U.S. Army Corps of Engineers

F U S R A P

Niagara Falls Storage Site FUSRAP Site
Lewiston, New York

NFSS Remedial Investigation Report Addendum

Text
Figures
Tables
Appendices

Prepared for:

U.S. Army Corps of Engineers
Buffalo District

Prepared by:

Science Applications International Corporation
Columbus, Ohio

Contract: W912QR-08-D-0008

April 2011

REMEDIAL INVESTIGATION REPORT ADDENDUM for the NIAGARA FALLS STORAGE SITE

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TABLE OF CONTENTS

TABLE OF CONTENTS (CONTINUED)

TABLE OF CONTENTS (CONTINUED)

TABLE OF CONTENTS (CONTINUED)

TABLE OF CONTENTS (CONTINUED)

TABLE OF CONTENTS (CONTINUED)

APPENDICES

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FIGURES

FIGURES (CONTINUED)

FIGURES (CONTINUED)

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TABLES

TABLES (CONTINUED)

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ACRONYMS

AEC	Atomic Energy Commission
AL	Action Limit
amsl	Above Mean Sea Level
ANOVA	Analysis of Variance
ARAR	Applicable or Relevant and Appropriate Requirements
aSRC	Analysis of Variance Site Related Contaminant
ASTM	American Society for Testing and Materials
bgs	Below Ground Surface
BNI	Bechtel National, Inc.
BOP	Balance of Plant
BRA	Baseline Risk Assessment
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
CFR	Code of Federal Regulations
CGI	Combustible Gas Indicator
Ci	Curie
COC	Chemical of Concern
COPC	Chemical of Potential Concern
CWM	Chemical Waste Management
DCE	Dichloroethene or Dichloroethylene
DDT	Dichlorodiphenyltrichloroethane
DERP-FUDS	Defense Environmental Restoration Program - Formerly Used Defense Site
DNAPL	Dense Non-Aqueous Phase Liquids
DoD	United States Department of Defense
DOE	United States Department of Energy
DQO	Data Quality Objectives
EA	EA Engineering, Science, Technology
EM	Engineering Manual
EPA	United States Environmental Protection Agency
EPC	Exposure Point Concentration
EPDM	Ethylene Propylene Diene Monomer
ERDA	Energy Research and Development Administration
ESP	Environmental Surveillance Program
EU	Exposure Unit
FS	Feasibility Study
FSP	Field Sampling Plan
FUSRAP	Formerly Utilized Sites Remedial Action Program
GEL	General Engineering Laboratories
GIS	Geographic Information System
GLC	Glacio-Lacustrine Clay
HGL	HydroGeoLogic Inc.
HHRA	Human Health Risk Assessment

ACRONYMS (CONTINUED)

ID	Identification (as in sample or well ID)
IDW	Investigative-Derived Waste
IWCS	Interim Waste Containment Structure
KAPL	Knolls Atomic Power Laboratory
L	Liter
LCS	Laboratory Control Sample
LCSD	Laboratory Control Sample Duplicate
LOOW	Lake Ontario Ordnance Works
LWBZ	Lower Water-Bearing Zone
mrem	Millirem
MCL	Maximum Contaminant Level
MED	Manhattan Engineer District
MS	Matrix Spike
MSD	Matrix Spike Duplicate
MW	Monitoring Well
NA	Not Available
NAD83	North American Datum of 1983
NaI	Sodium Iodide
NCP	National Oil and Hazardous Substance Pollution Contingency Plan
NELAC	National Environmental Laboratory Accreditation Conference
NFSS	Niagara Falls Storage Site
NGVD29	National Geodetic Vertical Datum of 1929
NIOSH	National Institute for Occupational Safety and Health
NIRS	National Inorganics and Radionuclide Survey
NORM	Naturally Occurring Radioactive Materials
NRC	Nuclear Regulatory Commission
NYCRR	New York Codes, Rules and Regulations
NYSDEC	New York State Department of Environmental Conservation
NYSDOH	New York State Department of Health
ORAU	Oak Ridge Associated Universities
ORNL	Oak Ridge National Laboratory
OSL	Optically Stimulated Luminescence
OU	Operable Unit
PAH	Polycyclic Aromatic Hydrocarbons
PCB	Polychlorinated Biphenyls
PCE	Tetrachloroethene or Tetrachloroethylene
pCi/g	Picocuries Per Gram
PID	Photo-Ionization Detector
PPE	Personal Protective Equipment
ppm	Parts Per Million
PRG	Preliminary Remediation Goal
pSRC	Preliminary Site-Related Constituent
PVC	Polyvinyl Chloride
QA	Quality Assurance

ACRONYMS (CONTINUED)

QC	Quality Control
QSM	Quality Systems Manual
RAGS	Risk Assessment Guidance for Superfund
RI	Remedial Investigation
RIR	Remedial Investigation Report
RME	Reasonable Maximum Exposure
ROC	Radionuclide of Concern
ROPC	Radionuclide of Potential Concern
RPP	Radiation Protection Plan
SAIC	Science Applications International Corporation
SAP	Sampling and Analysis Plan
SEC	Special Exposure Cohort
SERA	Screening-Level Ecological Risk Assessment
SESOIL	Seasonal Soil Compartment
SRC	Site-Related Constituents
SSHP	Site Safety and Health Plan
SVOC	Semi-Volatile Organic Compound
TAT	Turn Around Time
TCE	Trichloroethene or Trichloroethylene
TLD	Thermo Luminescent Dosimeters
TNORM	Technologically-Enhanced, Naturally-Occurring Radioactive Material
TNT	Trinitrotoluene
TWP	Temporary Well Point
µg	Microgram
U.S.	United States
UCL	Upper Confidence Limit
USACE	United States Army Corps of Engineers
USGS	United States Geological Survey
UTL	Upper Tolerance Limit
UURI	Underground Utilities Remedial Investigation
UWBZ	Upper Water-Bearing Zone
VF	Volatilization Factor
VOC	Volatile Organic Compound
WDD	West Drainage Ditch
WSDEC	Washington State Department of Ecology
WWTP	Waste Water Treatment Plant
yd^3	Cubic Yards

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GLOSSARY

ACTIVITY - A measure of the rate at which radioactive material is undergoing radioactive decay; usually given in terms of the number of nuclear disintegrations occurring in a given quantity of material over a unit of time. The special unit of activity is the curie (Ci).

AQUIFER - A water-bearing layer of permeable rock or soil that will yield water in usable quantities to wells. Confined aquifers are bounded on top and bottom by less-permeable materials. Unconfined aquifers are bounded on top by a water table.

BACKGROUND CONCENTRATION (soil, groundwater, surface water, or sediment) – A background concentration is a concentration that occurs in an area that is not impacted by site activities and contains characteristics similar to site conditions. Background concentrations for both chemical and radiological constituents were used in the identification of site-related constituents (SRCs) presented in this Remedial Investigation (RI) and in the evaluation of human health risk presented in the Baseline Risk Assessment (BRA). The determination of background concentrations involved the establishment of a background data set by using results from samples collected in areas unimpacted by site activities for each medium and the calculation of a background value for each analyte within each medium. The background concentration is often expressed using an upper tolerance limit (UTL) that is statistically derived from the background data set.

BACKGROUND RADIATION - In this RI, background radiation includes both the natural and man-made (e.g., fallout) radiation in the human environment. It includes cosmic rays and radiation from the naturally radioactive elements that occur both outside and inside the bodies of humans and animals. For persons living in the United States, the average annual individual dose from background radiation is approximately 620 mrem/yr (310 mrem/yr from natural sources and 310 mrem/yr from man-made sources) (National Council on Radiation Protection and Measurements Report No. 160).

BASELINE RISK ASSESSMENT (BRA) - The BRA evaluates current and potential future risks to human health and the environment from site contamination. It is a decision-making tool for use in determining the need for further investigation or site cleanup based upon present site conditions.

BEDROCK - A solid rock formation usually underlying one or more other loose formations.

COMPREHENSIVE ENVIRONMENTAL RESPONSE, COMPENSATION, AND LIABILITY ACT (CERCLA) - CERCLA was originally enacted in 1980. It is also known as Superfund. This act concerns releases of hazardous substances into the environment, and the cleanup of these substances and hazardous waste sites.

CONTAINMENT - Confining the radioactive wastes within prescribed boundaries, e.g., within a waste containment structure.

CHEMICAL OF CONCERN (COC) – A chemical parameter that has been identified as posing unacceptable risk to human health and the environment.

CHEMICAL OF POTENTIAL CONCERN (COPC) - SRCs exceeding preliminary remediation goals (PRGs), evaluated quantitatively in the BRA.

CURIE (Ci) - A measure of the rate of radioactive decay. One curie is equal to 37 billion disintegrations per second (3.7×10^{10} dis/s), which is approximately equal to the decay of one gram of radium.

CUTOFF WALL - A low-permeability, engineered subsurface structure designed to minimize groundwater flow in a direction perpendicular to the wall.

DECAY CHAIN (DECAY SERIES) - The nuclides in the sequence of radioactive decay from one nuclide to another until a stable (nonradioactive) nuclide is reached. The uranium-238 decay chain starts with naturally radioactive uranium-238 and ends with stable lead-206. The term "decay" is also referred to as "disintegration" or "transformation."

DETECT – An analytical result reported above analytical thresholds that is not assigned a rejected (R) or undetected (U) flag, noting that estimated (J-flagged) results are typically accepted as detects.

DISTRIBUTION COEFFICIENT (K_d) - Ratio of the concentration of a constituent absorbed on soil particles to the concentration of the dissolved constituent in water.

DENSE NON-AQUEOUS PHASE LIQUID (DNAPL) - a liquid that is denser than water and is immiscible (i.e. does not mix with water). It forms a separate phase in the presence of water.

DOSE - Total radiation delivered to a specific part of the body, or to the body as a whole.

EXPOSURE UNIT (EU) - A geographic area in which a receptor is assumed to work or live, and where a receptor may be exposed to SRCs detected during the RI.

FEASIBILITY STUDY (FS) – An FS develops, screens, and compares remedial alternatives for a site. The FS incorporates conclusions from the RI, BRA, and groundwater fate and transport modeling.

GROUNDWATER - Usually considered being the water within the zone of saturation below the soil surface.

GROUNDWATER FATE AND TRANSPORT MODEL – A groundwater fate and transport model simulates the flow of groundwater and the movement of dissolved constituents present in an aquifer system.

HYDRAULIC CONDUCTIVITY - The quantity of water that will flow through a unit cross-sectional area of porous material per unit of time under a hydraulic gradient of 100 at a specific temperature.

LEACH - To remove or separate soluble components from a solid by contact with water or other liquids.

PERMEABILITY - The relative ease with which a porous medium can transmit a liquid under a hydraulic gradient. In hydrology, the capacity of rock, soil, or sediment for allowing the passage of water.

PIEZOMETRIC SURFACE - The surface defined by the levels to which groundwater will rise in tightly cased wells that tap an artesian aquifer.

PLUME - A line or column of water containing chemicals moving from the source to areas further away.

RADIONUCLIDE - An unstable nuclide that undergoes radioactive decay.

RADIONUCLIDE OF CONCERN (ROC) – A radionuclide that has been identified as posing unacceptable risk to human health and the environment.

RADIONUCLIDE OF POTENTIAL CONCERN (ROPC) - SRCs exceeding radiological screening levels, evaluated quantitatively in the BRA.

RADIATION - A very general term that covers many forms of particles and energy, from sunlight and radio waves to the energy that is released from inside an atom. Radiation can be in the form of electromagnetic waves (gamma rays, X-rays) or particles (alpha particles, beta particles, protons, neutrons).

RADIOISOTOPE - An unstable isotope of an element that spontaneously loses particles and energy through radioactive decay.

RADIUM-226 - A radioactive solid produced by the decay of thorium-230. It is an alpha emitter and is hazardous when it gets into the body. Radium-226 has a half-life of 1,600 years and can accumulate in certain parts of the body such as bone.

RADON-222 - A radioactive gas produced by the decay of radium-226. It is hazardous mainly because its solid decay products can be deposited in the lungs where they decay in a matter of minutes, emitting alpha radiation that irradiates nearby tissue. Radon-222 has a half-life of 3.8 days.

REMEDIAL INVESTIGATION (RI) – An RI is a site investigation consisting of a records search, environmental sampling, risk assessment, and groundwater flow modeling to define the identity, amount, and location of contaminants at a site.

RESIDUES - For this RI, the K-65, L-30/F-32, and L-50 residues that resulted from the processing of uranium ores.

RUNOFF - All rainfall and snowmelt that does not soak into the ground, does not evaporate immediately, or is not used by vegetation, and hence flows over the land surface.

SECULAR EQUILIBRIUM - In a radioactive decay series, the state that prevails when the ratios between the amounts of successive members of the series remain constant over time.

SITE-RELATED CONSTITUENT (SRC) - Chemicals or radionuclides that were present in a given medium and EU at concentrations statistically greater than the corresponding background concentrations. SRCs were determined for soil (0 to 10 ft bgs), surface soil (0 to 0.5 ft bgs), sediments, surface water, groundwater, pipeline/utility sediments, and pipeline/utility water.

SOURCE TERM - The quantity of radioactive material **(**or other pollutant) released to the environment at its point of release (source).

SPECIFIC ACTIVITY - The activity per unit mass of a pure substance (see ACTIVITY).

THORIUM-230 - A radioactive solid produced by the decay of uranium-238. It has a half-life of 77,000 years.

TILL - Unstratified glacial deposits consisting of clay, sand, gravel, and boulders intermingled.

URANIUM (NATURAL) - A naturally occurring radioactive element that consists of 99.2830% by weight uranium-238, 0.7110% uranium-235, and 0.0054% uranium-234.

VICINITY PROPERTY - Vicinity properties are those properties that were designated by the U.S. Department of Energy (DOE) as eligible properties in the Formerly Utilized Sites Remedial Action Program (FUSRAP) and located within the boundaries of the former Lake Ontario Ordnance Works (LOOW) but outside the boundaries of what is now the Niagara Falls Storage Site (NFSS).

METRIC CONVERSION CHART

To Convert to Metric			To Convert from Metric		
If You Know	Multiply By	To Get	If You Know	Multiply By	To Get
Length					
inches	2.54	centimeters	centimeters	0.3937	inches
feet	30.48	centimeters	centimeters	0.0328	feet
feet	0.3048	meters	meters	3.281	feet
yards	0.9144	meters	meters	1.0936	yards
miles	1.60934	kilometers	kilometers	0.6214	miles
Area					
square inches	6.4516	square centimeters	square centimeters	0.155	square inches
square feet	0.092903	square meters	square meters	10.7639	square feet
square yards	0.8361	square meters	square meters	1.196	square yards
acres	0.40469	hectares	hectares	2.471	acres
square miles	2.58999	square kilometers	square kilometers	0.3861	square miles
Volume					
fluid ounces	29.574	milliliters	milliliters	0.0338	fluid ounces
gallons	3.7854	liters	liters	0.26417	gallons
gallons	0.00378	cubic meters	cubic meters	264.55	gallons
cubic feet	0.028317	cubic meters	cubic meters	35.315	cubic feet
cubic yards	0.76455	cubic meters	cubic meters	1.308	cubic yards
Weight					
ounces	28.3495	grams	grams	0.03527	ounces
pounds	0.4536	kilograms	kilograms	2.2046	pounds
Temperature					
Fahrenheit	Subtract 32 then multiply by 5/9ths	Celsius	Celsius	Multiply by 9/5ths then add 32	Fahrenheit
Radiation					
picocurie	0.037	Becquerel	Becquerel	27.027027	Picocuries
curie	3.70E+10	Becquerel	Becquerel	2.703E-11	Curies
rem	0.01	sievert	sievert	100	rem
RAD	0.01	Gray	Gray	100	RADs

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EXECUTIVE SUMMARY

ES.1 INTRODUCTION

The Niagara Falls Storage Site (NFSS) Remedial Investigation Report (RIR) Addendum addresses potential data gaps and specific concerns raised following completion of the 2007 RIR [United States Army Corps of Engineers (USACE) 2007a]. Over 300 comments on the 2007 RIR documents were submitted to the USACE (herein referred to as "the Corps") for review. A wide range of topics were addressed in the comments; however, two main concerns of 2007 RIR reviewers formed the basis for additional field investigation activities needed to further evaluate site conditions. These concerns included:

- Potential off-site migration of groundwater and contaminants along the northern, southern and western boundaries of the site; and

- The physical integrity of the interim waste containment structure (IWCS), specifically the potential for a breach of the waste containment structure with leaching of wastes and residues.

RIR Addendum field activities focused on the collection of soil and groundwater data to refine the nature and extent of radiological and chemical groundwater plumes near the NFSS property boundary and in the vicinity of the IWCS. In addition to a description of field investigative activities and results, this RIR Addendum addresses the following general topics:

- Refinement of the nature and extent of select radiological and chemical groundwater plumes near the NFSS property boundary and in the vicinity of the IWCS;

- Evaluation of the integrity of the IWCS;

- Re-examination and justification of soil and groundwater background data sets;

- Screening of railroad ballast and building/road core samples;

- Evaluation and screening of 2008/2009 Environmental Surveillance Program (ESP) radiological and chemical data;

- Screening of split sample results collected during the Lake Ontario Ordnance Works (LOOW) Underground Utilities Remedial Investigation (UURI);

- Re-evaluation of plutonium data;

- Presentation of supplemental documentation; and

- Corrections and revisions to the 2007 RIR and Baseline Risk Assessment (BRA).

In general, the scope identified for the RIR Addendum is intended to address public concerns, further define nature and extent of site-related constituents (SRCs), chemicals of concern (COCs), and radionuclides of concern (ROCs) in areas of interest, and provide data to move forward into the Feasibility Study (FS) process.

To define the nature and extent of chemical and radiological contamination associated with surface water and sediment at the NFSS, SRCs were identified. SRCs were defined to be chemicals or radionuclides that were present in a given medium and exposure unit (EU) at concentrations greater than the corresponding background concentrations. SRCs are then subjected to additional screening steps, including a comparison to conservative risk-based concentrations known as preliminary remediation goals (PRGs), to determine which constituents warrant quantitative risk evaluation. These constituents are referred to as chemicals of potential concern (COPCs) or radionuclides of potential concern (ROPCs). The BRA identifies COCs and ROCs which are constituents that exceed target cancer risk levels of 10^{-4} or a non-cancer risk threshold of a Hazard Index greater than one. Radionuclides that present a total dose greater than 25 mrem/yr were also identified as ROCs. The BRA for the NFSS identified COPCs and ROPCs, but no COCs or ROCs in sediment or surface water in on-site surface water bodies.

ES.2 REMEDIAL INVESTIGATION/FEASIBILITY STUDY PURPOSE AND OBJECTIVES

The Corps conducted the Remedial Investigation (RI) activities to define the nature and extent of COCs and ROCs at the NFSS. COCs and ROCs are parameters that have been identified as posing unacceptable risk to human health and the environment. The overall strategy for the site is to clean up radiological and chemical contamination to meet the requirements of the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA), within the scope required by Formerly Utilized Sites Remedial Action Program (FUSRAP). The RI, and its associated documents, including this RIR Addendum, will provide primary data for the FS, which will be used to identify and evaluate various remedial action alternatives and assist in the development of a protective and cost-effective remedy for the site. As stated previously, this NFSS RIR Addendum addresses potential data gaps and specific concerns raised following completion of the 2007 RIR (USACE 2007a).

Environmental investigation and remediation activities at the NFSS are managed by the Corps, Buffalo District, under the FUSRAP. The long-term objective of this project is to evaluate the need for cleanup of contamination resulting from work related to the Nation's early atomic energy program. USACE's cleanup authority under FUSRAP is limited to radioactive contamination from the Manhattan Engineer District/Atomic Energy Commission (MED/AEC) activities, including hazardous substances associated with these activities. Under FUSRAP, other radioactive contamination or hazardous substances are normally addressed only when commingled with MED/AEC contamination. However, because the NFSS is federally owned, the Corps will remediate all radioactive contamination and hazardous substances that present an unacceptable risk to human health or the environment (USACE 2004). Consequently, this RIR Addendum addresses both chemical and radiological contamination at the NFSS.

ES.3 RIR ADDENDUM DATA COLLECTION AND ANALYSIS

The RIR Addendum fieldwork was conducted from mid-November 2009 to the end of January 2010. A total of 23 temporary well points (TWPs) were installed and sampled for soil and groundwater to further delineate impacts to the soil and groundwater along the western and northern boundaries of the NFSS. Ten of the 23 TWPs were converted to permanent monitoring wells in the upper water-bearing zone (UWBZ) in the Brown Clay Unit, which underlies the IWCS. The field and analytical data collected during the RIR Addendum has been incorporated into the evaluations presented in this addendum and will also be used for future FS related tasks.

ES.4 NATURE AND EXTENT OF GROUNDWATER CONTAMINATION

RIR Addendum groundwater sampling activities focused on addressing groundwater contamination in three main areas of the NFSS (see Figure ES-1):

- The Baker-Smith Area in EUs 1 and 2;
- The Acidification Area in EU 4; and
- IWCS and Vicinity in EUs 7, 9, 10 and 11.

ES.4.1 Baker-Smith Area in EUs 1 and 2

During previous phases of the RI, a plume with elevated concentrations of dissolved total uranium was found near the former Baker-Smith Area. RI data identified the potential for the presence of this plume off-site on the north side of EU 1.

Re-evaluation of the dissolved total uranium plume in EUs 1 and 2 incorporating the results of the RIR Addendum fieldwork indicates that the north-south width of the plume is more constrained than originally presented in the 2007 RIR. The southwestern edge of the uranium plume is bounded to the northwest by two TWPs with uranium concentration below background upper tolerance limits (UTLs). RIR Addendum sampling results confirm that dissolved uranium in groundwater is currently present to the north of EU 1 at concentrations greater than the maximum contaminant level (MCL) of 30 µg/L. Groundwater modeling results indicate that groundwater contamination is not migrating (laterally) and that the groundwater plumes at the NFSS are horizontally static, essentially maintaining an equilibrium condition of adsorption with slow advective flow following removal of most ground surface source terms (USACE 2011). A review of site operational information and environmental investigative data indicate that groundwater contamination in this area is the result of historic site operations and past waste storage practices. Most of the soil contamination that contributed to current groundwater contamination was removed during the remedial efforts performed by the United States Department of Energy (DOE) in 1981.

Supplemental radiological sampling conducted in July 2009 attempted to better delineate the extent of the uranium contamination in groundwater extending from the Baker Smith Area on NFSS (i.e., EU 1) to the off-site Town of Lewiston property [i.e. the former LOOW Waste Water Treatment Plant (WWTP)]. The Corps collected unfiltered groundwater split samples from shallow groundwater-monitoring wells installed hydraulically downgradient of former WWTP structures. Uranium in LOOW wells MW-BP-15 and MW-BP-16 were less than 1 pCi/L above background and well below the safe drinking water standard. Uranium in well MW-BP-14 was below the background level. Therefore, results of this sampling indicated that uranium contamination in groundwater is bounded to within the Town of Lewiston (former LOOW WWTP) property where groundwater is not a source of drinking water. Measures are underway to restrict public access to this area.

ES.4.2 Acidification Area in EU 4

Plumes with elevated concentrations of dissolved total uranium, boron, and chlorinated solvents (e.g., tetrachlorethylene (PCE) and degradation products) were found in the Acidification Area during previous phases of the RI. Data from the RI indicated the possible contribution of volatile organic compounds (VOCs) to groundwater from dense non-aqueous phase liquid (DNAPL) at this location.

Two small UWBZ groundwater areas exhibiting concentrations of dissolved total uranium greater than the groundwater UTL of 16.7 µg/L (i.e. NFSS background level for groundwater) and MCL of 30 µg/L are present in the central and north-central portions of EU 4. The maximum concentration of dissolved

total uranium in these two areas is 36.7 µg/L and is located north of the storm sewer line near the western portion of the northern plume. The northwestern portion of this plume in the downgradient groundwater flow direction is not bounded by any sample results. Two groundwater samples collected immediately north-northeast of this plume indicate that dissolved total uranium concentrations are less than the MCL in this area. Groundwater modeling results indicate that groundwater contamination is not migrating (laterally) and that the groundwater plumes at the NFSS are horizontally static, essentially maintaining an equilibrium condition of adsorption with slow advective flow following removal of most ground surface source terms by DOE (USACE 2011). Additionally, off-site exposure to this plume is unlikely because the groundwater is not used as a source of drinking water and Chemical Waste Management (CWM) Chemical Services is located downgradient of this plume where public access is restricted.

During the RIR Addendum effort, investigation of known VOC and radiological contamination was the focus of sampling in EU 4. The dissolved total uranium plume located along the northern portion of EU 4 was identified during recent RIR Addendum sampling efforts. The scope of the RIR Addendum at the time of sampling did not include provisions for bounding this newly identified area of radiological contamination. Additional investigation of the uranium plume in this area may be warranted. Possible future sampling of this area has yet to be defined by the Corps. During the Balance of Plant (BOP) operable unit (OU) FS and the Groundwater OU FS, the Corps will conduct additional field activities to address any data gaps, if necessary.

The boron plume identified within the UWBZ in the central portion of EU 4 was further evaluated during RIR Addendum sampling. This dissolved boron plume was bounded to the north by several sample locations that exhibit dissolved boron concentrations below the background level indicating that this plume is not currently migrating off-site. Furthermore, groundwater flow and transport modeling indicates that the existing boron plume in EU 4 will exhibit little dispersion over the next 10,000 years and is not expected to exceed screening levels at the property boundary (USACE 2011).

During previous phases of the RI, a southeast to northwest trending VOC plume was identified in EU 4 within the UWBZ. This plume contains PCE and its degradation products, trichloroethylene (TCE), cis-1,2-dichloroethylene (cis-1,2-DCE), trans-1,2- dichloroethylene (trans-1,2-DCE), and vinyl chloride. As noted in Section 5.3.3 of the 2007 RIR, there are no known past uses in this EU that would account for the presence of VOCs in groundwater. Although the source of the VOCs was not established, their presence may be due to past storage activities of the military and AEC. The organic plume in EU 4 appears to originate near monitoring wells MW415, MW415A, MW930 and TWP933. Visible DNAPL was observed during the RIR Addendum sampling at locations MW930 and TWP933. PCE and its degradation products are present in both surface and subsurface soil within the boundary of the VOC groundwater plume. Review of soil and groundwater data in EU 4 indicate that, in addition to DNAPL, contamination within subsurface soil is contributing to observed VOC groundwater concentrations. The BOP FS will address the remedial alternatives for PCE and its degradation products present in EU 4 soil.

The downgradient extent of the organic plume appears to be within 150 feet of the northern property boundary. This VOC groundwater plume is currently bounded on-site to the north and west by wells showing either dry conditions or no detections of VOCs. According to the latest groundwater modeling results only minor dispersion of this VOC plume is predicted over time, and despite the increased presence of sand lenses within EU 4, the plume is not predicted to extend off-site (USACE 2011). Furthermore, the maximum on-site concentrations of PCE, TCE, cis-1,2-DCE, and vinyl chloride in the Brown Clay Till are all expected to biodegrade to concentrations below their respective screening level values within 300 years.

The Corps currently monitors the VOC plume through the ESP by collecting semi-annual groundwater samples for VOC analysis from bounding wells MW934 and 411A. It is important to note that

groundwater is not used as a source of drinking water and CWM Chemical Services property is located downgradient of this plume where public access is restricted. The BOP FS will address the remedial alternatives for PCE and its degradation products present in EU 4 soil. Furthermore, the Corps will conduct additional field activities to address data gaps in support of the BOP FS, as warranted.

Potential inhalation pathway risks associated with elevated VOC concentrations in EU 4 groundwater were estimated by modeling volatilization to ambient air and by using soil gas sampling results to consider the potential for soil gas to impact a potential building as a result of vapor intrusion. Groundwater and soil gas sampling results indicate that the presence of VOCs in groundwater has the potential to impact human health in an industrial setting, in either the presence or absence of a future building. Since this potential health impact is via the inhalation pathway, it could occur even if the site groundwater is not used as a drinking water source. Exposure to VOCs in groundwater through inhalation is currently a potential risk only to on-site personnel, not to off-site receptors. The Corps is mitigating this potential risk by limiting access to this area of the NFSS until a long-term remedy is in place. Unacceptable risk for potential future receptors will be considered in the development of remedial action objectives for EU 4 during the FS.

As stated above, the screening methods used to evaluate risk due to the inhalation of VOCs indicate that the presence of VOCs in groundwater at EU4 has the potential to impact human health in an industrial setting or as the result of vapor intrusion into a building. However, both of the methods used include a high degree of uncertainty. Estimation of ambient air concentrations requires assumptions regarding ambient air mixing zone height, wind speed and effective diffusion between soil and groundwater. Details regarding these calculations are provided in Appendix 4-B. The screening for potential soil gas to impact to a building requires an assumption be made regarding a hypothetical building in the EU4 area, which currently does not exist.

ES.4.3 IWCS and Vicinity in EUs 7, 9, 10 and 11

During previous phases of the RI, plumes of dissolved uranium were found around the north and west sides of the IWCS and in the area south-southeast of the IWCS. RI data identified the potential for the presence of this plume off-site on the west side of the IWCS.

RIR Addendum wells north and northwest of the IWCS contained concentrations of dissolved total uranium greater than the UTL (groundwater background UTL); this suggests the dissolved total uranium groundwater plumes identified in the 2007 RIR north of the IWCS and along the western boundary of EU 7 are continuous. The former lagoons and airborne migration and/or surface runoff from the surface storage of R-10 residues north of Building 411 represent likely sources of this contamination. RIR Addendum sampling indicates that concentrations of dissolved total uranium in EU 9 groundwater are above the background level (16.7 µg/L) west of EU 7. Results of RIR Addendum sampling also indicate that concentrations of dissolved total uranium in groundwater are present above the background level in EU 9 west of the northern portion of the IWCS. Concentrations of dissolved total uranium in groundwater at these two locations, both just east of the West Drainage Ditch (WDD) in EU 9, are roughly two times greater than the background level. The location west of EU 7 is included in the plume north of the IWCS, while the location west of the IWCS remains unconnected to the plume on the west side of the IWCS. This observation suggests that the plume on the west side of the IWCS has not migrated to the boundary of EU 10 and is, in fact, bounded to the west by multiple sampling points below the UTL.

RIR Addendum groundwater sampling results from EU 10 confirm the presence of dissolved total uranium in groundwater south of the IWCS at concentrations greater than the background level.

Additionally, RIR Addendum sampling results confirm that dissolved total uranium concentrations are not present above the background level off-site.

Surface water samples collected from the WDD during the RI (1999-2001) contained total uranium at levels above the background UTL for groundwater. Surface water sample results collected from the WDD in 2008, 2009 and 2010 indicate that total uranium concentrations in the WDD are currently at levels below the surface water background level of 12.4 µg/L. The observed decrease in total uranium distribution in the WDD surface water between the time of RI sampling and more recent sampling suggests that the WDD is not greatly impacted by groundwater contaminant transport. Concentrations of total uranium observed in the WDD surface water and sediment during the RI are more likely indicative of material entering the WDD due to historical soil erosion and turbid overland flow.

Available site operational information and environmental investigative data indicate that groundwater contamination surrounding the IWCS is the result of historic site operations and past waste storage practices. Most of the soil contamination that contributed to current groundwater contamination was removed during the remedial efforts performed by the DOE in the 1980s.

ES.5 ASSESSMENT OF THE INTEGRITY OF THE IWCS

Additional assessments of the IWCS integrity since the RIR was completed in 2007 included an examination of topographic survey information to assess potential settlement of the IWCS cap, an overview of the IWCS cap maintenance procedures and ESP monitoring techniques, a review of aerial photos and assessment of groundwater plumes in the vicinity of the IWCS, and a review of information regarding the potential for building pipelines within the IWCS to provide a pathway for release from the IWCS to the environment. Based upon all RI, RIR Addendum, and ESP data, the IWCS is currently functioning as designed.

ES.5.1 Topographic Survey

Surface elevations measured across the IWCS between 1991 (when the configuration of the IWCS was finalized after a 1991 addition) and 2009 exhibited an average change in magnitude of only 0.1 ft (or 1.2 inches). Very minor settling is evident in the central portion of the IWCS cap where the former R-10 pile was located and where waste drums and miscellaneous debris were added to the IWCS in 1991. The average negative change in surface elevation for this area of the IWCS between 1991 and 2009 was negative 0.14 ft, with a range of negative 0.05 to negative 0.25 feet.

ES.5.2 IWCS Cap Maintenance Procedures and ESP Monitoring Techniques

Inspection and maintenance procedures conducted to ensure the integrity of the cap include: monthly walkovers and visual inspections of the cap; and maintaining of the cap vegetative cover. Additionally, the ESP monitoring of radon and gamma radiation is a direct indicator of cap performance and integrity. The most direct measurement of cap performance is radon flux monitoring which is measured directly on top of the cap. Radon flux monitoring is the primary indicator of ongoing releases from the IWCS through the cap. External gamma radiation measurement taken at the site perimeter provides information regarding the magnitude of any releases, should they occur. The conclusions of ESP monitoring techniques are briefly described below.

Radon-222 Flux Monitoring
As in previous years, radon flux monitoring conducted in 2008 indicates that results are well below the 20.0 $pCi/m^2/s$ standard specified in 40 Code of Federal Regulations (CFR) Part 61, Subpart Q, are

comparable to background levels, and demonstrate the continued effectiveness of the IWCS cap in reducing the potential for radon-222 migration and exposure.

External Gamma Radiation Monitoring
External gamma radiation monitoring results along the perimeter of the IWCS for years 1998 through 2008 have been, and continue to be, at or near background levels and are well below the DOE guideline of 100 mrem/year for all pathways, excluding radon.

Radon Gas Monitoring
Consistent with results from previous years, all radon-222 results from the 2008 ESP were well below the DOE off-site limit of 3.0 pCi/L above background. Without subtracting background levels the results for year 2008 ranged from non-detect (less than 0.2 pCi/L) to 0.2 pCi/L (USACE 2009e).

ES.5.3 Review of Aerial Photos and Assessment of Groundwater Plumes in the Vicinity of the IWCS

Historical site operations documented by a 1956 aerial photo of the IWCS area were compared to current levels of dissolved total uranium in groundwater in this same area. One of the key features in the 1956 aerial photo is the radioactive R-10 storage pile which was left uncovered and unprotected in this area for a number of years. The uranium groundwater plumes west of the IWCS correspond to the location of the former radioactive R-10 storage pile that is now enclosed within the IWCS. The uranium groundwater plumes south of the IWCS are believed to be associated with former Building 409 and nearby residue storage activities. The 1956 aerial photo shows material piles located south of the IWCS that correspond to elevated concentrations of dissolved total uranium observed in area groundwater.

Groundwater plumes may appear to be emanating from the IWCS, however, aerial photos showing historic site operations, the RI data, and longer-term ESP data trends do not support this conclusion. Groundwater plumes in the vicinity of the IWCS were established prior to IWCS construction, and were truncated by construction of the IWCS cut-off wall. Long-term trends in the RI and ESP groundwater data for wells surrounding the IWCS show steady-state to declining contaminant concentration levels for total uranium suggesting that the IWCS is performing as designed. An exception to this observation is well OW11B, which exhibits an increasing trend in uranium concentrations. However, this well is near a former pipeline east of the IWCS and is no longer considered to be part of the groundwater plume. During the BOP FS, the Corps will conduct additional field activities to address BOP data gaps, such as the integrity of the underground utility lines south and east of the IWCS. Additionally, the Corps will continue to maintain and monitor the site and evaluate, in the IWCS FS, long-term remedies to ensure future protectiveness of human health and the environment.

ES.5.4 Assessment of Potential for Pipelines to Provide a Pathway for Releases from the IWCS to the Environment

The former LOOW, located on 7,500 acres of land in Niagara County, was used to manufacture trinitrotoluene (TNT) during World War II. The TNT production, production support, and storage areas were constructed on approximately 2,500 acres. Several subsurface pipelines connected former LOOW buildings and some pipelines were used to transfer acids to the TNT production facilities. During the public information session held in September 2008, following release of the 2007 RIR, concern was expressed that pipelines within the IWCS that connected former freshwater treatment plant buildings might allow for contaminant migration to groundwater. The possibility of contaminant transport via pipeline bedding material exists, but due to the absence or discontinuous nature of bedding material in the majority of the underground utility lines investigated at the former LOOW, this threat is reduced. The

potential for these pipelines to act as preferential pathways for contaminant flow is very low for the following reasons:

- As-built drawings reviewed during the RI for former LOOW freshwater treatment plant buildings do not indicate the use of any bedding material for pipelines. As-built drawings for former LOOW freshwater treatment plant buildings also show that the building foundations and the connecting pipelines are located in the brown clay layer, which, due to the clay's low permeability, reduces the potential for contaminant migration surrounding the pipelines. Furthermore, approximately 18 ft of low-permeability gray clay, which underlies the brown clay layer, inhibits potential vertical groundwater flow and contaminant transport from the pipelines.

- Results of the UURI indicated that the 42-inch diameter water supply line that traverses from the LOOW fresh water treatment plant (located on the NFSS) was not underlain by bedding material.

- Pipelines connecting the former LOOW freshwater treatment plant buildings were removed or filled and the ends plugged, further reducing the possibility of contaminant transport from the pipelines within the IWCS (USDOE 1986).

During the BOP FS, the Corps will conduct additional field activities to address BOP data gaps, such as the integrity of the underground utility lines south and east of the IWCS.

ES.6 RE-EXAMINATION AND JUSTIFICATION OF THE NFSS GROUNDWATER BACKGROUND DATA SET

A re-examination of the NFSS groundwater background data set was performed to assess the effects of combining data from the UWBZ and the lower water-bearing zone (LWBZ) to determine site-wide groundwater SRCs. Results of this re-examination suggest that dividing the combined background groundwater data set into separate data sets for the two water-bearing zones does not result in more descriptive background statistics or more reliable delineation of SRCs. Furthermore, this evaluation supports the continued use of a combined background data set to determine site-specific groundwater background levels and SRCs, as was done for the 2007 RIR (USACE 2007a).

A review of mean and maximum values for radium-226, radium-228 and uranium levels in NFSS background groundwater data provides a qualitative indication that NFSS background groundwater levels for these radionuclides are comparable to typical levels observed in domestic groundwater sources. As part of this review, three literature sources for national drinking water levels were used to provide a basis of comparison to NFSS background levels for radionuclides, even though the sizes of the data sets vary greatly. The NFSS data set contains only 24 results for radionuclides as opposed to the nationwide data sets that contain hundreds or thousands of data results. The literature sources used for comparison include:

- results from the National Inorganics and Radionuclide Survey (NIRS), a nationwide occurrence study of radon and other naturally occurring radionuclides in public water supplies (EPA 2000a),

- radiation levels commonly observed in public water sources (Drinking Water Treatment Wastes (EPA 2009b), and

- regional occurrence and distribution of uranium and radon-222 in groundwater in the glacial aquifer system of the United States as well as in the Cambrian-Ordovician and the New York and

New England crystalline aquifer systems that underlie the glacial aquifer system (Ayotte, J.D. et al. 2007).

Information obtained from these literature sources is detailed in Section 6.0.

Thus, according to results of this background data assessment, NFSS background groundwater does not appear to have been impacted by previous LOOW or NFSS site operations, and is appropriate for assessing current groundwater conditions at the NFSS.

ES.7 COMPARISON OF NFSS SOIL BACKGROUND LEVELS TO UNITED STATES AND NEW YORK AREA SOIL BACKGROUND LEVELS

A comparison of the NFSS soil background levels to other background levels from data collected for the U. S., New York State, and Tonawanda, New York area were used to address the appropriateness of applying NFSS soil background data to define the nature and extent of contaminants at the NFSS. Data sources used for this data comparison include:

- background radionuclide concentrations in surface soil at inactive uranium mills and sites formerly utilized for MED and early AEC projects throughout the United States (Myrick et al. 1983),

- chemical background concentration ranges in rural surface soil [(soil cleanup objective development for the New York State Brownfield Program) NYSDEC and NYSDOH 2006], and

- Ashland 2 South and Tonawanda area soil background data [defined in support of the 1993 Remedial Investigation Report for the Tonawanda Sites (Linde, Ashland 1, Ashland 2 and Seaway) DOE 1993].

The comparison of the maximum, mean, and UTL values for parameters in the NFSS soil background data set to other background soil data set statistics indicate that, in many cases, the NFSS background levels appear to be less than background levels observed in U.S., New York State, and Tonawanda, New York area background soils. In cases where NFSS background levels appear to be greater than other soil background levels, the differences in the background values are often relatively small. These observations suggest that the NFSS soil background data is similar to U.S., New York State and Tonawanda area soil background data.

Therefore, the comparison of NFSS soil background levels to other soil background levels from data collected for the U.S, New York State and the Tonawanda, New York area supports the conclusion that the NFSS soil background data set is appropriate for evaluating the nature and extent of contaminants at the NFSS.

Additionally, literature research revealed that in undisturbed areas, the U.S. average concentrations of radium-226 and uranium-238 show a nearly 1:1 correlation (Myrick et al 1983). The close relationship between radium-226 and uranium-238 activities observed in NFSS subsurface background soil lends credence to the opinion that NFSS background soil locations are from an undisturbed area not affected by previous site operations.

ES.8 CHARACTERIZATION OF REMEDIAL INVESTIGATION BUILDING CORE, RAILROAD BALLAST AND ROAD CORE SAMPLES

To further characterize radiological contamination at the NFSS, a review was conducted of Building 401 floor core and underlying soil samples, railroad ballast samples, and core samples of road pavement from across the site. The NFSS RI did not identify SRCs for these media because no suitable background data sets for building cores, railroad ballast, or road core materials are available. Although the materials used to construct the NFSS roadways and railroad bedding are not directly comparable to surface soil, to ensure that no SRCs were missed, it was decided that the road core and railroad ballast samples should be screened using the NFSS site-specific background levels for surface soil.

SRCs previously identified in the NFSS RI for site-wide surface soil include a variety of isotopes. No new SRCs were identified for railroad ballast and road core samples during screening of existing analytical results for these media using background surface soil levels.

The ratio of various radionuclides in railroad ballast and road materials was assessed to determine whether they are at, or near, secular equilibrium, meaning that the material has not been processed to remove radium or uranium. Since the Manhattan Project involved uranium enrichment and extraction processes, materials associated with the MED/AEC operations have concentrations of uranium relative to radium that would be significantly different from naturally occurring material. Therefore, the ratio of radium and uranium in railroad ballast and road materials was used to determine whether these materials may have been impacted by MED/AEC activities, or whether they represent naturally-occurring materials with elevated levels of radiation (NORM).

The delineation of MED/AEC-materials at the NFSS was complicated by the presence of a phosphate slag material with elevated radiological activity that was used throughout the Niagara Falls area for bedding under asphalt and for general gravel applications [Oak Ridge National Laboratory (ORNL) 1986]. Since naturally-occurring earthen materials, like phosphate slag, contain roughly equivalent levels of uranium and radium on a picocurie per gram (pCi/g) basis, while MED/AEC-materials are expected to have higher levels of radium, the ratio of radium-226 to uranium-238 was used to assess whether the materials found were MED-related. While many of the road core samples had comparable levels of radium-226 and uranium-238, several locations were identified with elevated ratios. The analysis of railroad ballast and road core samples also revealed several locations with concentrations of radium-226 above 5 pCi/g. The Applicable or Relevant and Appropriate Requirements (ARARs) for the NFSS have not yet been determined, however 5 pCi/g is the cleanup criterion for radium-226 in surface soil listed in 40 CFR 192 (EPA 1983). It is presented here for comparative purposes only. BOP materials with an elevated ratio of radium-226 to uranium-238, and with radium-226 concentrations greater than the ARAR-based action level will be re-examined during the FS.

ES.9 SUPPLEMENTAL ENVIRONMENTAL SURVEILLANCE PROGRAM DATA FOR RADIONUCLIDES IN GROUNDWATER, AND IN SURFACE WATER AND SEDIMENTS IN ONSITE DRAINAGES

Enhancements to the ESP initiated in 2008 included the addition of ten groundwater-monitoring well locations analyzed for an expanded list of water quality parameters, supplemental radionuclides and isotopic uranium. The supplemental analysis of groundwater for radionuclides conducted in 2008-2009 showed all non-detect results. Analytical results for other radionuclides monitored by the ESP sampling are presented and discussed in the Annual 2008 Environmental Surveillance Technical Memoranda (USACE 2009).

To characterize current conditions in surface water and sediment, enhancements to the ESP initiated in 2008 included the addition of five new surface water and sediment locations (bringing the total number of locations up to 10) analyzed for an expanded list of radiological and chemical parameters, twice a year, up from once a year. Analytical results for surface water and sediment from the enhanced ESP sampling were merged with the RI data set and screened for SRCs using the same screening technique as was used for the RI.

Using the RI data set supplemented with ESP data, four constituents are identified as surface water SRCs that were not previously identified in the 2007 RIR. However, all four constituents were detected at concentrations lower than their respective risk-based PRGs, so do not qualify as COPCs or ROPCs. Three of the seven locations where surface water SRCs were identified for the supplemental ESP data set are boundary locations where surface water flows on to NFSS from off-site locations.

Using the RI data set supplemented with ESP data, 33 constituents are identified as sediment SRCs that were not previously identified in the 2007 RIR. However, 14 of these constituents do not exceed risk-based PRGs so do not qualify as COPCs or ROPCs, and eight of the remaining constituents exceed background levels at a single location. Because new COPCs and ROPCs were identified in sediments, these constituents should be subjected to further risk evaluation to confirm whether or not they are COCs (rather than simply COPCs and ROPCs) during the BOP FS. This risk evaluation should utilize the same methodology as that used for the NFSS BRA (USACE 2007b). If confirmed, these new ditch COCs should be compared to the list of soil COCs for determination of whether or not additional COCs need to be considered when developing soil cleanup goals for the BOP. It is important to note that for the remaining 11 SRCs identified in sediment using the supplemental 2008, 2009 and 2010 ESP dataset, more than 40% of the above background level detections occurred at site boundary locations where surface water flows on to the NFSS from adjacent properties. While the new sediment SRCs include a variety of constituents, the most prevalent chemical fraction for the new SRCs is polycyclic aromatic hydrocarbons (PAHs).

Supplemental ESP data for surface water and sediment sampling collected along the WDD were used to assess potential impacts to the WDD from the NFSS including uncertainty associated with the uranium groundwater plume west of the IWCS. By comparing RI data to more recent ESP data, a marked decrease in total uranium in the WDD was observed. ESP results indicate that total uranium concentrations in the WDD are currently at levels below the background UTL at all three sampling locations along the ditch. The observed decrease in total uranium in the WDD surface water between the time of RI sampling and the ESP sampling conducted during 2008, 2009 and 2010 suggests that the WDD is not significantly impacted by groundwater contaminant transport. Concentrations of total uranium observed in the WDD surface water and sediment during the RI are likely more indicative of material entering the WDD due to historical soil erosion and turbid overland flow.

ES.10 RADIOLOGICAL INVESTIGATION OF UNDERGROUND UTILITY LINES ON THE FORMER LAKE ONTARIO ORDNANCE WORKS PROPERTY

The LOOW UURI (USACE 2008a) was conducted during the fall of 2005 through January 2007 to investigate chemical contamination present in sediment, waste water and soil associated with underground utilities that were put in place to support the formerly used defense sites within the footprint of the LOOW, and which did not appear to have been impacted heavily by non-Department of Defense (DoD) site users (UURI Fact Sheet, USACE 2007d). Sediment and waste water were sampled within pipelines, and soil was sampled beneath pipelines and at pipeline discharge points, which included a discharge line from the former LOOW WWTP to the Niagara River referred to as the 30-inch line (USACE 2009a). Radiological results from waste water and pipeline sediment collected as split samples

during the LOOW UURI were screened against radionuclide background criteria established for the NFSS to determine if they might be considered NFSS SRCs.

Radiological SRCs were identified in three out of 27 soil sample locations. The SRCs identified include uranium-234, uranium-235, and uranium-238. At two soil sample locations with radiological SRCs, the same radionuclides were identified as SRCs in sediments. Given the age and generally poor repair of the underground utility system at the LOOW, media mixing could be occurring that would account for this observation.

A total of eight radiological SRCs were identified in sediments with SRCs identified at 13 of the 15 sediment sample locations. Some of the highest concentrations of radiological SRCs detected in sediment were collected from sumps within the former LOOW WWTP. Although operation of the LOOW WWTP ceased in the mid-1970s, residual radiological contamination appears to be present in pipeline and sump sediments.

Radiological SRCs were identified in five out of 18 waste water sample locations and the SRCs identified (uranium-234, uranium-235 and uranium-238) were the same as those identified in pipeline soil. Since these lines were sealed around the same time that samples were collected for radiological analysis, the impact of sealing pipelines may not be evident in the radiological sample results reported here. During the UURI, it was noted that trends in constituent concentration were not discernable in many of the pipelines. This appears to occur for the acid waste and sanitary lines leaving the NFSS and can be attributed to the fact that several lines, including the former LOOW acid waste, sanitary sewer, and water lines, were previously sealed to prevent open conveyance for contaminant migration. Since only low concentrations of the radiological SRCs were detected in waste water samples, and the pipelines were subsequently sealed, the detected SRCs pose little risk.

ES.11 RE-EVALUATION OF PLUTONIUM-239/240 IN SOIL

A review of plutonium-239/240 analytical results collected from NFSS soil during the RI and RIR Addendum field activities was conducted to re-evaluate conclusions regarding the nature and extent of plutonium contamination in site soils.

The NFSS RI database included analytical results for plutonium-239/240 from 59 samples of on-site environmental media, which included four low-level detections. The highest concentration of plutonium-239/240 was measured in a floor core collected in Building 401; however, this sample included significant interference from the tracer peak and is not believed to have any counts attributable to plutonium-239/240. Two other RI samples with plutonium detections included partial tracer interference, but are still believed to include some plutonium-239/240.

Each radionuclide has a unique energy spectrum measured as peaks or spectral plots during sample analysis. Nuclide identification is made by comparing measured peak energies with spectral plots stored within the analytical instrument's software library. However, the laboratory identification of radionuclides, at low concentrations, typical of environmental soils, can easily be mistaken, due to incomplete chemical separation, and coincident or overlapping spectral peaks, resulting in false positive results. Tracer peaks, from reference standards, are a laboratory quality control measurement used to test interferences found in samples.

The RI data set was augmented with plutonium results for 17 surface soil samples re-analyzed for plutonium-239/240 and inadvertently omitted from the RI database. Data for the 17 missing samples included three low-level detections for plutonium-239/240. Of the three low-level plutonium-239/240 detections included in this data set, one contained significant tracer interference and is not believed to be a

positive plutonium-239/240 result and one contained partial tracer interference, but is still believed to include some plutonium-239/240. The remaining sample was collected in EU 1 where Knolls Atomic Power Laboratories (KAPL) materials, which may have contained plutonium, had been stored. During RIR Addendum field investigations an additional 40 samples were collected and analyzed for plutonium-239/240. Plutonium-239/240 was not detected in any of the RIR Addendum field investigation samples.

Although the RI database included limited sampling for plutonium-239/240, the database contains results for americium-241, which could be indicative of other transuranic compounds associated with the nuclear industry, including plutonium. Out of a total of 768 americium-241 results, only 9 were listed as detected (~1%). The small number of americium-241 detections (9 of 768), and the low concentrations detected, indicate that americium-241 is not a COC at the NFSS, and also suggests that other transuranic compounds, such as plutonium-239/240, are unlikely to be present at significant concentrations or to be widespread in NFSS soils/sediment.

ES.12 SUPPLEMENTAL DOCUMENTATION AND REVISIONS TO THE REMEDIAL INVESTIGATION REPORT AND THE BASELINE RISK ASSESSMENT

Several comments received on the 2007 RIR concerned the public availability of specific documentation that was either referenced in the 2007 RIR or that contained information pertinent to conclusions presented in the 2007 RIR. Supplemental documentation requested by 2007 RIR reviewers is presented in this RIR Addendum to ensure that the public has the opportunity to review documentation forming the basis of 2007 RIR conclusions. This supplemental information is in the form of published reports and papers, fact sheets, correspondence, and field notes. These items are included as appendices on a compact disc accompanying this RIR Addendum.

2007 RIR and BRA items requiring revision to address public comments or to accurately portray pertinent information for the RI have been presented in this RIR Addendum. These items include:

- *Tables in Appendix K of the 2007 RIR showing downhole gamma logging results:* The revision corrects a formula error for the X and Y axes used to display the data.

- *The discussion of the SRC determination process presented in Section 4 of the 2007 RIR:* The text has been revised so the SRC determination process accurately corresponds to the process depicted in 2007 RIR Figure 4-1. Also included in this section is a response to EPA concerning the screening methodology for radionuclides.

- *Tables 2.1 (Background Data Summary for NFSS with Upper Tolerance Limits) and 2.2 (Toxicity Criteria and Chemical-Specific Parameters for Chemical SRCs) of the Baseline Risk Assessment:* Table 2.1 has been revised to correct the UTL for arsenic in surface soil. Table 2.2 of the BRA has been revised to include reference columns for the toxicity information.

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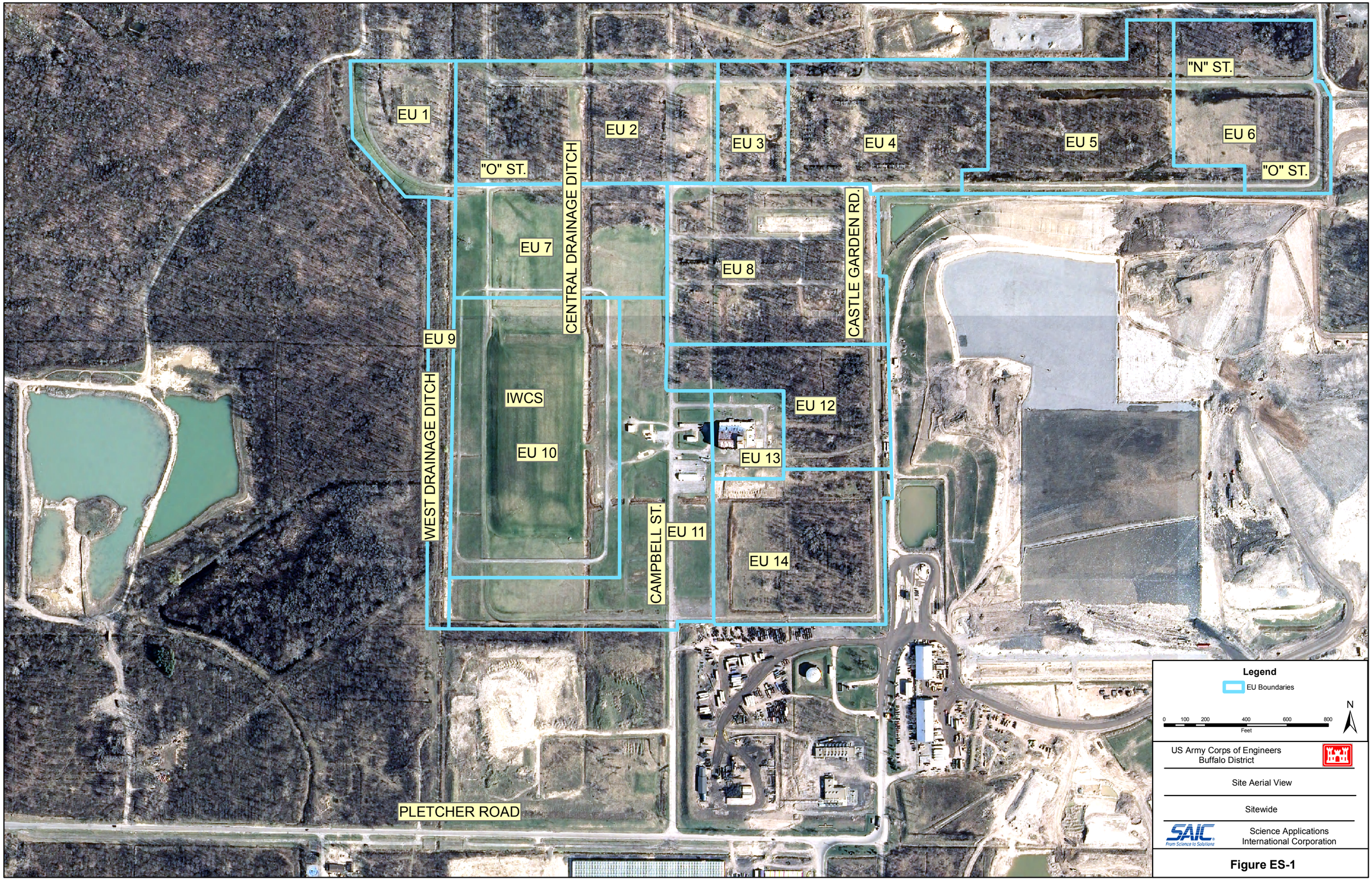

EU 1
EU 2
EU 3
EU 4
EU 5
EU 6
EU 7
EU 8
EU 9
EU 10
EU 11
EU 12
EU 13
EU 14
"N" ST.
"O" ST.
"O" ST.
CENTRAL DRAINAGE DITCH
WEST DRAINAGE DITCH
CASTLE GARDEN RD.
CAMPBELL ST.
IWCS
PLETCHER ROAD
Legend
EU Boundaries
0 100 200 400 600 800
Feet
N
US Army Corps of Engineers
Buffalo District
Site Aerial View
Sitewide
SAIC
From Science to Solutions
Science Applications
International Corporation
Figure ES-1

1.0 PROJECT INTRODUCTION

This document presents results for tasks identified to complete the Remedial Investigation Report (RIR) Addendum for the Niagara Falls Storage Site (NFSS) in Lewiston, New York. This introductory section provides information regarding the project background and explains the authority, purpose and objectives of the NFSS Remedial Investigation (RI). An outline of the report organization is also included at the end of this section.

1.1 BACKGROUND

In December 2007, the United States Army Corps of Engineers (USACE) (herein referred to as "the Corps" in general text and "USACE" in references) issued the 2007 RIR (USACE 2007a) for the NFSS, which is owned by the U.S. Government. The site is located at 1397 Pletcher Road, in the township of Lewiston, Niagara County, New York. The 191-acre parcel is part of the former Lake Ontario Ordinance Works (LOOW) that was used by the War Department beginning in 1942 for the production of trinitrotoluene (TNT). In 1944, the Manhattan Engineer District (MED) began using the site for storage of radioactive residues that resulted from the processing of uranium ores during the development of the atomic bomb. The site vicinity is shown on Figure 1-1. Regional and site aerial views are presented in Figures 1-2 and 1-3. The site layout with site features is shown on Figure 1-4.

The RI at the NFSS was a multi-phase effort that began in 1999. The main objectives of the RI were to define the nature and extent of chemical and radiological site-related constituents (SRCs) on the NFSS resulting from past MED and Atomic Energy Commission (AEC) activities, and to conduct a baseline human health risk assessment (HRRA) and a screening-level ecological risk assessment (SERA) to estimate potential human health, ecological, and environmental impacts of chemical and radiological constituents at the NFSS. Another objective of the RI was to evaluate the integrity of the Interim Waste Containment Structure (IWCS). Environmental sampling results, construction details, and results of a gamma walkover survey were reviewed during the RI to investigate the potential for a breach of the IWCS. A Baseline Risk Assessment (BRA) (USACE 2007b) and a Groundwater Fate and Transport Model (USACE 2007c) were completed as part of the RI to meet these objectives.

Findings presented in the 2007 RIR were reviewed by federal, state and local governments, and the public. Comments received during the review period for the 2007 RIR were compiled to identify common concerns and data gaps related to data and conclusions presented in the 2007 RIR. Following review of the 2007 RIR comments, the Corps made the decision to produce an addendum to the 2007 RIR that would address these concerns and data gaps. Tasks to be completed for this RIR Addendum have not only been defined based on review of written comments, but also from discussions held between the Corps and the public during public information workshops held in May and September 2008 and June 2009. The scope of the RIR Addendum is defined in Section 2 of this document.

1.2 AUTHORITY, PURPOSE, AND OBJECTIVES OF THE REMEDIAL INVESTIGATION

Environmental investigation and remediation activities at the site are managed by the Corps, Buffalo District, under the Formerly Utilized Sites Remedial Action Program (FUSRAP). The Energy and Water Development Appropriations Act for Fiscal Year 2000, Public Law 106-60, requires that the Corps comply with the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA), 42 United States Code 9601 et seq., as amended, as well as the National Oil and Hazardous Substance Pollution Contingency Plan (NCP), in conducting FUSRAP cleanup work. Therefore, the Corps is conducting FUSRAP cleanups in accordance with CERCLA.

The Corps conducted the RI activities to define the nature and extent of chemicals of concern (COCs) and radionuclides of concern (ROCs) at the NFSS. COCs and ROCs are parameters that have been identified as posing unacceptable risk to human health and the environment. The overall strategy for the site is to clean up radiological and chemical contamination to meet the requirements of the CERCLA, within the scope required by FUSRAP. The RI, and its associated documents, will provide primary data for the Feasibility Study (FS), which will be used to identify and evaluate various remedial action alternatives and assist in the development of a protective and cost-effective remedy for the site.

