of the page - Text: "It is noted that the ILCR for both receptors for surface water is 1.3..." ILCR should be HI.**

   RESPONSE: CONCUR. "ILCR" will be revised to "HI".

8. **Page 42, Section 7.8.1, Numbered items - The starting number needs to be re-set to 1.**

   RESPONSE: CONCUR. The starting number will be reset to 1.

9. **Page 46, Section 8.2 - Text: "Table 6-2 presents the remedial objectives for the fourth operable unit, per Table 4 from the OU-2 Record of Decision."**

   The OU-2 Record of Decision clearly states that the "Table 4" criteria are applicable to the RWR and YWR areas. With regard to the Pond 13/Wet Well area the ROD states:

```
II. POND 13/WET WELL AREA ALTERNATIVES
ALTERNATIVE 1BALTERNATIVE 1B WOULD INCLUDE EXCAVATION OF CONTAMINATED SOILS
AND SEDIMENTS FOR ON-SITE INCINERATION AND TREATMENT BY CARBON ADSORPTION OF
GROUND WATER REMOVED VIA EXTRACTION WELLS, FOLLOWED BY DIRECT DISCHARGE TO
POND 13.
THE OBJECTIVE OF THIS ALTERNATIVE WITH REGARD TO SOILS AND SEDIMENTS IS
COMPLETE REMOVAL OF ALL CONTAMINATED MATERIAL THAT CONTAINS TOTAL
NITROAROMATIC CONCENTRATIONS EXCEEDING THE CRITERIA FOR 10-6 RISK LEVEL, AND
IN ACCORDANCE WITH TABLE 13. THIS ACTION WOULD ELIMINATE THE SOURCE OF
CONTAMINATED GROUND WATER WHICH PROVIDES THE CONDUIT FOR CONTAMINATION TO
REACH POND 13 AND WOULD LIMIT THE DURATION OF GROUND WATER TREATMENT. GROUND
WATER WOULD BE EXTRACTED AND TREATED ON-SITE USING A TRANSPORTABLE CARBON
UNIT IN ACCORDANCE WITH THE
STANDARDS DEVELOPED AND LISTED IN TABLE 14.

=============================================================================
TABLE 14. GROUND WATER CRITERIA FOR POND 13/WET WELL AREA
COMPOUND  PPLV (UG/L)
TNT       4,600
DNB             12,000
TNB             6,200
=============================================================================
2,4-DNT
10-6 RISK       260
10-5 RISK       2,600
2,6-DNT
10-6 RISK       52
10-5 RISK       520
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   The following is a extracted from a November 29, 1993 letter from EPA RPM Robert Tompson to COE PM Wayne Budrus:

During the recent 30 percent Site Management Plan review conference, held in Nashville, TN, a question was posed regarding the remediation goals for groundwater cleanup contained in the second Record of Decision (ROD) for the West Virginia Ordnance Works (WVOW) NPL site. Specifically, the question was centered on the groundwater remediation goal set for the Pond 13/Wet Well area, as listed in Table 14 of the second ROD. The U.S. Environmental Protection Agency (EPA) has reviewed the issue, and we have made the following determination as described below.

The initial Remedial Investigation (RI) and Supplemental RI for the WVOW site incorrectly concluded that the shallow and deep aquifers at the WVOW site were hydraulically isolated, with little or no hydraulic connection. The contamination detected in the deep aquifer was attributed to contamination being carried into the deep aquifer from shallow aquifer sediments during the drilling of the deep monitoring wells. However, 1992 Army pre-design field investigations found that there are actually shallow and deep layers of one aquifer system present at the WVOW site. The pre-design investigation data suggests the possibility for both downward flow from the shallow aquifer to the deep aquifer, and an upward flow component from the deep aquifer to the upper aquifer in the vicinity of Pond 13. The 1992 Army groundwater sampling results indicated continuing contamination of the deep aquifer by nitroaromatics, specifically 2,6-DNT at 0.19 µg/l.

Given that the lower aquifer is a drinking water source aquifer (City of Point Pleasant Municipal Well Field), or has the potential to be used as a drinking water source aquifer; given that low level nitroaromatic contamination has been consistently found in the lower aquifer at the WVOW site, and given that the lower aquifer and upper aquifers are hydraulically connected, **the Ground Water remediation criteria listed in Table 14 of the second ROD are no longer applicable.** The site conditions, i.e. the presumed hydrogeology of the Pond 13 area under which the criteria listed in Table 14 were prepared, have significantly changed. The aquifer present under the WVOW NPL site should now be considered a drinking water source. Therefore, **the appropriate remedial objectives for groundwater at the WVOW site are listed in Table 4 of the second ROD**, page 15 (copy enclosed). All groundwater remediation at the WVOW site, including Operable Unit Four, must attain these remedial objectives.

Adoption of Mr. Tompson's interpretation appears the criteria of NCP §300.435(c)(2) of differing "*significantly from the remedy selected in the ROD with respect to scope, performance, or cost,...*" which should trigger an ESD at a minimum.

In the opinion the WVDEP project manager, without having undergone the formal ESD process the applicability of the OU-2 ROD criteria to the Pond 13 area are still in question.

RESPONSE: The OU-2 ROD is unclear on which table should apply. Table 4 is titled "Remedial Objectives for Second Operable Unit" and Table 14 is titled "Ground Water Criteria for Pond 13/Wet Well Area." Alternative 4A, which was selected for the Pond 13/Wet Well Area, does not specify which of these tables should apply to groundwater treatment for that area. The statement in Mr. Thompson's memo that the aquifers are connected may not be accurate, based on subsequent studies. During the Tier 1 team meeting on 4 May 05, it was proposed that the RGO's developed for OU-9 be applied to this area, but that discussion was tabled. Because the issue of which levels should apply appears to be beyond the scope of the FYR, two actions will be taken. An additional evaluation using Table 14 value will be performed and incorporated, and a discussion of why this was done will be added. Additionally, a recommendation will be made for the Tier 1 team to determine which levels should apply to Pond 13/Wet Well Area groundwater treatment.