The long-term objective of this project is to evaluate the need for cleanup of contamination resulting from work related to the Nation's early atomic energy program. USACE's cleanup authority under FUSRAP is limited to radioactive contamination from the MED/AEC activities, including hazardous substances associated with these activities. Under FUSRAP other radioactive contamination or hazardous substances are normally addressed only when commingled with MED/AEC contamination. However, because the NFSS is federally owned, the Corps will remediate all radioactive contamination and hazardous substances that present an unacceptable risk to human health or the environment (USACE 2004). To support this objective, extensive sampling has occurred as part of the RI conducted at the NFSS. The extent of site-wide RI sampling can be seen on Figure 1-5. All RI sampling locations, including those from the RIR Addendum sampling activities, are shown on Figure 1-5.

1.3 REPORT ORGANIZATION

Because discussions presented in this RIR Addendum are targeted to address specific data gaps and 2007 RIR reviewer comments, several investigative topics are included as part of this RIR Addendum. Each of these topics are somewhat independent of each other; thus, findings of RIR Addendum scope items described later in Section 2.2 (Description of Tasks) have been presented as separate sections of this report. Related scope items pertaining to a single topic have been addressed in the same section (e.g., research activities used to evaluate the integrity of the IWCS are discussed in Section 5, Assessment of the Integrity of the IWCS).

Each section of this RIR Addendum provides an explanation of the purpose and objective of the investigative activity. Details and conclusions of the researched topic are then presented. Supporting figures and tables for each text section are included at the end of the corresponding section. Supporting appendices are provided in an appendix section of the report. This RIR Addendum is organized as follows:

- *Section 1, Project Introduction*, includes an overview of the RIR Addendum project including a brief site description; responsible parties, project objectives, and project organization; and a description of the report organization.

- *Section 2, Scope of the Remedial Investigation Report Addendum*, includes a description of the purpose and formulation of the RIR Addendum scope of activities and a description of tasks for completion of the RIR Addendum.

- *Section 3, Data Collection and Sample Analysis*, includes a description of data quality objectives (DQOs); a summary of field investigation activities; characterization of surface soil, subsurface soil, groundwater, and soil gas; and a presentation of site photos.

- *Section 4, Nature and Extent of Groundwater Contamination*, provides a brief operational history of each investigative area, describes the occurrence of primary contaminants in groundwater

within each area incorporating analytical data obtained during RIR Addendum investigative activities; and discusses possible sources and effects of past site use.

- *Section 5, Supplemental Assessment of the Integrity of the IWCS*, provides an evaluation of the integrity of the IWCS through the review of Environmental Surveillance Program (ESP) data, pipeline schedules, aerial photos, and topographic surveys.

- *Section 6, Re-examination and Justification of the NFSS Groundwater Background Data Set*, includes an evaluation of combining the data from the Upper Water-Bearing Zone (UWBZ) and the Lower Water-Bearing Zone (LWBZ), as well as a comparison of radionuclide levels in background groundwater to national and New York State drinking water source data to further address concerns that NFSS background groundwater may have been impacted by previous LOOW and NFSS site operations.

- *Section 7, Comparison of NFSS Soil Background Levels to United States and New York Area Soil Background Levels*, provides results of an evaluation to compare the NFSS background levels to other background levels from data collected for the United States, New York State and the Tonawanda, New York area in an effort to address public comments concerning the appropriateness of using this background data set to identify the nature and extent of contaminants at the NFSS.

- *Section 8, Characterization of Remedial Investigation Building Core, Railroad Ballast and Road Core Samples*, presents results of a review conducted of Building 401 floor core and underlying soil samples, railroad ballast samples, and core samples of road pavement from across the NFSS. The review includes a risk screening and an evaluation of naturally-occurring radioactive materials (NORM).

- *Section 9, Supplemental Environmental Surveillance Program Data for Groundwater, and Surface Water and Sediments in On-site Drainages*, presents an update to SRCs, COCs, and ROCs using the Spring and Fall 2008/2009 ESP sampling results from on-site ditches and the West Drainage Ditch (WDD). Presents a discussion of additional cesium, plutonium, strontium, tritium, and technetium groundwater data from the 2008/2009 ESP sampling.

- *Section 10, Radiological Investigation of Underground Utility Lines on the Former Lake Ontario Ordnance Works Property*, presents screening results of radiological data from waste water and pipeline sediment collected as split samples during the LOOW Underground Utilities Remedial Investigation (UURI).

- *Section 11, Re-evaluation of Plutonium-239/240 in Soil*, presents a re-evaluation of the nature and extent of plutonium in NFSS soils using results from the first three phases of the RI and from RIR Addendum sampling activities.

- *Section 12, Presentation of Supplemental Documentation*, summarizes and presents supplemental documentation requested by 2007 RIR reviewers. This supplemental information, either referenced in the 2007 RIR or pertinent to conclusions presented in the 2007 RIR, is in the form of published reports and papers, fact sheets, correspondence, and field notes.

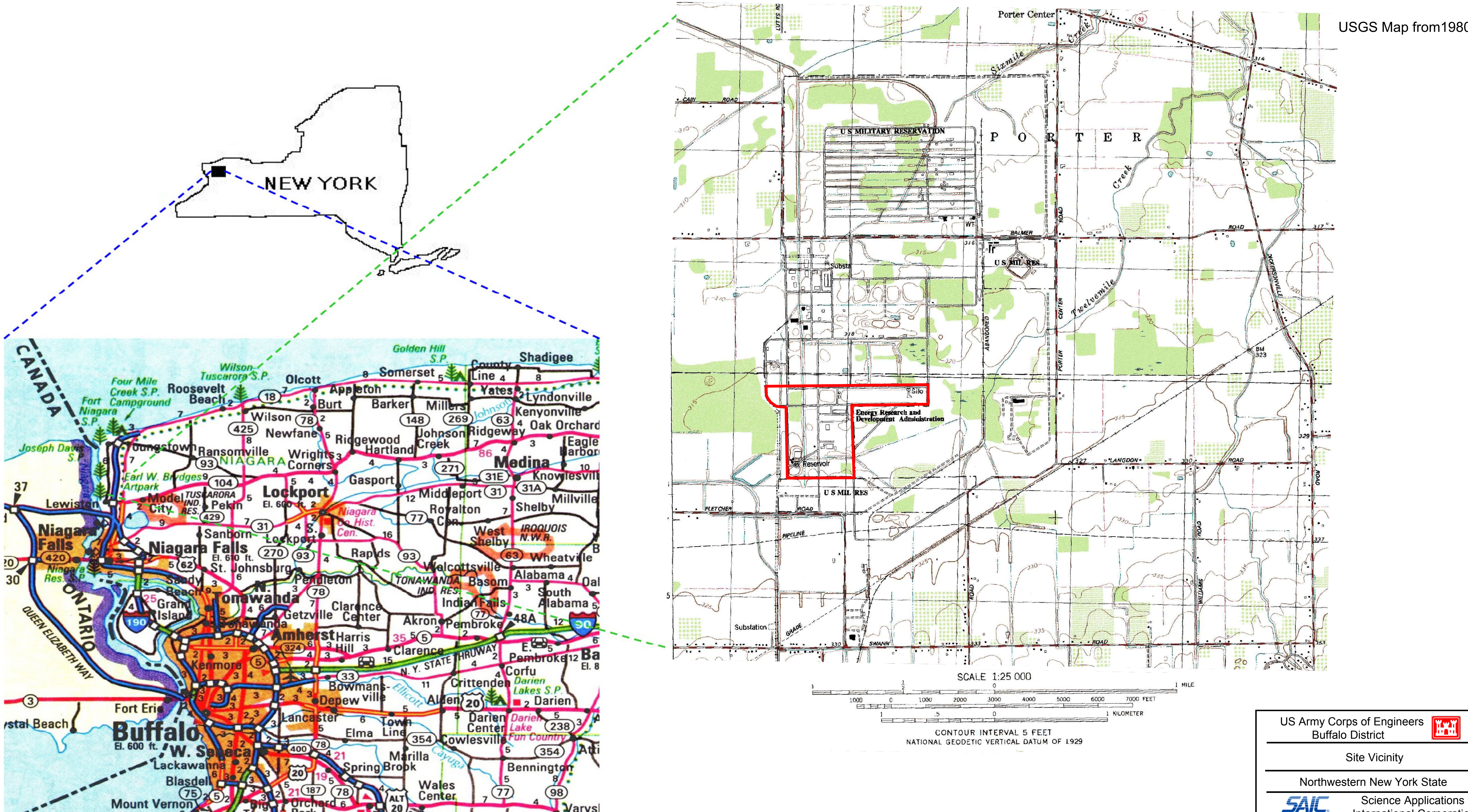
- *Section 13, Table and Text Revisions to the Remedial Investigation Report and the Baseline Risk Assessment*, includes items from the 2007 RIR (USACE 2007a) that have been revised to address public comment or to accurately portray pertinent information for the RI.

- *Section 14, Conclusions,* summarizes the key findings of the RIR Addendum scope items.

- *Section 15, References,* provides a comprehensive list of sources referenced in this RIR Addendum.

SECTION 1

FIGURES



US Army Corps of Engineers
Buffalo District

Site Vicinity

Northwestern New York State

Science Applications International Corporation

Figure 1-1

BALMER ROAD

SOUTHWEST DRAINAGE DITCH

CHEMICAL WASTE MANAGEMENT PROPERTY

FORMER LOOW PROPERTY

LEWISTON-PORTER SCHOOLS

WALLEYE PONDS

EU 1

EU 2

EU 3

EU 4

EU 5

EU 6

EU 7

EU 8

MODERN LANDFILL

EU 9

BORROW PITS

IWCS

EU 12

EU 10

EU 13

EU 11

EU 14

CREEK ROAD

CAMPBELL STREET

PLETCHER ROAD

GREENHOUSE

Legend

EU Boundaries

0 750 1,500

Feet

N

US Army Corps of Engineers
Buffalo District

Regional Aerial View

Sitewide

SAIC From Science to Solutions

Science Applications
International Corporation

Figure 1-2

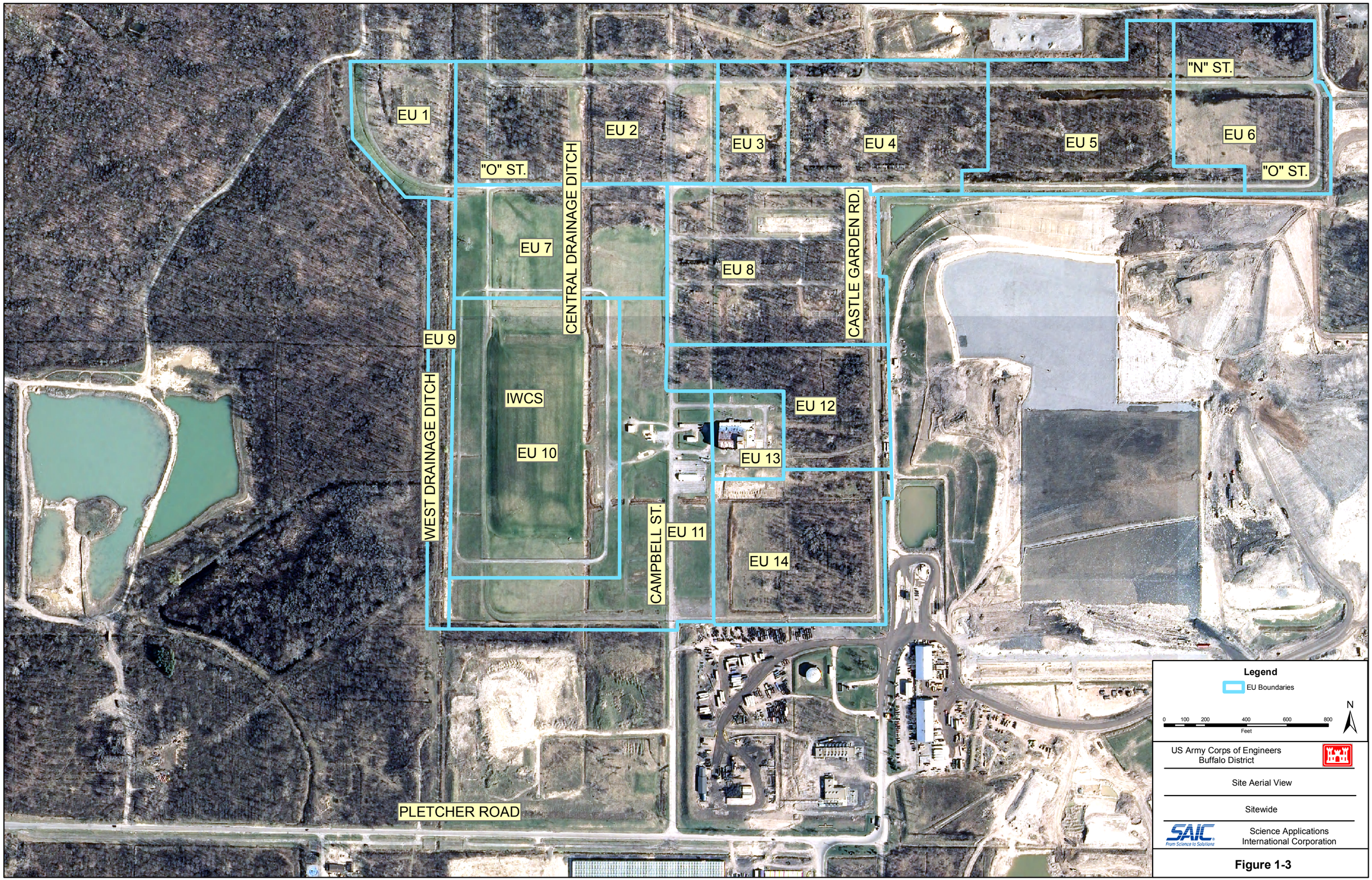
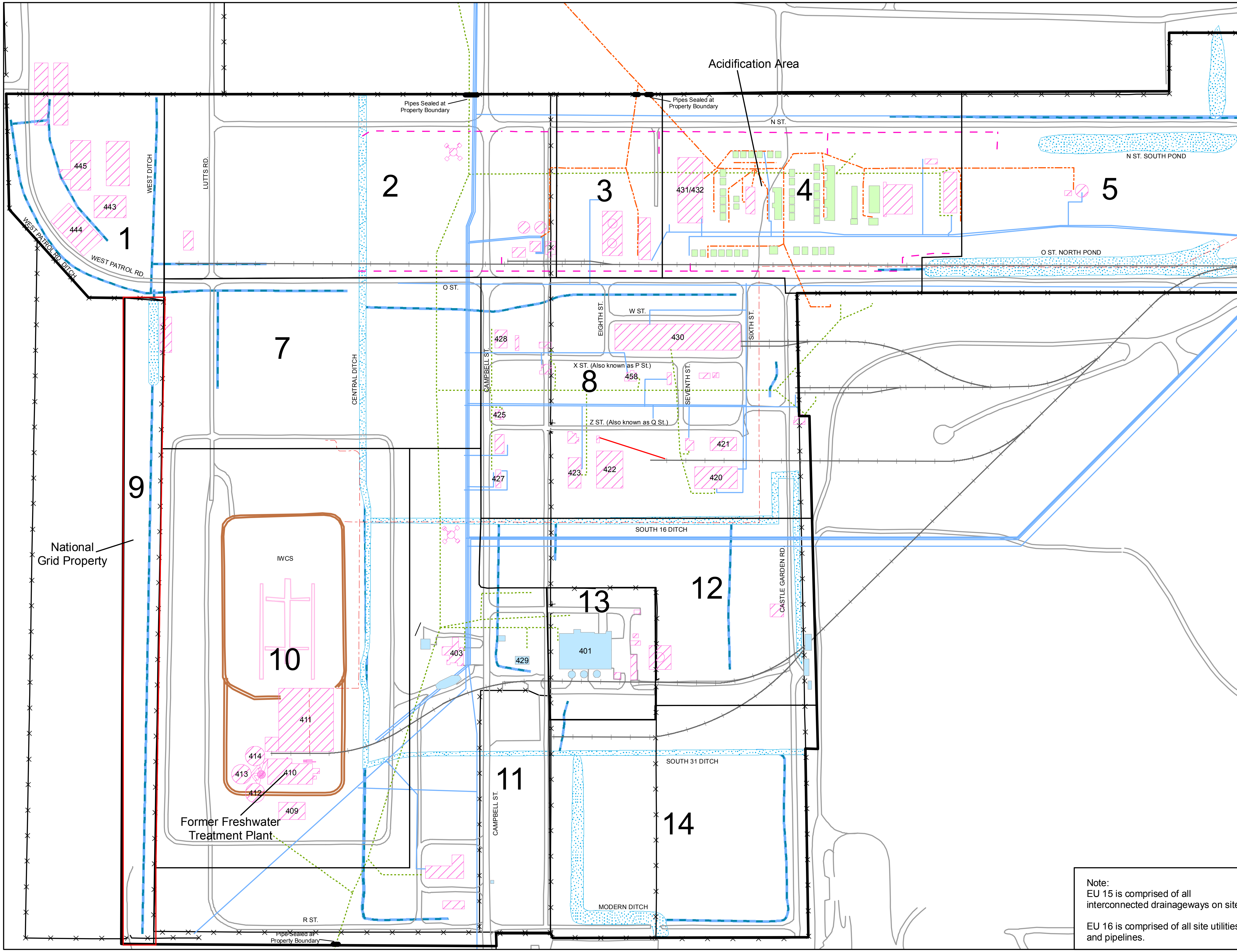

EU 1
EU 2
EU 3
EU 4
EU 5
EU 6
EU 7
EU 8
EU 9
EU 10
EU 11
EU 12
EU 13
EU 14
"N" ST.
"O" ST.
"O" ST.
CENTRAL DRAINAGE DITCH
WEST DRAINAGE DITCH
CASTLE GARDEN RD.
CAMPBELL ST.
IWCS
PLETCHER ROAD
Legend
EU Boundaries
0 100 200 400 600 800
Feet
N
US Army Corps of Engineers
Buffalo District
Site Aerial View
Sitewide
SAIC
From Science to Solutions
Science Applications
International Corporation

Figure 1-3



Note:
EU 15 is comprised of all interconnected drainageways on site.

EU 16 is comprised of all site utilities and pipelines.

Legend

- Structure abandoned above grade
- Existing structure
- Former structure
- Acid sewer
- Water lines
- Fuel line
- Sanitary sewer
- Storm sewer
- Former K-65 transfer pipeline
- IWCS cutoff wall
- Surface water (inundated 50% of year)
- Ephemeral ditches
- Roads
- Former railroad
- EU boundaries
- National Grid Boundary
- Site boundary

0 120 240 480
Feet
N

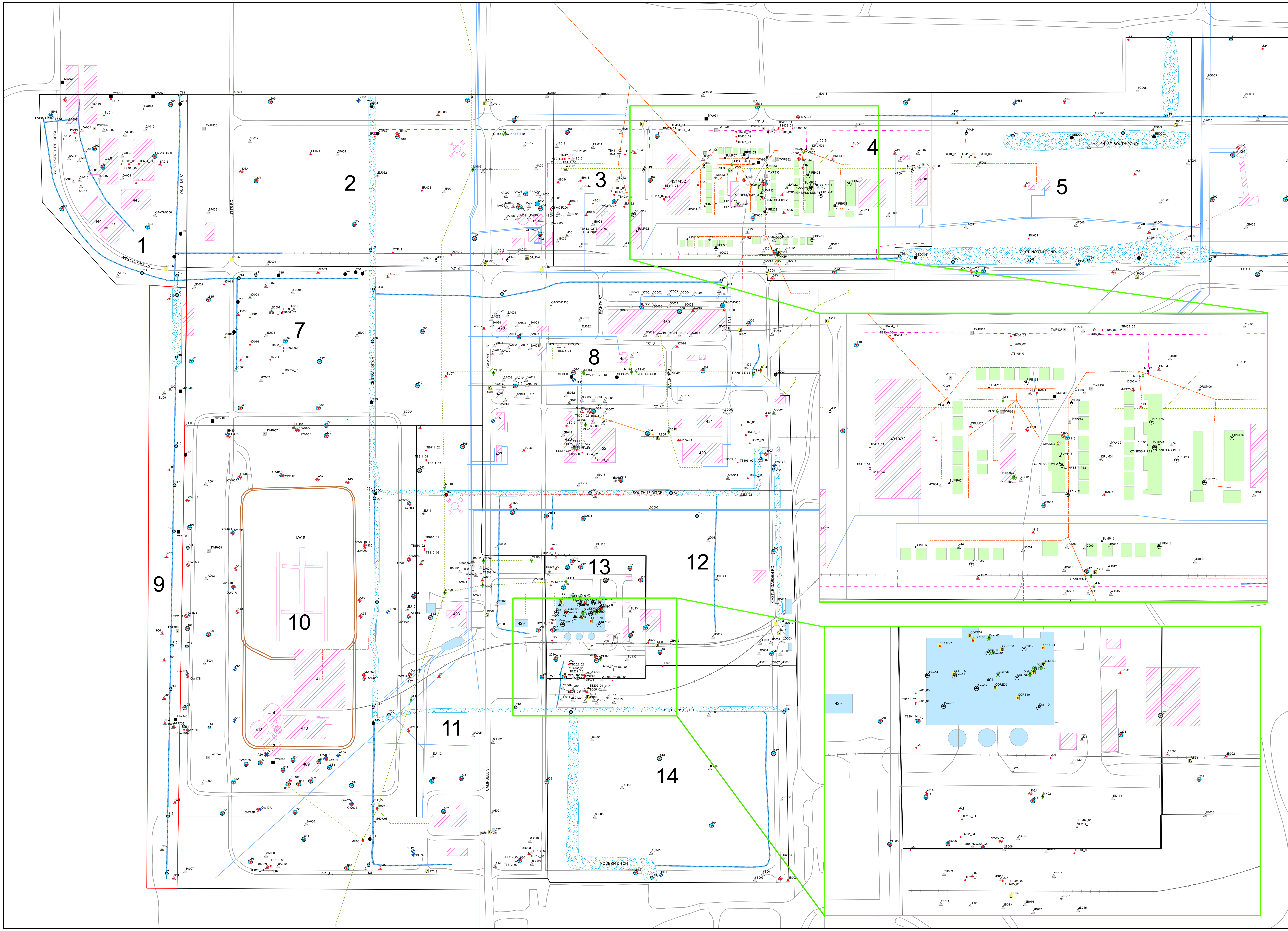
US Army Corps of Engineers
Buffalo District

Site Layout with EU Boundaries

Sitewide

Science Applications International Corporation

Figure 1-4



Legend

- Drum residue
- UWBZ TWP
- LWBZ well
- UWBZ well
- Manhole sediment
- Manhole water
- Pipe sediment
- Pipe water
- Railroad ballast
- Core
- Soil boring
- Sediment
- Surface soil
- Sump sediment
- Sump water
- Surface water

NFSS RIR Locations

- RIR Addendum Monitoring Wells
- RIR Addendum Temporary Well Points
- Structure abandoned above grade
- Existing structure
- Former structure
- Acid sewer
- Water lines
- Fuel line
- Sanitary sewer
- Storm sewer
- Former K-65 transfer pipeline
- Surface water (inundated 50% of year)
- Ephemeral ditches
- WCS cutoff wall
- Roads
- Former railroad
- National Grid Boundary
- EU boundary

N

0 150 300 450 600

Feet

US Army Corps of Engineers Buffalo District

Sitewide Remedial Investigation and Remedial Investigation Report Addendum Sample Locations

Sitewide

SAIC Science Applications International Corporation

Figure 1-5

2.0 SCOPE OF THE REMEDIAL INVESTIGATION REPORT ADDENDUM

This section further explains the purpose of the RIR Addendum and the basis for the formulation of the RIR Addendum scope of activities. Additionally, tasks completed for the RIR Addendum are listed and described in the subsections below.

2.1 PURPOSE OF THE RIR ADDENDUM AND FORMULATION OF SCOPE

This RIR Addendum addresses comments, concerns, and data gaps identified by federal, state and local regulatory agencies, and the public following release of the 2007 RIR (USACE 2007a). A wide range of topics were addressed in the comments; however, two main concerns of 2007 RIR reviewers formed the basis for additional field investigation activities needed to further evaluate site conditions. These concerns included:

- Potential off-site migration of groundwater and contaminants along the northern and western boundaries of the site, and groundwater and contaminant migration along the southern boundary of the IWCS; and

- The physical integrity of the IWCS, specifically the potential for a breach of the waste containment structure with significant leaching of wastes and residues.

RIR Addendum field activities focused on the collection of soil and groundwater data to refine the nature and extent of radiological and chemical groundwater plumes near the NFSS property boundary and in the vicinity of the IWCS. In addition to a description of field investigative activities and results, this RIR Addendum addresses the following general topics:

- Refinement of the nature and extent of select radiological and chemical groundwater plumes near the NFSS property boundary and in the vicinity of the IWCS;
- Evaluation of the integrity of the IWCS;
- Re-examination and justification of soil and groundwater background data sets;
- Screening of railroad ballast and building/road core samples;
- Evaluation and screening of 2008/2009 ESP radiological and chemical data;
- Screening of split sample results collected during the LOOW UURI;
- Re-evaluation of plutonium data;
- Presentation of supplemental documentation; and
- Corrections and revisions to the 2007 RIR and BRA.

In general, the scope identified for the RIR Addendum is intended to address public concerns, further define nature and extent of SRCs, COCs, and ROCs in areas of interest, and provide data to move forward into the FS process.

2.2 DESCRIPTION OF TASKS

Tasks to be completed for the RIR Addendum were defined based on review of written comments, as well as from discussions held between the Corps and the public during public information workshops. The lists in the following sections provide a comprehensive description of tasks completed for the RIR Addendum.

2.2.1 Site Characterization

A portion of the scope of the RIR Addendum was designed to support additional site characterization. Tasks completed for site characterization purposes included the installation of temporary well points and permanent monitoring wells; the collection of soil, groundwater and soil gas samples; the evaluation of sand lenses as preferential pathways for contaminant migration; the identification of SRCs, COCs, and ROCs for previously unevaluated data; additional groundwater and soil contamination delineation; the update of site sampling maps; review of historical photographs; and the development of a current site photo tour. Tasks completed in support of site characterization are listed below:

- Installed groundwater monitoring wells that will allow the Corps to monitor (via the ESP) the extent of off-site groundwater contamination and determine the potential for a breach of the IWCS.

- Installed temporary and permanent wells to identify potential preferential pathways from the IWCS to off-site areas and investigate sand lens occurrence near the IWCS. Investigation focused on areas of elevated uranium and increased sand lens occurrence as determined by an assessment conducted by HydroGeoLogic Inc. (HGL) that used the 2007 RIR Phase 1 through 3 borings, the cutoff wall construction profiles, and uranium occurrence in groundwater.

- Revised and updated the nature and extent maps presented in the 2007 RIR (Figures 5-1 through 5-4 and 5-8 through 5-12) using data obtained from additional RI sampling. Re-interpretation of the nature and extent of groundwater constituents excluded water in subsurface pipelines and included potential off-site extent. The evaluation included a discussion of the potential sources of contamination in the vicinity of Building 409.

- Delineated the extent of uranium contamination in groundwater to the north, west, and south sides of the IWCS and defined the off-site extent of the following groundwater plumes:

    - The total/dissolved uranium plume located west of the IWCS and east of the WDD;

    - The total/dissolved uranium plume in Exposure Unit (EU) 1;

    - The total/dissolved uranium/volatile organic compound (VOC) plume in EU 4; and

    - The total/dissolved boron plume in EU 4 (collocated with uranium/VOC plume listed above).

- Determined the potential for interaction from groundwater to surface water in the West and Central Drainage Ditches.

- Incorporated the spring and fall of 2008/2009 ESP sampling results from on-site ditches and the WDD to update SRCs, chemicals of potential concern (COPCs), and radionuclides of potential concern (ROPCs).

- Presented and discussed additional cesium, plutonium, strontium, tritium, and technetium groundwater data from the fall of 2008 ESP sampling. Added cesium, plutonium, and strontium results from the 2009 ESP sampling.

- Collected soil gas samples in EU 4 to determine if inhalation risk to a future construction worker exists.

- Presented radiological results from surface water and sediment collected as part of the LOOW UURI. Radiological results were screened with applicable background criteria to determine if they are considered to be SRCs.

- Chemical and radiological results for railroad ballast and core samples were screened with surface soil background criteria. An SRC screen was conducted using surface soil background values to determine if any chemical or radionuclide from these samples is considered to be an SRC. A risk evaluation using both chemical and radiological results for SRCs was conducted to determine if there are additional COPC/ROPCs to be considered in the FS. An evaluation of NORM versus MED material associated with these samples was conducted using the ratio of radiological constituents and scientific interpretation.

- Presented an aerial site map labeled with important features (roads, ditches, structures, etc.) to better identify the location and features of the site.

- Included a sample location map for the entire site to provide an overall perspective of the extent of site sampling that has occurred.

- Presented a photo site tour of the NFSS.

- Discussed major findings of the aerial historical photo review conducted by the U.S. Army Geospatial Center.

2.2.2 Evaluation of IWCS Integrity

An evaluation of the integrity of the IWCS used results of site characterization activities in addition to results of a topographic survey of the IWCS area, results of a pipeline survey, a comparison of historical aerial views and areas of groundwater contamination, and a review of information gathered as part of the ESP. Tasks to support an evaluation of the IWCS integrity included:

- Described overall conclusions from the ESP (i.e., years sampled, summary of sampling, trend analysis, photos, etc.), including operations and maintenance activities to demonstrate efforts taken to ensure IWCS integrity.

- Discussed pipelines that have been severed or filled in the IWCS vicinity. Compared the deepest line/under drain versus the depth of the clay dike, and included backup photos to show piping was severed and filled with concrete.

- Presented results of a comparison of aerial views and groundwater plumes in the IWCS vicinity.

- Assessed integrity of the IWCS cap using historic and recent topographic surveys. Described settling that may have occurred since construction of the IWCS.

2.2.3 Background Data Evaluation

Further evaluation of soil and groundwater background data was performed to confirm that the current understanding and application of these data are appropriate. Tasks completed to evaluate background data are listed below.

- Evaluated the impact of combining background data for the UWBZ and LWBZ, and using this data as a single background data set, rather than as two separate background data sets as originally presented in the 2007 RIR.

- Compared NFSS-specific background groundwater concentrations for radionuclides with the range of results from naturally occurring concentrations of radionuclides in groundwater, as indicated in surveys of drinking water sources cited by United States Environmental Protection Agency (EPA) in promulgating the uranium maximum contaminant level (MCL) for drinking water sources.

- Compared NFSS-specific background soil concentrations with ranges of concentrations identified by New York State Department of Environmental Conservation (NYSDEC) in their soil survey to support promulgation of 6 New York Codes, Rules and Regulations (NYCRR) 375.

2.2.4 Plutonium Evaluation

To address concerns about the possible presence of plutonium in site media and its potential health risk, plutonium analytical results obtained from investigation-derived waste (IDW) and ESP sampling were reviewed, as were several surface soil samples not previously reported in the 2007 RIR. Additionally, analytical results for cesium, plutonium, strontium, tritium, and technetium obtained from ESP sampling have also been presented in this RIR Addendum to evaluate the presence or absence of the fission products and transuranic listed above. Tasks completed to address these evaluations are listed below:

- Presented additional plutonium results from IDW sampling and discussed possible uncertainty associated with plutonium detections at the NFSS.

- Updated the RI database with 17 surface soil sample results reanalyzed at the laboratory for plutonium, and discuss these results.

- Discussed the total number of plutonium results and indicated whether the new results change conclusions about risk.

2.2.5 Supplemental Information and Corrections to the 2007 RIR and BRA

Several tasks for the RIR Addendum were intended to provide specific information requested by 2007 RIR reviewers, or to provide corrections and revisions to the 2007 RIR (USACE 2007a) and BRA (USACE 2007b). Supplemental information includes items such as historic documentation, research information pertaining to the NFSS, and corrections and revisions to the 2007 RIR and BRA. Revisions to the 2007 RIR and BRA include only items that affect conclusions to the RI and FS, and are deemed necessary to clarify pertinent information. Minor editorial revisions to the 2007 RIR and BRA are not addressed in this RIR Addendum. Tasks completed to provide supporting information and corrections to the 2007 RIR and BRA are listed below:

- Provided supplemental documentation pertinent to the NFSS RI.

- Provided corrections to the 2007 RIR and BRA as identified in written comments. (Note: Minor editorial corrections are not included in this RIR Addendum. Only revisions to 2007 RIR text, figures and tables that affect conclusions of the RI or that are pertinent to future evaluations are addressed by this RIR Addendum.)

- Revised the tables in Appendix K of the 2007 RIR showing downhole gamma logging results. The revision corrected a formula error for the X and Y axes used to display the data.

- Revised BRA Table 2.1 (Background List) and Table 2.2 (Toxicity Criteria) to include radiological parameters.

- Revised the discussion in Section 4 of the 2007 RIR, so that Steps 1 and 2 of the SRC determination process correspond to the process depicted in Figure 4-1 of the 2007 RIR.

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3.0 DATA COLLECTION AND SAMPLE ANALYSIS

This section was developed to present a detailed summary of the activities associated with the RIR Addendum fieldwork that occurred from November 16, 2009 through January 30, 2010 at the NFSS. Each activity performed during the fieldwork is described and field observations and results are presented. The information and results presented in this section will be used to support potential follow-up site characterization, as well as the design of remedial alternatives to be developed during the FS process.

3.1 RIR ADDENDUM FIELDWORK OVERVIEW AND SCOPE

A total of 23 temporary well points (TWPs) were installed and sampled for soil and groundwater to further delineate impacts to the soil and groundwater along the western and northern boundaries of the NFSS. Ten of the 23 TWPs were converted to permanent monitoring wells in the UWBZ in the Brown Clay Unit. The TWPs were installed in the Brown Clay Unit to screen encountered sand lenses above the confining Glacio-Lacustrine Clay (GLC) Unit at locations identified by Science Applications International Corporation (SAIC) with concurrence from the Corps.

3.1.1 RIR Addendum Fieldwork Goals and Objectives

The NFSS is divided into 14 physical EUs (Figure 1-4). The EUs were established based upon geographic location and environmental media, and provide common terminology for use in the planning and execution of RI activities. For the RIR Addendum fieldwork EUs 1, 4, 9 and 10 were the primary units for further investigation (Figure 1-4).

The overall goals and objectives for this NFSS RIR Addendum fieldwork effort were to obtain necessary data to address data gaps. The specific areas addressed in the field effort were to:

- Define potential off-site extent of the total/dissolved uranium groundwater plume west of the IWCS and east of the WDD (i.e., EU 9/10);
- Define potential off-site extent of the total/dissolved uranium groundwater plume in EU 1;
- Define potential off-site extent of the total/dissolved uranium/VOC groundwater plume in EU 4;
- Define potential off-site extent of the total/dissolved boron groundwater plume in EU 4;
- Investigate the presence of dense non-aqueous phase liquids (DNAPL) associated with well 415A in EU 4;
- Investigate sand lens occurrence near the IWCS to determine if there is a preferential pathway from the IWCS area to an off-site location and delineate the extent of uranium contamination in groundwater to the north, west, and south sides of the IWCS;
- Install groundwater monitoring wells that will allow the Corps to monitor the extent of potential off-site plumes and determine the potential for a cell breach; and
- Collect soil gas samples in the acidification area (EU 4) to evaluate the potential inhalation risk to a future construction worker in the VOC plumes.

These goals and objectives were used in the planning of the RIR Addendum Sampling and Analysis Plan (SAP) (USACE 2009a) to determine the locations of the TWPs as discussed in Section 3.1.1.2.

3.1.1.1 Data Quality Objectives

The following list restates the RI DQOs originally presented in the Phase I Field Sampling Plan (FSP) (USACE 1999). These are the fundamental objectives of the RI and will work in conjunction with the DQOs and goals developed for this RIR Addendum Investigation:

- Obtain information of sufficient quantity and quality to meet the requirement of a site inspection as described in *Guidance for Performing Site Inspections Under CERCLA: USEPA Directives 93.151-05* (EPA 1992b);

- Obtain information of sufficient quantity and quality to meet the requirement for use in a risk assessment as described in *Guidance for Data Usability in Risk Assessment* (EPA 1992a);

- Obtain information of sufficient quantity and quality to meet the requirements for development of a BRA based on *USEPA Risk Assessment Guidance for Superfund (RAGS)*, (EPA 1989) and subsequent guidance documents;

- Obtain information of sufficient quantity and quality to identify sources of contamination and migration pathways to adequately characterize potential contamination at areas included in this investigation; and

- Install TWPs and monitoring wells, and use the existing monitoring well network to collect groundwater samples and collect soil, sediment and surface water samples to obtain information of sufficient quantity and quality to determine if contaminants are migrating off-site or migrating on-site from off-site sources.

3.1.1.2 RIR Addendum DQOs

RIR Addendum activities were designed to address comments, concerns, and data gaps identified by federal, state, and local regulatory agencies and the public following release of the 2007 RIR (USACE 2007a). Tasks completed for the RIR Addendum were defined based on review of written comments from federal, state, and local oversight agencies and the public, as well as from discussions held between the Corps and the public during public information workshops.

The main focus of the RIR Addendum sampling effort was to define the extent of possible off-site migration of groundwater plumes in EUs 1, 4, and 10. To complete this objective, the RIR Addendum SAP (USACE 2009a) was developed to be consistent with DQOs used during the initial three phases of the NFSS RI. These DQOs are listed in Section 3.1.1.1. Also included in the SAP was a clear and definitive rationale for the proposed soil boring/TWP locations developed to meet the goals and objectives outlined in Sections 3.1.1 and 3.1.1.1. The preliminary boring/TWP locations, hereafter referred to as the TWP locations, are listed in Tables 3-1 through 3-3. The tables present a general description of each proposed sampling location and the justification for each TWP placement derived from the goals and objectives and developed during the SAP (USACE 2009a).

3.1.2 RIR Addendum Fieldwork Timeline

The RIR Addendum fieldwork was conducted from November 16, 2009 to January 30, 2010. Figure 3-1 presents the fieldwork schedule and summarizes the general activities performed in each cycle. The RIR Addendum fieldwork consisted of five cycles. All drilling activities (including surface completions and well abandonment) were completed by the end of the third cycle. Cycles 4 and 5 were necessary to complete the full suite sampling for the slow recharging wells.

3.2 FIELD METHODS AND PROCEDURES

This section describes the site characterization data collection program implemented in support of the NFSS RIR Addendum fieldwork. The general goal of the RIR Addendum fieldwork was to collect data of sufficient quantity and quality to provide data necessary to further delineate the extent of groundwater plumes in the UWBZ at different EUs at the NFSS. The following sections provide an overview of the data collection program, including the approach and techniques applied during sampling and data collection.

3.2.1 General Characterization

The following sections describe the general site characterization performed in the investigated EUs. Collected site characterization data includes field screening for chemical and radiological parameters, digital field photographs, well surveys, and waste sampling. The following sections detail the methods and procedures used to collect these various types of general site characterization data. Additionally, the sample identification (ID) nomenclature is presented.

3.2.1.1 Site Clearing Activities

Site clearing activities were performed to allow personnel and equipment to access the TWP locations.

Site clearing was performed by the on-site maintenance subcontractor Sudhakar, who was equipped with vehicle-mounted mowing equipment and hand tools as necessary to clear any undergrowth. The following activities were conducted:

- Mowing of undergrowth over entire area to allow ease of access;
- Removal of low lying branches of mature trees that would impede equipment and personnel access; and
- Shredding of small diameter shrubs and branches.

No data were generated by field clearing activities; therefore, they are not discussed further in the results section.

3.2.1.2 Field Photographs

Digital field photographs were taken to document field activities and notable site conditions. Field photographs were collected in accordance with methods and procedures outlined in the RIR Addendum SAP (USACE 2009a).

Field photographs documented general field operations and were representative of general tasks. Photographs were not meant to be used as a daily log of activities. Field photographs were taken using a digital camera and are presented in Appendix 3-A.

3.2.1.3 Field Screening

The following sections describe the field screening methods used during the RIR Addendum fieldwork activities. Field screening activities generally provided qualitative data associated with site radiological/chemical conditions and worker safety monitoring during field activities. All worker safety monitoring activities were conducted according to the requirements of the RIR Addendum Site Safety and Health Plan (SSHP) and Radiation Protection Plan (RPP) (USACE 2009b and USACE 2009c).

3.2.1.3.1 Ambient Air Sampling

Worker safety was monitored using personal lapel air samplers worn during intrusive sampling activities, per the requirements of the SSHP and RPP (USACE 2009b and USACE 2009c).

3.2.1.3.2 Chemical Parameters

Field screening for chemical parameters was conducted during soil and groundwater sampling to monitor worker safety, identify unanticipated site conditions, and determine subsurface sample locations.

Organic vapor monitoring was conducted during intrusive activities using a Multi-Rae Plus. The Multi-Rae Plus is a combination of a portable photo ionization detector (PID) and a multi-gas combustible gas indicator (CGI) unit. In addition to required breathing zone monitoring, all soil cores were surveyed immediately after the soil sample collection split spoon was opened. The tip of the Multi-Rae was moved slowly along the length of the soil core to detect the presence of organic vapors in the soil. Additionally, the soil core was segmented (at any layer contacts and/or evenly across the core) and the tip of the Multi-Rae Plus was placed in the gap between the segments. The maximum soil core screening measurements for each interval were recorded on field soil boring logs (Appendix 3-B). This field screening was also used in determining subsurface sample location as discussed further in Section 3.2.2.1.

Field screening for organic vapors, combustible gases, and oxygen was conducted during all groundwater sampling activities. The breathing zone was monitored directly over the open well. Any CGI readings above/below the action limits (ALs) identified in the SSHP (USACE 2009b) were recorded in field logbooks and additional safety precautions were taken (if needed). In the case of TWP933, the Multi-Rae detected VOCs at 1,248 parts per million (ppm) while collecting the groundwater screening samples. The work crew donned respirators for the remainder of the sampling at TWP933.

3.2.1.3.3 Radiological Parameters

Field screening for radiological parameters was conducted during the RIR Addendum fieldwork to identify and evaluate potential areas of elevated radiological contamination and to ensure worker safety. Breathing zone monitoring was conducted during intrusive activities which included TWP/monitoring well drilling and installation. During these activities, no levels reached the action level (i.e., measured background) within the breathing zone. In addition, all soil core samples were scanned to detect radiological activity. There were no detections of elevated activity for any core sample collected.

Soil core screening was conducted at each TWP location to detect areas/intervals of elevated radiological activity and to focus sample collection on potentially-impacted intervals. Field screening was performed using a portable Ludlum Model 2360 ratemeter with the Ludlum 43-93 detector (USACE 2009c). Upon removing the surface soil or soil core, the sample was initially scanned with the Ludlum 43-10 NaI 2x2 for gamma readings at a rate of approximately 1.5 inches/second to identify elevated readings. In addition to gamma readings a Ludlum Model 2221 radiation meter was used to perform a fixed 1-minute

count on the surface soil and each 2' soil core removed at a TWP. The alpha and beta results were recorded on field soil boring logs in counts per minute (Appendix 3-B).

For each soil boring location, the entire length of each soil core was scanned prior to soil homogenization. The screening was performed on each 2-ft interval to determine which 2-ft interval to select for analytical sampling. The soil for a single 2-ft interval was then homogenized to create one representative sample. For surface soil collections, the scan was performed immediately upon transfer of soil from the auger into a stainless steel bowl. No quantitative data were generated from the radiological soil core field screening activities; therefore, they are not discussed further in the results section.

The RIR Addendum SAP (USACE 2009a) required soil intervals with above-background radiological screening results be preferentially collected for soil characterization. All radiological field screening of TWP soils were within background levels.

3.2.1.4 Well Surveys

All abandoned TWP and permanent monitoring locations were surveyed in accordance with Engineering Manual (EM) 1110-1-4000 (USACE 1998). All locations were surveyed with reference to the previously established site benchmark.

The TWPs were surveyed at the ground surface immediately adjacent to the location. Monitoring well locations were surveyed at the core immediately adjacent to the well and elevations were provided for the top of the inner well casing, the top of the outer protective casing, and at the ground surface.

Horizontal coordinates were referenced to New York State Plane North American Datum of 1983 (NAD83) West Zone 3103 with a reported accuracy of 0.1 ft. Elevations are based on National Geodetic Vertical Datum of 1929 (NGVD29) datum with a reported accuracy of 0.01 ft. The survey data were used to spatially reference all of the locations and are presented in Figure 3-2. This figure presents the locations with their final nomenclature (i.e., either as TWP or MW).

3.2.1.5 Investigation Derived Waste

IDW samples were collected to characterize waste materials generated during the RIR Addendum for waste disposal. All IDW was labeled and containerized as it was generated and is stored on-site until it is safely removed from the site for disposal as per the *Waste Characterization Plan* (USACE 2009d).

The waste was categorized as solid or liquid IDW. Solid IDW encompasses all non-liquid wastes generated during intrusive activities and includes excess soil cuttings and spent personal protective equipment (PPE). Liquid IDW includes water from well development/sampling activities, as well as drilling/sampling equipment decontamination waste water.

The RI Addendum fieldwork IDW will be handled in the same manner as the RI and legacy wastes. Detailed results of the RIR Addendum waste will be presented in the Waste Characterization Report. The Waste Characterization Report will include waste sample characterization results and recommendations for disposal options.

3.2.1.6 Sample ID Structure

Samples collected were identified sequentially by following the numbering system identified in this section. During the NFSS RIR Addendum fieldwork, a specific sample ID structure was utilized to provide specific information about each sample collected. The sample ID system is presented in Figure 3-3 and shows examples of sample ID structure.

3.2.2 Soil Characterization

Surface and subsurface soil samples were collected for chemical and radiological analysis. Additionally, geotechnical samples were collected in the EU 4.

3.2.2.1 Soil Sampling for Chemical and Radiological Analysis

Surface and subsurface soil samples were collected and submitted for laboratory analyses from 23 TWP locations. Completion depths of the wells vary based on the depth of encountered sand lenses and confining GLC; the TWPs do not extend through the confining GLC. The soil cores were continuously logged by the field geologist and screened for VOCs using a Multi-Rae Plus and for radionuclides using a gamma scan. One surface and one subsurface soil sample was collected from each TWP boring. Boring logs are presented in Appendix 3-B.

Surface soil samples were collected using a stainless steel hand auger and placed in a stainless steel bowl. Radiological and chemical field screening was performed. The VOC soil sample for laboratory analysis was collected and placed in a 4 oz glass jar. The remaining soil material was combined in a stainless steel bowl and homogenized prior to transfer to the appropriate sample containers. Excess sample material was retained and managed as IDW. Hand auger sampling was used at each TWP location to gather the upper 6 inches of soil.

An all-terrain hollow-stem auger rig was used to complete subsurface soil sampling at TWP locations. Subsurface soil samples were collected using a 3-inch diameter stainless steel split-spoon sampler driven in advance of the augers using a hydraulic hammer in 2 ft intervals. After the soil samples were retrieved and the chemical/radiological field screening measurements were recorded, soil was collected for the VOC sample and placed in a glass 4 ounce jar and labeled with the time, VOC designation, and depth interval. The remaining soil in the spoon was put in a plastic bag and labeled with the time and depth interval and placed in a cooler with ice. Upon borehole termination, a review of the radiological and chemical field screening was performed of each 2 ft interval. The highest above-background screening results determined the interval to be collected. If no above-background readings were detected, the interval just above the saturated zone was collected. If screening results from the borehole intervals were within background levels and the borehole intervals were dry, soil from the interval just above the GLC was collected. The RIR Addendum SAP identified which above-background screening result should be prioritized for each EU; however, no above-background radiological readings were detected and therefore is not repeated here. The soil from each targeted sample interval was combined in a stainless steel bowl for homogenization prior to transfer to the appropriate laboratory sample containers. If an interval was not selected as the sample interval it was treated like the other soil boring cuttings as IDW.

Drilling and soil sample equipment decontamination was conducted by one of three methods during the RIR Addendum:

- Bucket wash/rinse at the soil boring location (soil sample split spoons);
- Steam cleaning in a temporary decontamination pad (down-hole drilling tools, augers, etc.); or
- Chemical decontamination (stainless steel sample bowls/spoons).

All decontamination waste, regardless of the decontamination method used, was retained and managed as project IDW. Details regarding decontamination procedures and IDW management are provided in the NFSS RIR Addendum SAP (USACE 2009a) and RI Waste Characterization Plan (USACE 2009d).

3.2.2.2 Geotechnical Sampling

Two geotechnical samples were collected at three TWP locations to characterize the geotechnical properties in the acidification area (EU 4). A total of six soil samples were collected for geotechnical analysis from the soil borings completed for the following TWPs shown on Figure 3-2:

- TWP932;
- TWP933; and
- TWP934.

The geotechnical samples were submitted for laboratory analysis of the following parameters:

- Soil Moisture by American Society for Testing and Materials (ASTM) D-2216;
- Bulk Density by ASTM D-5057; and
- Porosity by USACE EM 1110-2-1906 App II.

These analyses were performed on undisturbed soil from Shelby tubes. The Shelby tubes were slowly pushed with the hollow-stem auger rig and the hydraulic pressure was recorded on the soil boring logs. Upon removal, the ends of the Shelby tubes were sealed with wax and a plastic cap was placed on each end. During handling and storage, the Shelby tubes were kept upright to minimize disturbance of the soil samples.

3.2.3 Groundwater Characterization

The following sections describe the groundwater characterization performed for the NFSS RIR Addendum. Groundwater samples for initial screening were collected at each of the TWPs for specific analytes based on individual EUs. After the groundwater screening samples were analyzed, the results were examined to determine the best locations to complete as permanent monitoring wells. The permanent monitoring wells were then sampled for the full suite of analytes.

3.2.3.1 Temporary Well Points

The following sections describe the methods used to install the TWPs and complete the subsequent groundwater screening sample collection.

3.2.3.1.1 Installation

Installation of the TWP immediately followed the advance of the hollow-stem augers to borehole termination, as described in Section 3.2.2.1. The borehole diameter was approximately 8 inches. The

wells were installed using a hollow-stem auger rig, and were constructed using 2-inch ID polyvinyl chloride (PVC) schedule 40 casing and screen. The standard length of screen was 10 ft (variations from this are noted for each TWP in the following sections). Screened sections were slotted with openings equal to 0.010 inches (#10 slot). Coarse grade bentonite chips were used for the creation of an annular seal during well construction above the granular filter pack. The granular filter pack consisted of 0.4 mm silica quartz sand. The top of all wells were equipped with a securely-fitting well cap to prevent debris from entering the well. The TWPs were not completed with a protective casing or well pad unless they were selected to remain and become a permanent monitoring well (Section 3.2.3.2).

3.2.3.1.2 Groundwater Screening Sample Collection

Upon completion of all TWPs, groundwater screening samples were collected for filtered and unfiltered analytes. Development was not required prior to screening sample collection from TWPs. Static water level measurements were collected using an electronic water level meter prior to sample collection and recorded on the screening sample log form.

A modified low-flow sampling technique using a peristaltic pump was used to collect samples from the TWPs. Tubing was placed above any potential accumulated sediment at the bottom of the TWP to avoid drawing it into the sample tubing. Initial water quality parameters (e.g., pH, temperature, specific conductance, and dissolved oxygen) were collected using a Horiba® U-22 prior to sample collection with the first water removed from the TWP. The initial reading was recorded on the screening sample log form and sampling was conducted immediately thereafter.

Due to very slow groundwater recharge in some areas of the site, some TWPs would become dry before completing the required sample volume. In these instances, the work crew returned the following day to finish collecting the screening samples. After sampling was completed, water quality parameters were recorded if the TWP was not dry.

Groundwater screening samples were collected for TWPs and submitted for expedited 7-day turn-around-time for the laboratory analyses except for three TWPs installed in EU 4, which is described in greater detail in Section 3.3.2.1.3.

3.2.3.1.3 TWP Abandonment

If a TWP was not selected to be completed as a permanent monitoring well (Section 3.2.3.2), it was abandoned.

To abandon a TWP, the well casing was removed from each borehole. In all abandonments, the casing was removed in one piece. Grout was placed within the entire length of the borehole. The grout mixture consisted of approximately 6 pounds dry weight bentonite chips per 94-pound sack of dry Type I Portland cement, and a maximum of 6 to 7 gallons of water. Grout was placed from the bottom of the borehole to within 0.3 m (1 ft) of the ground surface, and the surface was graded using adjacent soil and leveled to match the site conditions.

3.2.3.2 Permanent Monitoring Wells

Section 3.2.3.1.1 described the methods used to install the TWPs and complete the subsequent groundwater screening sample collection. Ten of the TWPs were converted to permanent monitoring wells to be considered for incorporation into the ongoing on-site environmental surveillance program. The ten wells were selected by the Corps based on lithologic information, groundwater screening sample results, and the ability of the well location to provide data necessary to adequately monitor groundwater

contamination. The ten permanent wells were determined as the best wells to meet a key objective of this RIR Addendum as stated in Section 2.1; specifically to monitor the potential off-site migration of NFSS contaminants in groundwater. The general criteria for selecting the permanent well locations are listed in the following table.

Criteria	Reason to Abandon TWP or Convert TWP to Monitoring Well
Field screening results	Were the rapid-turn-around time total uranium results elevated or did the results only confirm existing data?
Future use of monitoring well	Would a monitoring well at this location be useful for future environmental sampling events?
Groundwater flow direction	Would a monitoring well in this location be useful in defining the furthest extent of its associated contaminant plume?
Monitoring well recovery rates	Would a monitoring well in this location be able to produce enough groundwater samples for future sampling events?
NFSS site boundary conditions	Would a monitoring well in this location help determine whether and associated contaminant plume was exiting the NFSS site boundary?

3.2.3.2.1 Surface Completions

All permanent wells were completed as above-grade installations. The well protection assembly used for construction of monitoring wells was composed of new 6-inch diameter steel protective casing. Protective casings were equipped with locking steel covers. The length of protective casing used for above-grade well installations was approximately 6 ft, approximately 3 ft of which was extended below the ground surface and concreted into place. Locks were installed to secure the protective casings. If the wells were located within 5 ft of an on-site road, guard posts were installed around the above-grade protective casings. The guard post length was approximately 6 ft, with approximately 2 ft extending below the ground surface and concreted into place. The top of each post was modified to preclude the entry of water by adding concrete.

A circular, sloping concrete pad was installed around the exterior of the protective casing at the ground surface. The thickness of each pad was at least 4 inches. Brass survey markers were mounted in each of the concrete pads for future labeling if desired.

3.2.3.2.2 Well Development

Due to the slow recharge of the wells, the well development procedure described in the RI Addendum SAP was modified with the Corps approval to complete well development with a disposable bailer. The objective of the bailer method was to remove three well volumes prior to groundwater sampling. If the volume could not be removed due to slow recharge, the wells were bailed dry on three consecutive days. An initial reading of water quality parameters (e.g., pH, temperature, specific conductance, dissolved oxygen) was collected using a Horiba® U-22 prior from the first bailer removed. Additional water quality parameter readings were collected when a well volume was removed and/or on each day the well was bailed.

3.2.3.2.3 Groundwater Sampling

Two sampling methods were employed to sample the permanent monitoring wells. If the recharge from the well was sufficient then the well was sampled with a peristaltic pump. If recharge was slow, the wells were sampled with a bailer.

The following method was used to sample with a peristaltic pump:

- Tubing was slowly lowered into the well to minimize turbidity.
- Once the tubing was in place and connected to the peristaltic pump, purging was begun at a maximum flow rate of 100 mL/min.
- The volume purged was based on stabilization of water quality parameters pH, temperature and specific conductance. Water quality parameters of pH, temperature, and specific conductance were recorded every 5 minutes during purging using a Horiba® U-22. Stabilization was complete when two successive readings stabilized to ±0.2 pH units, ±0.5 °C, and less than 10% variation in the specific conductivity.
- Sample collection occurs immediately after purging.

The following method was used to sample with a bailer:

- The well was bailed dry one day prior to sampling;
- Initial water quality parameters were collected from the first bailer removed;
- Sample collection occurred immediately after the water quality parameters were collected; and
- If insufficient recharge occurred and the sample volume could not be collected, the work crew returned to the well multiple times until the sample volume was complete.

In general, sample parameters were collected in the following order: VOCs, Semi-Volatile Organic Compounds (SVOCs), metals, and radionuclides. If a sample had to be collected over multiple days due to slow recharge, the order was adjusted as to not exceed the short holding time for the organic compounds.

3.3 FIELD OBSERVATIONS AND RESULTS

The following sections present the field observations and results by EU. For each RIR Addendum EU, the results are presented for soil, TWP groundwater screening, and permanent monitoring well groundwater activities.

3.3.1 EU 1

EU 1 (Baker-Smith Area and Vicinity) is located in the northwest corner of the NFSS. The WDD flows to the north through EU 1. During the operation of the LOOW, a pipe shop, machine shop, welding shop, and a store house were located in EU 1 near a rail line that ran roughly parallel to the West Patrol Road. Currently, EU 1 is bordered by the NFSS perimeter fence to the north and west. The ditches in EU 1, except for the WDD, are typically dry and carry water only after storm events. During the RI, a total uranium groundwater plume was found to extend from the west-central portion of EU 2 through the northwest portion of EU 1, trending from northwest to southeast and projected to extend off-site.

Activities for EU 1 included soil sampling, TWP installation/screening groundwater sampling, and permanent monitoring well installation/groundwater sampling.

3.3.1.1 TWPs

Due to the terrain, the actual locations of the TWPs were modified from the approved RIR Addendum SAP in the field with approval from the Corps (Figure 3-2). Only TWP921 remained outside of the NFSS boundary. TWP922 and TWP923 were moved south of the fence line to locations inside the NFSS boundary. TWP924, TWP925, and TWP926 locations remained approximately the same as presented in the RIR Addendum SAP (USACE 2009a). The justifications for the TWP locations remained consistent with those developed in the RIR Addendum SAP and presented in Table 3-1. TWP926 is located in EU 2 just east of the EU 1 boundary.

3.3.1.1.1 Soil Sampling

Two soil samples were collected during each of the TWP installations to obtain information of sufficient quantity and quality to determine if contaminants are migrating off-site or migrating on-site from an off-site source and to determine the impact of contamination to off-site soils due to groundwater flow. The borehole termination depth was determined by the presence of the GLC layer. No boring was advanced through the GLC layer.

One surface sample and one subsurface sample were collected for each of the borings. The subsurface interval collected for each TWP boring was as follows:

TWP	Subsurface Interval (ft bgs)	Borehole Depth (ft bgs)	Justification/Sample Material
TWP921	14-16	18	No field screening results above background; sample collected above the GLC layer; clay.
TWP922	12-14	18	Sample collected at greatest headspace reading (1.5 ppm); sand and clay.
TWP923	16-18	20	No field screening results above background; sample collected above the GLC layer; clay.
TWP924	12-14	16	No field screening results above background; sample collected above the GLC layer; clay.
TWP925	10-12	14	No field screening results above background; sample collected above the GLC layer; clay.
TWP926	8-10	14	No field screening results above background; sand.

Only one TWP borehole in EU 1 contained VOC screening results above the background reading of 0.0 ppm. This VOC reading was logged 12 to14 ft below ground surface (bgs) in an interval that contained coarse sand.

Three of the six EU 1 TWP borings contained a sand layer. Sand was logged in TWP921 from 0.6 to 2.3 ft bgs, TWP922 from 12.0 to 12.2 ft bgs, and TWP926 from 8.4 to 9.6 ft bgs.

3.3.1.1.2 Well Installation

Five TWPs were installed in EU 1 and one TWP was installed just east of the EU 1 boundary in EU 2. The final depths of the wells and their screened intervals are presented in the table below. All of the wells produced groundwater for sampling.

TWP	Screen length (ft)	Well Depth (ft bgs)
TWP921	9.46	16
TWP922	9.41	17
TWP923	9.41	20
TWP924	9.42	14.5
TWP925	9.42	13
TWP926	9.43	14

The well logs in Appendix 3-B provide detailed descriptions of each TWP installation.

3.3.1.1.3 Groundwater Screening Samples

Groundwater samples were collected from each of the six TWPs for groundwater screening parameters. All TWPs in EU 1 and EU 2 were sampled for filtered and unfiltered isotopic uranium analyses.

During sampling the purge rates in EU 1 ranged from less than 40 ml/min (with a steady drop in the water level) to 100 ml/min. The flow rate for the northern-most location (TWP921) was the slowest; the western-most location (TWP924) had the fastest flow rate.

The groundwater screening results from the TWPs were reviewed by the Corps to aid in the determination of the location of the permanent monitoring wells. A summary of the screening results are presented in Section 3.4.3.2.

3.3.1.2 Permanent Monitoring Wells

Three of the TWPs installed in the EU 1 area were converted to permanent monitoring wells by performing the surface completions described in Section 3.2.3.2.1. TWP924 through TWP926 were properly abandoned as described in Section 3.2.3.1.3. The three permanent wells selected by the Corps are the three northern-most locations (TWP921, TWP922, and TWP923) which are located at or north of the EU 1 boundary and the NFSS property. These three TWPs were converted to permanent wells to investigate the potential off-site extent of uranium contamination in groundwater to the northwest (downgradient).

All three permanent monitoring wells were sampled for the parameters presented in Table 3-4 with the methods presented in Table 3-5. The results for the monitoring well sampling are presented in Section 3.4.3.3.

3.3.2 EU 4

EU 4 (Acidification Area and Vicinity) is located along the northern boundary of the NFSS property. During the LOOW operation, materials related to the manufacture of TNT were stored in EU 4. In the 1950s, uranium rods were stored in buildings formerly located near the boundary between EU 3 and EU 4. Several subsurface pipelines used to transfer acids north to the former TNT production facilities remain in the EU.

Three groundwater contamination plumes identified in EU 4 during the RI were further investigated during the RIR Addendum fieldwork and include:

- Total uranium groundwater plume identified in the north-central portion of EU 4 near the former nitric acid concentrator;
- Dissolved boron plume in the central portion of EU 4; and
- A VOC groundwater plume in EU 4 that contains tetrachloroethylene (PCE) and trichloroethylene (TCE) and their degradation products (cis-1,2-dichloroethylene (DCE), trans-1,2-DCE, and vinyl chloride).

Activities for EU 4 included soil sampling, TWP installation/screening groundwater sample collection, and permanent monitoring well installation/groundwater sampling. Additionally, geotechnical and soil gas samples were collected at three TWPs.

3.3.2.1 TWPs

A total of eight TWPs were installed in EU 4 to define the extent and confirm the current configuration of VOC, metal, and uranium groundwater plumes. The location of the final TWPs was modified in the field from the RIR Addendum SAP with approval from the Corps (Figure 3-2). The eight wells installed included five TWPs and three soil gas wells. The locations of the soil gas wells were modified from the proposed locations in the SAP due to the field observations and groundwater screening results by the Corps.

3.3.2.1.1 Soil Sampling

Two soil samples were collected during each of the TWP installations to aid in plume configuration and to obtain information of sufficient quantity and quality for determining if contaminants are migrating off-site or migrating on-site from an off-site source. The borehole termination depth was determined by the presence of the GLC layer. No boring was advanced through the GLC layer.

One surface and one subsurface sample were collected for each of the borings. Additionally, two geotechnical samples were collected at TWP932, TWP933, and TWP934 at intervals noted below. The subsurface soil interval collected for each EU 4 TWP borings was as follows:

TWP	Subsurface Interval (ft bgs)	Borehole Depth (ft bgs)	Justification/Sample Material
TWP927	10-12	18	No field screening results above background; sample collected above saturated fine sand layer; clay.
TWP928	12-14	18	Sample collected at greatest headspace reading (16.5 ppm); clay.
TWP929	8-10	14	Sample collected at greatest headspace reading (0.8 ppm); sand and clay.
TWP930	15-17	17	Sample collected at greatest headspace reading (334 ppm); clay and sand.
TWP931	12-14	18	Sample collected at greatest headspace reading (1.1 ppm); clay and sand.
TWP932	14-16	18	Sample collected to incorporate clay above damp medium sand as well as sand; Shelby tubes collected at 4-6 ft and 10-12 ft bgs; all PID readings at 0 ppm.
TWP933	10-12	14	Sample collected at greatest headspace reading (35.2 ppm) not contained in Shelby tube, clay; Shelby tube collected at 4-6 ft and 12-14 ft bgs.
TWP934	16-18	18	Sample collected at greatest headspace reading (4.6 ppm) not contained in Shelby tube, sand and clay; Shelby tube collected at 4-6 ft and 14-16 ft bgs.

TWP927 and TWP932 contained VOC screening results at site background (0.0 ppm); TWP927 is north and east of the 2007 RIR projected plume and TWP932 is east of the plume.

Six of the eight EU 4 TWP borings contained a sand layer. Sand was logged in the following TWP borings:

TWP	Depth of Sand Interval (ft bgs)
TWP927	11.9-12.9
TWP929	8.0-9.0
TWP930	12.8-14-8 15.0-15.5
TWP931	13.7-14.0
TWP932	7.0-7.1 15.0-15.2
TWP934	15.5-16.5

For the soil gas wells (TWP932, TWP933, and TWP934), additional small sand intervals may be present but could not be identified due to geotechnical samples collected in the Shelby tubes.

3.3.2.1.2 Well Installation

Eight TWPs were installed in EU 4. The final depths of the wells and their screened intervals are presented in the table below.

TWP	Screen length (ft)	Well Depth (ft bgs)
TWP927	9.45	18
TWP928	9.42	16
TWP929	9.43	14
TWP930	9.41	17
TWP931	9.41	15
TWP932	9.41	18
TWP933	6.73	14
TWP934	9.42	18

For a more detailed description of each TWP installation see the well logs in Appendix 3-B.

3.3.2.1.3 Groundwater Screening Samples

Groundwater samples were collected from seven of the eight wells for groundwater screening parameters. TWP929 remained dry and never produced water for sampling. TWP927, TWP928, TWP930, and TWP931 were sampled for VOCs, and filtered and unfiltered metals and isotopic uranium analyses. The soil gas locations (TWP932-934) groundwater was sampled for VOCs and filtered and unfiltered isotopic uranium analyses as well as VOC vapor analysis by method TO-15. The soil gas TWP groundwater screening samples were analyzed at normal 30-day turn-around time (TAT). The results are presented in Section 3.4.3.2.

During sampling, the groundwater purge rates in EU 4 ranged from 28 ml/min to 55 ml/min. The groundwater screening results and field observation from TWP927, TWP928, TWP930, and TWP931 were reviewed prior to the installation of the soil gas TWPs (TWP932-934). These locations were modified by the Corp due to DNAPL observed in TWP930 during groundwater screening sample collection, as well as groundwater screening sample results and field observations from the other EU 4 TWPs.

3.3.2.1.4 Soil Gas Samples

One soil gas sample was collected from TWP932, TWP933, and TWP934 after the expedited groundwater sampling was completed. The following sampling procedure was followed:

- An air-tight PVC cap with a sample port and valve was placed over the top of the well casing and remained in place for a minimum of 24 hours to equalize the pressure in the well casing.

- Flexible PVC tubing was attached to the sample port. The port was opened and a reading was collected with a PID and recorded in the log book.

- The port was closed and a pump was attached to the tubing. The air above the water was purged from the well. Multiple attempts were made to remove the desired air volume; however, two well volumes were not removed per the RIR Addendum SAP due to groundwater drawing into the tubing. After purging was complete, a PID reading was recorded.

- The tubing from the sample port then was attached to a 6-liter summa canister with a dedicated regulator.

- The valve was opened and the summa canister collected the sample for 8 hours.

- At the conclusion of 8 hours, all valves were closed and the tubing was removed from the summa canister.

- A final PID reading was collected at the time the summa canister was disconnected from the tubing.

New flexible PVC tubing was used for each sample collected. Each summa canister was labeled with the start and end date, time of the sampling event, and the sampling location. The sample was packaged for shipment to the analytical laboratory for normal TAT and shipped to the contracted analytical laboratory.

3.3.2.2 Permanent Monitoring Wells

Two of the TWPs installed in the EU 4 area were converted to permanent monitoring wells by performing the surface completions described in Section 3.2.3.2.1. The remainder of the TWPs were properly abandoned as described in Section 3.2.3.1.3. TWP934, the northern-most TWP in EU 4, was converted to a permanent well to define the potential off-site extent of the VOC plume in groundwater to the northwest in a downgradient direction. TWP930 was converted to a permanent monitoring well to further define the VOC plume configuration in the acidification area.

The permanent monitoring wells were sampled for the parameters presented in Table 3-4 with the methods presented in Table 3-5. The results for the permanent monitoring well sampling are presented in Section 3.4.4.4.

3.3.3 IWCS Area

EU 9 (National Grid Property) is adjacent to the western boundary of the NFSS. The WDD is the principal site feature of the National Grid property. EU 10 (IWCS and Vicinity) is located along the western border of the NFSS property boundary. The predominant feature in EU 10 is the IWCS. EU 9 runs along the entire length of EU 10.

The 2007 RIR (USACE 2007a) identified dissolved total uranium plumes on the west and north sides of the IWCS, the southern portion of EU 10 extending along the water line that cuts diagonally across the southeastern corner of EU 10, and in EU 10 in the vicinity of former dewatering ponds (Figure 3-2).

Activities for EUs 9 and 10 included soil sampling, TWP installation/screening groundwater sample collection, and permanent monitoring well installation/groundwater sampling.

3.3.3.1 TWPs

The final TWP locations were modified from the RIR Addendum SAP in the field with approval from the Corps. Figure 3-2 presents the final TWP locations. TWP935, TWP938, TWP940, and TWP941 were installed outside the NFSS fence in EU 9. TWP937 and TWP943 were installed inside the IWCS fence to the north and south of the landfill, respectively. TWP939 and TWP942 were installed outside the IWCS fence and inside the NFSS boundary fence. TWP936 was installed 15 ft north of the EU 10 boundary in EU 7. The justifications for the TWP locations remained consistent with those developed in the SAP (USACE 2009a) and are presented in Table 3-3.

3.3.3.1.1 Soil Sampling

Two soil samples were collected during each of the TWP installations to obtain information of sufficient quantity and quality for determining if contaminants are migrating off-site. The borehole termination depth was determined by the presence of the GLC layer. No boring was advanced through the GLC layer.

One surface and one subsurface sample were collected for each of the borings. The subsurface soil interval collected for each TWP boring was as follows:

TWP	Subsurface Interval (ft bgs)	Borehole Depth (ft bgs)	Justification/Sample Material
TWP935	10-12	12	Sample collected at greatest headspace reading (0.6 ppm); 2 ft interval above the GLC; clay
TWP936	12-14	16	Sample collected to include material directly above the water level (5.3 ppm); clay.
TWP937	12-14	22	Sample collected at greatest headspace reading (3.3 ppm); sand.
TWP938	14-16	20	Sample collected at greatest headspace reading (3.3 ppm); sandy silt.
TWP939	2-4	12	Sample collected at greatest headspace reading (0.4 ppm); sand.
TWP940	8-10	12	No field screening results above background; sample collected above the GLC layer; sand and clay.
TWP941	10-12	14	No field screening results above background; sample collected above the GLC layer; clay.
TWP942	4-6	12	Sample collected to include material directly above the water level; clay and sand.
TWP943	8-10	12	No field screening results above background; sample collected to include material in contact with water; sand and clay.

Five TWPs had VOC screening results were above background (0.0 ppm). All five of the TWPs are on the northern portion of the IWCS Area.

Sand was logged in the following TWPs in the IWCS area:

TWP	Depth Interval for Sand (ft bgs)
TWP937	8.9-14.0
TWP940	5.5-8.5
TWP942	3.5-5.3
TWP943	8.0-8.5

Both of the TWPs in the inner IWCS fence area contained sand, as did TWP940 and TWP942 on the southern portion of EU 9 and 10, respectively.

3.3.3.1.2 Well Installation

A total of nine TWPs were installed in the IWCS area. The final depths of the wells and their screened intervals are presented in the table below.

TWP	Screen Length (ft)	Well Depth (ft bgs)
TWP935	7.59	12
TWP936	9.42	14
TWP937	9.42	20
TWP938	9.41	18
TWP939	6.56	11
TWP940	7.79	12
TWP941	7.85	12
TWP942	8.82	12
TWP943	5.80	12

For a more detailed description of each TWP installation, see the well logs in Appendix 3-B.

3.3.3.1.3 Groundwater Screening Samples

Groundwater samples were collected from each of the nine TWPs for groundwater screening parameters. All TWPs in the IWCS area were sampled for filtered and unfiltered isotopic uranium analyses.

During sampling, the purge rates in EU 9 ranged from 28 ml/min to 74 ml/min. The highest rate was observed at TWP940. At the other three TWPs in EU 9, sampling rates were below 45 ml/min. At the TWPs in EU 7 and EU 10, sampling rates ranged from 40 to 100 ml/min. The highest rate was observed at TWP939.

The groundwater screening results were reviewed to aid in the determination of the location of the permanent monitoring wells by the Corps. The results from the screening samples are presented in Section 3.4.5.2.

3.3.3.2 Permanent Monitoring Wells

In the IWCS area, the Corps selected five TWPs to convert to permanent monitoring wells (TWP936, TWP935, TWP938, TWP941, and TWP943). All of these wells were sampled using the bailer method due to slow recharge rates. The western most TWPs, in EU 9, were selected as compliance wells to monitor any potential off-site movement of NFSS contaminants. TWP936 was converted to a permanent well to monitor the potential northwest (downgradient) movement from the IWCS. TWP943 was converted to a permanent well to define groundwater contamination along the southern side of the IWCS and evaluate the potential connection with the Building 409 plume.

The permanent monitoring wells were sampled for the parameters presented in Table 3-4 with the methods presented in Table 3-5. The results for the permanent monitoring well samples are presented in Section 3.4.5.3.

3.4 ANALYTICAL RESULTS

Samples were analyzed by independent off-site laboratories under contract to SAIC and the Corps. Strict adherence to the requirements set forth in the RIR Addendum SAP was required of the analytical laboratories.

The off-site project analytical laboratory for analyses of all soil and groundwater samples was General Engineering Laboratories (GEL), LLC in Charleston, South Carolina. The geotechnical samples were analyzed by TestAmerica Laboratories, Inc. in South Burlington, Vermont. The soil gas samples were

analyzed by Lancaster Laboratories in Lancaster, Pennsylvania. The contracted laboratories are in full compliance with United States Department of Defense (DoD) Quality Systems Manual (QSM), Version 3 (DoD 2006) - including National Environmental Laboratory Accreditation Conference (NELAC) Chapter 5 and Appendix requirements.

The analytical results presented in the following sections summarize the data tables (Tables 3-6 through 3-36). The discussion summarizes and presents the maximum results for each of the detected parameters by EU and environmental medium. Result summaries presented in this section are representative of all the laboratory analyses conducted for the RIR Addendum for soil, groundwater (temporary and permanent wells), and soil gas. However, the discussion of nature and extent presented in Section 4 focuses on select organic, metal and radiological results. Analytical results not specifically addressed in later sections of this document will be used for future planning of remedial alternatives to be developed during the FS process.

3.4.1 Analytical Data Quality

The quality control (QC) effort followed the guidance presented in the SAP (USACE 2009a). Field QC measurements included trip blanks, field duplicates, and equipment rinsate blanks. Laboratory QC measurements included method blanks, laboratory control samples (LCSs), laboratory duplicates, and field collected matrix spike (MS)/matrix spike duplicate (MSD) samples.

Analysis of specific field and laboratory QC samples (including field duplicates, laboratory method blanks, LCSs, laboratory duplicates, rinsate blanks and MS/MSD samples) was performed to assess whether quality assurance (QA) objectives have been achieved. The QC samples are described in the RIR Addendum SAP (USACE 2009a).

Field duplicates were collected and analyzed to determine sample homogeneity and sampling methodology reproducibility. Requirements for field duplicates were assigned by the parameters defined in Table 4-1 in the RIR Addendum SAP (USACE 2009a).

A rinsate blank was used to assess the effectiveness of field decontamination processes. One rinsate blank was collected for soil sampling due to the use of stainless steel sampling equipment to collect and homogenize the soil. Because dedicated or disposable sampling equipment was used for groundwater sampling, no rinsate blanks were collected for groundwater.

Laboratory method blanks were analyzed to determine if samples could have been affected by laboratory contamination during preparation, analysis, or cleanup procedures. LCSs/ Laboratory Control Sample Duplicate (LCSDs) were employed to determine the accuracy and precision of the analytical method implemented by the laboratory without the presence of environmental sample matrix effects. MSs provide information about the effect of the sample matrix on the measurement methodology. Laboratory sample duplicates and field collected MSDs assist in determining the analytical precision of the analysis for each batch of project samples.

3.4.2 Data Validation

Sample results were verified and validated by the Corps. During the validation process, data quality issues were identified which required the application of data qualifiers to indicate usability of those results in this report. The following is the list of qualifiers and their definitions that were applied during data verification and validation and presented in the data tables (Tables 3-6 though 3-36):

- J = analytical result is an estimated concentration;
- U = analyte is a non-detect at the reporting limit;
- R = analytical result is unusable.

The validated data was reviewed and summarized in the following sections.

3.4.3 EU 1

The following sections present the results for all samples collected in EU 1 including soil, TWP screening groundwater, and monitoring well groundwater.

3.4.3.1 Soil Characterization

Fourteen soil samples were collected in the EU 1 area. Two samples, one surface and one subsurface, were collected at each TWP location. Additionally, a QC field duplicate surface sample was collected at TWP921 and TWP924. The results for the soil samples are presented in Tables 3-6 through 3-9. The QC field duplicate sample results are not discussed below.

Table 3-6 presents the VOC surface and subsurface soil results for the EU 1 area TWPs. Four VOCs (acetone, methylene chloride, toluene, and total xylenes) were detected in EU 1 soils. Only seven results were detected for the four VOCs. The table below summarizes the maximum detected results for each VOC and the associated TWP location.

VOCs in EU 1 Soils		
Parameter	**Maximum Detect**	**Location**
Acetone (µg/kg)	3.09 J	TWP921 Subsurface
Methylene chloride (µg/kg)	7.35	TWP922 Surface
Toluene (µg/kg)	5.34	TWP921 Surface
Xylenes (total) (µg/kg)	0.56 J	TWP921 Surface

Table 3-7 presents the SVOC surface and subsurface soil results for the EU 1 area TWPs. Only 13 positive results were observed for eight SVOCs detected in EU 1 soils. Surface soil results from one location, TWP921, contained the maximum detections for all eight SVOCs. The table below summarizes the maximum detected result for each SVOC at TWP921.

SVOCs in EU 1 Soils		
Parameter	**Maximum Detect**	**Location**
Benzo(a)anthracene (µg/kg)	36.3 J	TWP921 Surface
Benzo(a)pyrene (µg/kg)	40.9	TWP921 Surface
Benzo(b)fluoranthene (µg/kg)	75.1	TWP921 Surface
Benzo(g,h,i)perylene (µg/kg)	40.1	TWP921 Surface
Chrysene (µg/kg)	33.2 J	TWP921 Surface
Fluoranthene (µg/kg)	58.6	TWP921 Surface
Indeno(1,2,3-cd)pyrene (µg/kg)	30.2 J	TWP921 Surface
Pyrene (µg/kg)	48.7	TWP921 Surface

Table 3-8 presents the polycyclic aromatic hydrocarbons (PAHs) (by analytical method SW-846 8310), pesticide, and polychlorinated biphenyls (PCBs) soil results for EU 1. A total of 41 detected results were

identified for eight PAHs. All detections except one are located in surface soil. TWP922 contains the only subsurface soil detection; phenanthrene at 1.98 µg/kg. The only pesticide detected, 4,4'-dichlorodiphenyltrichloroethane (DDT), was observed in TWP923 and TWP924 surface soils. One PCB, aroclor-1260, was detected in EU 1 area soils at a concentration of 2.7 µg/kg in TWP922 surface soil. The table below summarizes the maximum detected results for each PAH, pesticide and PCB, and the associated TWP location.

PAHs, Pesticides and PCBs in EU 1 Soils		
Parameter	**Maximum Detect**	**Location**
Benzo(a)anthracene (µg/kg)	18.2	TWP922 Surface
Benzo(a)pyrene (µg/kg)	40.2	TWP922 Surface
Benzo(b)fluoranthene (µg/kg)	38.5	TWP922 Surface
Benzo(g,h,i)perylene (µg/kg)	25.1	TWP922 Surface
Chrysene (µg/kg)	15.5	TWP922 Surface
Fluoranthene (µg/kg)	16.7	TWP925 Surface
Phenanthrene (µg/kg)	9.36 J	TWP924 Surface
Pyrene (µg/kg)	122 J	TWP921 Surface
4,4'-DDT (µg/kg)	0.687 J	TWP924 Surface
Aroclor-1260 (µg/kg)	2.7 J	TWP922 Surface

Table 3-9 presents the results for the metal analysis of EU 1 soil. The table below summarizes the maximum detections for each metal and the associated TWP location. All metals included in the analysis were detected except for antinomy and selenium. The table below summarizes the maximum detected results for each metal and the associated TWP location.

Metals in EU 1 Soils		
Parameter	**Maximum Detect**	**Location**
Arsenic (mg/kg)	5.66 J	TWP925 Surface
Barium (mg/kg)	155	TWP925 Subsurface
Beryllium (mg/kg)	0.806	TWP925 Subsurface
Cadmium (mg/kg)	0.363	TWP924 Surface
Chromium (mg/kg)	25.8	TWP925 Subsurface
Lead (mg/kg)	53.9	TWP922 Surface
Mercury (µg/kg)	54.1	TWP924 Surface
Nickel (mg/kg)	27.8	TWP925 Subsurface
Silver (mg/kg)	0.67	TWP926 Surface
Thallium (mg/kg)	0.193 J	TWP921 Subsurface
Zinc (mg/kg)	96.4	TWP924 Surface

Table 3-9 presents the radiological compounds for the EU 1 area soil samples. A total of 11 radiological compounds were detected in the soil in the EU 1 area. Cesium-137, uranium-235, uranium-235/236, and uranium-238 by gamma spectroscopy were detected in four or fewer samples. The other detected radionuclides were observed in most, or all, of the samples. Many of the maximum results listed below were observed in soils at location TWP925, which is located on the southeastern edge of the total uranium plume identified in EU 1. The current understanding of the nature and extent of this plume based on RIR Addendum sampling results is discussed in Section 4 of this document.

Radionuclides in EU 1 Soils		
Parameter	**Maximum Detect**	**Location**
Cesium-137 (GammaSpec) (pCi/g)	0.229	TWP924 Surface
Potassium-40 (GammaSpec) (pCi/g)	30.3	TWP925 Subsurface
Radium-226 (AlphaSpec) (pCi/g)	1.3	TWP925 Surface
Radium-226 (GammaSpec) (pCi/g)	1.13	TWP925 Subsurface
Radium-228 (AlphaSpec) (pCi/g)	1.86	TWP922 Surface
Radium-228 (GammaSpec) (pCi/g)	1.47	TWP925 Subsurface
Thorium-228 (AlphaSpec) (pCi/g)	1.1	TWP921 Surface
Thorium-228 (GammaSpec) (pCi/g)	1.45	TWP925 Subsurface
Thorium-230 (AlphaSpec) (pCi/g)	1.88	TWP922 Surface
Thorium-232 (AlphaSpec) (pCi/g)	1.1	TWP922 Surface
Uranium-233/234 (AlphaSpec) (pCi/g)	2.15	TWP925 Surface
Uranium-235 (GammaSpec) (pCi/g)	0.474	TWP925 Surface
Uranium-235/236 (AlphaSpec) (pCi/g)	0.13	TWP923 Surface
Uranium-238 (AlphaSpec) (pCi/g)	2.88	TWP925 Surface
Uranium-238 (GammaSpec) (pCi/g)	2.95	TWP925 Surface

3.4.3.2 TWP Groundwater Screening

Filtered and unfiltered samples were collected for isotopic uranium analysis for all EU 1 area TWPs; the results are presented in Table 3-10. The table below summarizes the maximum detected results for each uranium isotope and the associated TWP location. Maximum groundwater screening results for the uranium isotopes were observed at locations TWP921 and TWP922. TWP921 is located just north of the NFSS property boundary fence in EU 1 and TWP922 is located just south of the NFSS property boundary fence along the northern edge of EU 1. These two locations were used to further define the downgradient extent of the total uranium groundwater plume identified in EU 1. Section 4 of this document discusses the current understanding of the nature and extent of this plume based on RIR Addendum sampling results.

Radionuclides in EU 1 TWP Screening Groundwater		
Parameter	**Maximum Detect**	**Location**
Uranium-233/234 (pCi/L)	10.8	TWP922
Uranium-233/234, Dissolved (pCi/L)	11.2	TWP921
Uranium-235/236 (pCi/L)	0.649	TWP921
Uranium-235/236, Dissolved (pCi/L)	0.499	TWP921
Uranium-238 (pCi/L)	8.79	TWP922
Uranium-238, Dissolved (pCi/L)	8.58	TWP921

3.4.3.3 Monitoring Well Groundwater

Three TWPs (TWP921, TWP922, and TWP923) were converted to permanent monitoring wells in the EU 1 area during the RIR Addendum field activities. These new wells are designated as MW921, MW922, and MW923. Eight samples were collected including filtered and unfiltered analyses at each monitoring well, and a field QC field duplicate sample for filtered and unfiltered analyses at MW922. The QC field duplicate sample is not discussed in the results below.

Tables 3-11 and 3-12 present the VOC and SVOC results for the new EU 1 monitoring wells, respectively. No VOCs or SVOCs were detected in these wells.

Table 3-13 presents the PAH (analytical method SW-846 8310), pesticide, and PCB results for the EU 1 monitoring wells. No PAHs, PCBs, or pesticides were detected in the new EU 1 monitoring wells.

Table 3-14 presents the metal results for the EU 1 monitoring wells. Nine metals were detected in EU 1 groundwater. The table below summarizes the maximum detected results for each metal, including total and dissolved fractions, and the associated well location.

Metals in EU 1 Groundwater

Parameter	Maximum Detect	Location
Antimony (µg/L)	4.98 J	MW921
Arsenic (µg/L)	9.05	MW921
Barium (µg/L)	14.6	MW923
Barium, Dissolved (µg/L)	7.91	MW923
Chromium (µg/L)	4.39 J	MW923
Chromium, Dissolved (µg/L)	3.16 J	MW922
Lead (µg/L)	1.69 J	MW922
Nickel (µg/L)	10.5	MW923
Nickel, Dissolved (µg/L)	16.7	MW923
Selenium (µg/L)	1.71 J	MW922
Selenium, Dissolved (µg/L)	2.15 J	MW921
Thallium (µg/L)	0.393 J	MW921
Zinc (µg/L)	53.4	MW922
Zinc, Dissolved (µg/L)	32.9	MW923

Table 3-14 presents analytical results for radionuclides observed in groundwater collected from the new EU 1 monitoring wells. Nine radionuclides were detected in EU groundwater. The radionuclides were analyzed by alpha and gamma spectroscopy; the only radionuclide detected by gamma spectroscopy was dissolved potassium-40. The remainder of detected radionuclides were measured by alpha spectroscopy. The table below summarizes the maximum detected results for each radionuclide, including total and dissolved fractions, and the associated well location. Radionuclide groundwater results were used to further define the downgradient extent of the total uranium groundwater plume identified in EU 1. Section 4 of this document discusses the current understanding of the nature and extent of this plume based on RIR Addendum sampling results.

Radionuclides in EU 1 Groundwater		
Parameter	**Maximum Detect**	**Location**
Potassium-40, Dissolved (pCi/L)	31.9	MW923
Radium-226 (pCi/L)	0.623	MW922
Radium-226, Dissolved (pCi/L)	0.687	MW922
Radium-228, Dissolved (pCi/L)	0.795	MW921
Thorium-228 (pCi/L)	0.185	MW922
Thorium-230 (pCi/L)	0.323 J	MW922
Thorium-230, Dissolved (pCi/L)	0.0604	MW921
Thorium-232 (pCi/L)	0.146	MW922
Uranium-233/234 (pCi/L)	14.5	MW921
Uranium-233/234, Dissolved (pCi/L)	15.6	MW921
Uranium-235/236 (pCi/L)	0.631	MW923
Uranium-235/236, Dissolved (pCi/L)	0.592	MW923
Uranium-238 (pCi/L)	11.6	MW921

3.4.4 EU 4

The following sections present the results for all samples collected in EU 4; this includes soil, geotechnical, TWP screening groundwater, soil gas, and monitoring well groundwater.

3.4.4.1 Soil Characterization

A total of 17 soil samples were collected in EU 4. Two samples (one surface and one subsurface) were collected at each TWP location. A QC field duplicate surface sample was collected at TWP932. The results for the soil samples are presented in Tables 3-15 through 3-18. The QC field duplicate sample results are not discussed in this report. Additionally, six geotechnical samples were collected in EU 4; the results are presented in Table 3-19.

Table 3-15 presents the VOC results for the EU 4 TWPs. Nine VOCs were detected in EU 4 soils. Due to high concentrations of some of the VOCs in TWP930 and TWP933 subsurface soil, samples from these two locations had to be diluted prior to analysis. The dilution of the samples raised the detection limit for the whole suite of VOC analyses and it cannot be assumed that non-detected parameters are not present at concentrations similar to those observed in the other samples with lower detection limits. Elevated concentrations of tetrachloroethylene and trichloroethylene observed in soils at TWP928, TWP930, and TWP933 is consistent with the confirmation of DNAPL in the subsurface in the central portion of EU 4. These locations were used to further define the extent of the organic groundwater plume identified in EU 4. Section 4 of this document presents a discussion of the current understanding of the nature and extent of this plume based on RIR Addendum sampling results. The table below summarizes the maximum detected results for each VOC observed in EU 4 soils, including the associated TWP location.

VOCs in EU 4 Soils		
Parameter	**Maximum Detect**	**Location**
Acetone (µg/kg)	5.64 J	TWP932 Subsurface
1,1-Dichloroethylene (µg/kg)	0.478 J	TWP928 Subsurface
cis-1,2-Dichloroethylene (µg/kg)	251	TWP933 Subsurface
Methylene chloride (µg/kg)	3.7 J	TWP931 Subsurface
Tetrachloroethylene (µg/kg)	75600	TWP930 Subsurface
Toluene (µg/kg)	0.386 J	TWP931 Subsurface
trans-1,2-Dichloroethylene (µg/kg)	8.47	TWP928 Subsurface
Trichloroethylene (µg/kg)	908 J	TWP930 Subsurface
Vinyl chloride (µg/kg)	1.61	TWP928 Subsurface

Table 3-16 presents the results for the SVOC results for the EU 4 soils. SVOCs were not collected for the soil gas TWPs (TWP932, TWP933, and TWP934). Due to dilution performed for the TWP930 surface soil sample, the dilution raised the detection limit for the entire suite of analyses and it cannot be assumed that non-detected parameters are not present at concentrations similar to those observed in the other samples with lower detection limits. A total of 12 SVOCs were detected in EU 4 soils; all detections were identified in the surface soil. The table below summarizes the maximum detected results for each SVOC observed in EU 4 soils, including the associated TWP location.

SVOCs in EU 4 Soils		
Parameter	**Maximum Detect**	**Location**
Anthracene (µg/kg)	50.1	TWP929 Surface
Benzo(a)anthracene (µg/kg)	63.9	TWP927 Surface
Benzo(a)pyrene (µg/kg)	167 J	TWP930 Surface
Benzo(b)fluoranthene (µg/kg)	316	TWP929 Surface
Benzo(g,h,i)perylene (µg/kg)	547	TWP930 Surface
Carbazole (µg/kg)	12.2 J	TWP929 Surface
Chrysene (µg/kg)	214	TWP929 Surface
Fluoranthene (µg/kg)	112	TWP927 Surface
Indeno(1,2,3-cd)pyrene (µg/kg)	110	TWP929 Surface
2-Methylnaphthalene (µg/kg)	11.3 J	TWP931 Surface
Phenanthrene (µg/kg)	53.3	TWP927 Surface
Pyrene (µg/kg)	71.8	TWP927 Surface

Table 3-17 presents the PAH (by analytical method SW-846 8310), pesticide, and PCB results for the soil samples collected in EU 4. Eleven PAHs were detected in EU 4 soils. PAHs were only detected in the surface soil of TWP927, TWP928, and TWP929; however, the detection limits for TWP930 were elevated due to dilution required to run the analysis. No pesticides were identified in EU 4 soils. Two PCBs were detected in EU 4 soils. The PCBs were only detected in the surface soils. The maximum results for both PCBs were identified in soil from TWP931. The table below summarizes the maximum detected results for each PAH and PCB observed in EU 4 soils, including the associated TWP location.

PAHs and PCBs in EU 4 Soils		
Parameter	**Maximum Detect**	**Location**
Anthracene (µg/kg)	45.4	TWP929 Surface
Benzo(a)anthracene (µg/kg)	40.3	TWP927 Surface
Benzo(a)pyrene (µg/kg)	96.9	TWP929 Surface
Benzo(b)fluoranthene (µg/kg)	160	TWP929 Surface
Benzo(g,h,i)perylene (µg/kg)	93.9	TWP929 Surface
Chrysene (µg/kg)	161	TWP929 Surface
Dibenzo(a,h)anthracene (µg/kg)	11.4	TWP927 Surface
Fluoranthene (µg/kg)	63.8	TWP927 Surface
Fluorene (µg/kg)	11.4 J	TWP929 Surface
Phenanthrene (µg/kg)	37.8	TWP929 Surface
Pyrene (µg/kg)	47.4	TWP929 Surface
Aroclor-1254 (µg/kg)	601	TWP931 Surface
Aroclor-1260 (µg/kg)	1,400	TWP931 Surface

Table 3-18 presents the metal results for the EU 4 soil samples. All metals were detected in at least one sample except for antimony. The table below summarizes the maximum detections and the corresponding location for each of the detected metals.

Metals in EU 4 Soils		
Parameter	**Maximum Result**	**Location**
Aluminum (mg/kg)	21,300	TWP932 Surface
Antimony (mg/kg)	0.439 J	TWP931 Surface
Arsenic (mg/kg)	4.64	TWP929 Surface
Barium (mg/kg)	159	TWP932 Surface
Beryllium (mg/kg)	1.34	TWP933 Surface
Boron (mg/kg)	37.2	TWP932 Subsurface
Cadmium (mg/kg)	0.527	TWP930 Surface
Calcium (mg/kg)	48,100	TWP932 Subsurface
Chromium (mg/kg)	25.3	TWP932 Surface
Cobalt (mg/kg)	12.4	TWP932 Subsurface
Copper (mg/kg)	32.2	TWP932 Surface
Iron (mg/kg)	23,900	TWP932 Subsurface
Lead (mg/kg)	175	TWP931 Surface
Lithium (mg/kg)	26.3	TWP934 Subsurface
Magnesium (mg/kg)	18,900	TWP934 Surface
Manganese (mg/kg)	833 J	TWP933 Surface
Mercury (µg/kg)	70.5	TWP930 Surface
Nickel (mg/kg)	33.3	TWP932 Surface
Potassium (mg/kg)	5,360	TWP932 Surface
Silver (mg/kg)	0.712	TWP928 Surface
Sodium (mg/kg)	284 J	TWP934 Subsurface
Thallium (mg/kg)	0.212 J	TWP932 Surface
Vanadium (mg/kg)	47.1	TWP932 Surface
Zinc (mg/kg)	81.9	TWP931 Surface

Table 3-18 presents the radiological compounds for the EU 4 soils. The wells used to collect soil gas samples were only analyzed for uranium isotopes by alpha spectroscopy. The table below summarizes the maximum detections and the corresponding location for each of the detected radionuclides in EU 4 soils.

Radionuclides in EU 4 Soils		
Parameter	**Maximum Detect**	**Location**
Cesium-137 (GammaSpec) (pCi/g)	0.486	TWP930 Surface
Potassium-40 (GammaSpec) (pCi/g)	26	TWP929 Subsurface
Radium-226 (AlphaSpec) (pCi/g)	2.72 J	TWP930 Surface
Radium-226 (GammaSpec) (pCi/g)	1.89	TWP930 Surface
Radium-228 (AlphaSpec) (pCi/g)	1.67	TWP928 Subsurface
Radium-228 (GammaSpec) (pCi/g)	1.22	TWP930 Subsurface
Thorium-228 (AlphaSpec) (pCi/g)	1.3	TWP930 Subsurface
Thorium-228 (GammaSpec) (pCi/g)	1.22	TWP928 Subsurface
Thorium-230 (AlphaSpec) (pCi/g)	2.15	TWP929 Surface
Thorium-232 (AlphaSpec) (pCi/g)	1.63	TWP928 Subsurface
Uranium-233/234 (AlphaSpec) (pCi/g)	1.59	TWP928 Surface
Uranium-238 (AlphaSpec) (pCi/g)	1.38	TWP928 Surface

Geotechnical results are presented in Table 3-19. Two samples were collected at each of the wells monitored for soil gas: TWP932, TWP933, and TWP934. The six geotechnical samples were collected for three analyses: moisture content, in-place density, and specific gravity. The geotechnical samples consist of two, 2 ft intervals collected in a Shelby tube. The first interval was collected from a shallow depth of 4 to 6 ft bgs; the second interval ranges from 10 to 16 ft bgs. The depth is noted within the sample ID structure as well as described in Section 3.3.2.1.1.

The moisture content was the most variable between all three wells (Table 3-19). In the shallow interval the moisture content ranges from 14.3% to 17.4%. In the deep interval, the moisture content ranges from 15.6% to 35.9%. The in-place density ranges from 1.31 to 1.88 g/cm^3; the endpoints of this range correlate to the endpoints of moisture content where the maximum moisture content correlates to the minimum in-place density and vice versa. The overall average specific gravity for all six samples is 2.749 with a standard deviation of 0.02%.

3.4.4.2 TWP Groundwater Screening

As shown in Table 3-4 the analytical parameters collected for the EU 4 TWP groundwater include VOCs, metals and isotopic uranium. Most TWPs in EU 4 were analyzed for VOCs and isotopic uranium; only TWPs used to monitor soil gas included metals as part of the analytical suite. Tables 3-20 through 3-22 present the groundwater screening results. Due to the presence of the DNAPL in samples collected at TWP930 and TWP933, these samples had to be diluted prior to analysis at the laboratory. The dilution raised the detection limit for the entire suite of analyses and it cannot be assumed that non-detected parameters are not present at concentrations similar to those observed in the other samples with lower detection limits. The presence of DNAPL was so great in TWP933 that the sample had to be analyzed as a solid for the isotopic uranium analysis. The samples associated with TWP930 and TWP933 contain the fewest number of detections due to the elevated detection limits; however the detections that were obtained were comparatively very high especially for the VOCs, as discussed below. In order to complete the laboratory analysis, the samples had to be heavily diluted to be within the calibration range of the instrumentation resulting in very high detection limits for the other parameters. Laboratory notes for the sample collected from TWP933 state that it is a "...black liquid insoluble in water and only slightly soluble in methanol. An intermediate dilution was prepared in purge and trap methanol. Due to the non-homogeneous matrix, the concentrations of target compounds in the reported results are in poor agreement with each other."

Table 3-20 presents the VOC results for the EU 4 TWPs. A total of 14 VOCs were detected in EU 4 TWP groundwater. The TWP with the greatest number of VOC detections in groundwater is TWP928. However, the two TWPs that visibly contained DNAPL during sampling, TWP930 and TWP933, contained only two detections, each at very high concentrations for PCE and TCE. TWP933 results for PCE and TCE represent the maximum results for these parameters at 134,000,000 and 9,500,000 µg/L, respectively. TWP930 results for tetrachloroethylene and trichloroethylene are 114,000 and 12,500 µg/L, respectively. These two locations were used to identify the source of the organic groundwater plume in the central portion of EU 4. Section 4 of this document presents a discussion of the current understanding of the nature and extent of this plume based on RIR Addendum sampling results. The table below summarizes the maximum detected results for each VOC observed in EU 4 TWP groundwater, including the associated TWP location.

VOCs in EU 4 TWP Screening Groundwater

Parameter	Maximum Detect	Location
Acetone (µg/L)	13.6	TWP928
Benzene (µg/L)	0.31 J	TWP931
2-Butanone (µg/L)	4.98 J	TWP928
Chloroform (µg/L)	1.61	TWP934
Chloromethane (µg/L)	0.657 J	TWP928
1,1-Dichloroethylene (µg/L)	0.951 J	TWP928
cis-1,2-Dichloroethylene (µg/L)	522	TWP928
trans-1,2-Dichloroethylene (µg/L)	6.9	TWP928
2-Hexanone (µg/L)	1.6 J	TWP928
Methylene chloride (µg/L)	115 J	TWP928
Tetrachloroethylene (µg/L)	134,000,000	TWP933
Toluene (µg/L)	0.72 J	TWP931
Trichloroethylene (µg/L)	9,500,000 J	TWP933
Vinyl chloride (µg/L)	9.88	TWP928

Table 3-21 presents the filtered and unfiltered metal results for the wells used to monitor soil gas in EU 4. TWP934 contains a majority of the maximum results for the metal analyses. TWP933 only contained seven detections, four of which were the maximum results for filtered and unfiltered chromium and mercury samples. The maximum result for each detected metal is summarized in the table below.

Metals in EU 4 TWP Screening Groundwater				
Parameter	**Maximum Unfiltered Result**	**TWP**	**Maximum Dissolved Result**	**TWP**
Aluminum (µg/L)	69,500	TWP934	20.2 J	TWP932
Antimony (µg/L)	15 J	TWP932	No detects	NA
Arsenic (µg/L)	18.5	TWP934	8.46	TWP932
Barium (µg/L)	478	TWP934	67.1	TWP934
Beryllium (µg/L)	3.54	TWP934	No detects	NA
Boron (µg/L)	29,300	TWP932	29,200	TWP932
Cadmium (µg/L)	0.872 J	TWP934	No detects	NA
Calcium (µg/L)	243,000	TWP934	142,000	TWP934
Chromium (µg/L)	1,870 J	TWP933	1,850 J	TWP933
Cobalt (µg/L)	28.8	TWP934	4.13	TWP934
Copper (µg/L)	74.9	TWP934	6.14	TWP934
Iron (µg/L)	76,900	TWP934	1,000	TWP932
Lead (µg/L)	33	TWP934	No detects	NA
Lithium (µg/L)	180	TWP934	96	TWP934
Magnesium (µg/L)	395,000	TWP934	290,000	TWP934
Manganese (µg/L)	1,750	TWP934	325	TWP934
Mercury (µg/L)	222	TWP933	275	TWP933
Nickel (µg/L)	74.5	TWP934	10.2	TWP934
Potassium (µg/L)	14,600	TWP934	4,400	TWP934
Silver (µg/L)	1.83 J	TWP934	No detects	NA
Sodium (µg/L)	189,000	TWP934	185,000	TWP934
Thallium (µg/L)	0.804 J	TWP934	No detects	NA
Vanadium (µg/L)	93.3	TWP934	No detects	NA
Zinc (µg/L)	178	TWP934	6.58 J	TWP934

Table 3-22 presents the filtered and unfiltered results for the uranium isotopes in TWP screening groundwater. All three uranium isotopes were detected at each TWP location except for TWP933. Section 4 of this document presents a discussion of the current understanding of the nature and extent of uranium in EU 4 groundwater based on RIR Addendum sampling results. The table below summarizes the maximum detected results for each radionuclide observed in EU 4 TWP groundwater, including the associated TWP location.

Radionuclides in EU 4 TWP Screening Groundwater		
Parameter	**Maximum Detect**	**Location**
Uranium-233/234 (pCi/L)	11.5	TWP934
Uranium-233/234, Dissolved (pCi/L)	11	TWP934
Uranium-235/236 (pCi/L)	0.596	TWP927
Uranium-235/236, Dissolved (pCi/L)	0.459	TWP934
Uranium-238 (pCi/L)	10.3	TWP934
Uranium-238, Dissolved (pCi/L)	9.2	TWP934

3.4.4.3 Soil Gas

Soil gas vapor samples were collected at TWP932, TWP933, and TWP934. The soil gas results are presented in Table 3-23. The VOC method EPA TO-15 was used for the soil gas analysis. A total of 16 parameters were detected in the soil gas samples. However, as with the soil and groundwater analyses at TWP930 and TWP933, the soil gas samples had to be diluted to obtain values for the high concentration VOCs. The TWP930 sample was diluted by a factor of ten and TWP933 was diluted by a factor of 10,000. As a result, the minimum detection limit for the remaining analytes was increased. The maximum results for the detected analytes can be explained by their proximity to monitoring wells 415A and TWP933. TWP933 contained the highest PID readings and visible DNAPL in the screening groundwater samples. The following results are presented from lowest to highest concentration (i.e., north to south).

A total of 11 VOCs were detected in soil gas from TWP934. The two maximum detected results at TWP934 are for acetone (9.4 µg/m^3) and carbon disulfide (4.5 µg/m^3). TWP932 consists of ten detected VOCs; the maximum detected results at this location were acetone (50 µg/m^3) and pentane (350 µg/m^3). TWP933 contained six detects at very high concentrations. The detected results in TWP933 soil gas sample include 61,000, 440,000, 390,000, and 78,000 µg/m^3 for cis-1,2-DCE, PCE, TCE, and vinyl chloride, respectively. In the 2007 RIR, five VOCs were detected in the organic plume identified in EU 4 (Section 3.3.2); four of these five VOC analytes were detected in the TWP933 soil gas sample.

3.4.4.4 Monitoring Well Groundwater

Two TWPs were converted to permanent monitoring wells in EU 4, TWP930 and TWP934. The newly installed wells are designated as MW930 and MW934. The location of MW934 corresponds to the northern most TWP location in EU 4; MW930 is downgradient of preexisting well 415A. Tables 3-24 through 3-27 presents the results for the full suite of analyses performed on MW930 and MW934 groundwater samples.

Table 3-24 presents the VOC results for the new monitoring wells in EU 4. Four VOCs were detected in EU 4 groundwater. The table below summarizes the maximum detected results, and in this case, the only detected results for each VOC observed in EU 4 groundwater, including the associated well location.

VOCs in EU 4 Groundwater		
Parameter	**Maximum Detect**	**Location**
Chloroform (µg/L)	3.61	MW934
dis-1,2-Dichloroethylene (µg/L)	670 J	MW930
Tetrachloroethylene (µg/L)	64,200	MW930
Trichloroethylene (µg/L)	9,860	MW930

Tables 3-25 and 3-26 present the SVOC, PAH (by analytical method SW-846 8310), PCB, and pesticide results for the new monitoring wells in EU 4. No detections were identified in either of the wells.

Table 3-27 presents the results for metal analyses for the EU 4 monitoring wells. Five metals were detected in EU 4. The table below summarizes the maximum detected results for each metal observed in EU 4 groundwater, including the associated well location.

Metals in EU 4 Groundwater		
Parameter	**Maximum Detect**	**Location**
Arsenic (µg/L)	2.68 J	MW934
Barium (µg/L)	20.1	MW930
Barium, Dissolved (µg/L)	20.6	MW930
Chromium (µg/L)	2.19 J	MW934
Chromium, Dissolved (µg/L)	5.2 J	MW930
Lead (µg/L)	0.678 J	MW934
Nickel (µg/L)	8.27	MW934
Nickel, Dissolved (µg/L)	8.88	MW934
Zinc (µg/L)	30.5	MW934
Zinc, Dissolved (µg/L)	8.16 J	MW934

Table 3-27 present the results for the radiological compounds. A total of 16 radiological compounds were detected in the newly installed EU 4 monitoring wells. The radiological compounds were analyzed by alpha and gamma spectroscopy. No results were detected using the gamma spectroscopy method; the results provided in the table below were all detected by alpha spectroscopy. The maximum detections were all identified in MW934, the northern most monitoring well. The distribution of uranium in EU 4 groundwater is further discussed in Section 4 of this document.

Radionuclides in EU 4 Groundwater		
Parameter	**Maximum Detect**	**Location**
Radium-226 (pCi/L)	1.16	MW934
Radium-226, Dissolved (pCi/L)	0.608	MW934
Radium-228 (pCi/L)	1.6	MW934
Uranium-233/234 (pCi/L)	11.7	MW934
Uranium-233/234, Dissolved (pCi/L)	13.3	MW934
Uranium-235/236 (pCi/L)	0.734	MW934
Uranium-235/236, Dissolved (pCi/L)	0.716	MW934
Uranium-238, (pCi/L)	9.35	MW934
Uranium-238, Dissolved (pCi/L)	12	MW934

3.4.5 IWCS Area

The following sections present the results for all samples collected in IWCS area (i.e., EU 7, EU 9, and EU 10); this includes soil, TWP screening groundwater, and monitoring well groundwater.

3.4.5.1 Soil Characterization

A total of 19 soil samples were collected in the IWCS area. Soil samples were collected from areas outside of the perimeter of the IWCS; the IWCS itself was not breached during this sampling. Two samples, one surface and one subsurface, were collected at each TWP location. A QC field duplicate surface sample was collected at TWP934. The results for the soil samples are presented in Tables 3-28 through 3-31. The QC field duplicate sample results will not be discussed below.

Table 3-28 presents the VOC results for the IWCS area soil. Three VOCs, acetone, methylene chloride and TCE, were detected in IWCS area soils. The table below summarizes the maximum detected results for each VOC observed in IWCS area soils, including the associated TWP location.

VOCs in IWCS Area Soils		
Parameter	**Maximum Detect**	**Location**
Acetone (µg/kg)	2.76 J	TWP940 Subsurface
Methylene chloride (µg/kg)	4.02 J	TWP936 Subsurface
Tetrachloroethylene (µg/kg)	0.919 J	TWP936 Surface

Table 3-29 presents the SVOC results for the IWCS area. The surface sample at TWP935 contained the only SVOC detects in the IWCS area. TWP935 is the northern most TWP in EU 9. Nine SVOCs were detected; the maximum detect was 50.6 µg/kg for fluoranthene.

Table 3-30 presents the PAH (by analytical method SW-846 8310), PCB, and pesticide results for the IWCS area. Ten of these parameters were detected in IWCS area soils; only three detections are located in the subsurface soil samples. The maximum subsurface soil result is 3.5 µg/kg for phenanthrene. The surface soil at TWP935 contained the maximum result for most of the detected parameters as listed in the table below. None of the other samples had detections for these parameters that exceeded 10 µg/kg.

PAHs, Pesticides and PCBs in IWCS Area Soils		
Parameter	**Maximum Detect**	**Location**
Acenaphthylene (µg/kg)	2.17 J	TWP942 Subsurface
Benzo(a)anthracene (µg/kg)	55 J	TWP935 Surface
Benzo(a)pyrene (µg/kg)	40.5 J	TWP935 Surface
Benzo(b)fluoranthene (µg/kg)	46.4 J	TWP935 Surface
Benzo(g,h,i)perylene (µg/kg)	22.2	TWP935 Surface
Benzo(k)fluoranthene (µg/kg)	25.9 J	TWP935 Surface
Chrysene (µg/kg)	5.32	TWP936 Surface
Fluoranthene (µg/kg)	86 J	TWP935 Surface
Phenanthrene (µg/kg)	24.1	TWP935 Surface
Pyrene (µg/kg)	63.7 J	TWP935 Surface

Table 3-31 presents the metal results for the IWCS area soils. All metal parameters were detected except for antimony and selenium. Only two maximum detections for the metal analyses were identified in the subsurface soil. The following table presents the maximum results for the IWCS metal soil samples.

Metals in IWCS Area Soils		
Parameter	**Maximum Result**	**Location**
Arsenic (mg/kg)	5.6	TWP941 Subsurface
Barium (mg/kg)	491	TWP939 Subsurface
Beryllium (mg/kg)	1.21	TWP943 Surface
Cadmium (mg/kg)	0.321	TWP936 Surface
Chromium (mg/kg)	24.8	TWP943 Surface
Lead (mg/kg)	19.3	TWP935 Surface
Mercury (µg/kg)	48.3 J	TWP937 Surface
Nickel (mg/kg)	32.8	TWP937 Surface
Silver (mg/kg)	0.63	TWP939 Surface
Thallium (mg/kg)	0.167 J	TWP943 Surface
Zinc (mg/kg)	74.4	TWP936 Surface

Table 3-31 presents the results for the radiological compounds for the IWCS area soils. Nine parameters were detected. The following table presents the maximum results for the IWCS radionuclide soil samples, including the associated TWP location.

Radionuclides in IWCS Area Soils		
Parameter	**Maximum Detect**	**Location**
Cesium-137 (GammaSpec) (pCi/g)	0.134	TWP942 Surface
Potassium-40 (GammaSpec) (pCi/g)	26.4	TWP935 Subsurface
Radium-226 (AlphaSpec) (pCi/g)	5	TWP937 Surface
Radium-226 (GammaSpec) (pCi/g)	5.25	TWP937 Surface
Radium-228 (AlphaSpec) (pCi/g)	3.46	TWP940 Subsurface
Radium-228 (GammaSpec) (pCi/g)	1.38	TWP943 Surface
Thorium-228 (AlphaSpec) (pCi/g)	1.5	TWP936 Surface
Thorium-228 (GammaSpec) (pCi/g)	1.27	TWP943 Surface
Thorium-230 (AlphaSpec) (pCi/g)	5.93	TWP937 Surface
Thorium-232 (AlphaSpec) (pCi/g)	1.4	TWP939 Surface
Uranium-233/234 (AlphaSpec) (pCi/g)	1.55	TWP936 Surface
Uranium-235/236 (AlphaSpec) (pCi/g)	0.188	TWP942 Subsurface
Uranium-238 (AlphaSpec) (pCi/g)	1.55	TWP936 Surface
Uranium-238 (GammaSpec) (pCi/g)	1.75	TWP940 Subsurface

3.4.5.2 TWP Groundwater Screening

Filtered and unfiltered samples were collected for isotopic uranium analysis for all IWCS area TWPs; the results are presented in Table 3-32. The following table presents the maximum results for detected uranium isotopes in the IWCS area groundwater screening samples, including the associated TWP location. Radiological groundwater results from IWCS area TWPs were used to refine the interpretation of the isotopic and total uranium plumes in the vicinity of the IWCS. The distribution of uranium in IWCS area groundwater is further discussed in Section 4 of this document.

Radionuclides in IWCS Area TWP Screening Groundwater		
Parameter	**Maximum Detect**	**Location**
Uranium-233/234 (pCi/L)	20.4	TWP935
Uranium-233/234, Dissolved (pCi/L)	18.1	TWP937
Uranium-235/236 (pCi/L)	0.899	TWP935
Uranium-235/236, Dissolved (pCi/L)	0.752	TWP935
Uranium-238 (pCi/L)	18.1	TWP935
Uranium-238, Dissolved (pCi/L)	14.7	TWP937

3.4.5.3 Monitoring Well Groundwater

Five TWPs (TWP935, TWP936, TWP938, TWP941 and TWP943) were converted to permanent monitoring wells during RIR Addendum field activities. These monitoring wells are designated as MW935, MW936, MW938, MW941 and MW943. Ten samples were collected including filtered and unfiltered analyses at each monitoring well for the parameters identified in Table 3-4.

Tables 3-33 and 3-34 present the VOC and SVOC results for the newly installed IWCS monitoring wells. No VOCs or SVOCs were detected in groundwater collected from these wells.

Table 3-35 presents the PAH (by analytical method SW-846 8310), pesticide, and PCB results for the IWCS area monitoring wells. Only two pesticides were detected and these were observed in MW935: aldrin at 0.0238 µg/L and endosulfan I at 0.0409 µg/L.

Table 3-36 presents the metals for the IWCS area monitoring wells. Nine metals were detected in IWCS area groundwater. The following table presents the maximum results for detected metals in IWCS area groundwater, including the associated TWP location.

Metals in IWCS Area Groundwater		
Parameter	**Maximum Detect**	**Location**
Antimony (µg/L)	5.71 J	MW938
Arsenic (µg/L)	3.48 J	MW938
Arsenic, Dissolved (µg/L)	5.98	MW938
Barium (µg/L)	19.2	MW943
Barium, Dissolved (µg/L)	14.5	MW943
Cadmium (µg/L)	0.361 J	MW938
Chromium (µg/L)	7.38 J	MW938
Chromium, Dissolved (µg/L)	6.54 J	MW938
Lead (µg/L)	0.622 J	MW938
Nickel (µg/L)	16.6	MW936
Nickel, Dissolved (µg/L)	16.5	MW936
Thallium (µg/L)	0.39 J	MW935
Thallium, Dissolved (µg/L)	0.487 J	MW941
Zinc (µg/L)	34.2	MW935
Zinc, Dissolved (µg/L)	11.7	MW936

Table 3-36 presents radiological compounds for the IWCS monitoring wells. Seven radionuclides were detected in IWCS area groundwater. Analyses were performed by alpha and gamma spectroscopy; no analytes were detected by gamma spectroscopy. The alpha spectroscopy analysis is more sensitive than the gamma spectroscopy analysis. Because of this sensitivity, the alpha spectroscopy analysis uses lower detection limits, which results in a greater number of positive results compared to gamma spectroscopy analyses. Because the detection limits for gamma spectroscopy are greater, no analytes were detected using this method of analysis during the RI. Summary results presented in the table below represent the alpha spectroscopy results only.

Radionuclides in IWCS Area Groundwater		
Parameter	**Maximum Detect**	**Location**
Radium-226 (pCi/L)	1.34	MW943
Radium-226, Dissolved (pCi/L)	0.425	MW941
Radium-228 (pCi/L)	0.624	MW941
Radium-228, Dissolved (pCi/L)	0.585	MW935
Thorium-230, Dissolved (pCi/L)	0.067	MW938
Thorium-232 (pCi/L)	0.0964	MW935
Uranium-233/234 (pCi/L)	20.9	MW936
Uranium-233/234, Dissolved (pCi/L)	15.4	MW938
Uranium-235/236 (pCi/L)	1.0	MW936
Uranium-235/236, Dissolved (pCi/L)	0.703	MW935
Uranium-238, (pCi/L)	15.4	MW936
Uranium-238, Dissolved (pCi/L)	12.3	MW938

Radiological groundwater results from newly installed IWCS area monitoring wells were used to refine the interpretation of the isotopic and total uranium plumes in the vicinity of the IWCS. The distribution of uranium in IWCS area groundwater is further discussed in Section 4.

3.5 SUMMARY

The field and analytical data collected during the RIR Addendum fieldwork is varied and will be utilized in a myriad of ways. The geological data from the boring logs will be used to further interpret the on-site geology and allow for additional interpolation of the sand lenses and their ability to transport groundwater through the UWBZ (Section 12.10). All of the analytical data will be included in the site database and will be incorporated into all future data analysis. The soil gas vapor analyses were used to evaluate the potential inhalation risk to a future construction worker from the organic plume in EU 4 (Section 4). The monitoring well data will be used to evaluate future monitoring requirements of the NFSS ESP. Additionally, the data has been used to revise the groundwater plumes identified in the 2007 RIR and presented in Section 4 of this addendum.