10. **Page 60, Section 9.7 - Text states that pre-excavation samples were collected, but no samples were collected post-excavation. Since no post-excavations samples were taken, do we have a good level of confidence that no seriously contaminated residual remains in place?**

RESPONSE: The purpose of the Wet Well Area excavation was to remove a "hot spot" of nitroaromatic-contaminated soil that impacts groundwater. Originally, it was estimated that only 200 CY of soil would need to be removed to accomplish this. However, far more contaminated material was discovered during excavation and about 1,100 CY of soil was removed. This was the maximum amount of material that could be removed and treated within the available funding. The Contractor was able to "chase" the contamination by visually identifying and removing the "hotter" areas during excavation. This effort is anticipated to yield the desired result of accelerating groundwater cleanup, without removal of all nitroaromatic-contaminated soil.

Appendix D: RESPONSIVENESS SUMMARY

No comments were received from the public during the FYR process. A copy of the newspaper notice announcing the FYR process is included. Additional information is available in Section 4.2 of the report text.

WEST VIRGINIA ORDNANCE WORKS FIVE-YEAR REVIEW

A Five-Year Review is being performed on the former West Virginia Ordnance Works (WVOW) site by the US Army Corps of Engineers (USACE). The WVOW is located in Point Pleasant, WV. The site is being investigated and remediated under the Defense Environmental Restoration Program for Formerly-Used Defense Sites (DERP-FUDS) and is included on the US Environmental Protection Agency's (USEPA's) National Priorities List. Much of this former World War II TNT-manufacturing facility is currently managed by the WV Division of Natural Resources as the Clifton F. McClintic Wildlife Management Area, although portions of the site are owned by private and public owners. Production of TNT led to contamination of soil and groundwater in portions of the site by TNT and other nitroaromatic compounds. Several remedies have been agreed upon by USACE, USEPA Region III, and the WV Department of Environmental Protection and implemented at operable units (OUs) within the site in order to protect human health and the environment:

OU-1	TNT Manufacturing Area and the Burning Grounds - capping of soil Wastewater Process Lines - excavation and flashing
OU-2	Yellow Water Reservoir - draining and capping
OU-3	Red Water Reservoir - draining and capping
OU-4	Pumping and Treating of Groundwater from OUs-2 and 3 (ongoing)
OU-5	Pond 13/Wet Well Area - excavation and bioremediation of soil (ongoing)

No further action was required at the following OUs due to lack of nitroaromatic contamination:

OU-10	South Acids Area, Cooling Tower Area, and Toluene Storage Areas
OU-11	Sellite Plant
OU-12	North and South Powerhouses

The purpose of the Five-Year Review is to evaluate the protectiveness of these remedies. USACE anticipates completing the Five-Year Review by September 30, 2004. The Public Repository, which documents the rationale for all remedial action decisions made on the site, is maintained at the Mason County Public Library, located at 6th and Viand Streets in Point Pleasant, WV. Additional information is available on the WVOW Restoration Advisory Board website:
http://www.lrh.usace.army.mil/projects/fuds/WVOW.htm

USACE welcomes public feedback on completed and ongoing efforts at WVOW and also welcomes questions by contacting the following:

Mr. Ken Woodard
U.S. Army Corps of Engineers
502 8th St
Huntington, WV 25701
Kenneth.L.Woodard@usace.army.mil
(800) 822-8413
(304) 399-5322

Appendix E: FIVE-YEAR REVIEW ACCEPTANCE LETTER FROM USEPA REGION III

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
REGION III
1650 Arch Street
Philadelphia, Pennsylvania 19103-2029

JUL 18 2005

Colonel William E. Bulen
U.S. Army Corps of Engineers
Huntington District
502 Eighth Street
Huntington, WV 25701-2070

Re: Former West Virginia Ordnance Works
Third Five-Year Review Report

Dear Colonel Bulen:

The U.S. Environmental Protection Agency (EPA) Region III, has reviewed the report entitled Third Five-Year Review-Former West Virginia Ordnance Works. The report was prepared by your District to address the Comprehensive Environmental Response, Compensation and Liability Act (CERCLA) Section 121(c) five-year review requirements. EPA has reviewed this five-year review report and has compared it to the OSWER Directive 9355.7-03B-P, *Comprehensive Five-Year Review Guidance* (EPA, June 2001). EPA concurs with the District's determination that the remedies in place are interim in nature and protective to a limited degree and we recognize that further studies are underway to complete final remedy implementation measures.

EPA would like to congratulate the District for preparing a Comprehensive Five Year Review Report that meets the intent of EPA's Five-Year Review Guidance Document.

Should you have any questions, please contact John Potosnak, PE at 215-814-3362.

Sincerely,

Abraham Ferdas, Director
Hazardous Site Cleanup Division

cc: Mr. Peter Costello, West Virginia Dept. of Environmental Protection