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SECTION 3

FIGURES

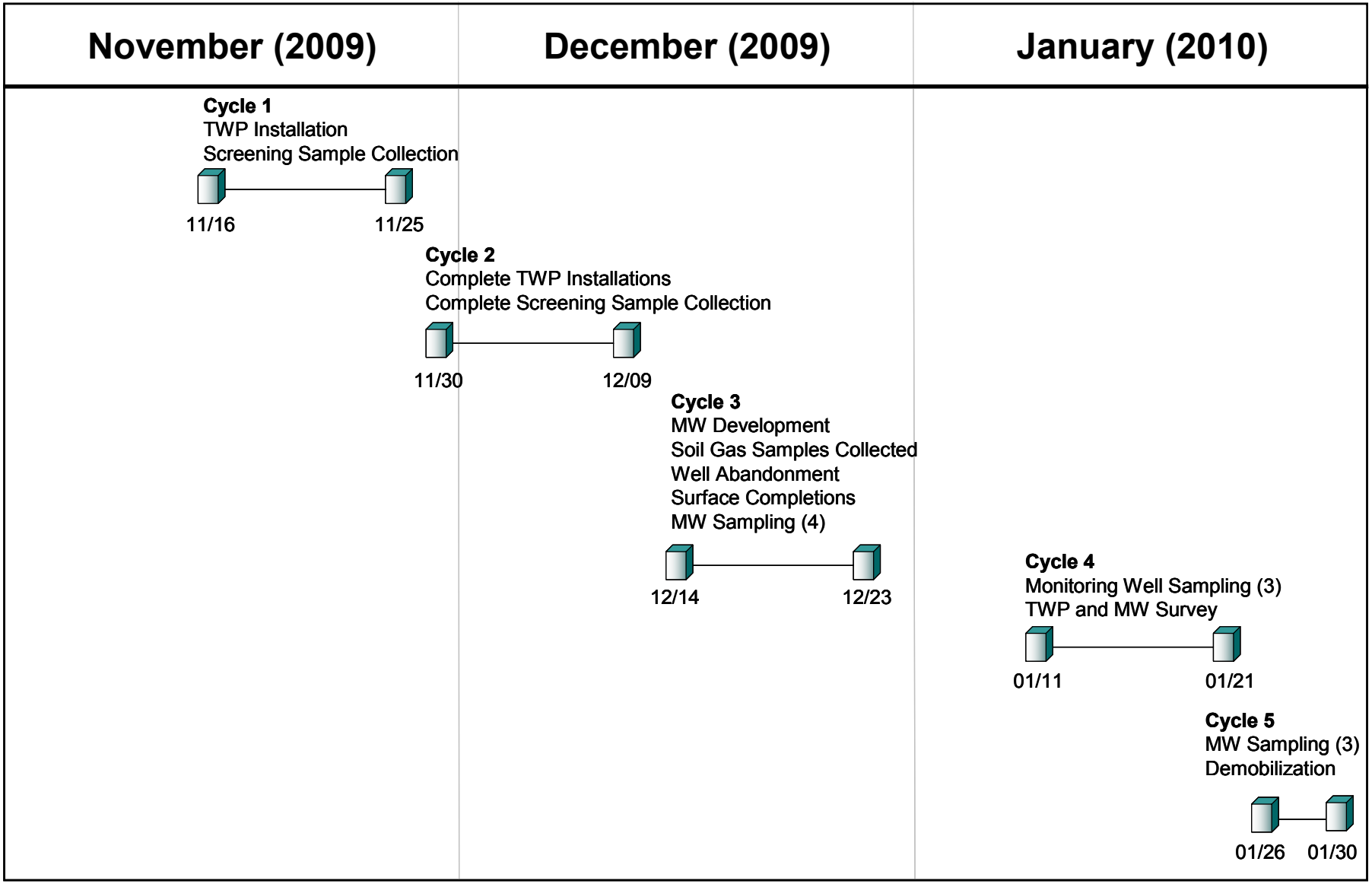

Figure 3-1. RIR Addendum Field Activity Timeline

MW921
MW922
MW923
TWP924
TWP925
TWP926
445
443
444
1
2
3
MW934
TWP928
TWP927
MW930
TWP929
TWP932
TWP934
TWP933
431/432
4
5
6
434
7
428
430
8
458
425
421
423
422
420
427
MW935
MW936
TWP937
MW938
TWP939
9
10
TWP940
411
MW941
414
413
410
412
MW943
409
TWP942
11
403
429
401
13
12
14

MW=Monitoring Well
TWP=Temporary Well Point
RI=Remedial Investigation
RIR=Remedial Investigation Report Addendum

Legend

- Structure abandoned above grade
- Existing structure
- Former structure
- Acid sewer
- Water lines
- Fuel line
- Sanitary sewer
- Storm sewer
- Former K-65 transfer pipeline
- Surface water (inundated 50% of year)
- WCS cutoff wall
- Roads
- National Grid Boundary
- EU boundary
- RIR Monitoring Well
- RIR Temporary Well Point

0 150 300 450 600
Feet

N

US Army Corps of Engineers
Buffalo District

Remedial Investigation Report Addendum
Sample Locations

Sitewide

Science Applications
International Corporation

Figure 3-2

Sampling Location Identification: XXXNNxx-xx-#### XXXNNxxxxF-####	
XXX = Sample Location Code	Examples 921 - Temporary Well Point Location 921 935 - Temporary Well Point Location 935
NN = Sample Type	Examples SS = Surface Soil SB = Subsurface Soil TW = Groundwater From TWP GW = Groundwater From Monitoring Well
xx-xx = Sample Depth Or xxxx = Sampling Event	Examples 0.0-0.5 = Surface Soil Sample Depth 1.0-3.0 = Subsurface Soil Sample Depth 0001 = Sample event at specific location (used for groundwater sampling)
F = Filtered Sample (Liquid Sample Only)	Examples F = Filtered Sample
#### = Sequential Sample Number [unique for entire investigation]	Examples 0001 – Unique identifier nonspecific to media 0086 – Unique identifier nonspecific to media 9003 – QA/QC sample for the project
Examples of Sample IDs for this Investigation 921SS0.0-0.5-0001 – Surface Soil Sample collected from 0.0-0.5'bgs from location 921 921SB14.0-16.0-0002 – Subsurface Soil Sample collected from 14.0-16.0'bgs from location 921 921TW0001-0003 – 1st Groundwater sample collected from TWP921 unfiltered 921TW0001F-0004 – 1st Groundwater sample collected from TWP921 filtered 921SS0.0-0.5-9002– Duplicate subsurface soil sample collected from 0.0-0.5'bgs from location 921 921GW0001-0109 – 1st Groundwater sample collected from permanent monitoring well at location 921 922GW0001-9008 – Duplicate groundwater sample collected from permanent monitoring well at location 922	

Figure 3-3. RIR Addendum Sample ID Structure

SECTION 3

TABLES

Table 3-1. RIR Addendum SAP TWP Justification for EU 1 Area

Exposure Unit	TWP	Location Description	Justification
EU 1	TWP921	Off-site near site boundary and northwest edge of plume	• Define the potential off-site extent of uranium contamination in groundwater to the northwest in a downgradient direction • Downgradient of former sampling location 505, which exhibited total dissolved uranium concentrations used to define the current plume configuration • Evaluate connectivity to sand lens observed at nearby former sampling location 505
	TWP922	Off-site near northern edge of plume; west of proposed location TWP923	• Define the potential off-site extent of uranium contamination in groundwater north of EU 1
	TWP923	Off-site near northern edge of plume; east of proposed location TWP922	• Define the potential off-site extent of uranium contamination in groundwater north of EU 1 • Downgradient of former sampling location 506, which exhibited total dissolved uranium concentrations used to define the current plume configuration
	TWP924	West side of plume near site boundary	• Define the potential extent of uranium contamination in groundwater to the west near the site boundary • Co-located with existing lower water-bearing zone wells
	TWP925	Inside plume near northwest edge; east of TWP924	• Assess aerial source potential • Further define the uranium groundwater plume configuration
EU 2	TWP926	Eastern portion of plume between former TWPs 506 and 808	• Further define the uranium groundwater plume configuration • Downgradient of former sampling location 808, which exhibited total dissolved uranium concentrations used to define the current plume configuration • Evaluate possible connectivity between former sampling locations 506 and 808.

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Table 3-2. RIR Addendum SAP TWP Justification for EU 4

Exposure Unit	TWP	Location Description	Justification
EU 4	TWP927	Northeast of plume, south of N Street, near former 408 trench sample locations	• Define the northwest extent of VOC and uranium groundwater contamination • Evaluate sand lens per HGL cross section G-G' • Confirm presence of minor concentrations of VOCs in former trench location
	TWP928	Northwest of plume, south of N Street	• Define the northwest extent of VOC and uranium groundwater contamination • Downgradient of the leading edge of the plume area • Evaluate connectivity of sand lenses • Obtain groundwater concentration information for this area of EU 4 (data gap)
	TWP929	Northwest of plume, southwest of proposed location TWP928	• Define the extent of VOC and uranium groundwater plumes • Downgradient of the leading edge of the plume area • Evaluate connectivity of sand lenses • Obtain groundwater concentration information for this area of EU 4 (data gap)
	TWP930	Slightly northeast of plume between proposed locations TWP927 and TWP932	• Define the extent and confirm the current configuration of VOC and uranium groundwater plumes • Evaluate connectivity of sand lenses to the north and northwest
	TWP931	Within northwestern leading edge of plume	• Define the northwest extent and confirm the current configuration of VOC and uranium groundwater plumes
	TWP932[1]	Within plume; north of well 415A	• Define the extent and confirm the current configuration of VOC, metal and uranium groundwater plumes • Location of a soil gas analysis near the current configuration of the plume • Evaluate sand lenses north of 415A • Investigate DNAPL associated with well 415A
	TWP933[1]	Within northeast edge of plume; west of well 415A	• Location of a soil gas analysis near a suspected high concentration area of the plume • Investigate DNAPL associated with well 415A
	TWP934[1]	Within northeast edge of plume; south of well 415A	• Location of a soil gas analysis in the downgradient direction of the plume area • Investigate DNAPL associated with well 415A

[1]TWP932, TWP933, and TWP934 locations were altered from the preliminary SAP locations in the field due to the screening results, see Section 3.3.2.1 for more details.

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Table 3-3. RIR Addendum SAP TWP Justification for EUs 7, 9 and 10

Exposure Unit	TWP	Location Description	Justification
EU 7	TWP936	Northwest of IWCS in the southwest corner of EU 7; on the border of EU7 and 10	• Define the extent of potential groundwater contamination to the northwest of the IWCS. • Evaluate downgradient connectivity to the minor sand lens (2 ft thickness) identified at former sampling location BH49
EU 9	TWP935	Northwest of IWCS near the WDD	• Further define potential groundwater contamination along the northwestern side of the IWCS downgradient of plume
	TWP938	West of the IWCS near the WDD; between existing wells OW14B and OW15B	• Further define potential groundwater contamination along the western side of the IWCS
EU 10	TWP937	North of the IWCS; east of TWP936; between BH49A and OW5B	• Further define potential groundwater contamination along the northern side of the IWCS • Evaluate concentration gradient between BH49A and OW5B
	TWP939	West of the northern portion of the IWCS	• Further define groundwater contamination along the western side of the IWCS • Evaluate connectivity of sand lenses between OW15A and A19 as suggested by the cross-section review performed by HGL
	TWP940[1]	West of the IWCS near the WDD	• Further define the extent of potential groundwater contamination along the western side of the IWCS
	TWP941[1]	West of the southern portion of the IWCS	• Further define potential groundwater contamination along the southwestern side of the IWCS • Evaluate connectivity to groundwater contamination observed at well OW18B
	TWP942	Southwest of the IWCS	• Further define potential groundwater contamination to the southwest of the IWCS (data gap) • Evaluate the potential connection between Building 409 plume and OW18B • Location is upgradient of well OW18B, where groundwater contamination has been identified
	TWP943	South of the IWCS along the west side of Building 409	• Further define groundwater contamination along the southern side of the IWCS • Evaluate sand lens • Evaluate the potential connection between Building 409 plume and the IWCS

[1]TWP940 and TWP941 were relocated in the field to EU 9 outside of the NFSS boundary.

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Table 3-4. RIR Addendum Analytical Parameters by Sampling Event

		Soil												Geotechnical			Groundwater Screening			Soil Gas	Permanent Well Groundwater											
EU	Temporary Well Point	Isotopic Thorium	Isotopic Uranium	Isotopic Plutonium	Strontium-90	Radium 226/228	Gamma Spectroscopy[1]	Metals	Metals + Boron and Lithium	PCB/Pesticide	VOCs	SVOCs	PAHs	Soil Moisture	Bulk Density	Porosity	Isotopic Uranium	Metals + Boron and Lithium	VOCs	VOCs by TO-15	Isotopic Thorium	Isotopic Uranium	Isotopic Plutonium	Strontium-90	Radium 226/228	Gamma Spectroscopy[1]	Metals	Metals + Boron and Lithium	PCB/Pesticide	VOCs	SVOCs	PAHs
EU 1	TWP921	X	X	X	X	X	X	X		X	X	X	X				X				X	X	X	X	X	X	X	X	X	X	X	X
EU 1	TWP922	X	X	X	X	X	X	X		X	X	X	X				X				X	X	X	X	X	X	X	X	X	X	X	X
EU 1	TWP923	X	X	X	X	X	X	X		X	X	X	X				X				X	X	X	X	X	X	X	X	X	X	X	X
EU 1	TWP924	X	X	X	X	X	X	X		X	X	X	X				X				Abandoned											
EU 1	TWP925	X	X	X	X	X	X	X		X	X	X	X				X				Abandoned											
EU 2	TWP926	X	X	X	X	X	X	X		X	X	X	X				X				Abandoned											
EU 4	TWP927	X	X	X	X	X	X	X		X	X	X	X				X				Abandoned											
EU 4	TWP928	X	X	X	X	X	X	X		X	X	X	X				X				Abandoned											
EU 4	TWP929	X	X	X	X	X	X	X		X	X	X	X				X				Abandoned											
EU 4	TWP930	X	X	X	X	X	X	X		X	X	X	X				X				X	X			X	X	X	X	X	X	X	X
EU 4	TWP931	X	X	X	X	X	X	X		X	X	X	X				X				Abandoned											
EU 4	TWP932		X						X		X			X	X	X	X	X	X	X	Abandoned											
EU 4	TWP933		X						X		X			X	X	X	X	X	X	X	Dry - Abandoned											
EU 4	TWP934		X						X		X			X	X	X	X	X	X	X	X	X			X	X	X	X	X	X	X	X
EU 9	TWP935	X	X	X	X	X	X	X		X	X	X	X				X				X	X			X	X	X	X	X	X	X	X
EU 10	TWP936	X	X	X	X	X	X	X		X	X	X	X				X				X	X			X	X	X	X	X	X	X	X
EU 10	TWP937	X	X	X	X	X	X	X		X	X	X	X				X				Abandoned											
EU 9	TWP938	X	X	X	X	X	X	X		X	X	X	X				X				X	X			X	X	X	X	X	X	X	X
EU 10	TWP939	X	X	X	X	X	X	X		X	X	X	X				X				Abandoned											
EU 9	TWP940	X	X	X	X	X	X	X		X	X	X	X				X				Abandoned											
EU 9	TWP941	X	X	X	X	X	X	X		X	X	X	X				X				X	X			X	X	X	X	X	X	X	X
EU 10	TWP942	X	X	X	X	X	X	X		X	X	X	X				X				Abandoned											
EU 10	TWP943	X	X	X	X	X	X	X		X	X	X	X				X				X	X			X	X	X	X	X	X	X	X

[1]Gamma Spectroscopy includes: U-235, U-238, Ra-226, Ra-228, Th-228, Pa-231, Ac-227, Co-60, Cs-137, K-40, Am-241
Full list of compounds presented in Table 3-5.
Note: When TWPs are converted to permanent monitoring wells the location identifier changes to MW (i.e. TWP930 was converted to permanent monitoring well MW930).

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Table 3-5. Analytical Methods for the RI Addendum Investigation

Parameter	Analytical Method
Soils	
Isotopic Plutonium	Alpha Spectroscopy – HASL 300
Isotopic Thorium	Alpha Spectroscopy – HASL 300
Isotopic Uranium	Alpha Spectroscopy – HASL 300
Radium-226	EPA 903 Mod-Lucas Cell/Emanation/GFPC
Radium-228	EPA 904 Mod - GFPC
Strontium-90	EPA 905.0 Mod
Gamma Spectroscopy[1]	Gamma Spectroscopy – HASL 300
Total VOCs	SW-846 8260B
Total SVOCs	SW-846 8270C
PAHs	SW-846 8310
PCBs	SW-846 8082
Total Pesticides	SW-846 8081A
TAL Metals	SW-846 6010B/7470A
TAL Metals + Boron + Lithium	SW-846 6010B/7470A
Geotechnical Parameters	
Soil Moisture	ASTM D2216
Bulk Density	ASTM D5057
Porosity	USACE EM 1110-2-1906 App II
Groundwater	
Isotopic Plutonium	Alpha Spectroscopy – HASL 300
Isotopic Thorium	Alpha Spectroscopy – HASL 300
Isotopic Uranium	Alpha Spectroscopy – HASL 300
Radium-226	EPA 903 Mod-Lucas Cell/Emanation/GFPC
Radium-228	EPA 904 Mod - GFPC
Strontium-90	EPA 905.0 Mod
Gamma Spectroscopy[1]	Gamma Spectroscopy – HASL 300
VOCs	SW-846 8260B
SVOCs	SW-846 8270C
PAHs	SW-846 8310
PCBs	SW-846 8082
Pesticides	SW-846 8081A
TAL Metals	SW-846 6010B/7470A
TAL Metals + Boron and Lithium	SW-846 6010B/7470A
Soil Gas	
VOCs	TO-15

[1]Gamma Spectroscopy includes: U-235, U-238, Ra-226, Ra-228, Th-228, Pa-231, Ac-227, Co-60, Cs-137, K-40, Am-241

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Table 3-6. EU 1 Area VOC Soil Results

Station	TWP921	TWP921	TWP921	TWP922	TWP922	TWP923	TWP923
Sample No	921SS0.0-0.5-0001	921SS0.0-0.5-9002	921SB14.0-16.0-0002	922SS0.0-0.5-0005	922SB12.0-14.0-0006	923SS0.0-0.5-0009	923SS16.0-18.0-0009
Collection Date	11/23/2009	11/23/2009	11/23/2009	11/17/2009	11/18/2009	11/17/2009	11/17/2009
Sample Depth (ft bgs)	0-0.5	0-0.5	14-16	0-0.5	12-14	0-0.5	16-18
Volatile Organic Compounds							
1,1,1-Trichloroethane (µg/kg)	0.343 U	0.343 U	0.365 U	0.352 U	0.349 U	0.322 U	0.364 U
1,1,2,2-Tetrachloroethane (µg/kg)	0.343 U	0.343 U	0.365 U	0.352 U	0.349 U	0.322 U	0.364 U
1,1,2-Trichloroethane (µg/kg)	0.343 U	0.343 U	0.365 U	0.352 U	0.349 U	0.322 U	0.364 U
1,1-Dichloroethane (µg/kg)	0.343 U	0.343 U	0.365 U	0.352 U	0.349 U	0.322 U	0.364 U
1,1-Dichloroethylene (µg/kg)	0.343 U	0.343 U	0.365 U	0.352 U	0.349 U	0.322 U	0.364 U
1,2-Dichloroethane (µg/kg)	0.343 U	0.343 U	0.365 U	0.352 U	0.349 U	0.322 U	0.364 U
1,2-Dichloropropane (µg/kg)	0.343 U	0.343 U	0.365 U	0.352 U	0.349 U	0.322 U	0.364 U
2-Butanone (µg/kg)	1.71 U	1.71 U	1.83 U	1.76 U	1.74 U	1.61 U	1.82 U
2-Hexanone (µg/kg)	1.71 U	1.71 U	1.83 U	1.76 U	1.74 U	1.61 U	1.82 U
4-Methyl-2-pentanone (µg/kg)	1.43 U	1.43 U	1.52 U	1.47 U	1.45 U	1.34 U	1.52 U
Acetone (µg/kg)	1.9 U	1.9 U	3.09 J	1.95 U	1.93 U	1.78 U	2.01 U
Benzene (µg/kg)	0.343 U	0.343 U	0.365 U	0.352 U	0.349 U	0.322 U	0.364 U
Bromodichloromethane (µg/kg)	0.343 U	0.343 U	0.365 U	0.352 U	0.349 U	0.322 U	0.364 U
Bromoform (µg/kg)	0.343 U	0.343 U	0.365 U	0.352 U	0.349 U	0.322 U	0.364 U
Bromomethane (µg/kg)	0.343 U	0.343 U	0.365 U	0.352 U	0.349 U	0.322 U	0.364 U
Carbon disulfide (µg/kg)	1.43 U	1.43 U	1.52 U	1.47 U	1.45 U	1.34 U	1.52 U
Carbon tetrachloride (µg/kg)	0.343 U	0.343 U	0.365 U	0.352 U	0.349 U	0.322 U	0.364 U
Chlorobenzene (µg/kg)	0.343 U	0.343 U	0.365 U	0.352 U	0.349 U	0.322 U	0.364 U
Chloroethane (µg/kg)	0.343 U	0.343 U	0.365 U	0.352 U	0.349 U	0.322 U	0.364 U
Chloroform (µg/kg)	0.343 U	0.343 U	0.365 U	0.352 U	0.349 U	0.322 U	0.364 U
Chloromethane (µg/kg)	0.343 U	0.343 U	0.365 U	0.352 U	0.349 U	0.322 U	0.364 U
cis-1,2-Dichloroethylene (µg/kg)	0.343 U	0.343 U	0.365 U	0.352 U	0.349 U	0.322 U	0.364 U
cis-1,3-Dichloropropylene (µg/kg)	0.343 U	0.343 U	0.365 U	0.352 U	0.349 U	0.322 U	0.364 U
Ethylbenzene (µg/kg)	0.343 U	0.343 U	0.365 U	0.352 U	0.349 U	0.322 U	0.364 U
Methylene chloride (µg/kg)	2.29 U	2.28 U	2.43 U	7.35	2.32 U	2.15 U	2.43 U
Styrene (µg/kg)	0.343 U	0.343 U	0.365 U	0.352 U	0.349 U	0.322 U	0.364 U
Tetrachloroethylene (µg/kg)	0.343 U	0.343 U	0.365 U	0.352 U	0.349 U	0.322 U	0.364 U
Toluene (µg/kg)	5.34	1.23	0.365 U	0.352 U	0.349 U	0.322 U	0.364 U
trans-1,2-Dichloroethylene (µg/kg)	0.343 U	0.343 U	0.365 U	0.352 U	0.349 U	0.322 U	0.364 U
trans-1,3-Dichloropropylene (µg/kg)	0.343 U	0.343 U	0.365 U	0.352 U	0.349 U	0.322 U	0.364 U
Trichloroethylene (µg/kg)	0.377 U	0.377 U	0.402 U	0.387 U	0.383 U	0.354 U	0.4 U
Vinyl chloride (µg/kg)	0.343 U	0.343 U	0.365 U	0.352 U	0.349 U	0.322 U	0.364 U
Xylenes (total) (µg/kg)	0.56 J	0.343 U	0.365 U	0.352 U	0.349 U	0.322 U	0.364 U

Table 3-6. EU 1 Area VOC Soil Results

Station	TWP924	TWP924	TWP924	TWP925	TWP925	TWP926	TWP926
Sample No	924SS0.0-0.5-0013	924SS0.0-0.5-9001	924SB12.0-14.0-0014	925SS0.0-0.5-0017	925SB10.0-12.0-0018	926SS0.0-0.5-0021	926SB8.0-10.0-0022
Collection Date	11/19/2009	11/19/2009	11/19/2009	11/18/2009	11/18/2009	11/19/2009	11/19/2009
Sample Depth (ft bgs)	0-0.5	0-0.5	12-14	0-0.5	10-12	0-0.5	8-12
Volatile Organic Compounds							
1,1,1-Trichloroethane (µg/kg)	0.402 U	0.406 U	0.333 U	0.36 U	0.348 U	0.408 U	0.382 U
1,1,2,2-Tetrachloroethane (µg/kg)	0.402 U	0.406 U	0.333 U	0.36 U	0.348 U	0.408 U	0.382 U
1,1,2-Trichloroethane (µg/kg)	0.402 U	0.406 U	0.333 U	0.36 U	0.348 U	0.408 U	0.382 U
1,1-Dichloroethane (µg/kg)	0.402 U	0.406 U	0.333 U	0.36 U	0.348 U	0.408 U	0.382 U
1,1-Dichloroethylene (µg/kg)	0.402 U	0.406 U	0.333 U	0.36 U	0.348 U	0.408 U	0.382 U
1,2-Dichloroethane (µg/kg)	0.402 U	0.406 U	0.333 U	0.36 U	0.348 U	0.408 U	0.382 U
1,2-Dichloropropane (µg/kg)	0.402 U	0.406 U	0.333 U	0.36 U	0.348 U	0.408 U	0.382 U
2-Butanone (µg/kg)	2.01 U	2.03 U	1.67 U	1.8 U	1.74 U	2.04 U	1.91 U
2-Hexanone (µg/kg)	2.01 U	2.03 U	1.67 U	1.8 U	1.74 U	2.04 U	1.91 U
4-Methyl-2-pentanone (µg/kg)	1.67 U	1.69 U	1.39 U	1.5 U	1.45 U	1.7 U	1.59 U
Acetone (µg/kg)	2.22 U	2.25 U	1.84 U	1.99 U	1.92 U	2.26 U	2.11 U
Benzene (µg/kg)	0.402 U	0.406 U	0.333 U	0.36 U	0.348 U	0.408 U	0.382 U
Bromodichloromethane (µg/kg)	0.402 U	0.406 U	0.333 U	0.36 U	0.348 U	0.408 U	0.382 U
Bromoform (µg/kg)	0.402 U	0.406 U	0.333 U	0.36 U	0.348 U	0.408 U	0.382 U
Bromomethane (µg/kg)	0.402 U	0.406 U	0.333 U	0.36 U	0.348 U	0.408 U	0.382 U
Carbon disulfide (µg/kg)	1.67 U	1.69 U	1.39 U	1.5 U	1.45 U	1.7 U	1.59 U
Carbon tetrachloride (µg/kg)	0.402 U	0.406 U	0.333 U	0.36 U	0.348 U	0.408 U	0.382 U
Chlorobenzene (µg/kg)	0.402 U	0.406 U	0.333 U	0.36 U	0.348 U	0.408 U	0.382 U
Chloroethane (µg/kg)	0.402 U	0.406 U	0.333 U	0.36 U	0.348 U	0.408 U	0.382 U
Chloroform (µg/kg)	0.402 U	0.406 U	0.333 U	0.36 U	0.348 U	0.408 U	0.382 U
Chloromethane (µg/kg)	0.402 U	0.406 U	0.333 U	0.36 U	0.348 U	0.408 U	0.382 U
cis-1,2-Dichloroethylene (µg/kg)	0.402 U	0.406 U	0.333 U	0.36 U	0.348 U	0.408 U	0.382 U
cis-1,3-Dichloropropylene (µg/kg)	0.402 U	0.406 U	0.333 U	0.36 U	0.348 U	0.408 U	0.382 U
Ethylbenzene (µg/kg)	0.402 U	0.406 U	0.333 U	0.36 U	0.348 U	0.408 U	0.382 U
Methylene chloride (µg/kg)	2.68 U	2.71 U	3.07 J	2.4 U	4.61 J	2.72 U	5.03 J
Styrene (µg/kg)	0.402 U	0.406 U	0.333 U	0.36 U	0.348 U	0.408 U	0.382 U
Tetrachloroethylene (µg/kg)	0.402 U	0.731 J	0.333 U	0.36 U	0.348 U	0.408 U	0.382 U
Toluene (µg/kg)	0.402 U	0.406 U	0.333 U	0.36 U	0.348 U	0.408 U	0.382 U
trans-1,2-Dichloroethylene (µg/kg)	0.402 U	0.406 U	0.333 U	0.36 U	0.348 U	0.408 U	0.382 U
trans-1,3-Dichloropropylene (µg/kg)	0.402 U	0.406 U	0.333 U	0.36 U	0.348 U	0.408 U	0.382 U
Trichloroethylene (µg/kg)	0.442 U	0.447 U	0.367 U	0.396 U	0.383 U	0.448 U	0.42 U
Vinyl chloride (µg/kg)	0.402 U	0.406 U	0.333 U	0.36 U	0.348 U	0.408 U	0.382 U
Xylenes (total) (µg/kg)	0.402 U	0.406 U	0.333 U	0.36 U	0.348 U	0.408 U	0.382 U

Table 3-7. EU 1 Area SVOC Soil Results

Station	TWP921	TWP921	TWP921	TWP922	TWP922
Sample No	921SS0.0-0.5-0001	921SS0.0-0.5-9002	921SB14.0-16.0-0002	922SS0.0-0.5-0005	922SB12.0-14.0-0006
Collection Date	11/23/2009	11/23/2009	11/23/2009	11/17/2009	11/18/2009
Sample Depth (ft bgs)	0-0.5	0-0.5	14-16	0-0.5	12-14
Semi-Volatile Organic Compounds					
1,1'-Biphenyl (µg/kg)	114 U	1140 U	121 U	117 U	115 U
2,4,5-Trichlorophenol (µg/kg)	75.8 U	758 U	80.7 U	78.2 U	77 U
2,4,6-Trichlorophenol (µg/kg)	75.8 U	758 U	80.7 U	78.2 U	77 U
2,4-Dichlorophenol (µg/kg)	75.8 U	758 U	80.7 U	78.2 U	77 U
2,4-Dimethylphenol (µg/kg)	133 U	1330 U	141 U	137 U	135 U
2,4-Dinitrophenol (µg/kg)	144 U	1440 U	153 U	149 U	146 U
2,4-Dinitrotoluene (µg/kg)	37.9 U	379 U	40.3 U	39.1 U	38.5 U
2,6-Dinitrotoluene (µg/kg)	37.9 U	379 U	40.3 U	39.1 U	38.5 U
2-Chloronaphthalene (µg/kg)	12.5 U	125 U	13.3 U	12.9 U	12.7 U
2-Chlorophenol (µg/kg)	75.8 U	758 U	80.7 U	78.2 U	77 U
2-Methyl-4,6-dinitrophenol (µg/kg)	75.8 U	758 U	80.7 U	78.2 U	77 U
2-Methylnaphthalene (µg/kg)	7.58 U	75.8 U	8.07 U	7.82 U	7.7 U
2-Nitrophenol (µg/kg)	75.8 U	758 U	80.7 U	78.2 U	77 U
3,3'-Dichlorobenzidine (µg/kg)	114 U	1140 U	121 U	117 U	115 U
4-Bromophenylphenylether (µg/kg)	75.8 U	758 U	80.7 U	78.2 U	77 U
4-Chloro-3-methylphenol (µg/kg)	75.8 U	758 U	80.7 U	78.2 U	77 U
4-Chloroaniline (µg/kg)	75.8 U	758 U	80.7 U	78.2 U	77 U
4-Chlorophenylphenylether (µg/kg)	75.8 U	758 U	80.7 U	78.2 U	77 U
4-Nitrophenol (µg/kg)	125 U	1250 U	133 U	129 U	127 U
Acenaphthene (µg/kg)	12.5 U	125 U	13.3 U	12.9 U	12.7 U
Acenaphthylene (µg/kg)	11.4 U	456	12.1 U	11.7 U	11.5 U
Acetophenone (µg/kg)	75.8 U	758 U	80.7 U	78.2 U	77 U
Anthracene (µg/kg)	7.58 U	131 J	8.07 U	7.82 U	7.7 U
Atrazine (µg/kg)	114 U	1140 U	121 U	117 U	115 U
Benzaldehyde (µg/kg)	114 U	1140 U	121 U	117 U	115 U
Benzo(a)anthracene (µg/kg)	36.3 J	924	12.1 U	11.7 U	11.5 U
Benzo(a)pyrene (µg/kg)	40.9	1900	12.1 U	11.7 U	11.5 U
Benzo(b)fluoranthene (µg/kg)	75.1	2910	12.1 U	11.7 U	11.5 U
Benzo(ghi)perylene (µg/kg)	40.1	1350	12.1 U	11.7 U	11.5 U
Benzo(k)fluoranthene (µg/kg)	11.4 U	114 U	12.1 U	11.7 U	11.5 U
bis(2-Chloroethoxy)methane (µg/kg)	75.8 U	758 U	80.7 U	78.2 U	77 U
bis(2-Chloroethyl) ether (µg/kg)	75.8 U	758 U	80.7 U	78.2 U	77 U
bis(2-Chloroisopropyl)ether (µg/kg)	75.8 U	758 U	80.7 U	78.2 U	77 U
bis(2-Ethylhexyl)phthalate (µg/kg)	75.8 U	758 U	80.7 U	78.2 U	77 U
Butylbenzylphthalate (µg/kg)	75.8 U	758 U	80.7 U	78.2 U	77 U
Caprolactam (µg/kg)	75.8 U	758 U	80.7 U	78.2 U	77 U
Carbazole (µg/kg)	11.4 U	114 U	12.1 U	11.7 U	11.5 U
Chrysene (µg/kg)	33.2 J	1050	12.1 U	11.7 U	11.5 U
Dibenzo(a,h)anthracene (µg/kg)	11.4 U	114 U	12.1 U	11.7 U	11.5 U
Dibenzofuran (µg/kg)	75.8 U	758 U	80.7 U	78.2 U	77 U
Diethylphthalate (µg/kg)	75.8 U	758 U	80.7 U	78.2 U	77 U
Dimethylphthalate (µg/kg)	75.8 U	758 U	80.7 U	78.2 U	77 U
Di-n-butylphthalate (µg/kg)	75.8 U	758 U	80.7 U	78.2 U	77 U
Di-n-octylphthalate (µg/kg)	75.8 U	758 U	80.7 U	78.2 U	77 U
Diphenylamine (µg/kg)	75.8 U	758 U	80.7 U	78.2 U	77 U
Fluoranthene (µg/kg)	58.6	790	12.1 U	11.7 U	11.5 U
Fluorene (µg/kg)	11.4 U	114 U	12.1 U	11.7 U	11.5 U
Hexachlorobenzene (µg/kg)	75.8 U	758 U	80.7 U	78.2 U	77 U
Hexachlorobutadiene (µg/kg)	75.8 U	758 U	80.7 U	78.2 U	77 U
Hexachlorocyclopentadiene (µg/kg)	75.8 U	758 U	80.7 U	78.2 U	77 U
Hexachloroethane (µg/kg)	75.8 U	758 U	80.7 U	78.2 U	77 U
Indeno(1,2,3-cd)pyrene (µg/kg)	30.2 J	1200	12.1 U	11.7 U	11.5 U
Isophorone (µg/kg)	75.8 U	758 U	80.7 U	78.2 U	77 U
m,p-Cresols (µg/kg)	114 U	1140 U	121 U	117 U	115 U
m-Nitroaniline (µg/kg)	75.8 U	758 U	80.7 U	78.2 U	77 U
Naphthalene (µg/kg)	11.4 U	114 U	12.1 U	11.7 U	11.5 U
Nitrobenzene (µg/kg)	75.8 U	758 U	80.7 U	78.2 U	77 U
N-Nitrosodipropylamine (µg/kg)	75.8 U	758 U	80.7 U	78.2 U	77 U
o-Cresol (µg/kg)	75.8 U	758 U	80.7 U	78.2 U	77 U
o-Nitroaniline (µg/kg)	75.8 U	758 U	80.7 U	78.2 U	77 U
Pentachlorophenol (µg/kg)	94.7 U	948 U	101 U	97.7 U	96.2 U
Phenanthrene (µg/kg)	11.4 U	114 U	12.1 U	11.7 U	11.5 U
Phenol (µg/kg)	75.8 U	758 U	80.7 U	78.2 U	77 U
p-Nitroaniline (µg/kg)	114 U	1140 U	121 U	117 U	115 U
Pyrene (µg/kg)	48.7	2160	12.1 U	11.7 U	11.5 U

Table 3-7. EU 1 Area SVOC Soil Results

Station	TWP923	TWP923	TWP924	TWP924	TWP924
Sample No	923SS0.0-0.5-0009	923SS16.0-18.0-0009	924SS0.0-0.5-0013	924SS0.0-0.5-9001	924SB12.0-14.0-0014
Collection Date	11/17/2009	11/17/2009	11/19/2009	11/19/2009	11/19/2009
Sample Depth (ft bgs)	0-0.5	16-18	0-0.5	0-0.5	12-14
Semi-Volatile Organic Compounds					
1,1'-Biphenyl (µg/kg)	107 U	121 U	133 U	135 U	110 U
2,4,5-Trichlorophenol (µg/kg)	71.4 U	80.5 U	88.8 U	90.2 U	73.6 U
2,4,6-Trichlorophenol (µg/kg)	71.4 U	80.5 U	88.8 U	90.2 U	73.6 U
2,4-Dichlorophenol (µg/kg)	71.4 U	80.5 U	88.8 U	90.2 U	73.6 U
2,4-Dimethylphenol (µg/kg)	125 U	141 U	155 U	158 U	129 U
2,4-Dinitrophenol (µg/kg)	136 U	153 U	169 U	171 U	140 U
2,4-Dinitrotoluene (µg/kg)	35.7 U	40.3 U	44.4 U	45.1 U	36.8 U
2,6-Dinitrotoluene (µg/kg)	35.7 U	40.3 U	44.4 U	45.1 U	36.8 U
2-Chloronaphthalene (µg/kg)	11.8 U	13.3 U	14.7 U	14.9 U	12.1 U
2-Chlorophenol (µg/kg)	71.4 U	80.5 U	88.8 U	90.2 U	73.6 U
2-Methyl-4,6-dinitrophenol (µg/kg)	71.4 U	80.5 U	88.8 U	90.2 U	73.6 U
2-Methylnaphthalene (µg/kg)	7.14 U	8.05 U	8.88 U	9.02 U	7.36 U
2-Nitrophenol (µg/kg)	71.4 U	80.5 U	88.8 U	93.1 J	73.6 U
3,3'-Dichlorobenzidine (µg/kg)	107 U	121 U	133 U	135 U	110 U
4-Bromophenylphenylether (µg/kg)	71.4 U	80.5 U	88.8 U	90.2 U	73.6 U
4-Chloro-3-methylphenol (µg/kg)	71.4 U	80.5 U	88.8 U	90.2 U	73.6 U
4-Chloroaniline (µg/kg)	71.4 U	80.5 U	88.8 U	90.2 U	73.6 U
4-Chlorophenylphenylether (µg/kg)	71.4 U	80.5 U	88.8 U	90.2 U	73.6 U
4-Nitrophenol (µg/kg)	118 U	133 U	147 U	149 U	121 U
Acenaphthene (µg/kg)	11.8 U	13.3 U	14.7 U	14.9 U	12.1 U
Acenaphthylene (µg/kg)	10.7 U	12.1 U	13.3 U	13.5 U	11 U
Acetophenone (µg/kg)	71.4 U	80.5 U	88.8 U	90.2 U	73.6 U
Anthracene (µg/kg)	7.14 U	8.05 U	8.88 U	9.02 U	7.36 U
Atrazine (µg/kg)	107 U	121 U	133 U	135 U	110 U
Benzaldehyde (µg/kg)	107 U	121 U	133 U	135 U	110 U
Benzo(a)anthracene (µg/kg)	10.7 U	12.1 U	13.3 U	13.5 U	11 U
Benzo(a)pyrene (µg/kg)	10.7 U	12.1 U	13.3 U	13.5 U	11 U
Benzo(b)fluoranthene (µg/kg)	10.7 U	12.1 U	17.8 J	21.5 J	11 U
Benzo(ghi)perylene (µg/kg)	10.7 U	12.1 U	13.3 U	13.5 U	11 U
Benzo(k)fluoranthene (µg/kg)	10.7 U	12.1 U	13.3 U	13.5 U	11 U
bis(2-Chloroethoxy)methane (µg/kg)	71.4 U	80.5 U	88.8 U	90.2 U	73.6 U
bis(2-Chloroethyl) ether (µg/kg)	71.4 U	80.5 U	88.8 U	90.2 U	73.6 U
bis(2-Chloroisopropyl)ether (µg/kg)	71.4 U	80.5 U	88.8 U	90.2 U	73.6 U
bis(2-Ethylhexyl)phthalate (µg/kg)	71.4 U	80.5 U	88.8 U	90.2 U	73.6 U
Butylbenzylphthalate (µg/kg)	71.4 U	80.5 U	88.8 U	90.2 U	73.6 U
Caprolactam (µg/kg)	71.4 U	80.5 U	88.8 U	90.2 U	73.6 U
Carbazole (µg/kg)	10.7 U	12.1 U	13.3 U	13.5 U	11 U
Chrysene (µg/kg)	10.7 U	12.1 U	13.3 U	13.5 U	11 U
Dibenzo(a,h)anthracene (µg/kg)	10.7 U	12.1 U	13.3 U	13.5 U	11 U
Dibenzofuran (µg/kg)	71.4 U	80.5 U	88.8 U	90.2 U	73.6 U
Diethylphthalate (µg/kg)	71.4 U	80.5 U	88.8 U	90.2 U	73.6 U
Dimethylphthalate (µg/kg)	71.4 U	80.5 U	88.8 U	90.2 U	73.6 U
Di-n-butylphthalate (µg/kg)	71.4 U	80.5 U	88.8 U	90.2 U	73.6 U
Di-n-octylphthalate (µg/kg)	71.4 U	80.5 U	88.8 U	90.2 U	73.6 U
Diphenylamine (µg/kg)	71.4 U	80.5 U	88.8 U	90.2 U	73.6 U
Fluoranthene (µg/kg)	10.7 U	12.1 U	14.2 J	16.5 J	11 U
Fluorene (µg/kg)	10.7 U	12.1 U	13.3 U	13.5 U	11 U
Hexachlorobenzene (µg/kg)	71.4 U	80.5 U	88.8 U	90.2 U	73.6 U
Hexachlorobutadiene (µg/kg)	71.4 U	80.5 U	88.8 U	90.2 U	73.6 U
Hexachlorocyclopentadiene (µg/kg)	71.4 U	80.5 U	88.8 U	90.2 U	73.6 U
Hexachloroethane (µg/kg)	71.4 U	80.5 U	88.8 U	90.2 U	73.6 U
Indeno(1,2,3-cd)pyrene (µg/kg)	10.7 U	12.1 U	13.3 U	13.5 U	11 U
Isophorone (µg/kg)	71.4 U	80.5 U	88.8 U	90.2 U	73.6 U
m,p-Cresols (µg/kg)	107 U	121 U	133 U	135 U	110 U
m-Nitroaniline (µg/kg)	71.4 U	80.5 U	88.8 U	90.2 U	73.6 U
Naphthalene (µg/kg)	10.7 U	12.1 U	13.3 U	13.5 U	11 U
Nitrobenzene (µg/kg)	71.4 U	80.5 U	88.8 U	90.2 U	73.6 U
N-Nitrosodipropylamine (µg/kg)	71.4 U	80.5 U	88.8 U	90.2 U	73.6 U
o-Cresol (µg/kg)	71.4 U	80.5 U	88.8 U	90.2 U	73.6 U
o-Nitroaniline (µg/kg)	71.4 U	80.5 U	88.8 U	90.2 U	73.6 U
Pentachlorophenol (µg/kg)	89.3 U	101 U	111 U	113 U	92 U
Phenanthrene (µg/kg)	10.7 U	12.1 U	13.3 U	13.5 U	11 U
Phenol (µg/kg)	71.4 U	80.5 U	88.8 U	90.2 U	73.6 U
p-Nitroaniline (µg/kg)	107 U	121 U	133 U	135 U	110 U
Pyrene (µg/kg)	10.7 U	12.1 U	13.3 U	13.5 U	11 U

Table 3-7. EU 1 Area SVOC Soil Results

Station	TWP925	TWP925	TWP926	TWP926
Sample No	925SS0.0-0.5-0017	925SB10.0-12.0-0018	926SS0.0-0.5-0021	926SB8.0-10.0-0022
Collection Date	11/18/2009	11/18/2009	11/19/2009	11/19/2009
Sample Depth (ft bgs)	0-0.5	10-12	0-0.5	8-12
Semi-Volatile Organic Compounds				
1,1'-Biphenyl (µg/kg)	119 U	116 U	135 U	127 U
2,4,5-Trichlorophenol (µg/kg)	79.5 U	77.1 U	90.3 U	84.8 U
2,4,6-Trichlorophenol (µg/kg)	79.5 U	77.1 U	90.3 U	84.8 U
2,4-Dichlorophenol (µg/kg)	79.5 U	77.1 U	90.3 U	84.8 U
2,4-Dimethylphenol (µg/kg)	139 U	135 U	158 U	148 U
2,4-Dinitrophenol (µg/kg)	151 U	146 U	172 U	161 U
2,4-Dinitrotoluene (µg/kg)	39.8 U	38.5 U	45.2 U	42.4 U
2,6-Dinitrotoluene (µg/kg)	39.8 U	38.5 U	45.2 U	42.4 U
2-Chloronaphthalene (µg/kg)	13.1 U	12.7 U	14.9 U	14 U
2-Chlorophenol (µg/kg)	79.5 U	77.1 U	90.3 U	84.8 U
2-Methyl-4,6-dinitrophenol (µg/kg)	79.5 U	77.1 U	90.3 U	84.8 U
2-Methylnaphthalene (µg/kg)	7.95 U	7.71 U	9.03 U	8.48 U
2-Nitrophenol (µg/kg)	79.5 U	77.1 U	90.3 U	84.8 U
3,3'-Dichlorobenzidine (µg/kg)	119 U	116 U	135 U	127 U
4-Bromophenylphenylether (µg/kg)	79.5 U	77.1 U	90.3 U	84.8 U
4-Chloro-3-methylphenol (µg/kg)	79.5 U	77.1 U	90.3 U	84.8 U
4-Chloroaniline (µg/kg)	79.5 U	77.1 U	90.3 U	84.8 U
4-Chlorophenylphenylether (µg/kg)	79.5 U	77.1 U	90.3 U	84.8 U
4-Nitrophenol (µg/kg)	131 U	127 U	149 U	140 U
Acenaphthene (µg/kg)	13.1 U	12.7 U	14.9 U	14 U
Acenaphthylene (µg/kg)	11.9 U	11.6 U	13.5 U	12.7 U
Acetophenone (µg/kg)	79.5 U	77.1 U	90.3 U	84.8 U
Anthracene (µg/kg)	7.95 U	7.71 U	9.03 U	8.48 U
Atrazine (µg/kg)	119 U	116 U	135 U	127 U
Benzaldehyde (µg/kg)	119 U	116 U	135 U	127 U
Benzo(a)anthracene (µg/kg)	11.9 U	11.6 U	13.5 U	12.7 U
Benzo(a)pyrene (µg/kg)	11.9 U	11.6 U	13.5 U	12.7 U
Benzo(b)fluoranthene (µg/kg)	19.7 J	11.6 U	13.5 U	12.7 U
Benzo(ghi)perylene (µg/kg)	11.9 U	11.6 U	13.5 U	12.7 U
Benzo(k)fluoranthene (µg/kg)	11.9 U	11.6 U	13.5 U	12.7 U
bis(2-Chloroethoxy)methane (µg/kg)	79.5 U	77.1 U	90.3 U	84.8 U
bis(2-Chloroethyl) ether (µg/kg)	79.5 U	77.1 U	90.3 U	84.8 U
bis(2-Chloroisopropyl)ether (µg/kg)	79.5 U	77.1 U	90.3 U	84.8 U
bis(2-Ethylhexyl)phthalate (µg/kg)	79.5 U	77.1 U	90.3 U	84.8 U
Butylbenzylphthalate (µg/kg)	79.5 U	77.1 U	90.3 U	84.8 U
Caprolactam (µg/kg)	79.5 U	77.1 U	90.3 U	84.8 U
Carbazole (µg/kg)	11.9 U	11.6 U	13.5 U	12.7 U
Chrysene (µg/kg)	17.6 J	11.6 U	13.5 U	12.7 U
Dibenzo(a,h)anthracene (µg/kg)	11.9 U	11.6 U	13.5 U	12.7 U
Dibenzofuran (µg/kg)	79.5 U	77.1 U	90.3 U	84.8 U
Diethylphthalate (µg/kg)	79.5 U	77.1 U	90.3 U	84.8 U
Dimethylphthalate (µg/kg)	79.5 U	77.1 U	90.3 U	84.8 U
Di-n-butylphthalate (µg/kg)	79.5 U	77.1 U	90.3 U	84.8 U
Di-n-octylphthalate (µg/kg)	79.5 U	77.1 U	90.3 U	84.8 U
Diphenylamine (µg/kg)	79.5 U	77.1 U	90.3 U	84.8 U
Fluoranthene (µg/kg)	13.4 J	11.6 U	13.5 U	12.7 U
Fluorene (µg/kg)	11.9 U	11.6 U	13.5 U	12.7 U
Hexachlorobenzene (µg/kg)	79.5 U	77.1 U	90.3 U	84.8 U
Hexachlorobutadiene (µg/kg)	79.5 U	77.1 U	90.3 U	84.8 U
Hexachlorocyclopentadiene (µg/kg)	79.5 U	77.1 U	90.3 U	84.8 U
Hexachloroethane (µg/kg)	79.5 U	77.1 U	90.3 U	84.8 U
Indeno(1,2,3-cd)pyrene (µg/kg)	11.9 U	11.6 U	13.5 U	12.7 U
Isophorone (µg/kg)	79.5 U	77.1 U	90.3 U	84.8 U
m,p-Cresols (µg/kg)	119 U	116 U	135 U	127 U
m-Nitroaniline (µg/kg)	79.5 U	77.1 U	90.3 U	84.8 U
Naphthalene (µg/kg)	11.9 U	11.6 U	13.5 U	12.7 U
Nitrobenzene (µg/kg)	79.5 U	77.1 U	90.3 U	84.8 U
N-Nitrosodipropylamine (µg/kg)	79.5 U	77.1 U	90.3 U	84.8 U
o-Cresol (µg/kg)	79.5 U	77.1 U	90.3 U	84.8 U
o-Nitroaniline (µg/kg)	79.5 U	77.1 U	90.3 U	84.8 U
Pentachlorophenol (µg/kg)	99.4 U	96.3 U	113 U	106 U
Phenanthrene (µg/kg)	11.9 U	11.6 U	13.5 U	12.7 U
Phenol (µg/kg)	79.5 U	77.1 U	90.3 U	84.8 U
p-Nitroaniline (µg/kg)	119 U	116 U	135 U	127 U
Pyrene (µg/kg)	11.9 U	11.6 U	13.5 U	12.7 U

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Table 3-8. EU 1 Area PAH, Pesticide, and PCB Soil Results

Station	TWP921	TWP921	TWP921	TWP922	TWP922	TWP923	TWP923
Sample No	921SS0.0-0.5-0001	921SS0.0-0.5-9002	921SB14.0-16.0-0002	922SS0.0-0.5-0005	922SB12.0-14.0-0006	923SS0.0-0.5-0009	923SS16.0-18.0-0009
Collection Date	11/23/2009	11/23/2009	11/23/2009	11/17/2009	11/18/2009	11/17/2009	11/17/2009
Sample Depth (ft bgs)	0-0.5	0-0.5	14-16	0-0.5	12-14	0-0.5	16-18
Polycyclic Aromatic Hydrocarbons [1]							
Acenaphthene (µg/kg)	1140 U	1140 U	6.08 U	5.85 U	5.81 U	5.35 U	6.06 U
Acenaphthylene (µg/kg)	381 U	381 U	2.03 U	1.95 U	1.94 U	1.78 U	2.02 U
Anthracene (µg/kg)	1140 U	1140 U	6.08 U	5.85 U	5.81 U	5.35 U	6.06 U
Benzo(a)anthracene (µg/kg)	122 U	276 J	0.649 U	18.2	0.619 U	0.998 J	0.646 U
Benzo(a)pyrene (µg/kg)	122 U	194 J	0.649 U	40.2	0.619 U	1.11 J	0.646 U
Benzo(b)fluoranthene (µg/kg)	122 U	122 U	0.649 U	38.5	0.619 U	1.51 J	0.646 U
Benzo(ghi)perylene (µg/kg)	122 U	122 U	0.649 U	25.1	0.619 U	0.99 J	0.646 U
Benzo(k)fluoranthene (µg/kg)	76.2 U	76.1 U	0.405 U	0.39 U	0.387 U	0.357 U	0.404 U
Chrysene (µg/kg)	130 U	130 U	0.693 U	15.5	0.662 U	0.923 J	0.691 U
Dibenzo(a,h)anthracene (µg/kg)	122 U	122 U	0.649 U	0.624 U	0.619 U	0.571 U	0.646 U
Fluoranthene (µg/kg)	122 U	485 J	0.649 U	10.4	0.619 U	1.9 J	0.646 U
Fluorene (µg/kg)	762 U	761 U	4.05 U	3.9 U	3.87 U	3.57 U	4.04 U
Indeno(1,2,3-cd)pyrene (µg/kg)	122 U	122 U	0.649 U	0.624 U	0.619 U	0.571 U	0.646 U
Naphthalene (µg/kg)	1140 U	1140 U	6.08 U	5.85 U	5.81 U	5.35 U	6.06 U
Phenanthrene (µg/kg)	381 U	466 J	2.03 U	6.15 J	1.98 J	1.78 U	2.02 U
Pyrene (µg/kg)	122 J	348 J	0.649 U	9.76	0.619 U	1.74 J	0.646 U
Pesticides							
4,4'-DDD (µg/kg)	1.9 U	1.9 U	2.03 U	0.389 U	0.386 U	0.356 U	0.403 U
4,4'-DDE (µg/kg)	1.9 U	1.9 U	2.03 U	0.389 U	0.386 U	0.356 U	0.403 U
4,4'-DDT (µg/kg)	1.9 U	1.9 U	2.03 U	0.389 U	0.386 U	0.639 J	0.403 U
Aldrin (µg/kg)	0.952 U	0.951 U	1.01 U	0.195 U	0.193 U	0.178 U	0.202 U
alpha-BHC (µg/kg)	0.952 U	0.951 U	1.01 U	0.195 U	0.193 U	0.178 U	0.202 U
alpha-Chlordane (µg/kg)	0.952 U	0.951 U	1.01 U	0.195 U	0.193 U	0.178 U	0.202 U
beta-BHC (µg/kg)	0.952 U	0.951 U	1.01 U	0.195 U	0.193 U	0.178 U	0.202 U
delta-BHC (µg/kg)	0.952 U	0.951 U	1.01 U	0.195 U	0.193 U	0.178 U	0.202 U
Dieldrin (µg/kg)	1.9 U	1.9 U	2.03 U	0.389 U	0.386 U	0.356 U	0.403 U
Endosulfan I (µg/kg)	0.952 U	0.951 U	1.01 U	0.195 U	0.193 U	0.178 U	0.202 U
Endosulfan II (µg/kg)	1.9 U	1.9 U	2.03 U	0.389 U	0.386 U	0.356 U	0.403 U
Endosulfan sulfate (µg/kg)	1.9 U	1.9 U	2.03 U	0.389 U	0.386 U	0.356 U	0.403 U
Endrin (µg/kg)	1.9 U	1.9 U	2.03 U	0.389 U	0.386 U	0.356 U	0.403 U
Endrin aldehyde (µg/kg)	1.9 U	1.9 U	2.03 U	0.389 U	0.386 U	0.356 U	0.403 U
Endrin ketone (µg/kg)	1.9 U	1.9 U	2.03 U	0.389 U	0.386 U	0.356 U	0.403 U
gamma-BHC (Lindane) (µg/kg)	0.952 U	0.951 U	1.01 U	0.195 U	0.193 U	0.178 U	0.202 U
gamma-Chlordane (µg/kg)	0.952 U	0.951 U	1.01 U	0.195 U	0.193 U	0.178 U	0.202 U
Heptachlor (µg/kg)	0.952 U	0.951 U	1.01 U	0.195 U	0.193 U	0.178 U	0.202 U
Heptachlor epoxide (µg/kg)	1.19 U	1.19 U	1.27 U	0.243 U	0.241 U	0.223 U	0.252 U
Methoxychlor (µg/kg)	9.52 U	9.51 U	10.1 U	1.95 U	1.93 U	1.78 U	2.02 U
Toxaphene (µg/kg)	31.7 U	31.7 U	33.7 U	6.48 U	6.43 U	5.93 U	6.72 U
PCBs							
Aroclor-1016 (µg/kg)	6.34 U	6.34 U	1.35 U	1.3 U	1.29 U	1.19 U	1.34 U
Aroclor-1221 (µg/kg)	6.34 U	6.34 U	1.35 U	1.3 U	1.29 U	1.19 U	1.34 U
Aroclor-1232 (µg/kg)	6.34 U	6.34 U	1.35 U	1.3 U	1.29 U	1.19 U	1.34 U
Aroclor-1242 (µg/kg)	6.34 U	6.34 U	1.35 U	1.3 U	1.29 U	1.19 U	1.34 U
Aroclor-1248 (µg/kg)	6.34 U	6.34 U	1.35 U	1.3 U	1.29 U	1.19 U	1.34 U
Aroclor-1254 (µg/kg)	6.34 U	6.34 U	1.35 U	1.3 U	1.29 U	1.19 U	1.34 U
Aroclor-1260 (µg/kg)	6.34 U	6.34 U	1.35 U	2.7 J	1.29 U	1.19 U	1.34 U

Table 3-8. EU 1 Area PAH, Pesticide, and PCB Soil Results

Station	TWP924	TWP924	TWP924	TWP925	TWP925	TWP926	TWP926
Sample No	924SS0.0-0.5-0013	924SS0.0-0.5-9001	924SB12.0-14.0-0014	925SS0.0-0.5-0017	925SB10.0-12.0-0018	926SS0.0-0.5-0021	926SB8.0-10.0-0022
Collection Date	11/19/2009	11/19/2009	11/19/2009	11/18/2009	11/18/2009	11/19/2009	11/19/2009
Sample Depth (ft bgs)	0-0.5	0-0.5	12-14	0-0.5	10-12	0-0.5	8-12
Polycyclic Aromatic Hydrocarbons [1]							
Acenaphthene (µg/kg)	6.66 U	6.75 U	5.53 U	5.98 U	5.78 U	6.77 U	6.35 U
Acenaphthylene (µg/kg)	2.22 U	2.25 U	1.84 U	1.99 U	1.93 U	2.26 U	2.12 U
Anthracene (µg/kg)	6.66 U	6.75 U	5.53 U	5.98 U	5.78 U	6.77 U	6.35 U
Benzo(a)anthracene (µg/kg)	8.75	10.7	0.59 U	7.77	0.616 U	6.85	0.677 U
Benzo(a)pyrene (µg/kg)	9.93	13.7	0.59 U	12.5	0.616 U	6.43	0.677 U
Benzo(b)fluoranthene (µg/kg)	13	17.2	0.59 U	21	0.616 U	7.88 J	0.677 U
Benzo(ghi)perylene (µg/kg)	13.5	12	0.59 U	10.7	0.616 U	5.92 J	0.677 U
Benzo(k)fluoranthene (µg/kg)	0.444 U	0.45 U	0.369 U	0.398 U	0.385 U	0.451 U	0.423 U
Chrysene (µg/kg)	11.3	15.1	0.63 U	12.6	0.659 U	6.03	0.724 U
Dibenzo(a,h)anthracene (µg/kg)	0.71 U	0.72 U	0.59 U	0.637 U	0.616 U	0.722 U	0.677 U
Fluoranthene (µg/kg)	12.5	19.5	0.59 U	16.7	0.616 U	10.9	0.677 U
Fluorene (µg/kg)	4.44 U	4.5 U	3.69 U	3.98 U	3.85 U	4.51 U	4.23 U
Indeno(1,2,3-cd)pyrene (µg/kg)	0.71 U	0.72 U	0.59 U	0.637 U	0.616 U	0.722 U	0.677 U
Naphthalene (µg/kg)	6.66 U	6.75 U	5.53 U	5.98 U	5.78 U	6.77 U	6.35 U
Phenanthrene (µg/kg)	9.36 J	14.9 J	1.84 U	6.48 J	1.93 U	6.33 J	2.12 U
Pyrene (µg/kg)	11.2	16.7	0.59 U	14.6	0.616 U	9.03	0.677 U
Pesticides							
4,4'-DDD (µg/kg)	0.445 U	0.45 U	0.369 U	0.399 U	0.385 U	0.45 U	0.422 U
4,4'-DDE (µg/kg)	0.445 U	0.45 U	0.369 U	0.399 U	0.385 U	0.45 U	0.422 U
4,4'-DDT (µg/kg)	0.687 J	0.45 U	0.369 U	0.399 U	0.385 U	0.45 U	0.422 U
Aldrin (µg/kg)	0.222 U	0.225 U	0.184 U	0.199 U	0.192 U	0.225 U	0.211 U
alpha-BHC (µg/kg)	0.222 U	0.225 U	0.184 U	0.199 U	0.192 U	0.225 U	0.211 U
alpha-Chlordane (µg/kg)	0.222 U	0.225 U	0.184 U	0.199 U	0.192 U	0.225 U	0.211 U
beta-BHC (µg/kg)	0.222 U	0.225 U	0.184 U	0.199 U	0.192 U	0.225 U	0.211 U
delta-BHC (µg/kg)	0.222 U	0.225 U	0.184 U	0.199 U	0.192 U	0.225 U	0.211 U
Dieldrin (µg/kg)	0.445 U	0.45 U	0.369 U	0.399 U	0.385 U	0.45 U	0.422 U
Endosulfan I (µg/kg)	0.222 U	0.225 U	0.184 U	0.199 U	0.192 U	0.225 U	0.211 U
Endosulfan II (µg/kg)	0.445 U	0.45 U	0.369 U	0.399 U	0.385 U	0.45 U	0.422 U
Endosulfan sulfate (µg/kg)	0.445 U	0.45 U	0.369 U	0.399 U	0.385 U	0.45 U	0.422 U
Endrin (µg/kg)	0.445 U	0.45 U	0.369 U	0.399 U	0.385 U	0.45 U	0.422 U
Endrin aldehyde (µg/kg)	0.445 U	0.45 U	0.369 U	0.399 U	0.385 U	0.45 U	0.422 U
Endrin ketone (µg/kg)	0.445 U	0.45 U	0.369 U	0.399 U	0.385 U	0.45 U	0.422 U
gamma-BHC (Lindane) (µg/kg)	0.222 U	0.225 U	0.184 U	0.199 U	0.192 U	0.225 U	0.211 U
gamma-Chlordane (µg/kg)	0.222 U	0.225 U	0.184 U	0.199 U	0.192 U	0.225 U	0.211 U
Heptachlor (µg/kg)	0.222 U	0.225 U	0.184 U	0.199 U	0.192 U	0.225 U	0.211 U
Heptachlor epoxide (µg/kg)	0.278 U	0.281 U	0.23 U	0.249 U	0.24 U	0.281 U	0.264 U
Methoxychlor (µg/kg)	2.22 U	2.25 U	1.84 U	1.99 U	1.92 U	2.25 U	2.11 U
Toxaphene (µg/kg)	7.4 U	7.49 U	6.14 U	6.64 U	6.4 U	7.49 U	7.02 U
PCBs							
Aroclor-1016 (µg/kg)	1.49 U	1.5 U	1.23 U	1.33 U	1.28 U	1.5 U	1.41 U
Aroclor-1221 (µg/kg)	1.49 U	1.5 U	1.23 U	1.33 U	1.28 U	1.5 U	1.41 U
Aroclor-1232 (µg/kg)	1.49 U	1.5 U	1.23 U	1.33 U	1.28 U	1.5 U	1.41 U
Aroclor-1242 (µg/kg)	1.49 U	1.5 U	1.23 U	1.33 U	1.28 U	1.5 U	1.41 U
Aroclor-1248 (µg/kg)	1.49 U	1.5 U	1.23 U	1.33 U	1.28 U	1.5 U	1.41 U
Aroclor-1254 (µg/kg)	1.49 U	1.5 U	1.23 U	1.33 U	1.28 U	1.5 U	1.41 U
Aroclor-1260 (µg/kg)	1.49 U	1.5 U	1.23 U	1.33 U	1.28 U	1.5 U	1.41 U

[1] PAHs analyzed by SW-846 8310

Table 3-9. EU 1 Area Metal and Radiological Compound Soil Results

Station	TWP921	TWP921	TWP921	TWP922	TWP922	TWP923	TWP923
Sample No	921SS0.0-0.5-0001	921SS0.0-0.5-9002	921SB14.0-16.0-0002	922SS0.0-0.5-0005	922SB12.0-14.0-0006	923SS0.0-0.5-0009	923SS16.0-18.0-0009
Collection Date	11/23/2009	11/23/2009	11/23/2009	11/17/2009	11/18/2009	11/17/2009	11/17/2009
Sample Depth (ft bgs)	0-0.5	0-0.5	14-16	0-0.5	12-14	0-0.5	16-18
Metals							
Antimony (mg/kg)	0.377 U	0.393 J	0.386 U	0.374 U	0.365 U	0.345 U	0.386 U
Arsenic (mg/kg)	4.06	3.7	2.78	3.79	2.79	3.86	3.73
Barium (mg/kg)	116	94.5	143	113	89.1	125	123
Beryllium (mg/kg)	0.562	0.442	0.739	0.684	0.274	0.37 J	0.554 J
Cadmium (mg/kg)	0.253	0.298	0.143 J	0.239	0.129 J	0.168 J	0.144 J
Chromium (mg/kg)	19.7	16.7	22.3	17.9	9.3	12.5	17.5
Lead (mg/kg)	16.8	18.5	6.83	53.9	3.29	5.8	5.83
Mercury (µg/kg)	28.5	31.4	7.23 J	22.2	6.47 J	14.2	6.27 J
Nickel (mg/kg)	19.5	16.5	24.7	20.1	11.6	16.6	20.7
Selenium (mg/kg)	0.569 U	0.562 U	0.6 U	0.576 U	0.561 U	0.532 U	0.591 U
Silver (mg/kg)	0.195 J	0.158 J	0.117 U	0.113 U	0.111 U	0.131 J	0.397 J
Thallium (mg/kg)	0.134 J	0.103 J	0.193 J	0.126 J	0.0673 U	0.0923 J	0.12 J
Zinc (mg/kg)	69.9	83.3	57.9	88.8 J	29.5 J	51.9 J	46.4 J
Radiological Compounds							
Actinium-227 (GammaSpec) (pCi/g)	0.127 U		0.274 U	-0.0476 U	-0.203 U	0.0369 U	0.154 U
Americium-241 (GammaSpec) (pCi/g)	-0.246 U		0.0875 U	0.192 U	-0.0538 U	0.0824 U	0.0956 U
Cesium-137 (GammaSpec) (pCi/g)	0.172		-0.00576 U	0.121	-0.046 U	0 U	-0.00655 U
Cobalt-60 (GammaSpec) (pCi/g)	0.0096 U		-0.0226 U	0.0283 U	-0.00743 U	0.014 U	-0.0111 U
Plutonium-238 (AlphaSpec) (pCi/g)	-0.0347 U		-0.0131 U	-0.0176 U	-0.0156 U	-0.0387 U	-0.032 U
Plutonium-239/240 (AlphaSpec) (pCi/g)	-0.0857 U		-0.0131 U	-0.105 U	0.0182 U	-0.116 U	-0.048 U
Potassium-40 (GammaSpec) (pCi/g)	18.1		27.3	20.5	16.3	14.3	20
Protactinium-231 (GammaSpec) (pCi/g)	-0.689 U		-0.767 U	-0.414 U	-0.123 U	-0.333 U	0.305 U
Radium-226 (AlphaSpec) (pCi/g)	0.555 J	0.517 J	0.681 J	0.618	0.388	0.875	0.384
Radium-226 (GammaSpec) (pCi/g)	0.692		0.836	1.09	0.891	0.398	0.772
Radium-228 (AlphaSpec) (pCi/g)	0.431 U	0.735	1.31	1.86	0.925	1.26	1.12
Radium-228 (GammaSpec) (pCi/g)	0.922		1.24	0.719	0.828	0.864	0.984
Strontium-90 (GammaSpec) (pCi/g)	-0.208 U		0.181 U	-0.358 U	-0.306 U	-0.748 U	-1.68 U
Thorium-228 (AlphaSpec) (pCi/g)	1.1		0.975	0.779	0.652	0.492	0.671
Thorium-228 (GammaSpec) (pCi/g)	0.991		1.24	0.931	0.867	0.666	1
Thorium-230 (AlphaSpec) (pCi/g)	1.16		1.01	1.88	0.406	0.592	0.462
Thorium-232 (AlphaSpec) (pCi/g)	1.01		1.03	1.1	0.748	0.649	0.977
Uranium-233/234 (AlphaSpec) (pCi/g)	0.444		0.721	2.03	0.545	0.458	0.39
Uranium-235 (GammaSpec) (pCi/g)	-0.0148 U		-0.0801 U	0.142 U	-0.024 U	0.0424 U	0.16 U
Uranium-235/236 (AlphaSpec) (pCi/g)	0.119		0.0217 U	0.0447 U	-0.00841 U	0.13	0.0781 U
Uranium-238 (AlphaSpec) (pCi/g)	0.941		0.853	1.74	0.731	0.554	0.677
Uranium-238 (GammaSpec) (pCi/g)	1.16 U		0.396 U	2.35 U	-0.403 U	0.237 U	0 U

Table 3-9. EU 1 Area Metal and Radiological Compound Soil Results

Station	TWP924	TWP924	TWP924	TWP925	TWP925	TWP926	TWP926
Sample No	924SS0.0-0.5-0013	924SS0.0-0.5-9001	924SB12.0-14.0-0014	925SS0.0-0.5-0017	925SB10.0-12.0-0018	926SS0.0-0.5-0021	926SB8.0-10.0-0022
Collection Date	11/19/2009	11/19/2009	11/19/2009	11/18/2009	11/18/2009	11/19/2009	11/19/2009
Sample Depth (ft bgs)	0-0.5	0-0.5	12-14	0-0.5	10-12	0-0.5	8-12
Metals							
Antimony (mg/kg)	0.438 U	0.441 U	0.352 U	0.385 U	0.375 U	0.439 U	0.42 U
Arsenic (mg/kg)	5.05 J	5.08 J	3.24	5.66 J	3.22 J	3.81	2.38
Barium (mg/kg)	142	196	106	113	155	97.7	102
Beryllium (mg/kg)	0.72	0.709	0.28	0.541	0.806	0.568	0.293
Cadmium (mg/kg)	0.363	0.326	0.133 J	0.207 J	0.141 J	0.214 J	0.123 J
Chromium (mg/kg)	21.6	22.9	10.1	17	25.8	17.2	9.98
Lead (mg/kg)	13.8	10.9	3.12	9.13	6.75	13	3.24
Mercury (mg/kg)	54.1	60.9	4.42 U	29.2	8.56 J	41	5.1 U
Nickel (mg/kg)	18.7	17.7	12.1	15.4	27.8	17.3	11.4
Selenium (mg/kg)	0.663 U	0.646 U	0.555 U	0.599 U	0.58 U	0.677 U	0.611 U
Silver (mg/kg)	0.22 J	0.466 J	0.194 J	0.65	0.364 J	0.67	0.469 J
Thallium (mg/kg)	0.16 J	0.142 J	0.0675 J	0.113 J	0.183 J	0.126 J	0.08 J
Zinc (mg/kg)	96.4	80.6	29	68.5	61.2	56	30.4
Radiological Compounds							
Actinium-227 (GammaSpec) (pCi/g)	0.253 U	-0.182 U	0.153 U	-0.106 U	-0.134 U	-0.127 U	-0.171 U
Americium-241 (GammaSpec) (pCi/g)	0.0385 U	0.00524 U	0.00243 U	-0.00493 U	-0.0771 U	0.0845 U	0.0457 U
Cesium-137 (GammaSpec) (pCi/g)	0.229	0.309	-0.0197 U	0.18	0.0117 U	0 U	0.00749 U
Cobalt-60 (GammaSpec) (pCi/g)	-0.0307 U	-0.00228 U	0.00157 U	0.011 U	0.00911 U	-0.0286 U	-0.0227 U
Plutonium-238 (AlphaSpec) (pCi/g)	0.00556 U	-0.154 U	-0.0778 U	-0.0147 U	0.316 U	-0.0443 U	-0.258 U
Plutonium-239/240 (AlphaSpec) (pCi/g)	-0.131 U	-0.059 U	-0.155 U	-0.0294 U	-0.077 U	-0.0541 U	-0.172 U
Potassium-40 (GammaSpec) (pCi/g)	15	19	14.4	14.8	30.3	15.9	12
Protactinium-231 (GammaSpec) (pCi/g)	0.643 U	-0.826 U	-0.0859 U	-1.46 U	-0.589 U	1.86 U	0.0716 U
Radium-226 (AlphaSpec) (pCi/g)	0.317 U	0.574	0.597	1.3	1.26	1.02	0.592
Radium-226 (GammaSpec) (pCi/g)	0.602	0.863	0.605	1.09	1.13	0.471	0.347
Radium-228 (AlphaSpec) (pCi/g)	1.21	1.64	1.46	1.23	1.5	1.09	0.689 U
Radium-228 (GammaSpec) (pCi/g)	0.781	0.934	0.79	0.946	1.47	0.974	0.412
Strontium-90 (GammaSpec) (pCi/g)	-0.333 U	0.491 U	0.892 U	0.351 U	-0.346 U	0.364 U	0.0158 U
Thorium-228 (AlphaSpec) (pCi/g)	1.08	1.08	0.691	0.757	0.857	0.995	0.453
Thorium-228 (GammaSpec) (pCi/g)	0.965	0.89	0.643	0.99	1.45	0.834	0.405
Thorium-230 (AlphaSpec) (pCi/g)	0.869	1.09	0.487	1.18	1.31	0.788	0.582
Thorium-232 (AlphaSpec) (pCi/g)	0.942	1.27	0.52	0.811	0.772	0.841	0.329
Uranium-233/234 (AlphaSpec) (pCi/g)	1.04	1.64	0.476	2.15	0.835	0.813	0.585
Uranium-235 (GammaSpec) (pCi/g)	0.135 U	-0.0522 U	-0.0905 U	0.474	0.0722 U	-0.0379 U	-0.0668 U
Uranium-235/236 (AlphaSpec) (pCi/g)	0.0427 U	0.00202 U	-0.0151 U	0.0653 U	-0.02 U	0.00157 U	0.0282 U
Uranium-238 (AlphaSpec) (pCi/g)	1.49	1.44	0.471	2.88	1.12	0.935	0.353
Uranium-238 (GammaSpec) (pCi/g)	0.734 U	1.04 U	0.206 U	2.95	0 U	0.947 U	1.64

Table 3-10. EU 1 Area Radiological Groundwater Screening Results

Station	TWP921	TWP921	TWP922	TWP922	TWP923	TWP923
Sample No	TW0001-0003	TW0001F-0004	922TW001-0007	922TW001F-0008	923TW0001-0011	923TW0001F-0012
Collection Date	12/01/09	12/01/09	11/20/09	11/20/09	11/22/09	11/22/09
Uranium-233/234 (pCi/L)	9.03		10.8		7.15	
Uranium-233/234, Dissolved (pCi/L)		11.2		6.21		4.49
Uranium-235/236 (pCi/L)	0.649		0.416		0.308	
Uranium-235/236, Dissolved (pCi/L)		0.499		0.256		0.185
Uranium-238 (pCi/L)	8.03		8.79		5.9	
Uranium-238, Dissolved (pCi/L)		8.58		5.44		4.24

All analyses performed by alpha spectroscopy.

Station	TWP924	TWP924	TWP925	TWP925	TWP926	TWP926
Sample No	924TW0001-0015	924TW0001F-0016	925TW0001-0019	925TW0001F-0020	926TW0001-0023	926TW0001F-0024
Collection Date	11/22/09	11/22/09	11/20/09	11/20/09	11/22/09	11/22/09
Uranium-233/234 (pCi/L)	1.51		4.2		2.73	
Uranium-233/234, Dissolved (pCi/L)		1.73		4.57		2.14
Uranium-235/236 (pCi/L)	0.0475 U		0.0987 U		0.181	
Uranium-235/236, Dissolved (pCi/L)		0 U		0.171 U		0.0914 U
Uranium-238 (pCi/L)	1.36		3.05		2.28	
Uranium-238, Dissolved (pCi/L)		1.25		3.33		2

All analyses performed by alpha spectroscopy.

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Table 3-11. EU 1 Area VOC Monitoring Well Results

Station	MW921	MW922	MW922	MW923
Sample No	921GW0001-0109	922GW0001-0111	922GW0001-9008	923GW001-0113
Collection Date	01/13/10	12/22/09	12/22/09	01/16/10
Volatile Organic Compounds				
1,1,1-Trichloroethane (µg/L)	0.325 U	0.325 U	0.325 U	0.325 U
1,1,2,2-Tetrachloroethane (µg/L)	0.25 U	0.25 U	0.25 U	0.25 U
1,1,2-Trichloroethane (µg/L)	0.25 U	0.25 U	0.25 U	0.25 U
1,1-Dichloroethane (µg/L)	0.3 U	0.3 U	0.3 U	0.3 U
1,1-Dichloroethylene (µg/L)	0.3 U	0.3 U	0.3 U	0.3 U
1,2-Dichloroethane (µg/L)	0.25 U	0.25 U	0.25 U	0.25 U
1,2-Dichloropropane (µg/L)	0.25 U	0.25 U	0.25 U	0.25 U
2-Butanone (µg/L)	1.25 U	1.25 U	1.25 U	1.25 U
2-Hexanone (µg/L)	1.25 U	1.25 U	1.25 U	1.25 U
4-Methyl-2-pentanone (µg/L)	1.25 U	1.25 U	1.25 U	1.25 U
Acetone (µg/L)	1.5 U	1.5 U	1.5 U	1.5 U
Benzene (µg/L)	0.3 U	0.3 U	0.3 U	0.3 U
Bromodichloromethane (µg/L)	0.25 U	0.25 U	0.25 U	0.25 U
Bromoform (µg/L)	0.25 U	0.25 U	0.25 U	0.25 U
Bromomethane (µg/L)	0.3 U	0.3 U	0.3 U	0.3 U
Carbon disulfide (µg/L)	1.25 U	1.25 U	1.25 U	1.25 U
Carbon tetrachloride (µg/L)	0.3 U	0.3 U	0.3 U	0.3 U
Chlorobenzene (µg/L)	0.25 U	0.25 U	0.25 U	0.25 U
Chloroethane (µg/L)	0.3 U	0.3 U	0.3 U	0.3 U
Chloroform (µg/L)	0.25 U	0.25 U	0.25 U	0.25 U
Chloromethane (µg/L)	0.3 U	0.3 U	0.3 U	0.3 U
cis-1,2-Dichloroethylene (µg/L)	0.3 U	0.3 U	0.3 U	0.3 U
cis-1,3-Dichloropropylene (µg/L)	0.25 U	0.25 U	0.25 U	0.25 U
Ethylbenzene (µg/L)	0.25 U	0.25 U	0.25 U	0.25 U
Methylene chloride (µg/L)	2 U	2 U	2 U	2 U
Styrene (µg/L)	0.25 U	0.25 U	0.25 U	0.25 U
Tetrachloroethylene (µg/L)	0.3 U	0.3 U	0.3 U	0.3 U
Toluene (µg/L)	0.25 U	0.25 U	0.25 U	0.25 U
trans-1,2-Dichloroethylene (µg/L)	0.3 U	0.3 U	0.3 U	0.3 U
trans-1,3-Dichloropropylene (µg/L)	0.25 U	0.25 U	0.25 U	0.25 U
Trichloroethylene (µg/L)	0.25 U	0.25 U	0.25 U	0.25 U
Vinyl chloride (µg/L)	0.5 U	0.5 U	0.5 U	0.5 U
Xylenes (total) (µg/L)	0.3 U	0.3 U	0.3 U	0.3 U

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Table 3-12. EU 1 Area SVOC Monitoring Well Results

Station	MW921	MW922	MW922	MW923
Sample No	921GW0001-0109	922GW0001-0111	922GW0001-9008	923GW001-0113
Collection Date	01/13/10	12/22/09	12/22/09	01/16/10
Semi-Volatile Organic Compounds				
1,1'-Biphenyl (µg/L)	2.9 U	3 U	3.13 U	2.74 U
2,4,5-Trichlorophenol (µg/L)	1.93 U	2 U	2.08 U	1.83 U
2,4,6-Trichlorophenol (µg/L)	1.93 U	2 U	2.08 U	1.83 U
2,4-Dichlorophenol (µg/L)	1.93 U	2 U	2.08 U	1.83 U
2,4-Dimethylphenol (µg/L)	1.93 U	2 U	2.08 U	1.83 U
2,4-Dinitrophenol (µg/L)	4.83 U	5 U	5.21 U	4.57 U
2,4-Dinitrotoluene (µg/L)	1.93 U	2 U	2.08 U	1.83 U
2,6-Dinitrotoluene (µg/L)	1.93 U	2 U	2.08 U	1.83 U
2-Chloronaphthalene (µg/L)	0.29 U	0.3 U	0.313 U	0.274 U
2-Chlorophenol (µg/L)	1.93 U	2 U	2.08 U	1.83 U
2-Methyl-4,6-dinitrophenol (µg/L)	2.9 U	3 U	3.13 U	2.74 U
2-Methylnaphthalene (µg/L)	0.29 U	0.3 U	0.313 U	0.274 U
2-Nitrophenol (µg/L)	1.93 U	2 U	2.08 U	1.83 U
3,3'-Dichlorobenzidine (µg/L)	1.93 U	2 U	2.08 U	1.83 U
4-Bromophenylphenylether (µg/L)	1.93 U	2 U	2.08 U	1.83 U
4-Chloro-3-methylphenol (µg/L)	1.93 U	2 U	2.08 U	1.83 U
4-Chloroaniline (µg/L)	1.93 U	2 U	2.08 U	1.83 U
4-Chlorophenylphenylether (µg/L)	1.93 U	2 U	2.08 U	1.83 U
4-Nitrophenol (µg/L)	1.93 U	2 U	2.08 U	1.83 U
Acenaphthene (µg/L)	0.3 U	0.31 U	0.323 U	0.283 U
Acenaphthylene (µg/L)	0.193 U	0.2 U	0.208 U	0.183 U
Acetophenone (µg/L)	1.93 U	2 U	2.08 U	1.83 U
Anthracene (µg/L)	0.193 U	0.2 U	0.208 U	0.183 U
Atrazine (µg/L)	2.9 U	3 U	3.13 U	2.74 U
Benzaldehyde (µg/L)	2.9 U	3 U	3.13 U	2.74 U
Benzo(a)anthracene (µg/L)	0.193 U	0.2 U	0.208 U	0.183 U
Benzo(a)pyrene (µg/L)	0.193 U	0.2 U	0.208 U	0.183 U
Benzo(b)fluoranthene (µg/L)	0.193 U	0.2 U	0.208 U	0.183 U
Benzo(ghi)perylene (µg/L)	0.193 U	0.2 U	0.208 U	0.183 U
Benzo(k)fluoranthene (µg/L)	0.193 U	0.2 U	0.208 U	0.183 U
bis(2-Chloroethoxy)methane (µg/L)	2.9 U	3 U	3.13 U	2.74 U
bis(2-Chloroethyl) ether (µg/L)	1.93 U	2 U	2.08 U	1.83 U
bis(2-Chloroisopropyl)ether (µg/L)	1.93 U	2 U	2.08 U	1.83 U
bis(2-Ethylhexyl)phthalate (µg/L)	1.93 U	2 U	2.08 U	1.83 U
Butylbenzylphthalate (µg/L)	1.93 U	2 U	2.08 U	1.83 U
Caprolactam (µg/L)	1.93 U	2 U	2.08 U	1.83 U
Carbazole (µg/L)	0.193 U	0.2 U	0.208 U	0.183 U
Chrysene (µg/L)	0.193 U	0.2 U	0.208 U	0.183 U
Dibenzo(a,h)anthracene (µg/L)	0.193 U	0.2 U	0.208 U	0.183 U
Dibenzofuran (µg/L)	1.93 U	2 U	2.08 U	1.83 U
Diethylphthalate (µg/L)	1.93 U	2 U	2.08 U	1.83 U
Dimethylphthalate (µg/L)	1.93 U	2 U	2.08 U	1.83 U

Table 3-12. EU 1 Area SVOC Monitoring Well Results

Station	MW921	MW922	MW922	MW923
Sample No	921GW0001-0109	922GW0001-0111	922GW0001-9008	923GW001-0113
Collection Date	01/13/10	12/22/09	12/22/09	01/16/10
Di-n-butylphthalate (µg/L)	1.93 U	2 U	2.08 U	1.83 U
Di-n-octylphthalate (µg/L)	2.9 U	3 U	3.13 U	2.74 U
Diphenylamine (µg/L)	2.9 U	3 U	3.13 U	2.74 U
Fluoranthene (µg/L)	0.193 U	0.2 U	0.208 U	0.183 U
Fluorene (µg/L)	0.193 U	0.2 U	0.208 U	0.183 U
Hexachlorobenzene (µg/L)	1.93 U	2 U	2.08 U	1.83 U
Hexachlorobutadiene (µg/L)	1.93 U	2 U	2.08 U	1.83 U
Hexachlorocyclopentadiene (µg/L)	2.9 U	3 U	3.13 U	2.74 U
Hexachloroethane (µg/L)	1.93 U	2 U	2.08 U	1.83 U
Indeno(1,2,3-cd)pyrene (µg/L)	0.193 U	0.2 U	0.208 U	0.183 U
Isophorone (µg/L)	2.9 U	3 U	3.13 U	2.74 U
m,p-Cresols (µg/L)	2.9 U	3 U	3.13 U	2.74 U
m-Nitroaniline (µg/L)	1.93 U	2 U	2.08 U	1.83 U
Naphthalene (µg/L)	0.29 U	0.3 U	0.313 U	0.274 U
Nitrobenzene (µg/L)	2.9 U	3 U	3.13 U	2.74 U
N-Nitrosodipropylamine (µg/L)	1.93 U	2 U	2.08 U	1.83 U
o-Cresol (µg/L)	1.93 U	2 U	2.08 U	1.83 U
o-Nitroaniline (µg/L)	1.93 U	2 U	2.08 U	1.83 U
Pentachlorophenol (µg/L)	1.93 U	2 U	2.08 U	1.83 U
Phenanthrene (µg/L)	0.193 U	0.2 U	0.208 U	0.183 U
Phenol (µg/L)	0.966 U	1 U	1.04 U	0.913 U
p-Nitroaniline (µg/L)	2.9 U	3 U	3.13 U	2.74 U
Pyrene (µg/L)	0.29 U	0.3 U	0.313 U	0.274 U

Table 3-13. EU 1 Area PAH, Pesticide, and PCB Monitoring Well Results

Station	MW921	MW922	MW922	MW923
Sample No	921GW0001-0109	922GW0001-0111	922GW0001-9008	923GW001-0113
Collection Date	01/13/10	12/22/09	12/22/09	01/16/10
Polycyclic Aromatic Hydrocarbons				
Acenaphthene (µg/L)	0.132 U	0.112 U	0.118 U	0.118 U
Acenaphthylene (µg/L)	0.132 U	0.112 U	0.118 U	0.118 U
Anthracene (µg/L)	0.138 U	0.116 U	0.123 U	0.123 U
Benzo(a)anthracene (µg/L)	0.0169 U	0.0143 U	0.0151 U	0.0152 U
Benzo(a)pyrene (µg/L)	0.0169 U	0.0143 U	0.0151 U	0.0152 U
Benzo(b)fluoranthene (µg/L)	0.0169 U	0.0143 U	0.0151 U	0.0152 U
Benzo(ghi)perylene (µg/L)	0.0169 U	0.0143 U	0.0151 U	0.0152 U
Benzo(k)fluoranthene (µg/L)	0.0169 U	0.0143 U	0.0151 U	0.0152 U
Chrysene (µg/L)	0.0169 U	0.0143 U	0.0151 U	0.0152 U
Dibenzo(a,h)anthracene (µg/L)	0.0169 U	0.0143 U	0.0151 U	0.0152 U
Fluoranthene (µg/L)	0.0169 U	0.0143 U	0.0151 U	0.0152 U
Fluorene (µg/L)	0.132 U	0.112 U	0.118 U	0.118 U
Indeno(1,2,3-cd)pyrene (µg/L)	0.0169 U	0.0143 U	0.0151 U	0.0152 U
Naphthalene (µg/L)	0.132 U	0.112 U	0.118 U	0.118 U
Phenanthrene (µg/L)	0.132 U	0.112 U	0.118 U	0.118 U
Pyrene (µg/L)	0.0169 U	0.0143 U	0.0151 U	0.0152 U
PCBs				
Aroclor-1016 (µg/L)	0.0314 U	0.0333 U	0.0333 U	0.149 U
Aroclor-1221 (µg/L)	0.0314 U	0.0333 U	0.0333 U	0.149 U
Aroclor-1232 (µg/L)	0.0314 U	0.0333 U	0.0333 U	0.149 U
Aroclor-1242 (µg/L)	0.0314 U	0.0333 U	0.0333 U	0.149 U
Aroclor-1248 (µg/L)	0.0314 U	0.0333 U	0.0333 U	0.149 U
Aroclor-1254 (µg/L)	0.0314 U	0.0333 U	0.0333 U	0.149 U
Aroclor-1260 (µg/L)	0.0314 U	0.0333 U	0.0333 U	0.149 U
Pesticides				
4,4'-DDD (µg/L)	0.0104 U	0.01 U	0.01 U	0.0099 U
4,4'-DDE (µg/L)	0.00518 U	0.005 U	0.005 U	0.00495 U
4,4'-DDT (µg/L)	0.0104 U	0.01 U	0.01 U	0.0099 U
Aldrin (µg/L)	0.00518 U	0.005 U	0.005 U	0.00495 U
alpha-BHC (µg/L)	0.00518 U	0.005 U	0.005 U	0.00495 U
alpha-Chlordane (µg/L)	0.00518 U	0.005 U	0.005 U	0.00495 U
beta-BHC (µg/L)	0.00622 U	0.006 U	0.006 U	0.00594 U
delta-BHC (µg/L)	0.00518 U	0.005 U	0.005 U	0.00495 U
Dieldrin (µg/L)	0.0104 U	0.01 U	0.01 U	0.0099 U
Endosulfan I (µg/L)	0.00518 U	0.005 U	0.005 U	0.00495 U
Endosulfan II (µg/L)	0.0104 U	0.01 U	0.01 U	0.0099 U
Endosulfan sulfate (µg/L)	0.0104 U	0.01 U	0.01 U	0.0099 U
Endrin (µg/L)	0.0104 U	0.01 U	0.01 U	0.0099 U
Endrin aldehyde (µg/L)	0.00518 U	0.005 U	0.005 U	0.00495 U
Endrin ketone (µg/L)	0.0104 U	0.01 U	0.01 U	0.0099 U
gamma-BHC (Lindane) (µg/L)	0.00518 U	0.005 U	0.005 U	0.00495 U
gamma-Chlordane (µg/L)	0.00518 U	0.005 U	0.005 U	0.00495 U

Table 3-13. EU 1 Area PAH, Pesticide, and PCB Monitoring Well Results

Station Sample No Collection Date	MW921 921GW0001-0109 01/13/10	MW922 922GW0001-0111 12/22/09	MW922 922GW0001-9008 12/22/09	MW923 923GW001-0113 01/16/10
Heptachlor (µg/L)	0.00518 U	0.005 U	0.005 U	0.00495 U
Heptachlor epoxide (µg/L)	0.00518 U	0.005 U	0.005 U	0.00495 U
Methoxychlor (µg/L)	0.0518 U	0.05 U	0.05 U	0.0495 U
Toxaphene (µg/L)	0.155 U	0.15 U	0.15 U	0.149 U

Table 3-14. EU 1 Area Metal and Radiological Compound Monitoring Well Results

Station	MW921	MW921	MW922	MW922	MW922	MW922	MW923	MW923
Sample No	921GW0001-0109	921GW0001F-0110	922GW0001-0111	922GW0001-9008	922GW0001F-0112	922GW0001F-9009	923GW001-0113	923GW0001F-0114
Collection Date	01/13/10	01/26/10	12/22/09	12/22/09	12/23/09	12/23/09	01/16/10	01/27/10
Metals								
Antimony (µg/L)	4.98 J		3 U	3 U			3 U	
Antimony, Dissolved (µg/L)		3 U			3 U	3 U		3 U
Arsenic (µg/L)	9.05		1.6 U	1.6 U			8.35 J	
Arsenic, Dissolved (µg/L)		1.6 U			1.6 U	1.6 U		1.6 U
Barium (µg/L)	5.97		12.7	10.2			14.6	
Barium, Dissolved (µg/L)		6.97			6.62	7.83		7.91
Beryllium (µg/L)	0.1 U		0.1 U	0.1 U			0.1 U	
Beryllium, Dissolved (µg/L)		0.1 U			0.1 U	0.1 U		0.1 U
Cadmium (µg/L)	0.11 U		0.11 U	0.11 U			0.11 U	
Cadmium, Dissolved (µg/L)		0.11 U			0.11 U	0.11 U		0.11 U
Chromium (µg/L)	3.09 J		2.55 J	2.94 J			4.39 J	
Chromium, Dissolved (µg/L)		2 U			3.16 J	3.33 J		2 U
Lead (µg/L)	0.5 U		1.69 J	0.834 J			0.617 J	
Lead, Dissolved (µg/L)		0.5 U			0.5 U	0.5 U		0.5 U
Mercury (µg/L)	0.066 U		0.066 U	0.066 U			0.066 U	
Mercury, Dissolved (µg/L)		0.066 U			0.066 U	0.066 U		0.066 U
Nickel (µg/L)	8.45		9.77	10.3			10.5	
Nickel, Dissolved (µg/L)		12.7			11.5	11.6		16.7
Selenium (µg/L)	1.31 J		1.71 J	1.02 J			1.62 J	
Selenium, Dissolved (µg/L)		2.15 J			1 U	1 U		2.13 J
Silver (µg/L)	1 U		1 U	1 U			1 U	
Silver, Dissolved (µg/L)		1 U			1 U	1 U		1 U
Thallium (µg/L)	0.393 J		0.3 U	0.3 U			0.3 U	
Thallium, Dissolved (µg/L)		0.3 U			0.3 U	0.3 U		0.3 U
Zinc (µg/L)	14.5		53.4	14.4			16.5	
Zinc, Dissolved (µg/L)		12			22.6	29.8		32.9
Radiological Compounds								
Actinium-227 (GammaSpec) (pCi/L)	-15.6 U		-8.62 U	1.13 U			-18 U	
Actinium-227, Dissolved (GammaSpec) (pCi/L)		-13.8 U			-11.4 U	-0.779 U		-4.92 U
Americium-241 (GammaSpec) (pCi/L)	8.53 U		3.7 U	3.1 U			3.38 U	
Americium-241, Dissolved (GammaSpec) (pCi/L)		6.58 U			-5.23 U	8.15 U		-15.3 U
Cesium-137 (GammaSpec) (pCi/L)	-1.41 U		-0.314 U	0.763 U			-3.42 U	
Cesium-137, Dissolved (GammaSpec) (pCi/L)		1.49 U			1.06 U	0.161 U		-3.04 U
Cobalt-60 (GammaSpec) (pCi/L)	-1.48 U		0.309 U	0.926 U			1.04 U	
Cobalt-60, Dissolved (GammaSpec) (pCi/L)		0.486 U			0.844 U	-0.897 U		0.595 U
Plutonium-238 (AlphaSpec) (pCi/L)	-0.0173 U		0 U	-0.0103 U			0 U	
Plutonium-238, Dissolved (AlphaSpec) (pCi/L)		0.0197 U			0 U	0 U		0.0152 U
Plutonium-239/240 (AlphaSpec) (pCi/L)	-0.00431 U		-0.00906 U	-0.0103 U			-0.00359 U	
Plutonium-239/240, Dissolved (AlphaSpec) (pCi/L)		-0.00471 U			0 U	-0.00307 U		0.04 U
Potassium-40 (GammaSpec) (pCi/L)	19.3 U		-26.6 U	21.8 U			16.8 U	
Potassium-40, Dissolved (GammaSpec) (pCi/L)		24.8 U			0 U	5.4 U		31.9
Protactinium-231 (GammaSpec) (pCi/L)	50.1 U		-1.54 U	13.4 U			75.2 U	
Protactinium-231, Dissolved (GammaSpec) (pCi/L)		-21.5 U			-4.99 U	-34.1 U		-2.74 U

Table 3-14. EU 1 Area Metal and Radiological Compound Monitoring Well Results

Station Sample No Collection Date	MW921 921GW0001-0109 01/13/10	MW921 921GW0001F-0110 01/26/10	MW922 922GW0001-0111 12/22/09	MW922 922GW0001-9008 12/22/09	MW922 922GW0001F-0112 12/23/09	MW922 922GW0001F-9009 12/23/09	MW923 923GW001-0113 01/16/10	MW923 923GW0001F-0114 01/27/10
Radium-226 (AlphaSpec) (pCi/L)	0.17 U		0.623	0.446			0.293 U	
Radium-226 (GammaSpec) (pCi/L)	-72.1 U		53.1 U	16.9 U			22.9 U	
Radium-226, Dissolved (AlphaSpec) (pCi/L)		0.21 U			0.687	0.345 U		0.565
Radium-226, Dissolved (GammaSpec) (pCi/L)		-38 U			3.79 U	1.21 U		15.1 U
Radium-228 (AlphaSpec) (pCi/L)	0.474 U		0.717 U	0.663 U			0.144 U	
Radium-228 (GammaSpec) (pCi/L)	1.19 U		-2.16 U	0.692 U			1.33 U	
Radium-228, Dissolved (AlphaSpec) (pCi/L)		0.795			0.431 U	0.259 U		-0.195 U
Radium-228, Dissolved (GammaSpec) (pCi/L)		6.87 U			-4.77 U	-2.56 U		-3.54 U
Strontium-90 (GammaSpec) (pCi/L)	0.439 U		0.707 U	-0.0134 U			0.317 U	
Strontium-90, Dissolved (GammaSpec) (pCi/L)		0.267 U			0.184 U	0.272 U		-0.209 U
Thorium-228 (AlphaSpec) (pCi/L)	0.112 U		0.185	0.198			-0.0464 U	
Thorium-228 (GammaSpec) (pCi/L)	0 U		0.717 U	1.33 U			-2.42 U	
Thorium-228, Dissolved (AlphaSpec) (pCi/L)		-0.00102 U			-0.0182 U	0.0219 U		0.00859 U
Thorium-228, Dissolved (GammaSpec) (pCi/L)		-1.16 U			2.46 U	0.965 U		0.513 U
Thorium-230 (AlphaSpec) (pCi/L)	0.0432 U		0.323 J	0.251 J			0.0111 U	
Thorium-230, Dissolved (AlphaSpec) (pCi/L)		0.0604			0.0214 U	-0.00885 U		-0.0124 U
Thorium-232 (AlphaSpec) (pCi/L)	0.0383 U		0.146	0.158			0.0272 U	
Thorium-232, Dissolved (AlphaSpec) (pCi/L)		-0.00104 U			-0.00097 U	-0.00097 U		0.017 U
Uranium-233/234 (AlphaSpec) (pCi/L)	14.5		12.3	12.2			13.7	
Uranium-233/234, Dissolved (AlphaSpec) (pCi/L)		15.6			12.5	11.4		11.7
Uranium-235 (GammaSpec) (pCi/L)	17.2 U		10.7 U	0.379 U			3.28 U	
Uranium-235, Dissolved (GammaSpec) (pCi/L)		-1.42 U			-1.98 U	9.55 U		9.9 U
Uranium-235/236 (AlphaSpec) (pCi/L)	0.418		0.423	0.339			0.631	
Uranium-235/236, Dissolved (AlphaSpec) (pCi/L)		0.515			0.578	0.618		0.592
Uranium-238 (AlphaSpec) (pCi/L)	11.6		10.2	10.1			10.7	
Uranium-238 (GammaSpec) (pCi/L)	-124 U		1.69 U	-14.7 U			0 U	
Uranium-238, Dissolved (AlphaSpec) (pCi/L)		12.3			8.24	9.41		9.84
Uranium-238, Dissolved (GammaSpec) (pCi/L)		138 U			148 U	58.1 U		-56 U

Table 3-15. EU 4 VOC Soil Results

Station	TWP927	TWP927	TWP928	TWP928	TWP929	TWP929	TWP930	TWP930
Sample No	927SS0.0-0.5-0025	927SB10.0-12.0-0026	928SS0.0-0.5-0029	928SB12.0-14.0-0030	929SS0.0-0.5-0033	929SB8.0-10.0-0034	930SS0.0-0.5-0037	930SB15.0-17.0-0038
Collection Date	11/20/09	11/20/09	11/20/09	11/20/09	11/21/09	11/21/09	11/21/09	11/21/09
Sample Depth (ft bgs)	0-0.5	10-12	0-0.5	12-14	0-0.5	8-10	0-0.5	15-17
Volatile Organic Compounds								
1,1,1-Trichloroethane (µg/kg)	0.349 U	0.36 U	1.85 U	0.368 U	0.348 U	0.349 U	0.331 U	354 U
1,1,2,2-Tetrachloroethane (µg/kg)	0.349 U	0.36 U	1.85 U	0.368 U	0.348 U	0.349 U	0.331 U	354 U
1,1,2-Trichloroethane (µg/kg)	0.349 U	0.36 U	1.85 U	0.368 U	0.348 U	0.349 U	0.331 U	354 U
1,1-Dichloroethane (µg/kg)	0.349 U	0.36 U	1.85 U	0.368 U	0.348 U	0.349 U	0.331 U	354 U
1,1-Dichloroethylene (µg/kg)	0.349 U	0.36 U	1.85 U	0.478 J	0.348 U	0.349 U	0.331 U	354 U
1,2-Dichloroethane (µg/kg)	0.349 U	0.36 U	1.85 U	0.368 U	0.348 U	0.349 U	0.331 U	354 U
1,2-Dichloropropane (µg/kg)	0.349 U	0.36 U	1.85 U	0.368 U	0.348 U	0.349 U	0.331 U	354 U
2-Butanone (µg/kg)	1.75 U	1.8 U	9.25 U	1.84 U	1.74 U	1.75 U	1.65 U	1770 U
2-Hexanone (µg/kg)	1.75 U	1.8 U	9.25 U	1.84 U	1.74 U	1.75 U	1.65 U	1770 U
4-Methyl-2-pentanone (µg/kg)	1.46 U	1.5 U	7.71 U	1.53 U	1.45 U	1.46 U	1.38 U	1470 U
Acetone (µg/kg)	1.93 U	1.99 U	10.2 U	2.82 J	1.92 U	1.93 U	1.83 U	1960 U
Benzene (µg/kg)	0.349 U	0.36 U	1.85 U	0.368 U	0.348 U	0.349 U	0.331 U	354 U
Bromodichloromethane (µg/kg)	0.349 U	0.36 U	1.85 U	0.368 U	0.348 U	0.349 U	0.331 U	354 U
Bromoform (µg/kg)	0.349 U	0.36 U	1.85 U	0.368 U	0.348 U	0.349 U	0.331 U	354 U
Bromomethane (µg/kg)	0.349 U	0.36 U	1.85 U	0.368 U	0.348 U	0.349 U	0.331 U	354 U
Carbon disulfide (µg/kg)	1.46 U	1.5 U	7.71 U	1.53 U	1.45 U	1.46 U	1.38 U	1470 U
Carbon tetrachloride (µg/kg)	0.349 U	0.36 U	1.85 U	0.368 U	0.348 U	0.349 U	0.331 U	354 U
Chlorobenzene (µg/kg)	0.349 U	0.36 U	1.85 U	0.368 U	0.348 U	0.349 U	0.331 U	354 U
Chloroethane (µg/kg)	0.349 U	0.36 U	1.85 U	0.368 U	0.348 U	0.349 U	0.331 U	354 U
Chloroform (µg/kg)	0.349 U	0.36 U	1.85 U	0.368 U	0.348 U	0.349 U	0.331 U	354 U
Chloromethane (µg/kg)	0.349 U	0.36 U	1.85 U	0.368 U	0.348 U	0.349 U	0.331 U	354 U
cis-1,2-Dichloroethylene (µg/kg)	0.349 U	0.36 U	1.85 U	248 J	0.348 U	0.349 U	0.331 U	354 U
cis-1,3-Dichloropropylene (µg/kg)	0.349 U	0.36 U	1.85 U	0.368 U	0.348 U	0.349 U	0.331 U	354 U
Ethylbenzene (µg/kg)	0.349 U	0.36 U	1.85 U	0.368 U	0.348 U	0.349 U	0.331 U	354 U
Methylene chloride (µg/kg)	2.33 U	2.4 U	12.3 U	2.45 U	2.32 U	2.33 U	2.46 J	2360 U
Styrene (µg/kg)	0.349 U	0.36 U	1.85 U	0.368 U	0.348 U	0.349 U	0.331 U	354 U
Tetrachloroethylene (µg/kg)	0.349 U	0.36 U	302	12800	2.13	0.443 J	3.1	75600
Toluene (µg/kg)	0.349 U	0.36 U	1.85 U	0.368 U	0.348 U	0.349 U	0.331 U	354 U
trans-1,2-Dichloroethylene (µg/kg)	0.349 U	0.36 U	1.85 U	8.47	0.348 U	0.349 U	0.331 U	354 U
trans-1,3-Dichloropropylene (µg/kg)	0.349 U	0.36 U	1.85 U	0.368 U	0.348 U	0.349 U	0.331 U	354 U
Trichloroethylene (µg/kg)	0.384 U	0.396 U	32	679	0.382 U	0.384 U	0.364 U	908 J
Vinyl chloride (µg/kg)	0.349 U	0.36 U	1.85 U	1.61	0.348 U	0.349 U	0.331 U	354 U
Xylenes (total) (µg/kg)	0.349 U	0.36 U	1.85 U	0.368 U	0.348 U	0.349 U	0.331 U	354 U

Table 3-15. EU 4 VOC Soil Results

Station	TWP931	TWP931	TWP932	TWP932	TWP932	TWP933	TWP933	TWP934	TWP934
Sample No	931SS0.0-0.5-0041	931SB8.0-10.0-0042	932SS0.0-0.5-0045	932SS0.0-0.5-9006	932SB14.0-16.0-0046	933SS0.0-0.5-0053	933SB10.0-12.0-0054	934SS0.0-0.5-0049	934SB16.0-18.0-0050
Collection Date	11/21/09	11/21/09	12/2/09	12/2/09	12/2/09	12/3/09	12/3/09	12/3/09	12/3/09
Sample Depth (ft bgs)	0-0.5	8-10	0-0.5	0-0.5	14-16	0-0.5	10-12	0-0.5	16-18
Volatile Organic Compounds									
1,1,1-Trichloroethane (µg/kg)	0.38 U	0.362 U	0.353 U	0.344 U	0.369 U	0.383 U	71.6 U	0.414 U	0.363 U
1,1,2,2-Tetrachloroethane (µg/kg)	0.38 U	0.362 U	0.353 U	0.344 U	0.369 U	0.383 U	71.6 U	0.414 U	0.363 U
1,1,2-Trichloroethane (µg/kg)	0.38 U	0.362 U	0.353 U	0.344 U	0.369 U	0.383 U	71.6 U	0.414 U	0.363 U
1,1-Dichloroethane (µg/kg)	0.38 U	0.362 U	0.353 U	0.344 U	0.369 U	0.383 U	71.6 U	0.414 U	0.363 U
1,1-Dichloroethylene (µg/kg)	0.38 U	0.362 U	0.353 U	0.344 U	0.369 U	0.383 U	71.6 U	0.414 U	0.363 U
1,2-Dichloroethane (µg/kg)	0.38 U	0.362 U	0.353 U	0.344 U	0.369 U	0.383 U	71.6 U	0.414 U	0.363 U
1,2-Dichloropropane (µg/kg)	0.38 U	0.362 U	0.353 U	0.344 U	0.369 U	0.383 U	71.6 U	0.414 U	0.363 U
2-Butanone (µg/kg)	1.9 U	1.81 U	1.76 U	1.72 U	1.85 U	1.92 U	358 U	2.07 U	1.82 U
2-Hexanone (µg/kg)	1.9 U	1.81 U	1.76 U	1.72 U	1.85 U	1.92 U	358 U	2.07 U	1.82 U
4-Methyl-2-pentanone (µg/kg)	1.58 U	1.51 U	1.47 U	1.43 U	1.54 U	1.6 U	298 U	1.72 U	1.51 U
Acetone (µg/kg)	2.1 U	2 U	1.95 U	1.9 U	5.64 J	2.12 U	396 U	5.55 J	2.01 U
Benzene (µg/kg)	0.38 U	0.362 U	0.353 U	0.344 U	0.369 U	0.383 U	71.6 U	0.414 U	0.363 U
Bromodichloromethane (µg/kg)	0.38 U	0.362 U	0.353 U	0.344 U	0.369 U	0.383 U	71.6 U	0.414 U	0.363 U
Bromoform (µg/kg)	0.38 U	0.362 U	0.353 U	0.344 U	0.369 U	0.383 U	71.6 U	0.414 U	0.363 U
Bromomethane (µg/kg)	0.38 U	0.362 U	0.353 U	0.344 U	0.369 U	0.383 U	71.6 U	0.414 U	0.363 U
Carbon disulfide (µg/kg)	1.58 U	1.51 U	1.47 U	1.43 U	1.54 U	1.6 U	298 U	1.72 U	1.51 U
Carbon tetrachloride (µg/kg)	0.38 U	0.362 U	0.353 U	0.344 U	0.369 U	0.383 U	71.6 U	0.414 U	0.363 U
Chlorobenzene (µg/kg)	0.38 U	0.362 U	0.353 U	0.344 U	0.369 U	0.383 U	71.6 U	0.414 U	0.363 U
Chloroethane (µg/kg)	0.38 U	0.362 U	0.353 U	0.344 U	0.369 U	0.383 U	71.6 U	0.414 U	0.363 U
Chloroform (µg/kg)	0.38 U	0.362 U	0.353 U	0.344 U	0.369 U	0.383 U	71.6 U	0.414 U	0.363 U
Chloromethane (µg/kg)	0.38 U	0.362 U	0.353 U	0.344 U	0.369 U	0.383 U	71.6 U	0.414 U	0.363 U
cis-1,2-Dichloroethylene (µg/kg)	0.38 U	0.543 J	0.353 U	0.344 U	0.382 J	8.82	251	0.414 U	0.363 U
cis-1,3-Dichloropropylene (µg/kg)	0.38 U	0.362 U	0.353 U	0.344 U	0.369 U	0.383 U	71.6 U	0.414 U	0.363 U
Ethylbenzene (µg/kg)	0.38 U	0.362 U	0.353 U	0.344 U	0.369 U	0.383 U	71.6 U	0.414 U	0.363 U
Methylene chloride (µg/kg)	2.54 U	3.7 J	2.35 U	2.29 U	2.46 U	2.55 U	477 U	2.76 U	2.42 U
Styrene (µg/kg)	0.38 U	0.362 U	0.353 U	0.344 U	0.369 U	0.383 U	71.6 U	0.414 U	0.363 U
Tetrachloroethylene (µg/kg)	2.55	1.28 J	0.353 U	1.98	0.369 U	7.15	17700	0.69 J	0.363 U
Toluene (µg/kg)	0.38 U	0.386 J	0.353 U	0.344 U	0.369 U	0.383 U	71.6 U	0.414 U	0.363 U
trans-1,2-Dichloroethylene (µg/kg)	0.38 U	0.362 U	0.353 U	0.344 U	0.369 U	0.817 J	71.6 U	0.414 U	0.363 U
trans-1,3-Dichloropropylene (µg/kg)	0.38 U	0.362 U	0.353 U	0.344 U	0.369 U	0.383 U	71.6 U	0.414 U	0.363 U
Trichloroethylene (µg/kg)	0.418 U	0.399 U	0.388 U	0.378 U	0.406 U	3.72	897	0.455 U	0.399 U
Vinyl chloride (µg/kg)	0.38 U	0.362 U	0.353 U	0.344 U	0.369 U	0.383 U	71.6 U	0.414 U	0.363 U
Xylenes (total) (µg/kg)	0.38 U	0.362 U	0.353 U	0.344 U	0.369 U	0.383 U	71.6 U	0.414 U	0.363 U

Table 3-16. EU 4 SVOC Soil Results

Station	TWP927	TWP927	TWP928	TWP928	TWP929	TWP929	TWP930	TWP930	TWP931	TWP931
Sample No	927SS0.0-0.5-0025	927SB10.0-12.0-0026	928SS0.0-0.5-0029	928SB12.0-14.0-0030	929SS0.0-0.5-0033	929SB8.0-10.0-0034	930SS0.0-0.5-0037	930SB15.0-17.0-0038	931SS0.0-0.5-0041	931SB8.0-10.0-0042
Collection Date	11/20/09	11/20/09	11/20/09	11/20/09	11/21/09	11/21/09	11/21/09	11/21/09	11/21/09	11/21/09
Sample Depth (ft bgs)	0-0.5	10-12	0-0.5	12-14	0-0.5	8-10	0-0.5	15-17	0-0.5	8-10
Semi-Volatile Organic Compounds										
1,1'-Biphenyl (µg/kg)	116 U	120 U	123 U	123 U	116 U	116 U	1100 U	117 U	127 U	120 U
2,4,5-Trichlorophenol (µg/kg)	77.5 U	80 U	81.7 U	81.7 U	77.2 U	77.2 U	732 U	78.3 U	84.5 U	80.2 U
2,4,6-Trichlorophenol (µg/kg)	77.5 U	80 U	81.7 U	81.7 U	77.2 U	77.2 U	732 U	78.3 U	84.5 U	80.2 U
2,4-Dichlorophenol (µg/kg)	77.5 U	80 U	81.7 U	81.7 U	77.2 U	77.2 U	732 U	78.3 U	84.5 U	80.2 U
2,4-Dimethylphenol (µg/kg)	136 U	140 U	143 U	143 U	135 U	135 U	1280 U	137 U	148 U	140 U
2,4-Dinitrophenol (µg/kg)	147 U	152 U	155 U	155 U	147 U	147 U	1390 U	149 U	160 U	152 U
2,4-Dinitrotoluene (µg/kg)	38.7 U	40 U	40.9 U	40.9 U	38.6 U	38.6 U	366 U	39.1 U	42.2 U	40.1 U
2,6-Dinitrotoluene (µg/kg)	38.7 U	40 U	40.9 U	40.9 U	38.6 U	38.6 U	366 U	39.1 U	42.2 U	40.1 U
2-Chloronaphthalene (µg/kg)	12.8 U	13.2 U	13.5 U	13.5 U	12.7 U	12.7 U	121 U	12.9 U	13.9 U	13.2 U
2-Chlorophenol (µg/kg)	77.5 U	80 U	81.7 U	81.7 U	77.2 U	77.2 U	732 U	78.3 U	84.5 U	80.2 U
2-Methyl-4,6-dinitrophenol (µg/kg)	77.5 U	80 U	81.7 U	81.7 U	77.2 U	77.2 U	732 U	78.3 U	84.5 U	80.2 U
2-Methylnaphthalene (µg/kg)	7.75 U	8 U	8.49 J	8.17 U	7.72 U	7.72 U	73.2 U	7.83 U	11.3 J	8.02 U
2-Nitrophenol (µg/kg)	77.5 U	80 U	81.7 U	81.7 U	77.2 U	77.2 U	732 U	78.3 U	84.5 U	80.2 U
3,3'-Dichlorobenzidine (µg/kg)	116 U	120 U	123 U	123 U	116 U	116 U	1100 U	117 U	127 U	120 U
4-Bromophenylphenylether (µg/kg)	77.5 U	80 U	81.7 U	81.7 U	77.2 U	77.2 U	732 U	78.3 U	84.5 U	80.2 U
4-Chloro-3-methylphenol (µg/kg)	77.5 U	80 U	81.7 U	81.7 U	77.2 U	77.2 U	732 U	78.3 U	84.5 U	80.2 U
4-Chloroaniline (µg/kg)	77.5 U	80 U	81.7 U	81.7 U	77.2 U	77.2 U	732 U	78.3 U	84.5 U	80.2 U
4-Chlorophenylphenylether (µg/kg)	77.5 U	80 U	81.7 U	81.7 U	77.2 U	77.2 U	732 U	78.3 U	84.5 U	80.2 U
4-Nitrophenol (µg/kg)	128 U	132 U	135 U	135 U	127 U	127 U	1210 U	129 U	139 U	132 U
Acenaphthene (µg/kg)	12.8 U	13.2 U	13.5 U	13.5 U	12.7 U	12.7 U	121 U	12.9 U	13.9 U	13.2 U
Acenaphthylene (µg/kg)	11.6 U	12 U	12.3 U	12.3 U	11.6 U	11.6 U	110 U	11.7 U	12.7 U	12 U
Acetophenone (µg/kg)	77.5 U	80 U	81.7 U	81.7 U	77.2 U	77.2 U	732 U	78.3 U	84.5 U	80.2 U
Anthracene (µg/kg)	9.8 J	8 U	8.17 U	8.17 U	50.1	7.72 U	73.2 U	7.83 U	8.45 U	8.02 U
Atrazine (µg/kg)	116 U	120 U	123 U	123 U	116 U	116 U	1100 U	117 U	127 U	120 U
Benzaldehyde (µg/kg)	116 U	120 U	123 U	123 U	116 U	116 U	1100 U	117 U	127 U	120 U
Benzo(a)anthracene (µg/kg)	63.9	12 U	24.3 J	12.3 U	11.6 U	11.6 U	110 U	11.7 U	12.7 U	12 U
Benzo(a)pyrene (µg/kg)	52.8	12 U	24.8 J	12.3 U	160	11.6 U	167 J	11.7 U	13.2 J	12 U
Benzo(b)fluoranthene (µg/kg)	105	12 U	48.3	12.3 U	316	11.6 U	110 U	11.7 U	19.2 J	12 U
Benzo(ghi)perylene (µg/kg)	48.2	12 U	25.6 J	12.3 U	174	11.6 U	547	11.7 U	15.8 J	12 U
Benzo(k)fluoranthene (µg/kg)	11.6 U	12 U	12.3 U	12.3 U	11.6 U	11.6 U	110 U	11.7 U	12.7 U	12 U
bis(2-Chloroethoxy)methane (µg/kg)	77.5 U	80 U	81.7 U	81.7 U	77.2 U	77.2 U	732 U	78.3 U	84.5 U	80.2 U
bis(2-Chloroethyl) ether (µg/kg)	77.5 U	80 U	81.7 U	81.7 U	77.2 U	77.2 U	732 U	78.3 U	84.5 U	80.2 U
bis(2-Chloroisopropyl)ether (µg/kg)	77.5 U	80 U	81.7 U	81.7 U	77.2 U	77.2 U	732 U	78.3 U	84.5 U	80.2 U
bis(2-Ethylhexyl)phthalate (µg/kg)	77.5 U	80 U	81.7 U	81.7 U	77.2 U	77.2 U	732 U	78.3 U	84.5 U	80.2 U
Butylbenzylphthalate (µg/kg)	77.5 U	80 U	81.7 U	81.7 U	77.2 U	77.2 U	732 U	78.3 U	84.5 U	80.2 U
Caprolactam (µg/kg)	77.5 U	80 U	81.7 U	81.7 U	77.2 U	77.2 U	732 U	78.3 U	84.5 U	80.2 U
Carbazole (µg/kg)	11.6 U	12 U	12.3 U	12.3 U	12.2 J	11.6 U	110 U	11.7 U	12.7 U	12 U
Chrysene (µg/kg)	60.6	12 U	27.3 J	12.3 U	214	11.6 U	110 U	11.7 U	12.7 U	12 U
Dibenzo(a,h)anthracene (µg/kg)	11.6 U	12 U	12.3 U	12.3 U	11.6 U	11.6 U	110 U	11.7 U	12.7 U	12 U
Dibenzofuran (µg/kg)	77.5 U	80 U	81.7 U	81.7 U	77.2 U	77.2 U	732 U	78.3 U	84.5 U	80.2 U
Diethylphthalate (µg/kg)	77.5 U	80 U	81.7 U	81.7 U	77.2 U	77.2 U	732 U	78.3 U	84.5 U	80.2 U
Dimethylphthalate (µg/kg)	77.5 U	80 U	81.7 U	81.7 U	77.2 U	77.2 U	732 U	78.3 U	84.5 U	80.2 U

Table 3-16. EU 4 SVOC Soil Results

Station	TWP927	TWP927	TWP928	TWP928	TWP929	TWP929	TWP930	TWP930	TWP931	TWP931
Sample No	927SS0.0-0.5-0025	927SB10.0-12.0-0026	928SS0.0-0.5-0029	928SB12.0-14.0-0030	929SS0.0-0.5-0033	929SB8.0-10.0-0034	930SS0.0-0.5-0037	930SB15.0-17.0-0038	931SS0.0-0.5-0041	931SB8.0-10.0-0042
Collection Date	11/20/09	11/20/09	11/20/09	11/20/09	11/21/09	11/21/09	11/21/09	11/21/09	11/21/09	11/21/09
Sample Depth (ft bgs)	0-0.5	10-12	0-0.5	12-14	0-0.5	8-10	0-0.5	15-17	0-0.5	8-10
Di-n-butylphthalate (µg/kg)	77.5 U	80 U	81.7 U	81.7 U	77.2 U	77.2 U	732 U	78.3 U	84.5 U	80.2 U
Di-n-octylphthalate (µg/kg)	77.5 U	80 U	81.7 U	81.7 U	77.2 U	77.2 U	732 U	78.3 U	84.5 U	80.2 U
Diphenylamine (µg/kg)	77.5 U	80 U	81.7 U	81.7 U	77.2 U	77.2 U	732 U	78.3 U	84.5 U	80.2 U
Fluoranthene (µg/kg)	112	12 U	37.2 J	12.3 U	24.3 J	11.6 U	110 U	11.7 U	12.9 J	12 U
Fluorene (µg/kg)	11.6 U	12 U	12.3 U	12.3 U	11.6 U	11.6 U	110 U	11.7 U	12.7 U	12 U
Hexachlorobenzene (µg/kg)	77.5 U	80 U	81.7 U	81.7 U	77.2 U	77.2 U	732 U	78.3 U	84.5 U	80.2 U
Hexachlorobutadiene (µg/kg)	77.5 U	80 U	81.7 U	81.7 U	77.2 U	77.2 U	732 U	78.3 U	84.5 U	80.2 U
Hexachlorocyclopentadiene (µg/kg)	77.5 U	80 U	81.7 U	81.7 U	77.2 U	77.2 U	732 U	78.3 U	84.5 U	80.2 U
Hexachloroethane (µg/kg)	77.5 U	80 U	81.7 U	81.7 U	77.2 U	77.2 U	732 U	78.3 U	84.5 U	80.2 U
Indeno(1,2,3-cd)pyrene (µg/kg)	38.2 J	12 U	16.9 J	12.3 U	110	11.6 U	110 U	11.7 U	12.7 U	12 U
Isophorone (µg/kg)	77.5 U	80 U	81.7 U	81.7 U	77.2 U	77.2 U	732 U	78.3 U	84.5 U	80.2 U
m,p-Cresols (µg/kg)	116 U	120 U	123 U	123 U	116 U	116 U	1100 U	117 U	127 U	120 U
m-Nitroaniline (µg/kg)	77.5 U	80 U	81.7 U	81.7 U	77.2 U	77.2 U	732 U	78.3 U	84.5 U	80.2 U
Naphthalene (µg/kg)	11.6 U	12 U	12.3 U	12.3 U	11.6 U	11.6 U	110 U	11.7 U	12.7 U	12 U
Nitrobenzene (µg/kg)	77.5 U	80 U	81.7 U	81.7 U	77.2 U	77.2 U	732 U	78.3 U	84.5 U	80.2 U
N-Nitrosodipropylamine (µg/kg)	77.5 U	80 U	81.7 U	81.7 U	77.2 U	77.2 U	732 U	78.3 U	84.5 U	80.2 U
o-Cresol (µg/kg)	77.5 U	80 U	81.7 U	81.7 U	77.2 U	77.2 U	732 U	78.3 U	84.5 U	80.2 U
o-Nitroaniline (µg/kg)	77.5 U	80 U	81.7 U	81.7 U	77.2 U	77.2 U	732 U	78.3 U	84.5 U	80.2 U
Pentachlorophenol (µg/kg)	96.8 U	100 U	102 U	102 U	96.5 U	96.6 U	915 U	97.9 U	106 U	100 U
Phenanthrene (µg/kg)	53.3	12 U	18.9 J	12.3 U	23.6 J	11.6 U	110 U	11.7 U	12.7 U	12 U
Phenol (µg/kg)	77.5 U	80 U	81.7 U	81.7 U	77.2 U	77.2 U	732 U	78.3 U	84.5 U	80.2 U
p-Nitroaniline (µg/kg)	116 U	120 U	123 U	123 U	116 U	116 U	1100 U	117 U	127 U	120 U
Pyrene (µg/kg)	71.8	12 U	27.6 J	12.3 U	52.4	11.6 U	110 U	11.7 U	12.7 U	12 U

Table 3-17. EU 4 PAH, Pesticide, and PCB Soil Results

Station	TWP927	TWP927	TWP928	TWP928	TWP929	TWP929	TWP930	TWP930	TWP931	TWP931
Sample No	927SS0.0-0.5-0025	927SB10.0-12.0-0026	928SS0.0-0.5-0029	928SB12.0-14.0-0030	929SS0.0-0.5-0033	929SB8.0-10.0-0034	930SS0.0-0.5-0037	930SB15.0-17.0-0038	931SS0.0-0.5-0041	931SB8.0-10.0-0042
Collection Date	11/20/09	11/20/09	11/20/09	11/20/09	11/21/09	11/21/09	11/21/09	11/21/09	11/21/09	11/21/09
Sample Depth (ft bgs)	0-0.5	10-12	0-0.5	12-14	0-0.5	8-10	0-0.5	15-17	0-0.5	8-10
Polycyclic Aromatic Hydrocarbons										
Acenaphthene (µg/kg)	5.8 U	5.99 U	6.16 U	6.09 U	5.79 U	5.82 U	549 U	5.89 U	63.3 U	6.02 U
Acenaphthylene (µg/kg)	1.93 U	2 U	2.05 U	2.03 U	1.93 U	1.94 U	183 U	1.96 U	21.1 U	2.01 U
Anthracene (µg/kg)	5.8 U	5.99 U	6.16 U	6.09 U	45.4	5.82 U	549 U	5.89 U	63.3 U	6.02 U
Benzo(a)anthracene (µg/kg)	40.3	0.639 U	18.7	0.65 U	0.618 U	0.621 U	58.6 U	0.628 U	6.76 U	0.642 U
Benzo(a)pyrene (µg/kg)	96.3	0.639 U	17.9	0.65 U	96.9	0.621 U	58.6 U	0.628 U	6.76 U	0.642 U
Benzo(b)fluoranthene (µg/kg)	98.8	0.639 U	24.7	0.65 U	160	0.621 U	58.6 U	0.628 U	6.76 U	0.642 U
Benzo(ghi)perylene (µg/kg)	81.6	0.639 U	17.1	0.65 U	93.9	0.621 U	58.6 U	0.628 U	6.76 U	0.642 U
Benzo(k)fluoranthene (µg/kg)	0.387 U	0.4 U	0.411 U	0.406 U	0.386 U	0.388 U	36.6 U	0.392 U	4.22 U	0.401 U
Chrysene (µg/kg)	44.7	0.683 U	18.2	0.695 U	161	0.664 U	62.6 U	0.671 U	7.22 U	0.686 U
Dibenzo(a,h)anthracene (µg/kg)	11.4	0.639 U	0.657 U	0.65 U	0.618 U	0.621 U	58.6 U	0.628 U	6.76 U	0.642 U
Fluoranthene (µg/kg)	63.8	0.639 U	27.6	0.65 U	58.2	0.621 U	58.6 U	0.628 U	6.76 U	0.642 U
Fluorene (µg/kg)	3.87 U	4 U	4.11 U	4.06 U	11.4 J	3.88 U	366 U	3.92 U	42.2 U	4.01 U
Indeno(1,2,3-cd)pyrene (µg/kg)	0.619 U	0.639 U	0.657 U	0.65 U	0.618 U	0.621 U	58.6 U	0.628 U	6.76 U	0.642 U
Naphthalene (µg/kg)	5.8 U	5.99 U	6.16 U	6.09 U	5.79 U	5.82 U	549 U	5.89 U	63.3 U	6.02 U
Phenanthrene (µg/kg)	21	2 U	19.3 J	2.03 U	37.8	1.94 U	183 U	1.96 U	21.1 U	2.01 U
Pyrene (µg/kg)	31.4	0.639 U	24	0.65 U	47.4	0.621 U	58.6 U	0.628 U	6.76 U	0.642 U
Pesticides										
4,4'-DDD (µg/kg)	3.87 U	0.4 U	2.05 U	0.406 U	1.93 U	1.94 U	3.67 U	1.96 U	8.45 U	2.01 U
4,4'-DDE (µg/kg)	3.87 U	0.4 U	2.05 U	0.406 U	1.93 U	1.94 U	3.67 U	1.96 U	8.45 U	2.01 U
4,4'-DDT (µg/kg)	3.87 U	0.4 U	2.05 U	0.406 U	1.93 U	1.94 U	3.67 U	1.96 U	8.45 U	2.01 U
Aldrin (µg/kg)	1.94 U	0.2 U	1.03 U	0.203 U	0.964 U	0.97 U	1.83 U	0.979 U	4.22 U	1 U
alpha-BHC (µg/kg)	1.94 U	0.2 U	1.03 U	0.203 U	0.964 U	0.97 U	1.83 U	0.979 U	4.22 U	1 U
alpha-Chlordane (µg/kg)	1.94 U	0.2 U	1.03 U	0.203 U	0.964 U	0.97 U	1.83 U	0.979 U	4.22 U	1 U
beta-BHC (µg/kg)	1.94 U	0.2 U	1.03 U	0.203 U	0.964 U	0.97 U	1.83 U	0.979 U	4.22 U	1 U
delta-BHC (µg/kg)	1.94 U	0.2 U	1.03 U	0.203 U	0.964 U	0.97 U	1.83 U	0.979 U	4.22 U	1 U
Dieldrin (µg/kg)	3.87 U	0.4 U	2.05 U	0.406 U	1.93 U	1.94 U	3.67 U	1.96 U	8.45 U	2.01 U
Endosulfan I (µg/kg)	1.94 U	0.2 U	1.03 U	0.203 U	0.964 U	0.97 U	1.83 U	0.979 U	4.22 U	1 U
Endosulfan II (µg/kg)	3.87 U	0.4 U	2.05 U	0.406 U	1.93 U	1.94 U	3.67 U	1.96 U	8.45 U	2.01 U
Endosulfan sulfate (µg/kg)	3.87 U	0.4 U	2.05 U	0.406 U	1.93 U	1.94 U	3.67 U	1.96 U	8.45 U	2.01 U
Endrin (µg/kg)	3.87 U	0.4 U	2.05 U	0.406 U	1.93 U	1.94 U	3.67 U	1.96 U	8.45 U	2.01 U
Endrin aldehyde (µg/kg)	3.87 U	0.4 U	2.05 U	0.406 U	1.93 U	1.94 U	3.67 U	1.96 U	8.45 U	2.01 U
Endrin ketone (µg/kg)	3.87 U	0.4 U	2.05 U	0.406 U	1.93 U	1.94 U	3.67 U	1.96 U	8.45 U	2.01 U
gamma-BHC (Lindane) (µg/kg)	1.94 U	0.2 U	1.03 U	0.203 U	0.964 U	0.97 U	1.83 U	0.979 U	4.22 U	1 U
gamma-Chlordane (µg/kg)	1.94 U	0.2 U	1.03 U	0.203 U	0.964 U	0.97 U	1.83 U	0.979 U	4.22 U	1 U
Heptachlor (µg/kg)	1.94 U	0.2 U	1.03 U	0.203 U	0.964 U	0.97 U	1.83 U	0.979 U	4.22 U	1 U
Heptachlor epoxide (µg/kg)	2.42 U	0.25 U	1.28 U	0.254 U	1.2 U	1.21 U	2.29 U	1.22 U	5.28 U	1.26 U
Methoxychlor (µg/kg)	19.4 U	2 U	10.3 U	2.03 U	9.64 U	9.7 U	18.3 U	9.79 U	42.2 U	10 U
Toxaphene (µg/kg)	64.5 U	6.66 U	34.1 U	6.76 U	32.1 U	32.3 U	61 U	32.6 U	141 U	33.5 U

Table 3-17. EU 4 PAH, Pesticide, and PCB Soil Results

Station	TWP927	TWP927	TWP928	TWP928	TWP929	TWP929	TWP930	TWP930	TWP931	TWP931
Sample No	927SS0.0-0.5-0025	927SB10.0-12.0-0026	928SS0.0-0.5-0029	928SB12.0-14.0-0030	929SS0.0-0.5-0033	929SB8.0-10.0-0034	930SS0.0-0.5-0037	930SB15.0-17.0-0038	931SS0.0-0.5-0041	931SB8.0-10.0-0042
Collection Date	11/20/09	11/20/09	11/20/09	11/20/09	11/21/09	11/21/09	11/21/09	11/21/09	11/21/09	11/21/09
Sample Depth (ft bgs)	0-0.5	10-12	0-0.5	12-14	0-0.5	8-10	0-0.5	15-17	0-0.5	8-10
PCBs										
Aroclor-1016 (µg/kg)	1.29 U	1.33 U	6.84 U	1.35 U	6.4 U	1.29 U	30.5 U	1.3 U	140 U	1.34 U
Aroclor-1221 (µg/kg)	1.29 U	1.33 U	6.84 U	1.35 U	6.4 U	1.29 U	30.5 U	1.3 U	140 U	1.34 U
Aroclor-1232 (µg/kg)	1.29 U	1.33 U	6.84 U	1.35 U	6.4 U	1.29 U	30.5 U	1.3 U	140 U	1.34 U
Aroclor-1242 (µg/kg)	1.29 U	1.33 U	6.84 U	1.35 U	6.4 U	1.29 U	30.5 U	1.3 U	140 U	1.34 U
Aroclor-1248 (µg/kg)	1.29 U	1.33 U	6.84 U	1.35 U	6.4 U	1.29 U	30.5 U	1.3 U	140 U	1.34 U
Aroclor-1254 (µg/kg)	1.29 U	1.33 U	45.4 J	1.35 U	104	1.29 U	396	1.3 U	601	1.34 U
Aroclor-1260 (µg/kg)	12	1.33 U	93.6 J	1.35 U	247	1.29 U	1030	1.3 U	1400	1.34 U

Table 3-18. EU 4 Metal and Radiological Compound Soil Results

Station	TWP927	TWP927	TWP928	TWP928	TWP929	TWP929	TWP930	TWP930
Sample No	927SS0.0-0.5-0025	927SB10.0-12.0-0026	928SS0.0-0.5-0029	928SB12.0-14.0-0030	929SS0.0-0.5-0033	929SB8.0-10.0-0034	930SS0.0-0.5-0037	930SB15.0-17.0-0038
Collection Date	11/20/09	11/20/09	11/20/09	11/20/09	11/21/09	11/21/09	11/21/09	11/21/09
Sample Depth (ft bgs)	0-0.5	10-12	0-0.5	12-14	0-0.5	8-10	0-0.5	15-17
Metals								
Aluminum (mg/kg)								
Antimony (mg/kg)	0.374 U	0.388 U	0.394 U	0.386 U	0.366 U	0.375 U	0.356 U	0.371 U
Arsenic (mg/kg)	4.02	2.96	3.2	3.22	4.64	3.76	2.55	3.01
Barium (mg/kg)	144	133	126	114	82.4	149	56.5	90.3
Beryllium (mg/kg)	0.562	0.638	0.6	0.624	0.466	0.685	0.383	0.522
Boron (mg/kg)								
Cadmium (mg/kg)	0.241	0.14 J	0.316	0.158 J	0.285	0.137 J	0.527	0.127 J
Calcium (mg/kg)								
Chromium (mg/kg)	17.1	18.3	22.5	20.9	12.8	18.8	8.01	16.1
Cobalt (mg/kg)								
Copper (mg/kg)								
Iron (mg/kg)								
Lead (mg/kg)	14.7	5.87	31.1	6.75	50.4	6.45	36.3	4.84
Lithium (mg/kg)								
Magnesium (mg/kg)								
Manganese (mg/kg)								
Mercury (µg/kg)	20.2	9.08 J	61.2	7.64 J	39.5 J	8.34 J	70.5	5.5 J
Nickel (mg/kg)	24.9	19.8	22.1	23.2	17.4	21.3	18.1	19.1
Potassium (mg/kg)								
Selenium (mg/kg)	0.57 U	0.599 U	0.617 U	0.584 U	0.57 U	0.575 U	0.537 U	0.589 U
Silver (mg/kg)	0.56 J	0.372 J	0.712	0.45 J	0.493 J	0.316 J	0.252 J	0.112 U
Sodium (mg/kg)								
Thallium (mg/kg)	0.143 J	0.131 J	0.173 J	0.157 J	0.101 J	0.133 J	0.093 J	0.109 J
Vanadium (mg/kg)								
Zinc (mg/kg)	44.7	47.8	65.5	53.5	56.9	51	63.8	43.7

Table 3-18. EU 4 Metal and Radiological Compound Soil Results

Station	TWP927	TWP927	TWP928	TWP928	TWP929	TWP929	TWP930	TWP930
Sample No	927SS0.0-0.5-0025	927SB10.0-12.0-0026	928SS0.0-0.5-0029	928SB12.0-14.0-0030	929SS0.0-0.5-0033	929SB8.0-10.0-0034	930SS0.0-0.5-0037	930SB15.0-17.0-0038
Collection Date	11/20/09	11/20/09	11/20/09	11/20/09	11/21/09	11/21/09	11/21/09	11/21/09
Sample Depth (ft bgs)	0-0.5	10-12	0-0.5	12-14	0-0.5	8-10	0-0.5	15-17
Radiological Compounds								
Actinium-227 (GammaSpec) (pCi/g)	0.00267 U	0.212 U	0.0695 U	0.0769 U	0.424 U	0.0636 U	-0.178 U	-0.476 U
Americium-241 (GammaSpec) (pCi/g)	-0.172 U	0.0127 U	0.108 U	0.066 U	-0.27 U	0.0899 U	0.00767 U	0.0776 U
Cesium-137 (GammaSpec) (pCi/g)	0.213	0.00603 U	0.47	-0.0105 U	0.375	0.0148 U	0.486	-0.0495 U
Cobalt-60 (GammaSpec) (pCi/g)	-0.00874 U	-0.0306 U	-0.00746 U	0.017 U	-0.00775 U	0.00694 U	0.0436 U	-0.0454 U
Plutonium-238 (AlphaSpec) (pCi/g)	-0.0176 U	-0.0266 U	-0.0229 U	-0.0302 U	0.0483 U	0.0836 U	0 U	-0.147 U
Plutonium-239/240 (AlphaSpec) (pCi/g)	-0.0529 U	-0.0531 U	0.0495 U	-0.0755 U	0.0966 U	0.18 U	0.0152 U	-0.0293 U
Potassium-40 (GammaSpec) (pCi/g)	19.2	22.9	14.2	25.6	14.4	26	10.4	21.1
Protactinium-231 (GammaSpec) (pCi/g)	-0.162 U	-0.305 U	0.726 U	0.0472 U	0.731 U	0.103 U	-1.19 U	0.391 U
Radium-226 (AlphaSpec) (pCi/g)	1.1	0.704	2.03	0.789	1.86 J	0.739 J	2.72 J	0.253 U
Radium-226 (GammaSpec) (pCi/g)	1.07	0.809	1.59	0.954	1.44	0.826	1.89	0.835
Radium-228 (AlphaSpec) (pCi/g)	0.832	0.0443 U	0.79	1.67	0.597 U	1.15	0.716	1.4
Radium-228 (GammaSpec) (pCi/g)	0.672	1.14	0.799	1.07	0.887	1.06	0.568	1.22
Strontium-90 (GammaSpec) (pCi/g)	0.478 U	-0.738 U	-0.0569 U	0.58 U	-0.0608 U	0.052 U	-0.0642 U	-0.104 U
Thorium-228 (AlphaSpec) (pCi/g)	0.473	0.882	0.786	1.19	0.468	0.963	0.491	1.3
Thorium-228 (GammaSpec) (pCi/g)	0.841	0.863	0.95	1.22	0.86	1.01	0.59	1
Thorium-230 (AlphaSpec) (pCi/g)	1	1.26	1.98	1.49	2.15	1.06	1.41	1.02
Thorium-232 (AlphaSpec) (pCi/g)	0.808	1.12	0.769	1.63	0.973	1.28	0.498	0.771
Uranium-233/234 (AlphaSpec) (pCi/g)	0.675	0.628	1.59	0.721	0.803	0.892	0.769	0.541
Uranium-235 (GammaSpec) (pCi/g)	0.355 U	0.00593 U	0.095 U	-0.0977 U	-0.105 U	0.163 U	0.0389 U	-0.133 U
Uranium-235/236 (AlphaSpec) (pCi/g)	-0.00855 U	0.0682 U	0.0949 U	-0.00848 U	-0.0122 U	-0.00848 U	0.113 U	0.0286 U
Uranium-238 (AlphaSpec) (pCi/g)	0.459	0.747	1.38	0.851	0.885	0.736	0.868	0.419
Uranium-238 (GammaSpec) (pCi/g)	1 U	1.81 U	1.13 U	0 U	0.684 U	1.33 U	0.739 U	0.952 U

Table 3-18. EU 4 Metal and Radiological Compound Soil Results

Station	TWP931	TWP931	TWP932	TWP932	TWP932	TWP933	TWP933	TWP934	TWP934
Sample No	931SS0.0-0.5-0041	931SB8.0-10.0-0042	932SS0.0-0.5-0045	932SS0.0-0.5-9006	932SB14.0-16.0-0046	933SS0.0-0.5-0053	933SB10.0-12.0-0054	934SS0.0-0.5-0049	934SB16.0-18.0-0050
Collection Date	11/21/09	11/21/09	12/2/09	12/2/09	12/2/09	12/3/09	12/3/09	12/3/09	12/3/09
Sample Depth (ft bgs)	0-0.5	8-10	0-0.5	0-0.5	14-16	0-0.5	10-12	0-0.5	16-18
Metals									
Aluminum (mg/kg)			21300	24200	18300	15300	16500	10800	15000
Antimony (mg/kg)	0.439 J	0.388 U	0.381 U	0.377 U	0.38 U	0.408 U	0.376 U	0.439 U	0.398 U
Arsenic (mg/kg)	3.53	2.72	4.12	5.56	3.91	4.44	3.79	3.15	3.31
Barium (mg/kg)	94	105	159	166	127	146	113	82	121
Beryllium (mg/kg)	0.464	0.417	0.831	0.997	0.909	1.34	0.837	0.582 J	0.667
Boron (mg/kg)			32.7	35.6	37.2	12 J	23.2	14 J	13.5 J
Cadmium (mg/kg)	0.495	0.108 J	0.308	0.413	0.148 J	0.353	0.204 J	0.338	0.157 J
Calcium (mg/kg)			37300	52700	48100	32000	41400	47200	41600
Chromium (mg/kg)	14.6	11.8	25.3	25.6	22.5	16.8 J	20 J	13.3 J	19.9 J
Cobalt (mg/kg)			8.39	9.48	12.4	8.45	11.1	6.49	10.6
Copper (mg/kg)			32.2	30.1	24.5	29.5	31.8	25.1	23.2
Iron (mg/kg)			21700	25800	23900	21600	22100	14500	22100
Lead (mg/kg)	175	3.72	22	20.4	6.7	17.1 J	6.93 J	25 J	6.37 J
Lithium (mg/kg)			22.6	21	24.9	23.4	25.2	16.1	26.3
Magnesium (mg/kg)			9960	14100	12200	7330	11600	18900	11900
Manganese (mg/kg)			630	1330	650	833 J	668 J	672 J	673 J
Mercury (µg/kg)	66.2	9.11 J	29.8	27.7	7.63 J	35.5	7.77 J	47.8	6.7 J
Nickel (mg/kg)	17	13.5	33.3	50.2	24.6	21.4 J	23.1 J	15.4	23.1
Potassium (mg/kg)			5360	5810	4410	1820	3250	1800	3060
Selenium (mg/kg)	0.604 U	0.604 U	0.574 U	0.573 U	0.599 U	0.619 U	0.593 U	0.688 U	0.581 U
Silver (mg/kg)	0.344 J	0.507 J	0.524 J	0.507 J	0.521 J	0.46 J	0.19 J	0.441 J	0.575 J
Sodium (mg/kg)			240 J	242 J	195 J	129 J	186 J	110 U	284 J
Thallium (mg/kg)	0.105 J	0.0833 J	0.212 J	0.231	0.171 J	0.106 J	0.122 J	0.0928 J	0.138 J
Vanadium (mg/kg)			47.1	51.3	37.6	30.2 J	32.8	22 J	32.7 J
Zinc (mg/kg)	81.9	32.7	62.1	64.6	55.3	59.1	57.8	57.7	54.5

Table 3-18. EU 4 Metal and Radiological Compound Soil Results

Station	TWP931	TWP931	TWP932	TWP932	TWP932	TWP933	TWP933	TWP934	TWP934
Sample No	931SS0.0-0.5-0041	931SB8.0-10.0-0042	932SS0.0-0.5-0045	932SS0.0-0.5-9006	932SB14.0-16.0-0046	933SS0.0-0.5-0053	933SB10.0-12.0-0054	934SS0.0-0.5-0049	934SB16.0-18.0-0050
Collection Date	11/21/09	11/21/09	12/2/09	12/2/09	12/2/09	12/3/09	12/3/09	12/3/09	12/3/09
Sample Depth (ft bgs)	0-0.5	8-10	0-0.5	0-0.5	14-16	0-0.5	10-12	0-0.5	16-18
Radiological Compounds									
Actinium-227 (GammaSpec) (pCi/g)	0.211 U	-0.181 U							
Americium-241 (GammaSpec) (pCi/g)	0.0328 U	-0.0155 U							
Cesium-137 (GammaSpec) (pCi/g)	0.35	0.00349 U							
Cobalt-60 (GammaSpec) (pCi/g)	-0.0163 U	-0.0146 U							
Plutonium-238 (AlphaSpec) (pCi/g)	-0.15 U	-0.0657 U							
Plutonium-239/240 (AlphaSpec) (pCi/g)	-0.109 U	-0.0394 U							
Potassium-40 (GammaSpec) (pCi/g)	18.2	20.5							
Protactinium-231 (GammaSpec) (pCi/g)	-0.165 U	-0.306 U							
Radium-226 (AlphaSpec) (pCi/g)	1.83 J	1.1 J							
Radium-226 (GammaSpec) (pCi/g)	1.36	0.643							
Radium-228 (AlphaSpec) (pCi/g)	1.41	0.875							
Radium-228 (GammaSpec) (pCi/g)	0.835	1.07							
Strontium-90 (GammaSpec) (pCi/g)	0.343 U	0.164 U							
Thorium-228 (AlphaSpec) (pCi/g)	0.564	0.649							
Thorium-228 (GammaSpec) (pCi/g)	1.04	0.883							
Thorium-230 (AlphaSpec) (pCi/g)	1.35	0.641							
Thorium-232 (AlphaSpec) (pCi/g)	0.748	1.04							
Uranium-233/234 (AlphaSpec) (pCi/g)	0.753	0.61	0.772		0.675	0.433	0.711	0.479	0.57
Uranium-235 (GammaSpec) (pCi/g)	0.0998 U	-0.132 U							
Uranium-235/236 (AlphaSpec) (pCi/g)	0.0553 U	0.0785 U	0.118 U		0.0345 U	0.0276 U	0.00145 U	0.0201 U	0.0361 U
Uranium-238 (AlphaSpec) (pCi/g)	0.526	1.08	0.789		0.978	0.722	0.861	0.665	0.578
Uranium-238 (GammaSpec) (pCi/g)	0.67 U	0 U							

Table 3-19. EU 4 Geotechnical Results

Station Sample No Collection Date	TWP932 932SB4.0-6.0-0100 12/02/2009	TWP932 932SB10.0-12.0-0101 12/02/2009	TWP933 933SB4.0-6.0-0104 12/03/2009	TWP933 933SB12.0-14.0-0105 12/03/2009	TWP934 934SB4.0-6.0-0102 12/03/2009	TWP934 934SB14.0-16.0-0103 12/03/2009
Moisture Content (%)	17.4	35.9	16.0	20.9	14.3	15.6
In-Place Density (g/cm^3)	1.73	1.31	1.84	1.60	1.88	1.73
Specific Gravity	2.708	2.781	2.746	2.744	2.748	2.767

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Table 3-20. EU 4 VOC Groundwater Screening Results

Station	TWP927	TWP928	TWP930	TWP931	TWP931	TWP932	TWP933	TWP934
Sample No	927TW0001-0027	928TW0001-0031	930TW0001-0039	931TW0001-0043	931TW0001-9003	932TW0001-0047	933TW0001-0051	934TW0001-0055
Collection Date	11/23/09	11/23/09	11/25/09	11/30/09	11/30/09	12/06/09	12/07/09	12/06/09
1,1,1-Trichloroethane (µg/L)	0.325 U	0.325 U	813 U	0.325 U	0.325 U	0.325 U	3250000 U	0.325 U
1,1,2,2-Tetrachloroethane (µg/L)	0.25 U	0.25 U	625 U	0.25 U	0.25 U	0.25 U	2500000 U	0.25 U
1,1,2-Trichloroethane (µg/L)	0.25 U	0.25 U	625 U	0.25 U	0.25 U	0.25 U	2500000 U	0.25 U
1,1-Dichloroethane (µg/L)	0.3 U	0.3 U	750 U	0.3 U	0.3 U	0.3 U	3000000 U	0.3 U
1,1-Dichloroethylene (µg/L)	0.3 U	0.951 J	750 U	0.3 U	0.3 U	0.3 U	3000000 U	0.3 U
1,2-Dichloroethane (µg/L)	0.25 U	0.25 U	625 U	0.25 U	0.25 U	0.25 U	2500000 U	0.25 U
1,2-Dichloropropane (µg/L)	0.25 U	0.25 U	625 U	0.25 U	0.25 U	0.25 U	2500000 U	0.25 U
2-Butanone (µg/L)	1.25 U	4.98 J	3130 U	1.25 U	1.25 U	1.25 U	12500000 U	1.25 U
2-Hexanone (µg/L)	1.25 U	1.6 J	3130 U	1.25 U	1.25 U	1.25 U	12500000 U	1.25 U
4-Methyl-2-pentanone (µg/L)	1.25 U	1.25 U	3130 U	1.25 U	1.25 U	1.25 U	12500000 U	1.25 U
Acetone (µg/L)	2.92 J	13.6	3750 U	3.13 J	3.2 J	3.09 J	15000000 U	3.76 J
Benzene (µg/L)	0.3 U	0.3 U	750 U	0.31 J	0.3 U	0.3 U	3000000 U	0.3 U
Bromodichloromethane (µg/L)	0.25 U	0.25 U	625 U	0.25 U	0.25 U	0.25 U	2500000 U	0.25 U
Bromoform (µg/L)	0.25 U	0.25 U	625 U	0.25 U	0.25 U	0.25 U	2500000 U	0.25 U
Bromomethane (µg/L)	0.3 U	0.3 U	750 U	0.3 U	0.3 U	0.3 U	3000000 U	0.3 U
Carbon disulfide (µg/L)	1.25 U	1.25 U	3130 U	1.25 U	1.25 U	1.25 U	12500000 U	1.25 U
Carbon tetrachloride (µg/L)	0.3 U	0.3 U	750 U	0.3 U	0.3 U	0.3 U	3000000 U	0.3 U
Chlorobenzene (µg/L)	0.25 U	0.25 U	625 U	0.25 U	0.25 U	0.25 U	2500000 U	0.25 U
Chloroethane (µg/L)	0.3 U	0.3 U	750 U	0.3 U	0.3 U	0.3 U	3000000 U	0.3 U
Chloroform (µg/L)	0.25 U	0.25 U	625 U	0.25 U	0.25 U	0.38 J	2500000 U	1.61
Chloromethane (µg/L)	0.3 U	0.657 J	750 U	0.3 U	0.3 U	0.31 J	3000000 U	0.3 U
cis-1,2-Dichloroethylene (µg/L)	0.3 U	522	750 U	1.79	7.13	0.3 U	3000000 U	0.3 U
cis-1,3-Dichloropropylene (µg/L)	0.25 U	0.25 U	625 U	0.25 U	0.25 U	0.25 U	2500000 U	0.25 U
Ethylbenzene (µg/L)	0.25 U	0.25 U	625 U	0.25 U	0.25 U	0.25 U	2500000 U	0.25 U
Methylene chloride (µg/L)	2.4 R	2.53 R	5000 U	2 U	2 U	2 U	20000000 U	2 U
Styrene (µg/L)	0.25 U	0.25 U	625 U	0.25 U	0.25 U	0.25 U	2500000 U	0.25 U
Tetrachloroethylene (µg/L)	0.587 J	2380	114000	0.93 J	0.9 J	0.77 J	134000000	0.51 J
Toluene (µg/L)	0.25 U	0.331 J	625 U	0.72 J	0.48 J	0.32 J	2500000 U	0.33 J

Table 3-20. EU 4 VOC Groundwater Screening Results

Station Sample No Collection Date	TWP927 927TW0001-0027 11/23/09	TWP928 928TW0001-0031 11/23/09	TWP930 930TW0001-0039 11/25/09	TWP931 931TW0001-0043 11/30/09	TWP931 931TW0001-9003 11/30/09	TWP932 932TW0001-0047 12/06/09	TWP933 933TW0001-0051 12/07/09	TWP934 934TW0001-0055 12/06/09
trans-1,2-Dichloroethylene (µg/L)	0.3 U	6.9	750 U	0.3 U	0.3 U	0.3 U	3000000 U	0.3 U
trans-1,3-Dichloropropylene (µg/L)	0.25 U	0.25 U	625 U	0.25 U	0.25 U	0.25 U	2500000 U	0.25 U
Trichloroethylene (µg/L)	0.25 U	930	12500	0.25 U	0.25 U	0.25 U	9500000 J	0.25 U
Vinyl chloride (µg/L)	0.5 U	9.88	1250 U	0.5 U	0.69 J	0.5 U	5000000 U	0.5 U
Xylenes (total) (µg/L)	0.3 U	0.3 U	750 U	0.3 U	0.3 U	0.3 U	3000000 U	0.3 U

Table 3-21. EU 4 Metals Groundwater Screening Results

Station	TWP932	TWP932	TWP933	TWP933	TWP934	TWP934
Sample No	932TW0001-0047	932TW0001F-0048	933TW0001-0051	933TW0001F-0052	934TW0001-0055	934TW0001F-0056
Collection Date	12/06/09	12/06/09	12/07/09	12/07/09	12/06/09	12/06/09
Aluminum (µg/L)	31.4 J		33400		69500	
Aluminum, Dissolved (µg/L)		20.2 J		7500 U		15 U
Antimony (µg/L)	15 J		1500 U		3 U	
Antimony, Dissolved (µg/L)		15 U		1500 U		3 U
Arsenic (µg/L)	10.9		800 U		18.5	
Arsenic, Dissolved (µg/L)		8.46		800 U		1.6 U
Barium (µg/L)	31.5		300 U		478	
Barium, Dissolved (µg/L)		29.8		300 U		67.1
Beryllium (µg/L)	0.1 U		50 U		3.54	
Beryllium, Dissolved (µg/L)		0.1 U		50 U		0.1 U
Boron (µg/L)	29300		2000 U		303	
Boron, Dissolved (µg/L)		29200		2000 U		278
Cadmium (µg/L)	0.11 U		55 U		0.872 J	
Cadmium, Dissolved (µg/L)		0.11 U		55 U		0.11 U
Calcium (µg/L)	107000		69800 J		243000	
Calcium, Dissolved (µg/L)		107000		53000 J		142000
Chromium (µg/L)	3.28 R		1870 J		62.9 J	
Chromium, Dissolved (µg/L)		4.29 J		1850 J		2 U
Cobalt (µg/L)	2.92		50 U		28.8	
Cobalt, Dissolved (µg/L)		3.09		50 U		4.13
Copper (µg/L)	3.03		165 U		74.9	
Copper, Dissolved (µg/L)		2.81		165 U		6.14
Iron (µg/L)	1230		16500 U		76900	
Iron, Dissolved (µg/L)		1000		16500 U		326
Lead (µg/L)	0.5 U		250 U		33	
Lead, Dissolved (µg/L)		0.5 U		250 U		0.5 U
Lithium (µg/L)	27.7		1000 U		180	
Lithium, Dissolved (µg/L)		27.2		1000 U		96
Magnesium (µg/L)	138000		2600 U		395000	
Magnesium, Dissolved (µg/L)		132000		2600 U		290000
Manganese (µg/L)	279		500 U		1750	

Table 3-21. EU 4 Metals Groundwater Screening Results

Station Sample No Collection Date	TWP932 932TW0001-0047 12/06/09	TWP932 932TW0001F-0048 12/06/09	TWP933 933TW0001-0051 12/07/09	TWP933 933TW0001F-0052 12/07/09	TWP934 934TW0001-0055 12/06/09	TWP934 934TW0001F-0056 12/06/09
Manganese, Dissolved (µg/L)		308		500 U		325
Mercury (µg/L)	0.066 U		222		0.066 U	
Mercury, Dissolved (µg/L)		0.209		275		0.066 U
Nickel (µg/L)	6.42		250 U		74.5	
Nickel, Dissolved (µg/L)		6.52		250 U		10.2
Potassium (µg/L)	3350		40000 U		14600	
Potassium, Dissolved (µg/L)		3460		40000 U		4400
Selenium (µg/L)	1 U		500 U		1 U	
Selenium, Dissolved (µg/L)		1 U		500 U		1 U
Silver (µg/L)	1 U		500 U		1.83 J	
Silver, Dissolved (µg/L)		1 U		500 U		1 U
Sodium (µg/L)	51400		40000 U		189000	
Sodium, Dissolved (µg/L)		49400		40000 U		185000
Thallium (µg/L)	0.3 U		150 U		0.804 J	
Thallium, Dissolved (µg/L)		0.3 U		150 U		0.3 U
Vanadium (µg/L)	3 U		1500 U		93.3	
Vanadium, Dissolved (µg/L)		3 U		1500 U		3 U
Zinc (µg/L)	30.6		1500 U		178	
Zinc, Dissolved (µg/L)		4.49 J		1500 U		6.58 J

Table 3-22. EU 4 Radiological Screening Results

Station	TWP927	TWP927	TWP928	TWP928	TWP930	TWP930	TWP931	TWP931
Sample No	927TW0001-0027	927TW0001F-0028	928TW0001-0031	928TW0001F-0032	930TW0001-0039	930TW0001F-0040	931TW0001-0043	931TW0001F-0044
Collection Date	11/23/09	11/23/09	11/23/09	11/23/09	11/25/09	11/25/09	11/30/09	11/30/09
Uranium-233/234 (pCi/L)	6.36		3.75		8.26		2.55	
Uranium-233/234, Dissolved (pCi/L)		7.54		5.46		7.81		3.24
Uranium-235/236 (pCi/L)	0.596		0.155		0.329		0.121	
Uranium-235/236, Dissolved (pCi/L)		0.322		0.178		0.271		0.162
Uranium-238 (pCi/L)	5.72		3.06		6.69		2.36	
Uranium-238, Dissolved (pCi/L)		6.55		4.18		6.27		3.01

All analyses performed by alpha spectroscopy.

Station	TWP931	TWP931	TWP932	TWP932	TWP933	TWP933	TWP934	TWP934
Sample No	931TW0001-9003	931TW0001F-9004	932TW0001-0047	932TW0001F-0048	933TW0001-0051	933TW0001F-0052	934TW0001-0055	934TW0001F-0056
Collection Date	11/30/09	11/30/09	12/06/09	12/06/09	12/07/09	12/07/09	12/06/09	12/06/09
Uranium-233/234 (pCi/L)	3.57		2.7		-0.0316 U *		11.5	
Uranium-233/234, Dissolved (pCi/L)		3.63		2.5		0.0873 U *		11
Uranium-235/236 (pCi/L)	0.193		0.17		0 U *		0.414	
Uranium-235/236, Dissolved (pCi/L)		0.238		0.0135 U		-0.0106 U *		0.459
Uranium-238 (pCi/L)	3.17		2.26		0.209 U *		10.3	
Uranium-238, Dissolved (pCi/L)		3.42		2.04		0.0356 U *		9.2

All analyses performed by alpha spectroscopy.

* TWP933 sample was analyzed as a solid due to the thickness of sample; therefore, the results are in pCi/g.

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Table 3-23. EU 4 Soil Gas Results

Temporary Well Point Sample No	TWP932 932SG0001-0107	TWP933 933SG0001-0108	TWP934 934SG0001-0106
Volatile Organic Compounds			
Acetone	50	17000 J	9.4
Acetonitrile	18 J	N.D.	N.D.
Acrolein	N.D.	N.D.	N.D.
Acrylonitrile	N.D.	N.D.	N.D.
Benzene	10 J	N.D.	0.81 J
Bromobenzene	N.D.	N.D.	N.D.
Bromodichloromethane	N.D.	N.D.	N.D.
Bromoform	N.D.	N.D.	N.D.
Bromomethane	N.D.	N.D.	N.D.
1,3-Butadiene	N.D.	N.D.	N.D.
2-Butanone	N.D.	N.D.	2.1 J
tert-Butyl Alcohol	N.D.	N.D.	N.D.
Carbon Disulfide	N.D.	N.D.	4.5
Carbon Tetrachloride	N.D.	N.D.	N.D.
Chlorobenzene	N.D.	N.D.	N.D.
Chlorodifluoromethane	N.D.	N.D.	0.78 J
Chloroethane	N.D.	N.D.	N.D.
Chloroform	N.D.	N.D.	N.D.
Chloromethane	N.D.	N.D.	0.98 J
3-Chloropropene	N.D.	N.D.	N.D.
Cumene	N.D.	N.D.	N.D.
Dibromochloromethane	N.D.	N.D.	N.D.
1,2-Dibromoethane	N.D.	N.D.	N.D.
Dibromomethane	N.D.	N.D.	N.D.
1,2-Dichlorobenzene	N.D.	N.D.	N.D.
1,3-Dichlorobenzene	N.D.	N.D.	N.D.
1,4-Dichlorobenzene	N.D.	N.D.	N.D.
Dichlorodifluoromethane	N.D.	N.D.	2.9 J
1,1-Dichloroethane	N.D.	N.D.	N.D.
1,2-Dichloroethane	N.D.	N.D.	N.D.
1,1-Dichloroethene	N.D.	N.D.	N.D.
cis-1,2-Dichloroethene	N.D.	61000	N.D.
trans-1,2-Dichloroethene	N.D.	N.D.	N.D.
Dichlorofluoromethane	N.D.	N.D.	N.D.
1,2-Dichloropropane	N.D.	N.D.	N.D.
cis-1,3-Dichloropropene	N.D.	N.D.	N.D.
trans-1,3-Dichloropropene	N.D.	N.D.	N.D.
1,4-Dioxane	N.D.	N.D.	N.D.
Ethyl Acetate	N.D.	N.D.	N.D.
Ethyl Acrylate	N.D.	N.D.	N.D.
Ethyl Methacrylate	N.D.	N.D.	N.D.
Ethylbenzene	N.D.	N.D.	N.D.
4-Ethyltoluene	N.D.	N.D.	N.D.
Freon 113	N.D.	N.D.	N.D.
Freon 114	N.D.	N.D.	N.D.
Heptane	N.D.	N.D.	N.D.
Hexachlorobutadiene	N.D.	N.D.	N.D.

Table 3-23. EU 4 Soil Gas Results

Temporary Well Point Sample No	TWP932 932SG0001-0107	TWP933 933SG0001-0108	TWP934 934SG0001-0106
Hexachloroethane	N.D.	N.D.	N.D.
Hexane	26 J	N.D.	N.D.
2-Hexanone	N.D.	N.D.	N.D.
Isooctane	N.D.	N.D.	N.D.
Methyl Acrylate	N.D.	N.D.	N.D.
Methyl Iodide	N.D.	N.D.	N.D.
Methyl Methacrylate	N.D.	N.D.	N.D.
Alpha Methyl Styrene	N.D.	N.D.	N.D.
Methyl t-Butyl Ether	N.D.	N.D.	N.D.
4-Methyl-2-Pentanone	N.D.	N.D.	N.D.
Methylene Chloride	33 J	N.D.	N.D.
Octane	N.D.	N.D.	N.D.
Pentane	350	N.D.	1.3 J
Propene	11 J	N.D.	0.97 J
Styrene	N.D.	N.D.	N.D.
1,1,1,2-Tetrachloroethane	N.D.	N.D.	N.D.
1,1,2,2-Tetrachloroethane	N.D.	N.D.	N.D.
Tetrachloroethene	16 J	440000	N.D.
Toluene	21 J	N.D.	1.2 J
1,2,4-Trichlorobenzene	N.D.	N.D.	N.D.
1,1,1-Trichloroethane	N.D.	N.D.	N.D.
1,1,2-Trichloroethane	N.D.	N.D.	N.D.
Trichloroethene	N.D.	390000	N.D.
Trichlorofluoromethane	N.D.	N.D.	1.7 J
1,2,3-Trichloropropane	N.D.	N.D.	N.D.
1,2,4-Trimethylbenzene	N.D.	N.D.	N.D.
1,3,5-Trimethylbenzene	N.D.	N.D.	N.D.
Vinyl Acetate	N.D.	N.D.	N.D.
Vinyl Chloride	N.D.	78000	N.D.
m/p-Xylene	9.2 J	N.D.	N.D.
o-Xylene	N.D.	N.D.	N.D.

N.D. = Not detected
All units µg/m3.
Soil Gas analyzed by EPA TO-15.

Table 3-24. EU 4 VOC Monitoring Well Results

Station Sample No Collection Date	MW930 930GW0001-0115 12/20/09	MW934 934GW0001-0117 12/22/09
Volatile Organic Compounds		
1,1,1-Trichloroethane (µg/L)	325 U	0.325 U
1,1,2,2-Tetrachloroethane (µg/L)	250 U	0.25 U
1,1,2-Trichloroethane (µg/L)	250 U	0.25 U
1,1-Dichloroethane (µg/L)	300 U	0.3 U
1,1-Dichloroethylene (µg/L)	300 U	0.3 U
1,2-Dichloroethane (µg/L)	250 U	0.25 U
1,2-Dichloropropane (µg/L)	250 U	0.25 U
2-Butanone (µg/L)	1250 U	1.25 U
2-Hexanone (µg/L)	1250 U	1.25 U
4-Methyl-2-pentanone (µg/L)	1250 U	1.25 U
Acetone (µg/L)	1500 U	1.5 U
Benzene (µg/L)	300 U	0.3 U
Bromodichloromethane (µg/L)	250 U	0.25 U
Bromoform (µg/L)	250 U	0.25 U
Bromomethane (µg/L)	300 U	0.3 U
Carbon disulfide (µg/L)	1250 U	1.25 U
Carbon tetrachloride (µg/L)	300 U	0.3 U
Chlorobenzene (µg/L)	250 U	0.25 U
Chloroethane (µg/L)	300 U	0.3 U
Chloroform (µg/L)	250 U	3.61
Chloromethane (µg/L)	300 U	0.3 U
cis-1,2-Dichloroethylene (µg/L)	670 J	0.3 U
cis-1,3-Dichloropropylene (µg/L)	250 U	0.25 U
Ethylbenzene (µg/L)	250 U	0.25 U
Methylene chloride (µg/L)	2000 U	2 U
Styrene (µg/L)	250 U	0.25 U
Tetrachloroethylene (µg/L)	64200	0.3 U
Toluene (µg/L)	250 U	0.25 U
trans-1,2-Dichloroethylene (µg/L)	300 U	0.3 U
trans-1,3-Dichloropropylene (µg/L)	250 U	0.25 U
Trichloroethylene (µg/L)	9860	0.25 U
Vinyl chloride (µg/L)	500 U	0.5 U
Xylenes (total) (µg/L)	300 U	0.3 U

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Table 3-25. EU 4 SVOC Monitoring Well Results

Station Sample No Collection Date	MW930 930GW0001-0115 12/20/09	MW934 934GW0001-0117 12/22/09
Semi-Volatile Organic Compounds		
1,1'-Biphenyl (µg/L)	3 U	3 U
2,4,5-Trichlorophenol (µg/L)	2 U	2 U
2,4,6-Trichlorophenol (µg/L)	2 U	2 U
2,4-Dichlorophenol (µg/L)	2 U	2 U
2,4-Dimethylphenol (µg/L)	2 U	2 U
2,4-Dinitrophenol (µg/L)	5 U	5 U
2,4-Dinitrotoluene (µg/L)	2 U	2 U
2,6-Dinitrotoluene (µg/L)	2 U	2 U
2-Chloronaphthalene (µg/L)	0.3 U	0.3 U
2-Chlorophenol (µg/L)	2 U	2 U
2-Methyl-4,6-dinitrophenol (µg/L)	3 U	3 U
2-Methylnaphthalene (µg/L)	0.3 U	0.3 U
2-Nitrophenol (µg/L)	2 U	2 U
3,3'-Dichlorobenzidine (µg/L)	2 U	2 U
4-Bromophenylphenylether (µg/L)	2 U	2 U
4-Chloro-3-methylphenol (µg/L)	2 U	2 U
4-Chloroaniline (µg/L)	2 U	2 U
4-Chlorophenylphenylether (µg/L)	2 U	2 U
4-Nitrophenol (µg/L)	2 U	2 U
Acenaphthene (µg/L)	0.31 U	0.31 U
Acenaphthylene (µg/L)	0.2 U	0.2 U
Acetophenone (µg/L)	2 U	2 U
Anthracene (µg/L)	0.2 U	0.2 U
Atrazine (µg/L)	3 U	3 U
Benzaldehyde (µg/L)	3 U	3 U
Benzo(a)anthracene (µg/L)	0.2 U	0.2 U
Benzo(a)pyrene (µg/L)	0.2 U	0.2 U
Benzo(b)fluoranthene (µg/L)	0.2 U	0.2 U
Benzo(ghi)perylene (µg/L)	0.2 U	0.2 U
Benzo(k)fluoranthene (µg/L)	0.2 U	0.2 U
bis(2-Chloroethoxy)methane (µg/L)	3 U	3 U
bis(2-Chloroethyl) ether (µg/L)	2 U	2 U
bis(2-Chloroisopropyl)ether (µg/L)	2 U	2 U
bis(2-Ethylhexyl)phthalate (µg/L)	2 U	2 U
Butylbenzylphthalate (µg/L)	2 U	2 U
Caprolactam (µg/L)	2 U	2 U
Carbazole (µg/L)	0.2 U	0.2 U
Chrysene (µg/L)	0.2 U	0.2 U
Dibenzo(a,h)anthracene (µg/L)	0.2 U	0.2 U
Dibenzofuran (µg/L)	2 U	2 U
Diethylphthalate (µg/L)	2 U	2 U
Dimethylphthalate (µg/L)	2 U	2 U
Di-n-butylphthalate (µg/L)	2 U	2 U

Table 3-25. EU 4 SVOC Monitoring Well Results

Station Sample No Collection Date	MW930 930GW0001-0115 12/20/09	MW934 934GW0001-0117 12/22/09
Di-n-octylphthalate (µg/L)	3 U	3 U
Diphenylamine (µg/L)	3 U	3 U
Fluoranthene (µg/L)	0.2 U	0.2 U
Fluorene (µg/L)	0.2 U	0.2 U
Hexachlorobenzene (µg/L)	2 U	2 U
Hexachlorobutadiene (µg/L)	2 U	2 U
Hexachlorocyclopentadiene (µg/L)	3 U	3 U
Hexachloroethane (µg/L)	2 U	2 U
Indeno(1,2,3-cd)pyrene (µg/L)	0.2 U	0.2 U
Isophorone (µg/L)	3 U	3 U
m,p-Cresols (µg/L)	3 U	3 U
m-Nitroaniline (µg/L)	2 U	2 U
Naphthalene (µg/L)	0.3 U	0.3 U
Nitrobenzene (µg/L)	3 U	3 U
N-Nitrosodipropylamine (µg/L)	2 U	2 U
o-Cresol (µg/L)	2 U	2 U
o-Nitroaniline (µg/L)	2 U	2 U
Pentachlorophenol (µg/L)	2 U	2 U
Phenanthrene (µg/L)	0.2 U	0.2 U
Phenol (µg/L)	1 U	1 U
p-Nitroaniline (µg/L)	3 U	3 U
Pyrene (µg/L)	0.3 U	0.3 U

Table 3-26. EU 4 PAH, Pesticide, and PCB Monitoring Well Results

Station Sample No Collection Date	MW930 930GW0001-0115 12/20/09	MW934 934GW0001-0117 12/22/09
Polycyclic Aromatic Hydrocarbons		
Acenaphthene (µg/L)	0.121 U	0.118 U
Acenaphthylene (µg/L)	0.121 U	0.118 U
Anthracene (µg/L)	0.126 U	0.123 U
Benzo(a)anthracene (µg/L)	0.0155 U	0.0151 U
Benzo(a)pyrene (µg/L)	0.0155 U	0.0151 U
Benzo(b)fluoranthene (µg/L)	0.0155 U	0.0151 U
Benzo(ghi)perylene (µg/L)	0.0155 U	0.0151 U
Benzo(k)fluoranthene (µg/L)	0.0155 U	0.0151 U
Chrysene (µg/L)	0.0155 U	0.0151 U
Dibenzo(a,h)anthracene (µg/L)	0.0155 U	0.0151 U
Fluoranthene (µg/L)	0.0155 U	0.0151 U
Fluorene (µg/L)	0.121 U	0.118 U
Indeno(1,2,3-cd)pyrene (µg/L)	0.0155 U	0.0151 U
Naphthalene (µg/L)	0.121 U	0.118 U
Phenanthrene (µg/L)	0.121 U	0.118 U
Pyrene (µg/L)	0.0155 U	0.0151 U
PCBs		
Aroclor-1016 (µg/L)	0.0297 U	0.0333 U
Aroclor-1221 (µg/L)	0.0297 U	0.0333 U
Aroclor-1232 (µg/L)	0.0297 U	0.0333 U
Aroclor-1242 (µg/L)	0.0297 U	0.0333 U
Aroclor-1248 (µg/L)	0.0297 U	0.0333 U
Aroclor-1254 (µg/L)	0.0297 U	0.0333 U
Aroclor-1260 (µg/L)	0.0297 U	0.0333 U
Pesticides		
4,4'-DDD (µg/L)	0.00893 U	0.01 U
4,4'-DDE (µg/L)	0.00446 U	0.005 U
4,4'-DDT (µg/L)	0.00893 U	0.01 U
Aldrin (µg/L)	0.00446 U	0.005 U
alpha-BHC (µg/L)	0.00446 U	0.005 U
alpha-Chlordane (µg/L)	0.00446 U	0.005 U
beta-BHC (µg/L)	0.00536 U	0.006 U
delta-BHC (µg/L)	0.00446 U	0.005 U
Dieldrin (µg/L)	0.00893 U	0.01 U
Endosulfan I (µg/L)	0.00446 U	0.005 U
Endosulfan II (µg/L)	0.00893 U	0.01 U
Endosulfan sulfate (µg/L)	0.00893 U	0.01 U
Endrin (µg/L)	0.00893 U	0.01 U
Endrin aldehyde (µg/L)	0.00446 U	0.005 U
Endrin ketone (µg/L)	0.00893 U	0.01 U
gamma-BHC (Lindane) (µg/L)	0.00446 U	0.005 U
gamma-Chlordane (µg/L)	0.00446 U	0.005 U

Table 3-26. EU 4 PAH, Pesticide, and PCB Monitoring Well Results

Station Sample No Collection Date	MW930 930GW0001-0115 12/20/09	MW934 934GW0001-0117 12/22/09
Heptachlor (µg/L)	0.00446 U	0.005 U
Heptachlor epoxide (µg/L)	0.00446 U	0.005 U
Methoxychlor (µg/L)	0.0446 U	0.05 U
Toxaphene (µg/L)	0.134 U	0.15 U

Table 3-27. EU 4 Metal and Radiological Compound Monitoring Well Results

Station	MW930	MW930	MW934	MW934
Sample No	930GW0001-0115	930GW0001F-0116	934GW0001-0117	934GW0001F-0118
Collection Date	12/20/09	12/21/09	12/22/09	12/22/09
Metals				
Antimony (µg/L)	3 U		3 U	
Antimony, Dissolved (µg/L)		3 U		3 U
Arsenic (µg/L)	1.6 U		2.68 J	
Arsenic, Dissolved (µg/L)		1.6 U		1.6 U
Barium (µg/L)	20.1		17	
Barium, Dissolved (µg/L)		20.6		17
Beryllium (µg/L)	0.1 U		0.1 U	
Beryllium, Dissolved (µg/L)		0.1 U		0.1 U
Cadmium (µg/L)	0.11 U		0.11 U	
Cadmium, Dissolved (µg/L)		0.11 U		0.11 U
Chromium (µg/L)	2 U		2.19 J	
Chromium, Dissolved (µg/L)		5.2 J		2.45 J
Lead (µg/L)	0.5 U		0.678 J	
Lead, Dissolved (µg/L)		0.5 U		0.5 U
Mercury (µg/L)	0.066 U		0.066 U	
Mercury, Dissolved (µg/L)		0.066 U		0.066 U
Nickel (µg/L)	5.4		8.27	
Nickel, Dissolved (µg/L)		7.18		8.88
Selenium (µg/L)	1 U		1 U	
Selenium, Dissolved (µg/L)		1 U		1 U
Silver (µg/L)	1 U		1 U	
Silver, Dissolved (µg/L)		1 U		1 U
Thallium (µg/L)	0.3 U		0.3 U	
Thallium, Dissolved (µg/L)		0.3 U		0.3 U
Zinc (µg/L)	4.32 J		30.5	
Zinc, Dissolved (µg/L)		4.42 J		8.16 J
Radiological Compounds				
Actinium-227 (GammaSpec) (pCi/L)	-15.3 U		-11.2 U	
Actinium-227, Dissolved (GammaSpec) (pCi/L)		-9.7 U		-17.6 U
Americium-241 (GammaSpec) (pCi/L)	6.26 U		-4.53 U	
Americium-241, Dissolved (GammaSpec) (pCi/L)		0.449 U		3.09 U
Cesium-137 (GammaSpec) (pCi/L)	-1.48 U		-0.716 U	
Cesium-137, Dissolved (GammaSpec) (pCi/L)		-0.729 U		1.56 U
Cobalt-60 (GammaSpec) (pCi/L)	0.463 U		0.474 U	
Cobalt-60, Dissolved (GammaSpec) (pCi/L)		0.733 U		0.139 U

Table 3-27. EU 4 Metal and Radiological Compound Monitoring Well Results

Station	MW930	MW930	MW934	MW934
Sample No	930GW0001-0115	930GW0001F-0116	934GW0001-0117	934GW0001F-0118
Collection Date	12/20/09	12/21/09	12/22/09	12/22/09
Potassium-40 (GammaSpec) (pCi/L)	0 U		13.9 U	
Potassium-40, Dissolved (GammaSpec) (pCi/L)		-24.1 U		9.01 U
Protactinium-231 (GammaSpec) (pCi/L)	-2.2 U		53.7 U	
Protactinium-231, Dissolved (GammaSpec) (pCi/L)		17.7 U		11.1 U
Radium-226 (AlphaSpec) (pCi/L)	0.562		1.16	
Radium-226 (GammaSpec) (pCi/L)	8.73 U		2.58 U	
Radium-226, Dissolved (AlphaSpec) (pCi/L)		-0.0199 U		0.608
Radium-226, Dissolved (GammaSpec) (pCi/L)		7.57 U		3.93 U
Radium-228 (AlphaSpec) (pCi/L)	0.103 U		1.6	
Radium-228 (GammaSpec) (pCi/L)	-5.3 U		-5.83 U	
Radium-228, Dissolved (AlphaSpec) (pCi/L)		0.0834 U		0.443 U
Radium-228, Dissolved (GammaSpec) (pCi/L)		0.224 U		0.039 U
Thorium-228 (AlphaSpec) (pCi/L)	0.0389 U		0.0415 U	
Thorium-228 (GammaSpec) (pCi/L)	2.1 U		0.556 U	
Thorium-228, Dissolved (AlphaSpec) (pCi/L)		-0.0323 U		0.0284 U
Thorium-228, Dissolved (GammaSpec) (pCi/L)		-0.768 U		2.08 U
Thorium-230 (AlphaSpec) (pCi/L)	0.0512 U		-0.00832 U	
Thorium-230, Dissolved (AlphaSpec) (pCi/L)		0.0465 U		-0.0369 U
Thorium-232 (AlphaSpec) (pCi/L)	-0.0102 U		0.0223 U	
Thorium-232, Dissolved (AlphaSpec) (pCi/L)		-0.001 U		-0.0064 U
Uranium-233/234 (AlphaSpec) (pCi/L)	6.39		11.7	
Uranium-233/234, Dissolved (AlphaSpec) (pCi/L)		6.36		13.3
Uranium-235 (GammaSpec) (pCi/L)	-10.1 U		4.05 U	
Uranium-235, Dissolved (GammaSpec) (pCi/L)		0.101 U		1.22 U
Uranium-235/236 (AlphaSpec) (pCi/L)	0.277		0.734	
Uranium-235/236, Dissolved (AlphaSpec) (pCi/L)		0.23		0.716
Uranium-238 (AlphaSpec) (pCi/L)	4.74		9.35	
Uranium-238 (GammaSpec) (pCi/L)	72.8 U		17.8 U	
Uranium-238, Dissolved (AlphaSpec) (pCi/L)		4.89		12
Uranium-238, Dissolved (GammaSpec) (pCi/L)		57.6 U		2.76 U

Table 3-28. IWCS Area VOC Soil Results

Station	TWP935	TWP935	TWP936	TWP936	TWP937	TWP937	TWP938	TWP938	TWP939
Sample No	935SS0.0-0.5-0057	935SB10.0-12.0-0058	936SS0.0-0.5-0061	936SB12.0-14.0-0062	937SS0.0-0.5-0073	937SB12.0-14.0-0074	938SS0.0-0.5-0069	938SB14.0-15.0-0070	939SS0.0-0.5-0065
Collection Date	11/24/09	11/24/09	11/22/09	11/22/09	12/01/09	12/01/09	11/24/09	11/24/09	11/22/09
Sample Depth (ft bgs)	0-0.5	10-12	0-0.5	12-14	0-0.5	12-14	0-0.5	14-16	0-0.5
Volatile Organic Compounds									
1,1,1-Trichloroethane (µg/kg)	0.378 U	0.367 U	0.405 U	0.366 U	0.352 U	0.339 U	0.38 U	0.334 U	0.377 U
1,1,2,2-Tetrachloroethane (µg/kg)	0.378 U	0.367 U	0.405 U	0.366 U	0.352 U	0.339 U	0.38 U	0.334 U	0.377 U
1,1,2-Trichloroethane (µg/kg)	0.378 U	0.367 U	0.405 U	0.366 U	0.352 U	0.339 U	0.38 U	0.334 U	0.377 U
1,1-Dichloroethane (µg/kg)	0.378 U	0.367 U	0.405 U	0.366 U	0.352 U	0.339 U	0.38 U	0.334 U	0.377 U
1,1-Dichloroethylene (µg/kg)	0.378 U	0.367 U	0.405 U	0.366 U	0.352 U	0.339 U	0.38 U	0.334 U	0.377 U
1,2-Dichloroethane (µg/kg)	0.378 U	0.367 U	0.405 U	0.366 U	0.352 U	0.339 U	0.38 U	0.334 U	0.377 U
1,2-Dichloropropane (µg/kg)	0.378 U	0.367 U	0.405 U	0.366 U	0.352 U	0.339 U	0.38 U	0.334 U	0.377 U
2-Butanone (µg/kg)	1.89 U	1.83 U	2.03 U	1.83 U	1.76 U	1.7 U	1.9 U	1.67 U	1.88 U
2-Hexanone (µg/kg)	1.89 U	1.83 U	2.03 U	1.83 U	1.76 U	1.7 U	1.9 U	1.67 U	1.88 U
4-Methyl-2-pentanone (µg/kg)	1.58 U	1.53 U	1.69 U	1.52 U	1.47 U	1.41 U	1.58 U	1.39 U	1.57 U
Acetone (µg/kg)	2.09 U	2.03 U	2.24 U	2.02 U	1.95 U	1.88 U	2.1 U	1.85 U	2.08 U
Benzene (µg/kg)	0.378 U	0.367 U	0.405 U	0.366 U	0.352 U	0.339 U	0.38 U	0.334 U	0.377 U
Bromodichloromethane (µg/kg)	0.378 U	0.367 U	0.405 U	0.366 U	0.352 U	0.339 U	0.38 U	0.334 U	0.377 U
Bromoform (µg/kg)	0.378 U	0.367 U	0.405 U	0.366 U	0.352 U	0.339 U	0.38 U	0.334 U	0.377 U
Bromomethane (µg/kg)	0.378 U	0.367 U	0.405 U	0.366 U	0.352 U	0.339 U	0.38 U	0.334 U	0.377 U
Carbon disulfide (µg/kg)	1.58 U	1.53 U	1.69 U	1.52 U	1.47 U	1.41 U	1.58 U	1.39 U	1.57 U
Carbon tetrachloride (µg/kg)	0.378 U	0.367 U	0.405 U	0.366 U	0.352 U	0.339 U	0.38 U	0.334 U	0.377 U
Chlorobenzene (µg/kg)	0.378 U	0.367 U	0.405 U	0.366 U	0.352 U	0.339 U	0.38 U	0.334 U	0.377 U
Chloroethane (µg/kg)	0.378 U	0.367 U	0.405 U	0.366 U	0.352 U	0.339 U	0.38 U	0.334 U	0.377 U
Chloroform (µg/kg)	0.378 U	0.367 U	0.405 U	0.366 U	0.352 U	0.339 U	0.38 U	0.334 U	0.377 U
Chloromethane (µg/kg)	0.378 U	0.367 U	0.405 U	0.366 U	0.352 U	0.339 U	0.38 U	0.334 U	0.377 U
cis-1,2-Dichloroethylene (µg/kg)	0.378 U	0.367 U	0.405 U	0.366 U	0.352 U	0.339 U	0.38 U	0.334 U	0.377 U
cis-1,3-Dichloropropylene (µg/kg)	0.378 U	0.367 U	0.405 U	0.366 U	0.352 U	0.339 U	0.38 U	0.334 U	0.377 U
Ethylbenzene (µg/kg)	0.378 U	0.367 U	0.405 U	0.366 U	0.352 U	0.339 U	0.38 U	0.334 U	0.377 U
Methylene chloride (µg/kg)	2.52 U	3.59 J	2.7 U	4.02 J	2.35 U	2.26 U	2.53 U	2.39 J	2.51 U
Styrene (µg/kg)	0.378 U	0.367 U	0.405 U	0.366 U	0.352 U	0.339 U	0.38 U	0.334 U	0.377 U
Tetrachloroethylene (µg/kg)	0.378 U	0.367 U	0.919 J	0.561 J	0.352 U	0.339 U	0.38 U	0.356 J	0.402 J
Toluene (µg/kg)	0.378 U	0.367 U	0.405 U	0.366 U	0.352 U	0.339 U	0.38 U	0.334 U	0.377 U
trans-1,2-Dichloroethylene (µg/kg)	0.378 U	0.367 U	0.405 U	0.366 U	0.352 U	0.339 U	0.38 U	0.334 U	0.377 U
trans-1,3-Dichloropropylene (µg/kg)	0.378 U	0.367 U	0.405 U	0.366 U	0.352 U	0.339 U	0.38 U	0.334 U	0.377 U
Trichloroethylene (µg/kg)	0.416 U	0.403 U	0.446 U	0.402 U	0.387 U	0.373 U	0.418 U	0.367 U	0.414 U
Vinyl chloride (µg/kg)	0.378 U	0.367 U	0.405 U	0.366 U	0.352 U	0.339 U	0.38 U	0.334 U	0.377 U
Xylenes (total) (µg/kg)	0.378 U	0.367 U	0.405 U	0.366 U	0.352 U	0.339 U	0.38 U	0.334 U	0.377 U

Table 3-28. IWCS Area VOC Soil Results

Station	TWP939	TWP940	TWP940	TWP941	TWP941	TWP942	TWP942	TWP943	TWP943	TWP943
Sample No	939SB2.0-4.0-0066	940SS0.0-0.5-0077	940SB8.0-10.0-0078	941SS0.0-0.5-0081	941SB10.0-12.0-0082	942SS0.0-0.5-0085	942SB4.0-6.0-0086	943SS0.0-0.5-0089	943SS0.0-0.5-9005	943SB8.0-10.0-0090
Collection Date	11/22/09	12/01/09	12/01/09	11/30/09	11/30/09	12/02/09	12/02/09	12/02/09	12/02/09	12/02/09
Sample Depth (ft bgs)	2-4	0-0.5	8-10	0-0.5	10-12	0-0.5	4-6	0-0.5	0-0.5	8-10
Volatile Organic Compounds										
1,1,1-Trichloroethane (µg/kg)	0.353 U	0.359 U	0.371 U	0.36 U	0.379 U	0.382 U	0.366 U	0.356 U	0.36 U	0.363 U
1,1,2,2-Tetrachloroethane (µg/kg)	0.353 U	0.359 U	0.371 U	0.36 U	0.379 U	0.382 U	0.366 U	0.356 U	0.36 U	0.363 U
1,1,2-Trichloroethane (µg/kg)	0.353 U	0.359 U	0.371 U	0.36 U	0.379 U	0.382 U	0.366 U	0.356 U	0.36 U	0.363 U
1,1-Dichloroethane (µg/kg)	0.353 U	0.359 U	0.371 U	0.36 U	0.379 U	0.382 U	0.366 U	0.356 U	0.36 U	0.363 U
1,1-Dichloroethylene (µg/kg)	0.353 U	0.359 U	0.371 U	0.36 U	0.379 U	0.382 U	0.366 U	0.356 U	0.36 U	0.363 U
1,2-Dichloroethane (µg/kg)	0.353 U	0.359 U	0.371 U	0.36 U	0.379 U	0.382 U	0.366 U	0.356 U	0.36 U	0.363 U
1,2-Dichloropropane (µg/kg)	0.353 U	0.359 U	0.371 U	0.36 U	0.379 U	0.382 U	0.366 U	0.356 U	0.36 U	0.363 U
2-Butanone (µg/kg)	1.76 U	1.79 U	1.85 U	1.8 U	1.9 U	1.91 U	1.83 U	1.78 U	1.8 U	1.81 U
2-Hexanone (µg/kg)	1.76 U	1.79 U	1.85 U	1.8 U	1.9 U	1.91 U	1.83 U	1.78 U	1.8 U	1.81 U
4-Methyl-2-pentanone (µg/kg)	1.47 U	1.49 U	1.54 U	1.5 U	1.58 U	1.59 U	1.52 U	1.48 U	1.5 U	1.51 U
Acetone (µg/kg)	1.95 U	1.98 U	2.76 J	1.99 U	2.1 U	2.12 U	2.02 U	1.97 U	1.99 U	2.01 U
Benzene (µg/kg)	0.353 U	0.359 U	0.371 U	0.36 U	0.379 U	0.382 U	0.366 U	0.356 U	0.36 U	0.363 U
Bromodichloromethane (µg/kg)	0.353 U	0.359 U	0.371 U	0.36 U	0.379 U	0.382 U	0.366 U	0.356 U	0.36 U	0.363 U
Bromoform (µg/kg)	0.353 U	0.359 U	0.371 U	0.36 U	0.379 U	0.382 U	0.366 U	0.356 U	0.36 U	0.363 U
Bromomethane (µg/kg)	0.353 U	0.359 U	0.371 U	0.36 U	0.379 U	0.382 U	0.366 U	0.356 U	0.36 U	0.363 U
Carbon disulfide (µg/kg)	1.47 U	1.49 U	1.54 U	1.5 U	1.58 U	1.59 U	1.52 U	1.48 U	1.5 U	1.51 U
Carbon tetrachloride (µg/kg)	0.353 U	0.359 U	0.371 U	0.36 U	0.379 U	0.382 U	0.366 U	0.356 U	0.36 U	0.363 U
Chlorobenzene (µg/kg)	0.353 U	0.359 U	0.371 U	0.36 U	0.379 U	0.382 U	0.366 U	0.356 U	0.36 U	0.363 U
Chloroethane (µg/kg)	0.353 U	0.359 U	0.371 U	0.36 U	0.379 U	0.382 U	0.366 U	0.356 U	0.36 U	0.363 U
Chloroform (µg/kg)	0.353 U	0.359 U	0.371 U	0.36 U	0.379 U	0.382 U	0.366 U	0.356 U	0.36 U	0.363 U
Chloromethane (µg/kg)	0.353 U	0.359 U	0.371 U	0.36 U	0.379 U	0.382 U	0.366 U	0.356 U	0.36 U	0.363 U
cis-1,2-Dichloroethylene (µg/kg)	0.353 U	0.359 U	0.371 U	0.36 U	0.379 U	0.382 U	0.366 U	0.356 U	0.36 U	0.363 U
cis-1,3-Dichloropropylene (µg/kg)	0.353 U	0.359 U	0.371 U	0.36 U	0.379 U	0.382 U	0.366 U	0.356 U	0.36 U	0.363 U
Ethylbenzene (µg/kg)	0.353 U	0.359 U	0.371 U	0.36 U	0.379 U	0.382 U	0.366 U	0.356 U	0.36 U	0.363 U
Methylene chloride (µg/kg)	2.35 U	2.39 U	2.47 U	2.4 U	2.53 U	2.55 U	2.44 U	2.37 U	2.4 U	2.42 U
Styrene (µg/kg)	0.353 U	0.359 U	0.371 U	0.36 U	0.379 U	0.382 U	0.366 U	0.356 U	0.36 U	0.363 U
Tetrachloroethylene (µg/kg)	0.353 U	0.359 U	0.371 U	0.36 U	0.379 U	0.382 U	0.366 U	0.356 U	0.36 U	0.363 U
Toluene (µg/kg)	0.353 U	0.359 U	0.371 U	0.36 U	0.379 U	0.382 U	0.366 U	0.356 U	0.36 U	0.363 U
trans-1,2-Dichloroethylene (µg/kg)	0.353 U	0.359 U	0.371 U	0.36 U	0.379 U	0.382 U	0.366 U	0.356 U	0.36 U	0.363 U
trans-1,3-Dichloropropylene (µg/kg)	0.353 U	0.359 U	0.371 U	0.36 U	0.379 U	0.382 U	0.366 U	0.356 U	0.36 U	0.363 U
Trichloroethylene (µg/kg)	0.388 U	0.394 U	0.408 U	0.396 U	0.417 U	0.421 U	0.402 U	0.391 U	0.396 U	0.399 U
Vinyl chloride (µg/kg)	0.353 U	0.359 U	0.371 U	0.36 U	0.379 U	0.382 U	0.366 U	0.356 U	0.36 U	0.363 U
Xylenes (total) (µg/kg)	0.353 U	0.359 U	0.371 U	0.36 U	0.379 U	0.382 U	0.366 U	0.356 U	0.36 U	0.363 U

Table 3-29. IWCS Area SVOC Soil Results

Station	TWP935	TWP935	TWP936	TWP936	TWP937	TWP937	TWP938	TWP938	TWP939
Sample No	935SS0.0-0.5-0057	935SB10.0-12.0-0058	936SS0.0-0.5-0061	936SB12.0-14.0-0062	937SS0.0-0.5-0073	937SB12.0-14.0-0074	938SS0.0-0.5-0069	938SB14.0-15.0-0070	939SS0.0-0.5-0065
Collection Date	11/24/09	11/24/09	11/22/09	11/22/09	12/01/09	12/01/09	11/24/09	11/24/09	11/22/09
Sample Depth (ft bgs)	0-0.5	10-12	0-0.5	12-14	0-0.5	12-14	0-0.5	14-16	0-0.5
Semi-Volatile Organic Compounds									
1,1'-Biphenyl (µg/kg)	126 U	121 U	135 U	121 U	117 U	113 U	126 U	111 U	126 U
2,4,5-Trichlorophenol (µg/kg)	83.8 U	81 U	89.9 U	81 U	78.2 U	75.4 U	84 U	73.7 U	83.7 U
2,4,6-Trichlorophenol (µg/kg)	83.8 U	81 U	89.9 U	81 U	78.2 U	75.4 U	84 U	73.7 U	83.7 U
2,4-Dichlorophenol (µg/kg)	83.8 U	81 U	89.9 U	81 U	78.2 U	75.4 U	84 U	73.7 U	83.7 U
2,4-Dimethylphenol (µg/kg)	147 U	142 U	157 U	142 U	137 U	132 U	147 U	129 U	146 U
2,4-Dinitrophenol (µg/kg)	159 U	154 U	171 U	154 U	149 U	143 U	160 U	140 U	159 U
2,4-Dinitrotoluene (µg/kg)	41.9 U	40.5 U	44.9 U	40.5 U	39.1 U	37.7 U	42 U	36.9 U	41.8 U
2,6-Dinitrotoluene (µg/kg)	41.9 U	40.5 U	44.9 U	40.5 U	39.1 U	37.7 U	42 U	36.9 U	41.8 U
2-Chloronaphthalene (µg/kg)	13.8 U	13.4 U	14.8 U	13.4 U	12.9 U	12.4 U	13.9 U	12.2 U	13.8 U
2-Chlorophenol (µg/kg)	83.8 U	81 U	89.9 U	81 U	78.2 U	75.4 U	84 U	73.7 U	83.7 U
2-Methyl-4,6-dinitrophenol (µg/kg)	83.8 U	81 U	89.9 U	81 U	78.2 U	75.4 U	84 U	73.7 U	83.7 U
2-Methylnaphthalene (µg/kg)	8.38 U	8.1 U	8.99 U	8.1 U	7.82 U	7.54 U	8.4 U	7.37 U	8.37 U
2-Nitrophenol (µg/kg)	83.8 U	81 U	89.9 U	81 U	78.2 U	75.4 U	84 U	73.7 U	83.7 U
3,3'-Dichlorobenzidine (µg/kg)	126 U	121 U	135 U	121 U	117 U	113 U	126 U	111 U	126 U
4-Bromophenylphenylether (µg/kg)	83.8 U	81 U	89.9 U	81 U	78.2 U	75.4 U	84 U	73.7 U	83.7 U
4-Chloro-3-methylphenol (µg/kg)	83.8 U	81 U	89.9 U	81 U	78.2 U	75.4 U	84 U	73.7 U	83.7 U
4-Chloroaniline (µg/kg)	83.8 U	81 U	89.9 U	81 U	78.2 U	75.4 U	84 U	73.7 U	83.7 U
4-Chlorophenylphenylether (µg/kg)	83.8 U	81 U	89.9 U	81 U	78.2 U	75.4 U	84 U	73.7 U	83.7 U
4-Nitrophenol (µg/kg)	138 U	134 U	148 U	134 U	129 U	124 U	139 U	122 U	138 U
Acenaphthene (µg/kg)	13.8 U	13.4 U	14.8 U	13.4 U	12.9 U	12.4 U	13.9 U	12.2 U	13.8 U
Acenaphthylene (µg/kg)	12.6 U	12.1 U	13.5 U	12.1 U	11.7 U	11.3 U	12.6 U	11.1 U	12.6 U
Acetophenone (µg/kg)	83.8 U	81 U	89.9 U	81 U	78.2 U	75.4 U	84 U	73.7 U	83.7 U
Anthracene (µg/kg)	8.38 U	8.1 U	8.99 U	8.1 U	7.82 U	7.54 U	8.4 U	7.37 U	8.37 U
Atrazine (µg/kg)	126 U	121 U	135 U	121 U	117 U	113 U	126 U	111 U	126 U
Benzaldehyde (µg/kg)	126 U	121 U	135 U	121 U	117 U	113 U	126 U	111 U	126 U
Benzo(a)anthracene (µg/kg)	30.7 J	12.1 U	13.5 U	12.1 U	11.7 U	11.3 U	12.6 U	11.1 U	12.6 U
Benzo(a)pyrene (µg/kg)	27.8 J	12.1 U	13.5 U	12.1 U	11.7 U	11.3 U	12.6 U	11.1 U	12.6 U
Benzo(b)fluoranthene (µg/kg)	49.2	12.1 U	13.5 U	12.1 U	11.7 U	11.3 U	12.6 U	11.1 U	12.6 U
Benzo(ghi)perylene (µg/kg)	20.2 J	12.1 U	13.5 U	12.1 U	11.7 U	11.3 U	12.6 U	11.1 U	12.6 U
Benzo(k)fluoranthene (µg/kg)	12.6 U	12.1 U	13.5 U	12.1 U	11.7 U	11.3 U	12.6 U	11.1 U	12.6 U
bis(2-Chloroethoxy)methane (µg/kg)	83.8 U	81 U	89.9 U	81 U	78.2 U	75.4 U	84 U	73.7 U	83.7 U
bis(2-Chloroethyl) ether (µg/kg)	83.8 U	81 U	89.9 U	81 U	78.2 U	75.4 U	84 U	73.7 U	83.7 U
bis(2-Chloroisopropyl)ether (µg/kg)	83.8 U	81 U	89.9 U	81 U	78.2 U	75.4 U	84 U	73.7 U	83.7 U
bis(2-Ethylhexyl)phthalate (µg/kg)	83.8 U	81 U	89.9 U	81 U	78.2 U	75.4 U	84 U	73.7 U	83.7 U
Butylbenzylphthalate (µg/kg)	83.8 U	81 U	89.9 U	81 U	78.2 U	75.4 U	84 U	73.7 U	83.7 U
Caprolactam (µg/kg)	83.8 U	81 U	89.9 U	81 U	78.2 U	75.4 U	84 U	73.7 U	83.7 U
Carbazole (µg/kg)	12.6 U	12.1 U	13.5 U	12.1 U	11.7 U	11.3 U	12.6 U	11.1 U	12.6 U
Chrysene (µg/kg)	32.5 J	12.1 U	13.5 U	12.1 U	11.7 U	11.3 U	12.6 U	11.1 U	12.6 U
Dibenzo(a,h)anthracene (µg/kg)	12.6 U	12.1 U	13.5 U	12.1 U	11.7 U	11.3 U	12.6 U	11.1 U	12.6 U
Dibenzofuran (µg/kg)	83.8 U	81 U	89.9 U	81 U	78.2 U	75.4 U	84 U	73.7 U	83.7 U
Diethylphthalate (µg/kg)	83.8 U	81 U	89.9 U	81 U	78.2 U	75.4 U	84 U	73.7 U	83.7 U
Dimethylphthalate (µg/kg)	83.8 U	81 U	89.9 U	81 U	78.2 U	75.4 U	84 U	73.7 U	83.7 U
Di-n-butylphthalate (µg/kg)	83.8 U	81 U	89.9 U	81 U	78.2 U	75.4 U	84 U	73.7 U	83.7 U
Di-n-octylphthalate (µg/kg)	83.8 U	81 U	89.9 U	81 U	78.2 U	75.4 U	84 U	73.7 U	83.7 U

Table 3-29. IWCS Area SVOC Soil Results

Station	TWP935	TWP935	TWP936	TWP936	TWP937	TWP937	TWP938	TWP938	TWP939
Sample No	935SS0.0-0.5-0057	935SB10.0-12.0-0058	936SS0.0-0.5-0061	936SB12.0-14.0-0062	937SS0.0-0.5-0073	937SB12.0-14.0-0074	938SS0.0-0.5-0069	938SB14.0-15.0-0070	939SS0.0-0.5-0065
Collection Date	11/24/09	11/24/09	11/22/09	11/22/09	12/01/09	12/01/09	11/24/09	11/24/09	11/22/09
Sample Depth (ft bgs)	0-0.5	10-12	0-0.5	12-14	0-0.5	12-14	0-0.5	14-16	0-0.5
Diphenylamine (µg/kg)	83.8 U	81 U	89.9 U	81 U	78.2 U	75.4 U	84 U	73.7 U	83.7 U
Fluoranthene (µg/kg)	50.6	12.1 U	13.5 U	12.1 U	11.7 U	11.3 U	12.6 U	11.1 U	12.6 U
Fluorene (µg/kg)	12.6 U	12.1 U	13.5 U	12.1 U	11.7 U	11.3 U	12.6 U	11.1 U	12.6 U
Hexachlorobenzene (µg/kg)	83.8 U	81 U	89.9 U	81 U	78.2 U	75.4 U	84 U	73.7 U	83.7 U
Hexachlorobutadiene (µg/kg)	83.8 U	81 U	89.9 U	81 U	78.2 U	75.4 U	84 U	73.7 U	83.7 U
Hexachlorocyclopentadiene (µg/kg)	83.8 U	81 U	89.9 U	81 U	78.2 U	75.4 U	84 U	73.7 U	83.7 U
Hexachloroethane (µg/kg)	83.8 U	81 U	89.9 U	81 U	78.2 U	75.4 U	84 U	73.7 U	83.7 U
Indeno(1,2,3-cd)pyrene (µg/kg)	18.4 J	12.1 U	13.5 U	12.1 U	11.7 U	11.3 U	12.6 U	11.1 U	12.6 U
Isophorone (µg/kg)	83.8 U	81 U	89.9 U	81 U	78.2 U	75.4 U	84 U	73.7 U	83.7 U
m,p-Cresols (µg/kg)	126 U	121 U	135 U	121 U	117 U	113 U	126 U	111 U	126 U
m-Nitroaniline (µg/kg)	83.8 U	81 U	89.9 U	81 U	78.2 U	75.4 U	84 U	73.7 U	83.7 U
Naphthalene (µg/kg)	12.6 U	12.1 U	13.5 U	12.1 U	11.7 U	11.3 U	12.6 U	11.1 U	12.6 U
Nitrobenzene (µg/kg)	83.8 U	81 U	89.9 U	81 U	78.2 U	75.4 U	84 U	73.7 U	83.7 U
N-Nitrosodipropylamine (µg/kg)	83.8 U	81 U	89.9 U	81 U	78.2 U	75.4 U	84 U	73.7 U	83.7 U
o-Cresol (µg/kg)	83.8 U	81 U	89.9 U	81 U	78.2 U	75.4 U	84 U	73.7 U	83.7 U
o-Nitroaniline (µg/kg)	83.8 U	81 U	89.9 U	81 U	78.2 U	75.4 U	84 U	73.7 U	83.7 U
Pentachlorophenol (µg/kg)	105 U	101 U	112 U	101 U	97.7 U	94.2 U	105 U	92.2 U	105 U
Phenanthrene (µg/kg)	14.1 J	12.1 U	13.5 U	12.1 U	11.7 U	11.3 U	12.6 U	11.1 U	12.6 U
Phenol (µg/kg)	83.8 U	81 U	89.9 U	81 U	78.2 U	75.4 U	84 U	73.7 U	83.7 U
p-Nitroaniline (µg/kg)	126 U	121 U	135 U	121 U	117 U	113 U	126 U	111 U	126 U
Pyrene (µg/kg)	38.5 J	12.1 U	13.5 U	12.1 U	11.7 U	11.3 U	12.6 U	11.1 U	12.6 U

Table 3-29. IWCS Area SVOC Soil Results

Station	TWP939	TWP940	TWP940	TWP941	TWP941	TWP942	TWP942	TWP943	TWP943	TWP943
Sample No	939SB2.0-4.0-0066	940SS0.0-0.5-0077	940SB8.0-10.0-0078	941SS0.0-0.5-0081	941SB10.0-12.0-0082	942SS0.0-0.5-0085	942SB4.0-6.0-0086	943SS0.0-0.5-0089	943SS0.0-0.5-9005	943SB8.0-10.0-0090
Collection Date	11/22/09	12/01/09	12/01/09	11/30/09	11/30/09	12/02/09	12/02/09	12/02/09	12/02/09	12/02/09
Sample Depth (ft bgs)	2-4	0-0.5	8-10	0-0.5	10-12	0-0.5	4-6	0-0.5	0-0.5	8-10
Semi-Volatile Organic Compounds										
1,1'-Biphenyl (µg/kg)	117 U	119 U	123 U	119 U	126 U	127 U	121 U	119 U	120 U	121 U
2,4,5-Trichlorophenol (µg/kg)	77.9 U	79.5 U	82.3 U	79.5 U	84.2 U	84.7 U	80.7 U	79.1 U	79.7 U	80.4 U
2,4,6-Trichlorophenol (µg/kg)	77.9 U	79.5 U	82.3 U	79.5 U	84.2 U	84.7 U	80.7 U	79.1 U	79.7 U	80.4 U
2,4-Dichlorophenol (µg/kg)	77.9 U	79.5 U	82.3 U	79.5 U	84.2 U	84.7 U	80.7 U	79.1 U	79.7 U	80.4 U
2,4-Dimethylphenol (µg/kg)	136 U	139 U	144 U	139 U	147 U	148 U	141 U	138 U	139 U	141 U
2,4-Dinitrophenol (µg/kg)	148 U	151 U	156 U	151 U	160 U	161 U	153 U	150 U	151 U	153 U
2,4-Dinitrotoluene (µg/kg)	39 U	39.7 U	41.1 U	39.7 U	42.1 U	42.4 U	40.4 U	39.5 U	39.8 U	40.2 U
2,6-Dinitrotoluene (µg/kg)	39 U	39.7 U	41.1 U	39.7 U	42.1 U	42.4 U	40.4 U	39.5 U	39.8 U	40.2 U
2-Chloronaphthalene (µg/kg)	12.9 U	13.1 U	13.6 U	13.1 U	13.9 U	14 U	13.3 U	13 U	13.1 U	13.3 U
2-Chlorophenol (µg/kg)	77.9 U	79.5 U	82.3 U	79.5 U	84.2 U	84.7 U	80.7 U	79.1 U	79.7 U	80.4 U
2-Methyl-4,6-dinitrophenol (µg/kg)	77.9 U	79.5 U	82.3 U	79.5 U	84.2 U	84.7 U	80.7 U	79.1 U	79.7 U	80.4 U
2-Methylnaphthalene (µg/kg)	7.79 U	7.95 U	8.23 U	7.95 U	8.42 U	8.47 U	8.07 U	7.91 U	7.97 U	8.04 U
2-Nitrophenol (µg/kg)	77.9 U	79.5 U	82.3 U	79.5 U	84.2 U	84.7 U	80.7 U	79.1 U	79.7 U	80.4 U
3,3'-Dichlorobenzidine (µg/kg)	117 U	119 U	123 U	119 U	126 U	127 U	121 U	119 U	120 U	121 U
4-Bromophenylphenylether (µg/kg)	77.9 U	79.5 U	82.3 U	79.5 U	84.2 U	84.7 U	80.7 U	79.1 U	79.7 U	80.4 U
4-Chloro-3-methylphenol (µg/kg)	77.9 U	79.5 U	82.3 U	79.5 U	84.2 U	84.7 U	80.7 U	79.1 U	79.7 U	80.4 U
4-Chloroaniline (µg/kg)	77.9 U	79.5 U	82.3 U	79.5 U	84.2 U	84.7 U	80.7 U	79.1 U	79.7 U	80.4 U
4-Chlorophenylphenylether (µg/kg)	77.9 U	79.5 U	82.3 U	79.5 U	84.2 U	84.7 U	80.7 U	79.1 U	79.7 U	80.4 U
4-Nitrophenol (µg/kg)	129 U	131 U	136 U	131 U	139 U	140 U	133 U	130 U	131 U	133 U
Acenaphthene (µg/kg)	12.9 U	13.1 U	13.6 U	13.1 U	13.9 U	14 U	13.3 U	13 U	13.1 U	13.3 U
Acenaphthylene (µg/kg)	11.7 U	11.9 U	12.3 U	11.9 U	12.6 U	12.7 U	12.1 U	11.9 U	12 U	12.1 U
Acetophenone (µg/kg)	77.9 U	79.5 U	82.3 U	79.5 U	84.2 U	84.7 U	80.7 U	79.1 U	79.7 U	80.4 U
Anthracene (µg/kg)	7.79 U	7.95 U	8.23 U	7.95 U	8.42 U	8.47 U	8.07 U	7.91 U	7.97 U	8.04 U
Atrazine (µg/kg)	117 U	119 U	123 U	119 U	126 U	127 U	121 U	119 U	120 U	121 U
Benzaldehyde (µg/kg)	117 U	119 U	123 U	119 U	126 U	127 U	121 U	119 U	120 U	121 U
Benzo(a)anthracene (µg/kg)	11.7 U	11.9 U	12.3 U	11.9 U	12.6 U	12.7 U	12.1 U	11.9 U	12 U	12.1 U
Benzo(a)pyrene (µg/kg)	11.7 U	11.9 U	12.3 U	11.9 U	12.6 U	12.7 U	12.1 U	11.9 U	12 U	12.1 U
Benzo(b)fluoranthene (µg/kg)	11.7 U	11.9 U	12.3 U	11.9 U	12.6 U	12.7 U	12.1 U	11.9 U	12 U	12.1 U
Benzo(ghi)perylene (µg/kg)	11.7 U	11.9 U	12.3 U	11.9 U	12.6 U	12.7 U	12.1 U	11.9 U	12 U	12.1 U
Benzo(k)fluoranthene (µg/kg)	11.7 U	11.9 U	12.3 U	11.9 U	12.6 U	12.7 U	12.1 U	11.9 U	12 U	12.1 U
bis(2-Chloroethoxy)methane (µg/kg)	77.9 U	79.5 U	82.3 U	79.5 U	84.2 U	84.7 U	80.7 U	79.1 U	79.7 U	80.4 U
bis(2-Chloroethyl) ether (µg/kg)	77.9 U	79.5 U	82.3 U	79.5 U	84.2 U	84.7 U	80.7 U	79.1 U	79.7 U	80.4 U
bis(2-Chloroisopropyl)ether (µg/kg)	77.9 U	79.5 U	82.3 U	79.5 U	84.2 U	84.7 U	80.7 U	79.1 U	79.7 U	80.4 U
bis(2-Ethylhexyl)phthalate (µg/kg)	77.9 U	79.5 U	82.3 U	79.5 U	84.2 U	84.7 U	80.7 U	79.1 U	79.7 U	80.4 U
Butylbenzylphthalate (µg/kg)	77.9 U	79.5 U	82.3 U	79.5 U	84.2 U	84.7 U	80.7 U	79.1 U	79.7 U	80.4 U
Caprolactam (µg/kg)	77.9 U	79.5 U	82.3 U	79.5 U	84.2 U	84.7 U	80.7 U	79.1 U	79.7 U	80.4 U
Carbazole (µg/kg)	11.7 U	11.9 U	12.3 U	11.9 U	12.6 U	12.7 U	12.1 U	11.9 U	12 U	12.1 U
Chrysene (µg/kg)	11.7 U	11.9 U	12.3 U	11.9 U	12.6 U	12.7 U	12.1 U	11.9 U	12 U	12.1 U
Dibenzo(a,h)anthracene (µg/kg)	11.7 U	11.9 U	12.3 U	11.9 U	12.6 U	12.7 U	12.1 U	11.9 U	12 U	12.1 U
Dibenzofuran (µg/kg)	77.9 U	79.5 U	82.3 U	79.5 U	84.2 U	84.7 U	80.7 U	79.1 U	79.7 U	80.4 U
Diethylphthalate (µg/kg)	77.9 U	79.5 U	82.3 U	79.5 U	84.2 U	84.7 U	80.7 U	79.1 U	79.7 U	80.4 U
Dimethylphthalate (µg/kg)	77.9 U	79.5 U	82.3 U	79.5 U	84.2 U	84.7 U	80.7 U	79.1 U	79.7 U	80.4 U
Di-n-butylphthalate (µg/kg)	77.9 U	79.5 U	82.3 U	79.5 U	84.2 U	84.7 U	80.7 U	79.1 U	79.7 U	80.4 U
Di-n-octylphthalate (µg/kg)	77.9 U	79.5 U	82.3 U	79.5 U	84.2 U	84.7 U	80.7 U	79.1 U	79.7 U	80.4 U

Table 3-29. IWCS Area SVOC Soil Results

Station	TWP939	TWP940	TWP940	TWP941	TWP941	TWP942	TWP942	TWP943	TWP943	TWP943
Sample No	939SB2.0-4.0-0066	940SS0.0-0.5-0077	940SB8.0-10.0-0078	941SS0.0-0.5-0081	941SB10.0-12.0-0082	942SS0.0-0.5-0085	942SB4.0-6.0-0086	943SS0.0-0.5-0089	943SS0.0-0.5-9005	943SB8.0-10.0-0090
Collection Date	11/22/09	12/01/09	12/01/09	11/30/09	11/30/09	12/02/09	12/02/09	12/02/09	12/02/09	12/02/09
Sample Depth (ft bgs)	2-4	0-0.5	8-10	0-0.5	10-12	0-0.5	4-6	0-0.5	0-0.5	8-10
Diphenylamine (µg/kg)	77.9 U	79.5 U	82.3 U	79.5 U	84.2 U	84.7 U	80.7 U	79.1 U	79.7 U	80.4 U
Fluoranthene (µg/kg)	11.7 U	11.9 U	12.3 U	11.9 U	12.6 U	12.7 U	12.1 U	11.9 U	12 U	12.1 U
Fluorene (µg/kg)	11.7 U	11.9 U	12.3 U	11.9 U	12.6 U	12.7 U	12.1 U	11.9 U	12 U	12.1 U
Hexachlorobenzene (µg/kg)	77.9 U	79.5 U	82.3 U	79.5 U	84.2 U	84.7 U	80.7 U	79.1 U	79.7 U	80.4 U
Hexachlorobutadiene (µg/kg)	77.9 U	79.5 U	82.3 U	79.5 U	84.2 U	84.7 U	80.7 U	79.1 U	79.7 U	80.4 U
Hexachlorocyclopentadiene (µg/kg)	77.9 U	79.5 U	82.3 U	79.5 U	84.2 U	84.7 U	80.7 U	79.1 U	79.7 U	80.4 U
Hexachloroethane (µg/kg)	77.9 U	79.5 U	82.3 U	79.5 U	84.2 U	84.7 U	80.7 U	79.1 U	79.7 U	80.4 U
Indeno(1,2,3-cd)pyrene (µg/kg)	11.7 U	11.9 U	12.3 U	11.9 U	12.6 U	12.7 U	12.1 U	11.9 U	12 U	12.1 U
Isophorone (µg/kg)	77.9 U	79.5 U	82.3 U	79.5 U	84.2 U	84.7 U	80.7 U	79.1 U	79.7 U	80.4 U
m,p-Cresols (µg/kg)	117 U	119 U	123 U	119 U	126 U	127 U	121 U	119 U	120 U	121 U
m-Nitroaniline (µg/kg)	77.9 U	79.5 U	82.3 U	79.5 U	84.2 U	84.7 U	80.7 U	79.1 U	79.7 U	80.4 U
Naphthalene (µg/kg)	11.7 U	11.9 U	12.3 U	11.9 U	12.6 U	12.7 U	12.1 U	11.9 U	12 U	12.1 U
Nitrobenzene (µg/kg)	77.9 U	79.5 U	82.3 U	79.5 U	84.2 U	84.7 U	80.7 U	79.1 U	79.7 U	80.4 U
N-Nitrosodipropylamine (µg/kg)	77.9 U	79.5 U	82.3 U	79.5 U	84.2 U	84.7 U	80.7 U	79.1 U	79.7 U	80.4 U
o-Cresol (µg/kg)	77.9 U	79.5 U	82.3 U	79.5 U	84.2 U	84.7 U	80.7 U	79.1 U	79.7 U	80.4 U
o-Nitroaniline (µg/kg)	77.9 U	79.5 U	82.3 U	79.5 U	84.2 U	84.7 U	80.7 U	79.1 U	79.7 U	80.4 U
Pentachlorophenol (µg/kg)	97.4 U	99.4 U	103 U	99.3 U	105 U	106 U	101 U	98.8 U	99.6 U	101 U
Phenanthrene (µg/kg)	11.7 U	11.9 U	12.3 U	11.9 U	12.6 U	12.7 U	12.1 U	11.9 U	12 U	12.1 U
Phenol (µg/kg)	77.9 U	79.5 U	82.3 U	79.5 U	84.2 U	84.7 U	80.7 U	79.1 U	79.7 U	80.4 U
p-Nitroaniline (µg/kg)	117 U	119 U	123 U	119 U	126 U	127 U	121 U	119 U	120 U	121 U
Pyrene (µg/kg)	11.7 U	11.9 U	12.3 U	11.9 U	12.6 U	12.7 U	12.1 U	11.9 U	12 U	12.1 U

Table 3-30. IWCS Area PAH, Pesticide, and PCB Soil Results

Station	TWP935	TWP935	TWP936	TWP936	TWP937	TWP937	TWP938	TWP938	TWP939
Sample No	935SS0.0-0.5-0057	935SB10.0-12.0-0058	936SS0.0-0.5-0061	936SB12.0-14.0-0062	937SS0.0-0.5-0073	937SB12.0-14.0-0074	938SS0.0-0.5-0069	938SB14.0-15.0-0070	939SS0.0-0.5-0065
Collection Date	11/24/09	11/24/09	11/22/09	11/22/09	12/01/09	12/01/09	11/24/09	11/24/09	11/22/09
Sample Depth (ft bgs)	0-0.5	10-12	0-0.5	12-14	0-0.5	12-14	0-0.5	14-16	0-0.5
Polycyclic Aromatic Hydrocarbons									
Acenaphthene (µg/kg)	6.3 U	6.11 U	6.74 U	6.08 U	5.86 U	5.66 U	6.33 U	5.56 U	6.27 U
Acenaphthylene (µg/kg)	2.1 U	2.04 U	2.25 U	2.03 U	1.95 U	1.89 U	2.11 U	1.85 U	2.09 U
Anthracene (µg/kg)	6.3 U	6.11 U	6.74 U	6.08 U	5.86 U	5.66 U	6.33 U	5.56 U	6.27 U
Benzo(a)anthracene (µg/kg)	55 J	0.651 U	5.01	0.648 U	3.34	0.604 U	0.675 U	0.593 U	0.669 U
Benzo(a)pyrene (µg/kg)	40.5 J	0.651 U	5.56	0.648 U	3.23 J	0.604 U	2.72 J	0.593 U	0.669 U
Benzo(b)fluoranthene (µg/kg)	46.4 J	0.651 U	7.83 J	0.648 U	0.625 U	0.604 U	0.675 U	0.593 U	0.669 U
Benzo(ghi)perylene (µg/kg)	22.2	0.651 U	5.1	0.648 U	2.74 J	0.604 U	2.2 J	0.593 U	0.669 U
Benzo(k)fluoranthene (µg/kg)	25.9 J	0.407 U	0.449 U	0.405 U	0.391 U	0.377 U	0.422 U	0.37 U	0.418 U
Chrysene (µg/kg)	0.718 U	0.696 U	5.32	0.693 U	2.45	0.645 U	0.721 U	0.633 U	0.715 U
Dibenzo(a,h)anthracene (µg/kg)	0.672 U	0.651 U	0.719 U	0.648 U	0.625 U	0.604 U	0.675 U	0.593 U	0.669 U
Fluoranthene (µg/kg)	86 J	0.651 U	8.99	0.648 U	3.77	0.604 U	2.43 J	0.593 U	0.669 U
Fluorene (µg/kg)	4.2 U	4.07 U	4.49 U	4.05 U	3.91 U	3.77 U	4.22 U	3.7 U	4.18 U
Indeno(1,2,3-cd)pyrene (µg/kg)	0.672 U	0.651 U	0.719 U	0.648 U	0.625 U	0.604 U	0.675 U	0.593 U	0.669 U
Naphthalene (µg/kg)	6.3 U	6.11 U	6.74 U	6.08 U	5.86 U	5.66 U	6.33 U	5.56 U	6.27 U
Phenanthrene (µg/kg)	24.1	2.04 U	4.49 J	2.03 U	1.95 U	1.89 U	3.23 J	1.85 U	2.09 U
Pyrene (µg/kg)	63.7 J	0.651 U	7.14	0.648 U	3.74	0.604 U	4.21 J	0.593 U	0.669 U
Pesticides									
4,4'-DDD (µg/kg)	2.1 U	2.03 U	2.25 U	2.03 U	0.391 U	0.377 U	2.11 U	1.85 U	2.09 U
4,4'-DDE (µg/kg)	2.1 U	2.03 U	2.25 U	2.03 U	0.391 U	0.377 U	2.11 U	1.85 U	2.09 U
4,4'-DDT (µg/kg)	2.1 U	2.03 U	2.25 U	2.03 U	0.391 U	0.377 U	2.11 U	1.85 U	2.09 U
Aldrin (µg/kg)	1.05 U	1.02 U	1.13 U	1.02 U	0.195 U	0.189 U	1.05 U	0.924 U	1.05 U
alpha-BHC (µg/kg)	1.05 U	1.02 U	1.13 U	1.02 U	0.195 U	0.189 U	1.05 U	0.924 U	1.05 U
alpha-Chlordane (µg/kg)	1.05 U	1.02 U	1.13 U	1.02 U	0.195 U	0.189 U	1.05 U	0.924 U	1.05 U
beta-BHC (µg/kg)	1.05 U	1.02 U	1.13 U	1.02 U	0.195 U	0.189 U	1.05 U	0.924 U	1.05 U
delta-BHC (µg/kg)	1.05 U	1.02 U	1.13 U	1.02 U	0.195 U	0.189 U	1.05 U	0.924 U	1.05 U
Dieldrin (µg/kg)	2.1 U	2.03 U	2.25 U	2.03 U	0.391 U	0.377 U	2.11 U	1.85 U	2.09 U
Endosulfan I (µg/kg)	1.05 U	1.02 U	1.13 U	1.02 U	0.195 U	0.189 U	1.05 U	0.924 U	1.05 U
Endosulfan II (µg/kg)	2.1 U	2.03 U	2.25 U	2.03 U	0.391 U	0.377 U	2.11 U	1.85 U	2.09 U
Endosulfan sulfate (µg/kg)	2.1 U	2.03 U	2.25 U	2.03 U	0.391 U	0.377 U	2.11 U	1.85 U	2.09 U
Endrin (µg/kg)	2.1 U	2.03 U	2.25 U	2.03 U	0.391 U	0.377 U	2.11 U	1.85 U	2.09 U
Endrin aldehyde (µg/kg)	2.1 U	2.03 U	2.25 U	2.03 U	0.391 U	0.377 U	2.11 U	1.85 U	2.09 U
Endrin ketone (µg/kg)	2.1 U	2.03 U	2.25 U	2.03 U	0.391 U	0.377 U	2.11 U	1.85 U	2.09 U
gamma-BHC (Lindane) (µg/kg)	1.05 U	1.02 U	1.13 U	1.02 U	0.195 U	0.189 U	1.05 U	0.924 U	1.05 U
gamma-Chlordane (µg/kg)	1.05 U	1.02 U	1.13 U	1.02 U	0.195 U	0.189 U	1.05 U	0.924 U	1.05 U
Heptachlor (µg/kg)	1.05 U	1.02 U	1.13 U	1.02 U	0.195 U	0.189 U	1.05 U	0.924 U	1.05 U
Heptachlor epoxide (µg/kg)	1.31 U	1.27 U	1.41 U	1.27 U	0.244 U	0.236 U	1.32 U	1.15 U	1.31 U
Methoxychlor (µg/kg)	10.5 U	10.2 U	11.3 U	10.2 U	1.95 U	1.89 U	10.5 U	9.24 U	10.5 U
Toxaphene (µg/kg)	34.9 U	33.8 U	37.5 U	33.8 U	6.5 U	6.28 U	35.1 U	30.8 U	34.8 U
PCBs									
Aroclor-1016 (µg/kg)	1.39 U	1.36 U	1.5 U	1.35 U	6.49 U	1.25 U	1.4 U	1.23 U	1.39 U
Aroclor-1221 (µg/kg)	1.39 U	1.36 U	1.5 U	1.35 U	6.49 U	1.25 U	1.4 U	1.23 U	1.39 U
Aroclor-1232 (µg/kg)	1.39 U	1.36 U	1.5 U	1.35 U	6.49 U	1.25 U	1.4 U	1.23 U	1.39 U
Aroclor-1242 (µg/kg)	1.39 U	1.36 U	1.5 U	1.35 U	6.49 U	1.25 U	1.4 U	1.23 U	1.39 U
Aroclor-1248 (µg/kg)	1.39 U	1.36 U	1.5 U	1.35 U	6.49 U	1.25 U	1.4 U	1.23 U	1.39 U
Aroclor-1254 (µg/kg)	1.39 U	1.36 U	1.5 U	1.35 U	6.49 U	1.25 U	1.4 U	1.23 U	1.39 U
Aroclor-1260 (µg/kg)	1.39 U	1.36 U	1.5 U	1.35 U	6.49 U	1.25 U	1.4 U	1.23 U	1.39 U

Table 3-30. IWCS Area PAH, Pesticide, and PCB Soil Results

Station	TWP939	TWP940	TWP940	TWP941	TWP941	TWP942	TWP942	TWP943	TWP943	TWP943
Sample No	939SB2.0-4.0-0066	940SS0.0-0.5-0077	940SB8.0-10.0-0078	941SS0.0-0.5-0081	941SB10.0-12.0-0082	942SS0.0-0.5-0085	942SB4.0-6.0-0086	943SS0.0-0.5-0089	943SS0.0-0.5-9005	943SB8.0-10.0-0090
Collection Date	11/22/09	12/01/09	12/01/09	11/30/09	11/30/09	12/02/09	12/02/09	12/02/09	12/02/09	12/02/09
Sample Depth (ft bgs)	2-4	0-0.5	8-10	0-0.5	10-12	0-0.5	4-6	0-0.5	0-0.5	8-10
Polycyclic Aromatic Hydrocarbons										
Acenaphthene (µg/kg)	5.86 U	5.97 U	6.18 U	6 U	6.3 U	6.36 U	6.07 U	5.93 U	5.99 U	6.04 U
Acenaphthylene (µg/kg)	1.95 U	1.99 U	2.06 U	2 U	2.1 U	2.12 U	2.17 J	1.98 U	2 U	2.01 U
Anthracene (µg/kg)	5.86 U	5.97 U	6.18 U	6 U	6.3 U	6.36 U	6.07 U	5.93 U	5.99 U	6.04 U
Benzo(a)anthracene (µg/kg)	0.625 U	0.637 U	0.659 U	0.64 U	0.672 U	6.1	0.648 U	4.32	5.03	0.644 U
Benzo(a)pyrene (µg/kg)	0.625 U	0.637 U	0.659 U	0.64 U	0.672 U	5.34	0.648 U	4.99 J	5.09 J	0.644 U
Benzo(b)fluoranthene (µg/kg)	0.625 U	0.637 U	0.659 U	0.64 U	0.672 U	6.74	0.648 U	5.59 J	5.7 J	0.644 U
Benzo(ghi)perylene (µg/kg)	0.625 U	0.637 U	1.6 J	0.64 U	0.672 U	4.35 J	0.648 U	3.35 J	3.64 J	0.644 U
Benzo(k)fluoranthene (µg/kg)	0.391 U	0.398 U	0.412 U	0.4 U	0.42 U	0.424 U	0.405 U	4.76 J	0.4 U	0.403 U
Chrysene (µg/kg)	0.668 U	0.68 U	0.704 U	0.684 U	0.718 U	4.96	0.692 U	3.87	4.23	0.688 U
Dibenzo(a,h)anthracene (µg/kg)	0.625 U	0.637 U	0.659 U	0.64 U	0.672 U	0.679 U	0.648 U	0.632 U	0.639 U	0.644 U
Fluoranthene (µg/kg)	0.625 U	0.637 U	0.659 U	0.64 U	0.672 U	7.08	0.648 U	7.53	6.59	0.644 U
Fluorene (µg/kg)	3.91 U	3.98 U	4.12 U	4 U	4.2 U	4.24 U	4.05 U	3.95 U	4 U	4.03 U
Indeno(1,2,3-cd)pyrene (µg/kg)	0.625 U	0.637 U	0.659 U	0.64 U	0.672 U	0.679 U	0.648 U	0.632 U	0.639 U	0.644 U
Naphthalene (µg/kg)	5.86 U	5.97 U	6.18 U	6 U	6.3 U	6.36 U	6.07 U	5.93 U	5.99 U	6.04 U
Phenanthrene (µg/kg)	1.95 U	1.99 U	3.5 J	2 U	2.1 U	5.47 J	2.02 U	4.19 J	3.48 J	2.01 U
Pyrene (µg/kg)	0.625 U	0.637 U	0.659 U	0.64 U	0.672 U	7.02	0.648 U	7.11	8.65 J	0.644 U
Pesticides										
4,4'-DDD (µg/kg)	1.95 U	0.398 U	0.412 U	0.4 U	0.418 U	0.425 U	0.406 U	0.393 U	0.399 U	0.401 U
4,4'-DDE (µg/kg)	1.95 U	0.398 U	0.412 U	0.4 U	0.418 U	0.425 U	0.406 U	0.393 U	0.399 U	0.401 U
4,4'-DDT (µg/kg)	1.95 U	0.398 U	0.412 U	0.4 U	0.418 U	0.425 U	0.406 U	0.393 U	0.399 U	0.401 U
Aldrin (µg/kg)	0.977 U	0.199 U	0.206 U	0.2 U	0.209 U	0.212 U	0.203 U	0.197 U	0.2 U	0.201 U
alpha-BHC (µg/kg)	0.977 U	0.199 U	0.206 U	0.2 U	0.209 U	0.212 U	0.203 U	0.197 U	0.2 U	0.201 U
alpha-Chlordane (µg/kg)	0.977 U	0.199 U	0.206 U	0.2 U	0.209 U	0.212 U	0.203 U	0.197 U	0.2 U	0.201 U
beta-BHC (µg/kg)	0.977 U	0.199 U	0.206 U	0.2 U	0.209 U	0.212 U	0.203 U	0.197 U	0.2 U	0.201 U
delta-BHC (µg/kg)	0.977 U	0.199 U	0.206 U	0.2 U	0.209 U	0.212 U	0.203 U	0.197 U	0.2 U	0.201 U
Dieldrin (µg/kg)	1.95 U	0.398 U	0.412 U	0.4 U	0.418 U	0.425 U	0.406 U	0.393 U	0.399 U	0.401 U
Endosulfan I (µg/kg)	0.977 U	0.199 U	0.206 U	0.2 U	0.209 U	0.212 U	0.203 U	0.197 U	0.2 U	0.201 U
Endosulfan II (µg/kg)	1.95 U	0.398 U	0.412 U	0.4 U	0.418 U	0.425 U	0.406 U	0.393 U	0.399 U	0.401 U
Endosulfan sulfate (µg/kg)	1.95 U	0.398 U	0.412 U	0.4 U	0.418 U	0.425 U	0.406 U	0.393 U	0.399 U	0.401 U
Endrin (µg/kg)	1.95 U	0.398 U	0.412 U	0.4 U	0.418 U	0.425 U	0.406 U	0.393 U	0.399 U	0.401 U
Endrin aldehyde (µg/kg)	1.95 U	0.398 U	0.412 U	0.4 U	0.418 U	0.425 U	0.406 U	0.393 U	0.399 U	0.401 U
Endrin ketone (µg/kg)	1.95 U	0.398 U	0.412 U	0.4 U	0.418 U	0.425 U	0.406 U	0.393 U	0.399 U	0.401 U
gamma-BHC (Lindane) (µg/kg)	0.977 U	0.199 U	0.206 U	0.2 U	0.209 U	0.212 U	0.203 U	0.197 U	0.2 U	0.201 U
gamma-Chlordane (µg/kg)	0.977 U	0.199 U	0.206 U	0.2 U	0.209 U	0.212 U	0.203 U	0.197 U	0.2 U	0.201 U
Heptachlor (µg/kg)	0.977 U	0.199 U	0.206 U	0.2 U	0.209 U	0.212 U	0.203 U	0.197 U	0.2 U	0.201 U
Heptachlor epoxide (µg/kg)	1.22 U	0.249 U	0.257 U	0.25 U	0.261 U	0.265 U	0.253 U	0.246 U	0.249 U	0.251 U
Methoxychlor (µg/kg)	9.77 U	1.99 U	2.06 U	2 U	2.09 U	2.12 U	2.03 U	1.97 U	2 U	2.01 U
Toxaphene (µg/kg)	32.5 U	6.63 U	6.85 U	6.65 U	6.95 U	7.07 U	6.75 U	6.55 U	6.64 U	6.68 U
PCBs										
Aroclor-1016 (µg/kg)	1.3 U	1.32 U	1.37 U	1.32 U	1.4 U	1.41 U	1.34 U	1.32 U	1.33 U	1.34 U
Aroclor-1221 (µg/kg)	1.3 U	1.32 U	1.37 U	1.32 U	1.4 U	1.41 U	1.34 U	1.32 U	1.33 U	1.34 U
Aroclor-1232 (µg/kg)	1.3 U	1.32 U	1.37 U	1.32 U	1.4 U	1.41 U	1.34 U	1.32 U	1.33 U	1.34 U
Aroclor-1242 (µg/kg)	1.3 U	1.32 U	1.37 U	1.32 U	1.4 U	1.41 U	1.34 U	1.32 U	1.33 U	1.34 U
Aroclor-1248 (µg/kg)	1.3 U	1.32 U	1.37 U	1.32 U	1.4 U	1.41 U	1.34 U	1.32 U	1.33 U	1.34 U
Aroclor-1254 (µg/kg)	1.3 U	1.32 U	1.37 U	1.32 U	1.4 U	1.41 U	1.34 U	1.32 U	1.33 U	1.34 U
Aroclor-1260 (µg/kg)	1.3 U	1.32 U	1.37 U	1.32 U	1.4 U	1.41 U	1.34 U	1.32 U	1.33 U	1.34 U

Table 3-31. IWCS Area Metal and Radiological Compound Soil Results

Station	TWP935	TWP935	TWP936	TWP936	TWP937	TWP937	TWP938	TWP938	TWP939
Sample No	935SS0.0-0.5-0057	935SB10.0-12.0-0058	936SS0.0-0.5-0061	936SB12.0-14.0-0062	937SS0.0-0.5-0073	937SB12.0-14.0-0074	938SS0.0-0.5-0069	938SB14.0-15.0-0070	939SS0.0-0.5-0065
Collection Date	11/24/09	11/24/09	11/22/09	11/22/09	12/01/09	12/01/09	11/24/09	11/24/09	11/22/09
Sample Depth (ft bgs)	0-0.5	10-12	0-0.5	12-14	0-0.5	12-14	0-0.5	14-16	0-0.5
Metals									
Antimony (mg/kg)	0.415 U	0.403 U	0.43 U	0.384 U	0.362 U	0.357 U	0.406 U	0.354 U	0.395 U
Arsenic (mg/kg)	5.19	2.54	2.56	3.63	3.12	2.22	4.53	2.83	2.6
Barium (mg/kg)	136	144	170	144	124	89.8	122	117	153
Beryllium (mg/kg)	0.659	0.722	0.715	0.698	0.774	0.364 J	0.729	0.394	0.712
Cadmium (mg/kg)	0.293	0.141 J	0.321	0.132 J	0.162 J	0.133 J	0.239 J	0.131 J	0.203 J
Chromium (mg/kg)	18.4	22.5	20.6	21.9	19.8	7.95	19.6	11.2	19.1
Lead (mg/kg)	19.3	5.85	12.1	6.47	16.1	2.73	8.28	3.42	8.85
Mercury (µg/kg)	28.2	7.81 J	46.6	8.02 J	48.3 J	4.47 U	18.5	4.11 J	30.4
Nickel (mg/kg)	20.2	23.8	18.5	25	32.8	10	18.3	14.1	17.6
Selenium (mg/kg)	0.612 U	0.589 U	0.656 U	0.595 U	0.552 U	0.54 U	0.618 U	0.537 U	0.613 U
Silver (mg/kg)	0.341 J	0.274 J	0.487 J	0.475 J	0.541 J	0.455 J	0.318 J	0.379 J	0.63
Thallium (mg/kg)	0.122 J	0.151 J	0.134 J	0.156 J	0.149 J	0.0706 J	0.134 J	0.0809 J	0.118 J
Zinc (mg/kg)	67.8	54.6	74.4	57.1	50.9	26.2	50.6	31.6	52
Radiological Compounds									
Actinium-227 (GammaSpec) (pCi/g)	0.249 U	-0.241 U	0.1 U	-0.256 U	-0.203 U	0.108 U	0.0108 U	0.158 U	-0.175 U
Americium-241 (GammaSpec) (pCi/g)	0.133 U	-0.163 U	-0.0221 U	-0.126 U	0.027 U	0.0322 U	0.0325 U	-0.031 U	0.0425 U
Cesium-137 (GammaSpec) (pCi/g)	0 U	-0.0281 U	0.11	-0.0192 U	0.0132 U	-0.00044 U	0.0418 U	0.00908 U	0.0537 U
Cobalt-60 (GammaSpec) (pCi/g)	0.0453 U	0.0207 U	0.0361 U	-0.00354 U	0.00327 U	-0.00845 U	0.0213 U	-0.000353 U	0.0147 U
Plutonium-238 (AlphaSpec) (pCi/g)	-0.0193 U	-0.0432 U	0.102 U	-0.0393 U	0.0321 U	-0.0983 U	0.0472 U	-0.0147 U	-0.0133 U
Plutonium-239/240 (AlphaSpec) (pCi/g)	0.0225 U	0 U	-0.0139 U	0.0153 U	-0.0366 U	0.0957 U	-0.0298 U	0.0319 U	-0.0797 U
Potassium-40 (GammaSpec) (pCi/g)	20.2	26.4	18.3	24.6	22.2	11.7	18.2	13.7	22
Protactinium-231 (GammaSpec) (pCi/g)	0.715 U	-0.348 U	0.105 U	-0.752 U	-0.95 U	-0.749 U	-0.271 U	0.41 U	-0.742 U
Radium-226 (AlphaSpec) (pCi/g)	0.648 J	0.351 U	1.03 J	0.828 J	5	0.422	0.285 U	0.657 J	0.766 J
Radium-226 (GammaSpec) (pCi/g)	0.918	0.705	0.931	0.965	5.25	0.545	0.785	0.711	1.09
Radium-228 (AlphaSpec) (pCi/g)	1.83	1.14	1.37	0.741	1.04	0.143 U	0.89	1.04	1.11
Radium-228 (GammaSpec) (pCi/g)	1.14	1.09	1.26	1.22	1.12	0.628	1.09	0.82	1.21
Strontium-90 (GammaSpec) (pCi/g)	-0.382 U	-0.0353 U	0.235 U	-0.0686 U	-0.228 U	-0.311 U	-0.0557 U	0.18 U	0.0157 U
Thorium-228 (AlphaSpec) (pCi/g)	1.01	0.91	1.5	0.856	0.917	0.823	0.9	0.544	1.11
Thorium-228 (GammaSpec) (pCi/g)	1.09	1.07	1.06	1.19	0.91	0.55	0.917	0.69	1.2
Thorium-230 (AlphaSpec) (pCi/g)	0.836	0.801	1.35	0.809	5.93	0.468	0.834	0.381	1.74
Thorium-232 (AlphaSpec) (pCi/g)	0.846	1.04	1.15	0.981	0.84	0.395	0.904	0.482	1.4
Uranium-233/234 (AlphaSpec) (pCi/g)	1.03	0.818	1.55	0.993	1.35	1	1.04	0.746	1.24
Uranium-235 (GammaSpec) (pCi/g)	0.201 U	0.075 U	0.213 U	-0.195 U	0.258 U	-0.0208 U	-0.034 U	-0.129 U	0.0287 U
Uranium-235/236 (AlphaSpec) (pCi/g)	0 U	0.0287 U	0.103 U	-0.00721 U	0.028 U	0.111	-0.0451 U	-0.0182 U	0.0131 U
Uranium-238 (AlphaSpec) (pCi/g)	1.15	0.811	1.55	1.03	0.954	0.651	0.885	0.509	1.2
Uranium-238 (GammaSpec) (pCi/g)	0.369 U	-0.873 U	2.21 U	1.29 U	0.278 U	0.663 U	1.25 U	1.82 U	0.612 U

Table 3-31. IWCS Area Metal and Radiological Compound Soil Results

Station	TWP939	TWP940	TWP940	TWP941	TWP941	TWP942	TWP942	TWP943	TWP943	TWP943
Sample No	939SB2.0-4.0-0066	940SS0.0-0.5-0077	940SB8.0-10.0-0078	941SS0.0-0.5-0081	941SB10.0-12.0-0082	942SS0.0-0.5-0085	942SB4.0-6.0-0086	943SS0.0-0.5-0089	943SS0.0-0.5-9005	943SB8.0-10.0-0090
Collection Date	11/22/09	12/01/09	12/01/09	11/30/09	11/30/09	12/02/09	12/02/09	12/02/09	12/02/09	12/02/09
Sample Depth (ft bgs)	2-4	0-0.5	8-10	0-0.5	10-12	0-0.5	4-6	0-0.5	0-0.5	8-10
Metals										
Antimony (mg/kg)	0.37 U	0.374 U	0.391 U	0.389 U	0.409 U	0.408 U	0.387 U	0.37 U	0.458 J	0.365 U
Arsenic (mg/kg)	3.78	2.3	2.09	4.17	5.6	3.48	2.24	5.58	3.91	3.45
Barium (mg/kg)	491	95.3	82.5	205 J	111	125	71.3	144	131	119
Beryllium (mg/kg)	0.595	0.743	0.376 J	0.808	0.766	0.64	0.515 J	1.21	0.748	0.938
Cadmium (mg/kg)	0.197 J	0.127 J	0.155 J	0.142 J	0.172 J	0.264	0.14 J	0.283	0.17 J	0.172 J
Chromium (mg/kg)	15.7	13.1	7.56	23.6	23.6	18.8	15.8	24.8	21.6	22.7
Lead (mg/kg)	4.96	3.65	2.76	6.81	6.32	16.4	4.66	10.6	11	6.32
Mercury (µg/kg)	16.4	9.39 J	4.52 U	8.8 J	9.73 J	28.5	4.95 U	13.2	15.4	4.98 J
Nickel (mg/kg)	17.8	13.8	10	26.5	25.5	17.4	16.1	25.9	23.2	23.5
Selenium (mg/kg)	0.561 U	0.561 U	0.567 U	0.573 U	0.631 U	0.581 U	0.581 U	0.565 U	0.571 U	0.581 U
Silver (mg/kg)	0.588	0.144 J	0.505 J	0.484 J	0.124 U	0.614 J	0.373 J	0.511 J	0.558 J	0.396 J
Thallium (mg/kg)	0.0926 J	0.1 J	0.068 U	0.158 J	0.154 J	0.133 J	0.112 J	0.167 J	0.147 J	0.166 J
Zinc (mg/kg)	39.7	32.6	25.3	59.5	58.3	59.9	37.7	62.4	56.4	55.7
Radiological Compounds										
Actinium-227 (GammaSpec) (pCi/g)	0.119 U	0.0981 U	0.0187 U	0.108 U	-0.122 U	-0.162 U	-0.0903 U	-0.00701 U		-0.156 U
Americium-241 (GammaSpec) (pCi/g)	-0.0244 U	-0.186 U	0.0941 U	-0.0485 U	-0.0693 U	0.0114 U	-0.0316 U	-0.407 U		-0.0104 U
Cesium-137 (GammaSpec) (pCi/g)	0.0231 U	-0.0219 U	0.0136 U	-0.0413 U	-0.00845 U	0.134	-0.0137 U	-0.0123 U		0.00611 U
Cobalt-60 (GammaSpec) (pCi/g)	0.00574 U	-0.027 U	0.00533 U	-0.0124 U	-0.00686 U	-0.0167 U	0.0216 U	0.0609 U		-0.0132 U
Plutonium-238 (AlphaSpec) (pCi/g)	-0.0161 U	-0.0309 U	-0.0278 U	0.0451 U	-0.0144 U	0 U	-0.014 U	-0.0125 U		-0.0139 U
Plutonium-239/240 (AlphaSpec) (pCi/g)	0.0672 U	-0.0926 U	-0.0417 U	-0.104 U	-0.0432 U	-0.0365 U	-0.112 U	0.0146 U		-0.0277 U
Potassium-40 (GammaSpec) (pCi/g)	17.4	22.4	20.8	22.7	26	20.1	14.5	22.1		17.4
Protactinium-231 (GammaSpec) (pCi/g)	-0.0841 U	-0.831 U	0.337 U	-0.356 U	-0.692 U	0.852 U	-0.391 U	-0.255 U		1.38 U
Radium-226 (AlphaSpec) (pCi/g)	0.13 U	0.674	0.49	0.823	0.413	0.914	0.468	0.759 J	1.2 J	0.376 U
Radium-226 (GammaSpec) (pCi/g)	0.668	1.01	0.694	0.83	0.741	1.09	0.537	0.951		0.608
Radium-228 (AlphaSpec) (pCi/g)	0.456 U	0.742 U	3.46	1.25	1.29	0.921 U	1.4	1.29	1.92	1.31
Radium-228 (GammaSpec) (pCi/g)	0.86	1.1	0.87	1.11	1.23	0.859	0.491	1.38		0.553
Strontium-90 (GammaSpec) (pCi/g)	-0.0847 U	0.0699 U	-0.0121 U	-0.053 U	0.439 U	-0.347 U	-0.117 U	0.27 U		-0.507 U
Thorium-228 (AlphaSpec) (pCi/g)	0.545	1	0.875	0.83	1.26	0.827	0.594	0.972		0.676
Thorium-228 (GammaSpec) (pCi/g)	0.942	1.14	0.91	1.06	1.14	1.13	0.59	1.27		0.674
Thorium-230 (AlphaSpec) (pCi/g)	0.765	0.855	0.806	0.637	0.673	1.51	0.785	1.17		0.736
Thorium-232 (AlphaSpec) (pCi/g)	0.555	0.675	0.687	1.07	0.892	0.705	0.417	1.19		0.626
Uranium-233/234 (AlphaSpec) (pCi/g)	0.878	1.08	0.651	1.09	0.751	1.21	0.386	1.2		1.04
Uranium-235 (GammaSpec) (pCi/g)	-0.0591 U	-0.0983 U	0.144 U	-0.112 U	-0.123 U	0.151 U	0.15 U	-0.0715 U		-0.0371 U
Uranium-235/236 (AlphaSpec) (pCi/g)	-0.0186 U	0.0818 U	0.0393 U	0.0637 U	-0.00948 U	0.0387 U	0.188	0.0347 U		0.112
Uranium-238 (AlphaSpec) (pCi/g)	0.588	0.985	0.844	1.08	0.688	0.885	0.759	1.34		1.04
Uranium-238 (GammaSpec) (pCi/g)	0.34 U	0.0267 U	1.75	0.416 U	-1.35 U	0 U	-0.829 U	1.28 U		0.0457 U

Table 3-32. IWCS Area Radiological Groundwater Screening Results

Station	TWP935	TWP935	TWP936	TWP936	TWP937	TWP937	TWP938	TWP938	TWP939
Sample No	935TW0001-0059	935TW0001F-0060	936TW0001-0063	936TW0001F-0064	937TW0001-0067	937TW0001F-0068	938TW0001-0071	938TW0001F-0072	939TW0001-0075
Collection Date	12/05/09	12/05/09	11/24/09	11/24/09	12/04/09	12/04/09	12/04/09	12/04/09	11/25/09
Uranium-233/234 (pCi/L)	20.4		10.3		16.6		10.4		4.56
Uranium-233/234, Dissolved (pCi/L)		16.9		12.5		18.1		10.4	
Uranium-235/236 (pCi/L)	0.899		0.416		0.614		0.334		0.235
Uranium-235/236, Dissolved (pCi/L)		0.752		0.497		0.648		0.372	
Uranium-238 (pCi/L)	18.1		8.32		14.5		8.75		3.98
Uranium-238, Dissolved (pCi/L)		14.4		9.97		14.7		8.71	

All analyses performed by alpha spectroscopy.

Station	TWP939	TWP940	TWP940	TWP941	TWP941	TWP942	TWP942	TWP943	TWP943
Sample No	939TW0001F-0076	940TW0001-0079	940TW0001F-0080	941TW0001-0083	941TW0001F-0084	942TW0001-0087	942TW0001F-0088	943TW0001-0091	943TW0001F-0092
Collection Date	11/25/09	12/04/09	12/04/09	12/05/09	12/05/09	12/03/09	12/03/09	12/03/09	12/03/09
Uranium-233/234 (pCi/L)		2.55		2.92		6.41		5.92	
Uranium-233/234, Dissolved (pCi/L)	4.91		2.44		0.774		7.22		5.68
Uranium-235/236 (pCi/L)		0.0967 U		0.113		0.29		0.257	
Uranium-235/236, Dissolved (pCi/L)	0.229		0.184		0.0512		0.397		0.206
Uranium-238 (pCi/L)		2.43		2.37		5.09		4.01	
Uranium-238, Dissolved (pCi/L)	3.74		2.12		0.663		5.82		4.84

All analyses performed by alpha spectroscopy.

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Table 3-33. IWCS Area VOC Monitoring Well Results

Station Sample No Collection Date	MW935 935GW0001-0119 01/16/10	MW936 936GW0001-0121 01/13/10	MW938 938GW0001-0123 01/14/10	MW941 941GW0001-0125 01/13/10	MW943 943GW0001-0127 12/22/09
Volatile Organic Compounds					
1,1,1-Trichloroethane (µg/L)	0.325 U	0.325 U	0.325 U	0.325 U	0.325 U
1,1,2,2-Tetrachloroethane (µg/L)	0.25 U	0.25 U	0.25 U	0.25 U	0.25 U
1,1,2-Trichloroethane (µg/L)	0.25 U	0.25 U	0.25 U	0.25 U	0.25 U
1,1-Dichloroethane (µg/L)	0.3 U	0.3 U	0.3 U	0.3 U	0.3 U
1,1-Dichloroethylene (µg/L)	0.3 U	0.3 U	0.3 U	0.3 U	0.3 U
1,2-Dichloroethane (µg/L)	0.25 U	0.25 U	0.25 U	0.25 U	0.25 U
1,2-Dichloropropane (µg/L)	0.25 U	0.25 U	0.25 U	0.25 U	0.25 U
2-Butanone (µg/L)	1.25 U	1.25 U	1.25 U	1.25 U	1.25 U
2-Hexanone (µg/L)	1.25 U	1.25 U	1.25 U	1.25 U	1.25 U
4-Methyl-2-pentanone (µg/L)	1.25 U	1.25 U	1.25 U	1.25 U	1.25 U
Acetone (µg/L)	1.5 U	1.5 U	1.5 U	1.5 U	1.5 U
Benzene (µg/L)	0.3 U	0.3 U	0.3 U	0.3 U	0.3 U
Bromodichloromethane (µg/L)	0.25 U	0.25 U	0.25 U	0.25 U	0.25 U
Bromoform (µg/L)	0.25 U	0.25 U	0.25 U	0.25 U	0.25 U
Bromomethane (µg/L)	0.3 U	0.3 U	0.3 U	0.3 U	0.3 U
Carbon disulfide (µg/L)	1.25 U	1.25 U	1.25 U	1.25 U	1.25 U
Carbon tetrachloride (µg/L)	0.3 U	0.3 U	0.3 U	0.3 U	0.3 U
Chlorobenzene (µg/L)	0.25 U	0.25 U	0.25 U	0.25 U	0.25 U
Chloroethane (µg/L)	0.3 U	0.3 U	0.3 U	0.3 U	0.3 U
Chloroform (µg/L)	0.25 U	0.25 U	0.25 U	0.25 U	0.25 U
Chloromethane (µg/L)	0.3 U	0.3 U	0.3 U	0.3 U	0.3 U
cis-1,2-Dichloroethylene (µg/L)	0.3 U	0.3 U	0.3 U	0.3 U	0.3 U
cis-1,3-Dichloropropylene (µg/L)	0.25 U	0.25 U	0.25 U	0.25 U	0.25 U
Ethylbenzene (µg/L)	0.25 U	0.25 U	0.25 U	0.25 U	0.25 U
Methylene chloride (µg/L)	2 U	2 U	2 U	2 U	2 U
Styrene (µg/L)	0.25 U	0.25 U	0.25 U	0.25 U	0.25 U
Tetrachloroethylene (µg/L)	0.3 U	0.3 U	0.3 U	0.3 U	0.3 U
Toluene (µg/L)	0.25 U	0.25 U	0.25 U	0.25 U	0.25 U
trans-1,2-Dichloroethylene (µg/L)	0.3 U	0.3 U	0.3 U	0.3 U	0.3 U

Table 3-33. IWCS Area VOC Monitoring Well Results

Station Sample No Collection Date	MW935 935GW0001-0119 01/16/10	MW936 936GW0001-0121 01/13/10	MW938 938GW0001-0123 01/14/10	MW941 941GW0001-0125 01/13/10	MW943 943GW0001-0127 12/22/09
trans-1,3-Dichloropropylene (µg/L)	0.25 U	0.25 U	0.25 U	0.25 U	0.25 U
Trichloroethylene (µg/L)	0.25 U	0.25 U	0.25 U	0.25 U	0.25 U
Vinyl chloride (µg/L)	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U
Xylenes (total) (µg/L)	0.3 U	0.3 U	0.3 U	0.3 U	0.3 U

Table 3-34. IWCS Area SVOC Monitoring Well Results

Station Sample No Collection Date	MW935 935GW0001-0119 01/16/10	MW936 936GW0001-0121 01/13/10	MW938 938GW0001-0123 01/14/10	MW941 941GW0001-0125 01/13/10	MW943 943GW0001-0127 12/22/09
Semi-Volatile Organic Compounds					
1,1'-Biphenyl (µg/L)	2.78 U	2.88 U	3.02 U	3.08 U	3 U
2,4,5-Trichlorophenol (µg/L)	1.85 U	1.92 U	2.01 U	2.05 U	2 U
2,4,6-Trichlorophenol (µg/L)	1.85 U	1.92 U	2.01 U	2.05 U	2 U
2,4-Dichlorophenol (µg/L)	1.85 U	1.92 U	2.01 U	2.05 U	2 U
2,4-Dimethylphenol (µg/L)	1.85 U	1.92 U	2.01 U	2.05 U	2 U
2,4-Dinitrophenol (µg/L)	4.63 U	4.81 U	5.03 U	5.13 U	5 U
2,4-Dinitrotoluene (µg/L)	1.85 U	1.92 U	2.01 U	2.05 U	2 U
2,6-Dinitrotoluene (µg/L)	1.85 U	1.92 U	2.01 U	2.05 U	2 U
2-Chloronaphthalene (µg/L)	0.278 U	0.288 U	0.302 U	0.308 U	0.3 U
2-Chlorophenol (µg/L)	1.85 U	1.92 U	2.01 U	2.05 U	2 U
2-Methyl-4,6-dinitrophenol (µg/L)	2.78 U	2.88 U	3.02 U	3.08 U	3 U
2-Methylnaphthalene (µg/L)	0.278 U	0.288 U	0.302 U	0.308 U	0.3 U
2-Nitrophenol (µg/L)	1.85 U	1.92 U	2.01 U	2.05 U	2 U
3,3'-Dichlorobenzidine (µg/L)	1.85 U	1.92 U	2.01 U	2.05 U	2 U
4-Bromophenylphenylether (µg/L)	1.85 U	1.92 U	2.01 U	2.05 U	2 U
4-Chloro-3-methylphenol (µg/L)	1.85 U	1.92 U	2.01 U	2.05 U	2 U
4-Chloroaniline (µg/L)	1.85 U	1.92 U	2.01 U	2.05 U	2 U
4-Chlorophenylphenylether (µg/L)	1.85 U	1.92 U	2.01 U	2.05 U	2 U
4-Nitrophenol (µg/L)	1.85 U	1.92 U	2.01 U	2.05 U	2 U
Acenaphthene (µg/L)	0.287 U	0.298 U	0.312 U	0.318 U	0.31 U
Acenaphthylene (µg/L)	0.185 U	0.192 U	0.201 U	0.205 U	0.2 U
Acetophenone (µg/L)	1.85 U	1.92 U	2.01 U	2.05 U	2 U
Anthracene (µg/L)	0.185 U	0.192 U	0.201 U	0.205 U	0.2 U
Atrazine (µg/L)	2.78 U	2.88 U	3.02 U	3.08 U	3 U
Benzaldehyde (µg/L)	2.78 U	2.88 U	3.02 U	3.08 U	3 U
Benzo(a)anthracene (µg/L)	0.185 U	0.192 U	0.201 U	0.205 U	0.2 U
Benzo(a)pyrene (µg/L)	0.185 U	0.192 U	0.201 U	0.205 U	0.2 U
Benzo(b)fluoranthene (µg/L)	0.185 U	0.192 U	0.201 U	0.205 U	0.2 U
Benzo(ghi)perylene (µg/L)	0.185 U	0.192 U	0.201 U	0.205 U	0.2 U

Table 3-34. IWCS Area SVOC Monitoring Well Results

Station Sample No Collection Date	MW935 935GW0001-0119 01/16/10	MW936 936GW0001-0121 01/13/10	MW938 938GW0001-0123 01/14/10	MW941 941GW0001-0125 01/13/10	MW943 943GW0001-0127 12/22/09
Benzo(k)fluoranthene (µg/L)	0.185 U	0.192 U	0.201 U	0.205 U	0.2 U
bis(2-Chloroethoxy)methane (µg/L)	2.78 U	2.88 U	3.02 U	3.08 U	3 U
bis(2-Chloroethyl) ether (µg/L)	1.85 U	1.92 U	2.01 U	2.05 U	2 U
bis(2-Chloroisopropyl)ether (µg/L)	1.85 U	1.92 U	2.01 U	2.05 U	2 U
bis(2-Ethylhexyl)phthalate (µg/L)	1.85 U	1.92 U	2.01 U	2.05 U	2 U
Butylbenzylphthalate (µg/L)	1.85 U	1.92 U	2.01 U	2.05 U	2 U
Caprolactam (µg/L)	1.85 U	1.92 U	2.01 U	2.05 U	2 U
Carbazole (µg/L)	0.185 U	0.192 U	0.201 U	0.205 U	0.2 U
Chrysene (µg/L)	0.185 U	0.192 U	0.201 U	0.205 U	0.2 U
Dibenzo(a,h)anthracene (µg/L)	0.185 U	0.192 U	0.201 U	0.205 U	0.2 U
Dibenzofuran (µg/L)	1.85 U	1.92 U	2.01 U	2.05 U	2 U
Diethylphthalate (µg/L)	1.85 U	1.92 U	2.01 U	2.05 U	2 U
Dimethylphthalate (µg/L)	1.85 U	1.92 U	2.01 U	2.05 U	2 U
Di-n-butylphthalate (µg/L)	1.85 U	1.92 U	2.01 U	2.05 U	2 U
Di-n-octylphthalate (µg/L)	2.78 U	2.88 U	3.02 U	3.08 U	3 U
Diphenylamine (µg/L)	2.78 U	2.88 U	3.02 U	3.08 U	3 U
Fluoranthene (µg/L)	0.185 U	0.192 U	0.201 U	0.205 U	0.2 U
Fluorene (µg/L)	0.185 U	0.192 U	0.201 U	0.205 U	0.2 U
Hexachlorobenzene (µg/L)	1.85 U	1.92 U	2.01 U	2.05 U	2 U
Hexachlorobutadiene (µg/L)	1.85 U	1.92 U	2.01 U	2.05 U	2 U
Hexachlorocyclopentadiene (µg/L)	2.78 U	2.88 U	3.02 U	3.08 U	3 U
Hexachloroethane (µg/L)	1.85 U	1.92 U	2.01 U	2.05 U	2 U
Indeno(1,2,3-cd)pyrene (µg/L)	0.185 U	0.192 U	0.201 U	0.205 U	0.2 U
Isophorone (µg/L)	2.78 U	2.88 U	3.02 U	3.08 U	3 U
m,p-Cresols (µg/L)	2.78 U	2.88 U	3.02 U	3.08 U	3 U
m-Nitroaniline (µg/L)	1.85 U	1.92 U	2.01 U	2.05 U	2 U
Naphthalene (µg/L)	0.278 U	0.288 U	0.302 U	0.308 U	0.3 U
Nitrobenzene (µg/L)	2.78 U	2.88 U	3.02 U	3.08 U	3 U
N-Nitrosodipropylamine (µg/L)	1.85 U	1.92 U	2.01 U	2.05 U	2 U

Table 3-34. IWCS Area SVOC Monitoring Well Results

Station Sample No Collection Date	MW935 935GW0001-0119 01/16/10	MW936 936GW0001-0121 01/13/10	MW938 938GW0001-0123 01/14/10	MW941 941GW0001-0125 01/13/10	MW943 943GW0001-0127 12/22/09
o-Cresol (µg/L)	1.85 U	1.92 U	2.01 U	2.05 U	2 U
o-Nitroaniline (µg/L)	1.85 U	1.92 U	2.01 U	2.05 U	2 U
Pentachlorophenol (µg/L)	1.85 U	1.92 U	2.01 U	2.05 U	2 U
Phenanthrene (µg/L)	0.185 U	0.192 U	0.201 U	0.205 U	0.2 U
Phenol (µg/L)	0.926 U	0.962 U	1.01 U	1.03 U	1 U
p-Nitroaniline (µg/L)	2.78 U	2.88 U	3.02 U	3.08 U	3 U
Pyrene (µg/L)	0.278 U	0.288 U	0.302 U	0.308 U	0.3 U

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Table 3-35. IWCS Area PAH, Pesticide, and PCB Monitoring Well Results

Station	MW935	MW936	MW938	MW941	MW943
Sample No	935GW0001-0119	936GW0001-0121	938GW0001-0123	941GW0001-0125	943GW0001-0127
Collection Date	01/16/10	01/13/10	01/14/10	01/13/10	12/22/09
Polycyclic Aromatic Hydrocarbons					
Acenaphthene (µg/L)	0.118 U	0.126 U	0.121 U	0.124 U	0.118 U
Acenaphthylene (µg/L)	0.118 U	0.126 U	0.121 U	0.124 U	0.118 U
Anthracene (µg/L)	0.123 U	0.131 U	0.126 U	0.129 U	0.123 U
Benzo(a)anthracene (µg/L)	0.0151 U	0.0162 U	0.0155 U	0.0158 U	0.0151 U
Benzo(a)pyrene (µg/L)	0.0151 U	0.0162 U	0.0155 U	0.0158 U	0.0151 U
Benzo(b)fluoranthene (µg/L)	0.0151 U	0.0162 U	0.0155 U	0.0158 U	0.0151 U
Benzo(ghi)perylene (µg/L)	0.0151 U	0.0162 U	0.0155 U	0.0158 U	0.0151 U
Benzo(k)fluoranthene (µg/L)	0.0151 U	0.0162 U	0.0155 U	0.0158 U	0.0151 U
Chrysene (µg/L)	0.0151 U	0.0162 U	0.0155 U	0.0158 U	0.0151 U
Dibenzo(a,h)anthracene (µg/L)	0.0151 U	0.0162 U	0.0155 U	0.0158 U	0.0151 U
Fluoranthene (µg/L)	0.0151 U	0.0162 U	0.0155 U	0.0158 U	0.0151 U
Fluorene (µg/L)	0.118 U	0.126 U	0.121 U	0.124 U	0.118 U
Indeno(1,2,3-cd)pyrene (µg/L)	0.0151 U	0.0162 U	0.0155 U	0.0158 U	0.0151 U
Naphthalene (µg/L)	0.118 U	0.126 U	0.121 U	0.124 U	0.118 U
Phenanthrene (µg/L)	0.118 U	0.126 U	0.121 U	0.124 U	0.118 U
Pyrene (µg/L)	0.0151 U	0.0162 U	0.0155 U	0.0158 U	0.0151 U
Pesticides					
4,4'-DDD (µg/L)	0.01 U	0.00952 U	0.00893 U	0.0102 U	0.01 U
4,4'-DDE (µg/L)	0.005 U	0.00476 U	0.00446 U	0.0051 U	0.005 U
4,4'-DDT (µg/L)	0.01 U	0.00952 U	0.00893 U	0.0102 U	0.01 U
Aldrin (µg/L)	0.0238	0.00476 U	0.00446 U	0.0051 U	0.005 U
alpha-BHC (µg/L)	0.005 U	0.00476 U	0.00446 U	0.0051 U	0.005 U
alpha-Chlordane (µg/L)	0.005 U	0.00476 U	0.00446 U	0.0051 U	0.005 U
beta-BHC (µg/L)	0.006 U	0.00571 U	0.00536 U	0.00612 U	0.006 U
delta-BHC (µg/L)	0.005 U	0.00476 U	0.00446 U	0.0051 U	0.005 U
Dieldrin (µg/L)	0.01 U	0.00952 U	0.00893 U	0.0102 U	0.01 U
Endosulfan I (µg/L)	0.0409	0.00476 U	0.00446 U	0.0051 U	0.005 U
Endosulfan II (µg/L)	0.01 U	0.00952 U	0.00893 U	0.0102 U	0.01 U
Endosulfan sulfate (µg/L)	0.01 U	0.00952 U	0.00893 U	0.0102 U	0.01 U

Table 3-35. IWCS Area PAH, Pesticide, and PCB Monitoring Well Results

Station Sample No Collection Date	MW935 935GW0001-0119 01/16/10	MW936 936GW0001-0121 01/13/10	MW938 938GW0001-0123 01/14/10	MW941 941GW0001-0125 01/13/10	MW943 943GW0001-0127 12/22/09
Endrin (µg/L)	0.01 U	0.00952 U	0.00893 U	0.0102 U	0.01 U
Endrin aldehyde (µg/L)	0.005 U	0.00476 U	0.00446 U	0.0051 U	0.005 U
Endrin ketone (µg/L)	0.01 U	0.00952 U	0.00893 U	0.0102 U	0.01 U
gamma-BHC (Lindane) (µg/L)	0.005 U	0.00476 U	0.00446 U	0.0051 U	0.005 U
gamma-Chlordane (µg/L)	0.005 U	0.00476 U	0.00446 U	0.0051 U	0.005 U
Heptachlor (µg/L)	0.005 U	0.00476 U	0.00446 U	0.0051 U	0.005 U
Heptachlor epoxide (µg/L)	0.005 U	0.00476 U	0.00446 U	0.0051 U	0.005 U
Methoxychlor (µg/L)	0.05 U	0.0476 U	0.0446 U	0.051 U	0.05 U
Toxaphene (µg/L)	0.15 U	0.143 U	0.134 U	0.153 U	0.15 U
PCBs					
Aroclor-1016 (µg/L)	0.157 U	0.0314 U	0.0314 U	0.0297 U	0.0333 U
Aroclor-1221 (µg/L)	0.157 U	0.0314 U	0.0314 U	0.0297 U	0.0333 U
Aroclor-1232 (µg/L)	0.157 U	0.0314 U	0.0314 U	0.0297 U	0.0333 U
Aroclor-1242 (µg/L)	0.157 U	0.0314 U	0.0314 U	0.0297 U	0.0333 U
Aroclor-1248 (µg/L)	0.157 U	0.0314 U	0.0314 U	0.0297 U	0.0333 U
Aroclor-1254 (µg/L)	0.157 U	0.0314 U	0.0314 U	0.0297 U	0.0333 U
Aroclor-1260 (µg/L)	0.157 U	0.0314 U	0.0314 U	0.0297 U	0.0333 U

Table 3-36. IWCS Area Metal and Radiological Compound Monitoring Well Results

Station	MW935	MW935	MW936	MW936	MW938	MW938	MW941	MW941	MW943	MW943
Sample No	935GW0001-0119	935GW0001F-0120	936GW0001-0121	936GW0001F-0122	938GW0001-0123	938GW0001F-0124	941GW0001-0125	941GW0001F-0126	943GW0001-0127	943GW0001F-0128
Collection Date	01/16/10	01/27/10	01/13/10	01/13/10	01/14/10	01/14/10	01/13/10	01/15/10	12/22/09	12/22/09
Metals										
Antimony (µg/L)	3 U		3 U		5.71 J		3 U		3 U	
Antimony, Dissolved (µg/L)		3 U		3.27 R		3 U		3 U		3 U
Arsenic (µg/L)	1.6 U		1.6 U		3.48 J		1.6 U		3.3 J	
Arsenic, Dissolved (µg/L)		1.6 U		1.6 U		5.98		3.2 U		3.63 J
Barium (µg/L)	5.98		10.8		18.2		9.92		19.2	
Barium, Dissolved (µg/L)		7.47		9.42		12.7		5.77		14.5
Beryllium (µg/L)	0.1 U		0.5 U		0.5 U		0.5 U		0.1 U	
Beryllium, Dissolved (µg/L)		0.1 U		0.5 U		0.5 U		0.1 U		0.1 U
Cadmium (µg/L)	0.11 U		0.152 J		0.361 J		0.11 U		0.11 U	
Cadmium, Dissolved (µg/L)		0.11 U		0.11 U		0.11 U		0.11 U		0.11 U
Chromium (µg/L)	4.05 J		4.6 J		7.38 J		3.93 J		4.05 J	
Chromium, Dissolved (µg/L)		2 U		5.64 J		6.54 J		2 U		2.47 J
Lead (µg/L)	0.5 U		0.5 U		0.622 J		0.552 J		0.5 U	
Lead, Dissolved (µg/L)		0.5 U		0.5 U		0.5 U		0.5 U		0.5 U
Mercury (µg/L)	0.066 U		0.066 U		0.066 U		0.066 U		0.066 U	
Mercury, Dissolved (µg/L)		0.066 U		0.066 U		0.066 U		0.066 U		0.066 U
Nickel (µg/L)	9.75		16.6		10.9		4.99		7.98	
Nickel, Dissolved (µg/L)		11.5		16.5		11.6		3.59		6.71
Selenium (µg/L)	1 U		1 U		1 U		1 U		1 U	
Selenium, Dissolved (µg/L)		1 U		1 U		1 U		1 U		1 U
Silver (µg/L)	1 U		1 U		1 U		1 U		1 U	
Silver, Dissolved (µg/L)		1 U		1 U		1 U		1 U		1 U
Thallium (µg/L)	0.39 J		0.3 U		0.3 U		0.303 J		0.3 U	
Thallium, Dissolved (µg/L)		0.3 U		0.3 U		0.3 U		0.487 J		0.3 U
Zinc (µg/L)	34.2		21.3		10.8		5.44 J		19.9	
Zinc, Dissolved (µg/L)		8.56 J		11.7		9.41 J		6.25 J		5.94 J
Radiological Compounds										
Actinium-227 (GammaSpec) (pCi/L)	-7.17 U		-10.7 U		-11.2 U		-24.7 U		0.528 U	
Actinium-227, Dissolved (GammaSpec) (pCi/L)		-10.6 U		-11.4 U		-35.8 U		-24.3 U		-6.22 U
Americium-241 (GammaSpec) (pCi/L)	4.99 U		23.3 U		-3.09 U		9.53 U		-0.17 U	
Americium-241, Dissolved (GammaSpec) (pCi/L)		-2.15 U		-1.25 U		-19.7 U		-0.788 U		8.82 U
Cesium-137 (GammaSpec) (pCi/L)	-0.783 U		-1.52 U		0.567 U		-2.55 U		-0.367 U	
Cesium-137, Dissolved (GammaSpec) (pCi/L)		0.47 U		3.12 U		1.43 U		-0.541 U		0.0793 U
Cobalt-60 (GammaSpec) (pCi/L)	-0.222 U		2.65 U		-4.55 U		2.97 U		-0.325 U	
Cobalt-60, Dissolved (GammaSpec) (pCi/L)		-0.337 U		-1.4 U		-1 U		-0.453 U		0.556 U
Potassium-40 (GammaSpec) (pCi/L)	26.7 U		22.2 U		6.2 U		45.9 U		18.6 U	
Potassium-40, Dissolved (GammaSpec) (pCi/L)		27.2 U		14.7 U		2.86 U		0 U		-14.1 U
Protactinium-231 (GammaSpec) (pCi/L)	-78.9 U		-105 U		129 U		-38.6 U		13.6 U	
Protactinium-231, Dissolved (GammaSpec) (pCi/L)		17.4 U		-31.9 U		93.1 U		23.7 U		1.23 U

Table 3-36. IWCS Area Metal and Radiological Compound Monitoring Well Results

Station	MW935	MW935	MW936	MW936	MW938	MW938	MW941	MW941	MW943	MW943
Sample No	935GW0001-0119	935GW0001F-0120	936GW0001-0121	936GW0001F-0122	938GW0001-0123	938GW0001F-0124	941GW0001-0125	941GW0001F-0126	943GW0001-0127	943GW0001F-0128
Collection Date	01/16/10	01/27/10	01/13/10	01/13/10	01/14/10	01/14/10	01/13/10	01/15/10	12/22/09	12/22/09
Radium-226 (AlphaSpec) (pCi/L)	0.392		0.48		0.565		0.142 U		1.34	
Radium-226 (GammaSpec) (pCi/L)	22.7 U		41 U		48.1 U		4.22 U		22.1 U	
Radium-226, Dissolved (AlphaSpec) (pCi/L)		0.357 U		0.139 U		0.421		0.425		0.369 U
Radium-226, Dissolved (GammaSpec) (pCi/L)		25.6 U		-26.3 U		4.94 U		-25 U		3.11 U
Radium-228 (AlphaSpec) (pCi/L)	0.197 U		0.517 U		0.604 U		0.624		0.393 U	
Radium-228 (GammaSpec) (pCi/L)	-2.85 U		5.82 U		2.4 U		-6.06 U		-3.52 U	
Radium-228, Dissolved (AlphaSpec) (pCi/L)		0.585		0.369 U		-0.0439 U		0.172 U		0.194 U
Radium-228, Dissolved (GammaSpec) (pCi/L)		5.36 U		1.15 U		-8.25 U		-5.53 U		-2.66 U
Thorium-228 (AlphaSpec) (pCi/L)	0.0428 U		-0.0146 U		0.0153 U		0.0321 U		-0.00621 U	
Thorium-228 (GammaSpec) (pCi/L)	3.46 U		-1.1 U		0 U		0.565 U		0.799 U	
Thorium-228, Dissolved (AlphaSpec) (pCi/L)		-0.00969 U		-0.000964 U		-0.00101 U		0.012 U		-0.000985 U
Thorium-228, Dissolved (GammaSpec) (pCi/L)		0.0471 U		1.82 U		-1.71 U		1.09 U		-2.05 U
Thorium-230 (AlphaSpec) (pCi/L)	0.0111 U		0.0302 U		-0.00477 U		0.0484 U		0.017 U	
Thorium-230, Dissolved (AlphaSpec) (pCi/L)		0.025 U		0.046 U		0.067		0.0229 U		-0.015 U
Thorium-232 (AlphaSpec) (pCi/L)	0.0964		0.0364 U		-0.00097 U		0.0176 U		0.0634	
Thorium-232, Dissolved (AlphaSpec) (pCi/L)		0.0166 U		-0.00097 U		-0.00102 U		0.0234 U		-0.00604 U
Uranium-233/234 (AlphaSpec) (pCi/L)	12.6		20.9		9.4		4.08		8.23	
Uranium-233/234, Dissolved (AlphaSpec) (pCi/L)		13.1		15.3		15.4		4.22		8.79
Uranium-235 (GammaSpec) (pCi/L)	1.45 U		-16 U		5.95 U		-20.3 U		-4.88 U	
Uranium-235, Dissolved (GammaSpec) (pCi/L)		-9.75 U		-16 U		-14.5 U		1.84 U		-6.27 U
Uranium-235/236 (AlphaSpec) (pCi/L)	0.667		1		0.523		0.122		0.318	
Uranium-235/236, Dissolved (AlphaSpec) (pCi/L)		0.703		0.544		0.515		0.209		0.279
Uranium-238 (AlphaSpec) (pCi/L)	10.6		15.4		7.65		3.34		6.38	
Uranium-238 (GammaSpec) (pCi/L)	16.3 U		39.5 U		21.1 U		-467 U		59.4 U	
Uranium-238, Dissolved (AlphaSpec) (pCi/L)		11.8		11.4		12.3		3.16		6.96
Uranium-238, Dissolved (GammaSpec) (pCi/L)		98 U		66.2 U		-112 U		52.9 U		85.2 U

4.0 NATURE AND EXTENT OF GROUNDWATER CONTAMINATION

The nature and extent of groundwater contamination at the NFSS was re-evaluated using data obtained as part of the RIR Addendum sampling activities. A description of the sampling methodology along with analytical data results for the sampling was presented in Section 3 of this RIR Addendum. Groundwater plumes identified during previous phases of the RI have been re-examined using this newly obtained data. Details and results of this review are discussed in this section.

4.1 INTRODUCTION

The 2007 RIR (USACE 2007a) presented information concerning nature and extent of contaminants for NFSS areas based on EU designation and past use. Several areas of groundwater contamination with the potential for off-site migration and unacceptable human health risks were identified for some of these EU areas. To further investigate the nature and extent of groundwater contamination in these areas, additional groundwater sampling was performed as part of the RIR Addendum sampling activities. RIR Addendum groundwater sampling activities focused on addressing groundwater contamination in the three key areas noted below:

- *The Baker-Smith Area in EUs 1 and 2:* A plume with elevated concentrations of dissolved total uranium was found near the former Baker-Smith Area. RI data identified the potential for the presence of this plume off-site on the north side of EU 1.

- *The Acidification Area in EU 4:* Plumes with elevated concentrations of dissolved total uranium, boron, and chlorinated solvents (e.g., PCE and degradation products) were found in the Acidification Area. Data from the RI indicated the possible contribution of VOCs to groundwater from DNAPL at this location.

- *IWCS and Vicinity (EUs 7, 9, 10 and 11):* Plumes of dissolved uranium were found around the north and west sides of the IWCS and in the area south-southeast of the IWCS. RI data identified the potential for the presence of this plume off-site on the west side of the IWCS.

The nature and extent of groundwater contamination in these three areas has been re-evaluated using the additional sampling results obtained during the RIR Addendum sampling activities. Results of this re-evaluation are presented in this section for each of the three groundwater areas of interest noted above. Sample locations used to interpret groundwater plume configurations for this RIR Addendum are shown on Figure 4-1. Revised interpretations of the groundwater plumes in these three areas are presented in Figures 4-2 through 4-12. Concentrations observed at each of the sampling locations are shown on Figures 4-2 through 4-12 as appropriate. The methodology for development of the plume figures is explained in Section 4.1.2.

As explained later in this discussion (Section 4.3), elevated concentrations of chlorinated VOCs (PCE, TCE, DCE, and vinyl chloride) were identified in EU 4 groundwater, soil, and soil gas samples. While chemical contamination is normally addressed only when collocated with radioactive contamination under FUSRAP, the Corps will remediate both radioactive and chemical contamination because NFSS is a federally-owned property. Although the groundwater on the NFSS is not a source of drinking water, the presence of high levels of VOCs in the soil and groundwater could have the potential to pose an unacceptable risk to on-site personnel breathing the vapors near the source term. Contact with vapors from the groundwater source term would require disturbance of the subsurface materials, such as would be expected during construction or excavation work. Potential inhalation pathway risks were estimated

using a two part screening level approach that included modeling of VOC concentrations in groundwater for volatilization to ambient air and evaluation of vapor intrusion into a potential future building. Results of an evaluation of the potential inhalation risks from VOCs detected in EU 4 are presented following the discussion of nature and extent of groundwater in EU 4.

4.1.1 Definition of Groundwater Plumes at NFSS

For this re-evaluation of nature and extent, and as previously presented in the 2007 RIR (USACE 2007a), a groundwater plume is defined as a group of wells or groundwater samples in proximity to each other that exhibited groundwater concentrations of a given SRC that exceeded the associated background screening level [as defined by the upper tolerance limit (UTL)] or MCL. The background screening level and MCL represent benchmark criteria used to identify sampling results that exceed natural site concentrations and drinking water standards. VOC contaminated groundwater plumes were defined by identifying analyte concentrations that exceeded the MCL. Whereas, metal and radiologically contaminated groundwater plumes were defined by identifying analyte concentrations that exceeded the background level. Additionally, metal and radiological concentrations within a groundwater plume were compared to the MCL, if an MCL was available.

The contaminated groundwater areas at the NFSS exist within a zone of low permeable material containing small lenses of sand with lesser amounts of silt and clay, and occasional gravel. The sand lenses extend a few tens of feet laterally and only a few feet vertically. Groundwater flow at the site is directed primarily to the northwest through the low permeable material; however, there is very little groundwater flow in subsurface areas consisting mainly of clay where there are no sand lenses. Portions of the clay material often appear dry when sampled. Also, due to very slow groundwater recharge in some areas of the site, several wells and TWPs become dry during groundwater sampling procedures. This observance supports the conclusion that slow movement of groundwater occurs along migration pathways where sand lenses are not abundant or connected.

Downgradient migration of groundwater through a sand lens is likely to be relatively fast, while migration through a tight clay unit may be very slow or non-existent. Therefore, the configuration of contamination in groundwater at the NFSS may be quite irregular, rather than uniform, as depicted by a classic, uniform plume. For this reason, the interpretation of the extent of contamination at the NFSS using the concept of a classic, uniform plume is not warranted. However, for the purpose of evaluating constituents present in groundwater for the 2007 RIR and RI Addendum, contaminated groundwater areas at the NFSS were referred to as "plumes."

For the 2007 RIR, the plume maps were hand drawn, based upon field data and subsequent background screening. Several groundwater plumes were delineated using only two or three data points, which in some cases conservatively estimated the actual extent of groundwater contamination. This conservatism was used to account for uncertainty associated with the distribution of data points and to ensure that plume boundaries are not underestimated. The re-assessment of groundwater plumes presented in this document uses additional data collected from wells and temporary well points installed during field activities for the RIR Addendum. By using these additional data points, a more accurate interpretation of the groundwater plume configurations was developed to depict groundwater contamination at the NFSS. The re-assessment also considered non-RI related sampling results collected at the NFSS, including ESP data (see Appendix 4-A).

4.1.2 Methodology of Groundwater Plume Interpretation

The methodology for interpretation of nature and extent of groundwater contamination in this RIR Addendum is consistent with the methodology developed for the 2007 RIR (USACE 2007a). The basic premise of this methodology is repeated here for review, with changes or exceptions noted.

Groundwater plumes delineated and discussed in this section include those for dissolved uranium isotopes and dissolved total uranium in all three areas that were re-evaluated, as well as dissolved boron, PCE, TCE, cis-1,2-DCE, trans-1,2-DCE, and vinyl chloride in EU 4. Groundwater plumes for unfiltered total uranium were not generated since the filtered fraction of total uranium is comparable and therefore, an unfiltered total uranium plume map would mimic the currently available filtered total uranium plume map. To illustrate the difference between dissolved uranium plume configurations developed for the 2007 RIR and the RIR Addendum, both plume configurations are shown on Figures 4-2 through 4-5. However, only updated plume configurations are shown for the boron and organic plumes in EU 4. Data used to interpret the plume configurations are included in a table on each of the plume figures.

Only groundwater data collected for the RI were used to interpret groundwater plume contours. However, USACE did conduct a qualitative evaluation of other non-RI related data collected at the site in groundwater plume areas (see Figures 4-2 through 4-12) to assess if this additional data would have a significant impact on the interpretation of plume contours. This additional data, which are primarily associated with the ESP, are presented in Appendix 4-A. The qualitative assessment of the groundwater plumes using ESP data confirmed that the ESP groundwater data is not significantly different than the RI groundwater data. Therefore, no adjustments to the groundwater plume contours were necessary.

Figures 4-2, 4-3, and 4-4 illustrate groundwater plume configurations for isotopic uranium including uranium -234, uranium-235, and uranium-238, respectively. Figure 4-5 illustrates the groundwater plume configurations for dissolved total uranium, which accounts for the presence of all of the uranium isotopes in groundwater. Because Figure 4-5 shows a complete interpretation of total uranium in groundwater at the NFSS and because the isotopic uranium plume configurations are, in general, consistent with the total uranium plume configurations, Figure 4-5 was used as the focus of the discussions presented in this section.

Figure 4-6 superimposes areas of historical contamination over the dissolved total uranium groundwater plumes identified in the UWBZ during the RI. These areas of historical contamination were identified in a 1981 characterization report for the NFSS (see Figure 5-2 of Battelle 1981). Areas of historical contamination were identified using beta-gamma instrumental surveys verified by analytical screening methods. Figure 4-6 illustrates that areas of historical contamination generally correspond to areas of radiological contamination in UWBZ groundwater as determined during the RI.

For metal and radionuclide plumes depicted in Figures 4-2 through 4-7, only the dissolved concentrations were used to define isoconcentrations (i.e., lines of equal concentration). During the RI and RIR Addendum sampling activities, samples for dissolved analyses were filtered in the field at the time of collection, removing much of the turbidity that may be present in the groundwater. Dissolved concentrations were also used to define plumes because portions of a constituent in an unfiltered sample can be sorbed onto particulate matter rather than be dissolved in the groundwater. Hence, dissolved fractions of constituents are likely to be more mobile in groundwater than non-dissolved fractions.

During development of plume figures for the 2007 RIR, water samples collected from subsurface utilities, including manholes and pipelines, were used to interpret plume configuration as a measure of conservatism since the potential existed for manholes and pipelines to be in direct contact with the groundwater. Additionally, it was also thought that bedding material was likely placed adjacent to the

pipelines when they were installed. If so, the conductive nature of the bedding material could have served to increase flow of groundwater around the pipelines. Recent review of pipeline installation details have revealed that bedding material was typically not used during pipeline installations. Results of the LOOW UURI indicated that the large, 42-inch diameter water supply line that transported water from the Niagara River to the LOOW freshwater treatment facility (formerly on the current NFSS property) was not underlain by bedding material. The LOOW UURI indicated that in general, LOOW pipelines did not appear to have bedding material, and many were encased in concrete (USACE 2008a). Additionally, the pipelines were capped or plugged with concrete (EA 2006). Also, there is no evidence to assume that manholes and pipelines are in constant contact with groundwater. Therefore, using water sampling results collected from manholes and pipelines to interpret plume configuration is now believed to be an overly conservative approach that inaccurately characterizes site groundwater conditions and results in a misrepresentation of the nature and extent of groundwater contamination at the NFSS. Thus, water collected from subsurface manholes and pipelines has been excluded from development of groundwater plume configuration for this RIR Addendum. Soil and groundwater contamination within pipelines will be addressed in the Feasibility Studies for the Balance of Plant (BOP) and Groundwater Operable Units (OUs). Furthermore, the Corps will conduct additional field activities to address BOP data gaps, such as the integrity of the underground utility lines.

For the 2007 RIR, the dissolved total uranium plume configuration was developed using laboratory reported concentrations in micrograms per liter (µg/L). Laboratory results for dissolved total uranium were not obtained during the RIR Addendum sampling activities, although radionuclide activities were obtained for the dissolved fraction for the individual uranium isotopes, including uranium-234, uranium-235 and uranium-238. To incorporate the RIR Addendum analytical results in the dissolved total uranium plume evaluation, the individual isotopic activities obtained from a particular groundwater sample were converted to a dissolved total uranium concentration in micrograms per liter using the following steps (Turner 1986).

First, each uranium isotopic activity reported in pCi/L is converted to a concentration in µg/L using the isotopic specific activity.

$$\frac{Isotopic\ Activity\ (pCi/L)}{Specific\ Activity\ (pCi/g)} \times 10^6 = Isotopic\ Concentration\ (\mu g/L)$$

Then, the individual isotopic activities are summed, resulting in a total uranium concentration in µg/L.

$$\sum C_{234} + C_{235} + C_{238} = Total\ Uranium\ Concentration\ (\mu g/L)$$

Where:

C_{234} = Uranium-234 concentration in µg/L
C_{235} = Uranium-235 concentration in µg/L
C_{238} = Uranium-238 concentration in µg/L

The following discussion presents a complete example of the methodology used to calculate the concentration of total dissolved uranium in water using the dissolved alpha spectroscopy isotopic uranium concentrations provided by the laboratory. Analytical values in the example below represent results for groundwater sample 921GW0001F-0110 from monitoring well MW921.

Isotopic specific activities obtained from the laboratory are as follows:

Isotope	Specific Activity (Ci/g)
Uranium-234	6.20E-03
Uranium-235	2.20E-06
Uranium-238	3.30E-07

Using the isotopic uranium data above, the equation to determine total uranium concentration (µg/L) is as follows:

$$\sum\left(\frac{Isotopic\ Concentration\left(\frac{pCi}{L}\right)}{\left(Isotopic\ Specific\ Activity\left(\frac{Ci}{g}\right)\times 1.00E12\left(\frac{pCi}{Ci}\right)\right)}\right)\times 1.00E06\left(\frac{\mu g}{g}\right)=Total\ U\left(\frac{\mu g}{L}\right)$$

Note: A conversion factor of 1.00E+12 pCi/Ci is applied to convert from Ci/g to pCi/g
A conversion factor of 1.00E+06 µg/g is applied to convert g to µg.

Using the equation above, an example for groundwater sample 921GW0001F-0110 from monitoring well MW921 is given below:

Isotope	Specific Activity (Ci/g)	Specific Activity (pCi/g)	AlphaSpec Concentration (pCi/L)	Concentration (g/L)	Concentration (µg/L)
Uranium-234	6.20E-03	6.20E+09	15.6	2.52E-09	2.52E-03
Uranium-235	2.20E-06	2.20E+06	0.515	2.34E-07	2.34E-01
Uranium-238	3.30E-07	3.30E+05	12.3	3.73E-05	3.73E+01
				Total Uranium	**37.51**

Table 4-1 presents the calculated dissolved total uranium results from monitoring wells and temporary well points installed during the RIR Addendum field work: These total uranium concentrations are later presented on Figure 4-5, which is discussed in Section 4.2.

4.2 NATURE AND EXTENT OF CONTAMINANTS IN GROUNDWATER WITHIN THE BAKER-SMITH AREA (EU 1)

Findings of RI Phases 1 through 3 indicated the presence of a dissolved total uranium plume that extends from the west-central portion of EU 2 through the northwest portion of EU 1. The source of this uranium plume is related to the radioactive wastes once stored in the Baker-Smith Area. During the operation of the LOOW, a pipe shop, machine shop, welding shop, and a store house were located in the Baker-Smith Area near a former rail line that ran roughly parallel to the West Patrol Road. In 1943, under direction of the MED, wooden barrels containing L-30 residues from the Linde Air Products refinery were transported to the LOOW and temporarily stored in structures in the Baker-Smith Area. The warehouses used to store the L-30 residues were likely Buildings 443, 444, and 445. The L-30 residues were later placed in Building 411 (Aerospace Corporation 1982). During operation of the NFSS by AEC, K-65 and Knolls Atomic Power Laboratory (KAPL) residues were stored in buildings located in the Baker-Smith Area. The KAPL residues were later transferred to Oak Ridge National Laboratory (ORNL) and the K-65 residues were moved to a silo in EU 6.

Results of a comprehensive characterization and hazard assessment completed in 1981 (Battelle 1981) indicated the presence of superficial radiological contamination in a small area near two small concrete pads. A remedial action was performed in the Baker-Smith Area in 1981 to remove contaminated materials identified as exceeding the United States Department of Energy (DOE) cleanup standards during the characterization effort.

Re-evaluation of the dissolved total uranium plume based on results of the RIR Addendum fieldwork indicates that the north-south width of the plume is more constrained than originally presented in the 2007 RIR. The uranium plume is bounded by groundwater samples collected at TWP924 and TWP925 with uranium concentrations below UTLs. Measured dissolved total uranium concentrations within the plume (i.e. exceeds the UTL of 16.7 µg/L) in the EU 1 area range from 25.2 µg/L to 47.2 µg/L. RIR Addendum sampling results confirm that dissolved uranium in groundwater is present to the north of EU 1 at concentrations greater than the MCL (30 µg/L). The dissolved total uranium concentration measured off-site just to the north of EU 1 is 37.51 µg/L. Groundwater modeling results indicate that groundwater contamination is not migrating (laterally) and that the groundwater plumes at the NFSS are horizontally static, essentially maintaining an equilibrium condition of adsorption with slow advective flow following removal of most ground surface source terms (USACE 2011). Figures 4-2 through 4-5 illustrate updated sitewide groundwater plume configurations for dissolved uranium-234, dissolved uranium-235, dissolved uranium-238, and dissolved total uranium, respectively. RIR Addendum sampling results have been incorporated into the updated plume configurations using the definitions and methodology described in Sections 4.1.1 and 4.1.2. The dissolved uranium plume configurations in the Baker-Smith Area can be seen in the northwest corner of the site in the west portion of EU 2 and extending along the north side of EU 1 (Figures 4-2 through 4-5).

To investigate possible sources for the total uranium groundwater plume, concentrations of total uranium in surface and subsurface soil sampling results collected from within the plume extent were examined. RI and RI Addendum sampling results indicated a maximum concentration of 5.29 µg/g at location TWP922 for total uranium in surface soil. This concentration is slightly greater than the background concentration of 3.94 µg/g. Locations 5A019 and EU014 exhibited total uranium concentrations of 4.12 µg/g and 3.95 µg/g in subsurface soil, respectively; these concentrations slightly exceed the background concentration of 3.58 µg/g. No other subsurface soil samples from within the plume exhibited total uranium concentrations greater than the background concentration. Most radionuclide concentrations in soil in EU 1 that exceeded background concentrations were observed at depths of less than 2 ft and were concentrated in the area immediately south of the defined groundwater plume near former building foundations. The maximum total uranium concentration in surface soil in this area was observed at location 503 at a concentration of 366 µg/g; however all other concentrations of total uranium in surface soil in this area were less than 28 µg/g. The maximum concentration of total uranium in subsurface soil near the perimeter of the plume was observed at location TB501_03, also located south of the re-evaluated groundwater plume, at a concentration of 18.2 µg/g at a depth of 2.7 ft bgs. These concentrations of uranium observed above background levels in EU 1 soils could potentially contribute to groundwater contamination over time.

Although it is evident that some radiological constituents are still present in the surface and subsurface soil in EU 1, there does not appear to be any significant soil contamination within the plume extent that can account for radionuclide concentrations observed in groundwater. A review of site operational information and environmental investigative data indicate that groundwater contamination in this area is the result of historic site operations and past waste storage practices used in the Baker-Smith Area. Most of the soil contamination that contributed to current groundwater contamination was removed during the remedial efforts performed by the DOE in 1981.

In July 2009, during sampling of the former LOOW Waste Water Treatment Plant (WWTP) conducted as part of the LOOW Phase IV Remedial Investigation, the Corps collected three (3) unfiltered FUSRAP groundwater split samples from shallow (to depths of 22.5 ft bgs) groundwater-monitoring wells installed hydraulically downgradient of former WWTP structures. The samples were analyzed for uranium. This supplemental radiological sampling was an attempt to better delineate the extent of the uranium contamination in groundwater extending from the Baker Smith Area on NFSS (i.e., EU 1) to the off-site Town of Lewiston property (i.e. the former LOOW WWTP). As stated above, during the RIR Addendum, dissolved total uranium was detected in groundwater along the northwest NFSS boundary at a concentration of 37.51 µg/L. Since uranium was detected in groundwater above the background level and slightly above the uranium safe drinking water standard (MCL), three hydraulically downgradient LOOW monitoring wells were sampled to determine the off-site extent of this uranium plume. Uranium in LOOW wells MW-BP-15 and MW-BP-16 were less than 1 pCi/L above background and well below the safe drinking water standard. Uranium in well MW-BP-14 was below the background level. Based upon this information, it can be inferred that uranium contamination in groundwater is bounded to within the Town of Lewiston (former LOOW WWTP) property where groundwater is not a source of drinking water. Measures are underway to restrict public access to this area.

4.3 NATURE AND EXTENT OF CONTAMINANTS IN GROUNDWATER WITHIN THE ACID AREA (EU 4)

During the operation of the LOOW, nitric acid and other materials related to the manufacture of TNT were stored in the acid area in EU 4. During the 1950s, uranium rods were stored in buildings formerly located near the boundary between EUs 3 and 4. These buildings were decontaminated and demolished in 1986 (USACE 2007a). As part of the RIR Addendum activities, the nature and extent of dissolved uranium, boron and VOC contaminated groundwater plumes previously identified in EU 4 were further evaluated.

4.3.1 Radiological Groundwater Plumes

Two small UWBZ groundwater areas exhibiting concentrations of dissolved total uranium greater than the UTL (16.7 µg/L) and MCL (30 µg/L) are present in the central and north-central portions of EU 4 (Figure 4-5). The distribution of dissolved uranium isotopes in these two areas is illustrated in Figures 4-2 through 4-4. The maximum concentration of dissolved total uranium in these two areas is 36.69 µg/L and is located north of the storm sewer line near the western portion of the northern plume (MW934). Surface and subsurface (depth of 18 ft bgs) soil samples collected at this downgradient location exhibited total uranium concentrations of 2.02 µg/g and 1.77 µg/g, respectively; these concentrations are less than corresponding soil background concentrations. One location outside of the plume, TWP928, along the southern edge of the northern plume, exhibited a total uranium concentration of 4.23 µg/g in surface soil, which is slightly greater than the surface soil background concentration of 3.94 µg/g. Two other soil samples collected near the eastern edge of the northern plume exhibited total uranium concentrations slightly greater than the background concentration; a surface soil sample at 4D017 (3.97 µg/g) and a subsurface soil at TB406_02 (5.75 µg/g at a depth of 2 ft bgs). No other soil sample results collected within or immediately adjacent to the two plume boundaries exhibit total uranium concentrations greater than background concentrations in surface or subsurface soil.

Therefore, a review of radiological soil and groundwater data in EU 4 indicates that observed soil concentrations do not appear to represent a source for current groundwater concentrations within the plume boundaries. Available site operational information and environmental investigative data indicate that groundwater contamination in this area is the result of historic site operations and past waste storage practices. Most of the soil contamination that contributed to the current groundwater contamination was removed during the remedial efforts performed by the DOE in the 1980s.

The northwestern portion of this plume in the downgradient groundwater flow direction is not bounded by any sample results. Two groundwater samples collected immediately north-northeast of this plume indicate that dissolved total uranium concentrations are less than the MCL in this area. Groundwater modeling results indicate that groundwater contamination is not migrating (laterally) and that the groundwater plumes at the NFSS are horizontally static, essentially maintaining an equilibrium condition of adsorption with slow advective flow following removal of most ground surface source terms by DOE (USACE 2011). Additionally, off-site exposure to this plume is unlikely because the groundwater is not used as a source of drinking water and Chemical Waste Management (CWM) Chemical Services is located downgradient of this plume where public access is restricted.

During the RIR Addendum effort, investigation of known VOC and radiological contamination was the focus of sampling in EU 4. The dissolved total uranium plume located along the northern portion of EU 4 was identified during recent RIR Addendum sampling efforts. The scope of the RIR Addendum at the time of sampling did not include provisions for bounding this newly identified area of radiological contamination. Additional investigation of the uranium plume in this area may be warranted. Possible future sampling of this area has yet to be defined by the Corps. During the BOP FS, the Corps will conduct additional field activities to address BOP data gaps.

4.3.2 Boron Groundwater Plume

During previous phases of the RI, a boron plume was identified within the UWBZ in the central portion of EU 4. Figure 4-7 illustrates the updated interpretation of this plume configuration. The maximum concentration of dissolved boron in this plume is 29,200 µg/L and was collected from RIR Addendum temporary well point TWP932. Wells 415 and 415A, sampled during previous phases of the RI, also exhibited two of the highest concentrations of dissolved boron in this plume. This dissolved boron plume is bounded to the north by several sample locations that exhibit dissolved boron concentrations below the background level of 4,750 µg/L, indicating that this plume is not currently migrating off-site. Furthermore, groundwater flow and transport modeling indicates that the existing boron plume in EU 4 will exhibit little dispersion over the next 10,000 years and is not expected to exceed screening levels at the property boundary (USACE 2011).

4.3.3 Volatile Organic Groundwater Plume

During Phases 1, 2 and 3 of the RI, a southeast to northwest trending volatile organic contaminant plume was identified in EU 4 within the UWBZ at a depth of 10 to 15 ft bgs. This plume contains PCE and its degradation products: TCE; cis-1,2-DCE; trans-1,2-DCE; and vinyl chloride. As noted in Section 5.3.3 of the 2007 RIR, there are no known past uses in this EU that would account for the presence of VOCs in groundwater. Although the source of the VOCs was not established, their presence may be due to past storage activities of the military and AEC. The current distribution of these VOCs in EU 4 groundwater is shown in Figures 4-8 through 4-12.

The source of the organic plume in EU 4 appears to be near wells MW415, MW415A, MW930 and TWP933. Groundwater was collected and analyzed from wells MW415 and MW415A during previous phases of the RI, while locations MW930 and TWP933 were sampled during RIR Addendum field activities. Locations MW930 and TWP933 contained visible DNAPL during sampling. Concentrations of PCE and TCE at location MW930 were 114,000 µg/L and 12,500 µg/L, respectively. Concentrations of PCE and TCE at location TWP933 were 134,000,000 µg/L and 9,500,000 µg/L, respectively. These concentrations observed at TWP933 exceed the solubility limits for PCE (150 mg/L) and TCE (1,280 mg/L).

PCE and its degradation products are present in both surface and subsurface soil within the boundary of the VOC groundwater plume. Four sampling locations consistently exhibit greater concentrations of these VOCs than other plume sampling locations: 415, TWP928, TWP930 (converted to MW930), and TWP933. Sampling locations 415 and TWP933 are near the DNAPL source area of the plume, while TWP930 and TWP928 are located downgradient of the DNAPL source area. PCE concentrations at these locations range from 12,400 µg/kg at 415 to 75,600 µg/kg at TWP930 at depths greater than 10 ft bgs. TCE concentrations in subsurface soil at these four locations range from 679 µg/kg at TWP928 to 3,050 µg/kg at 415. Therefore, the soil and groundwater data in EU 4 indicate that in addition to a DNAPL source, VOC contamination within subsurface soil is contributing to observed VOC groundwater concentrations.

Note that cis-1,2-DCE; trans-1,2-DCE; and vinyl chloride were not-detected in TWP933 groundwater due to elevated detection limits associated with the presence of DNAPL in the analyzed groundwater sample. Due to the high detection limits associated with these results, it cannot be assumed that cis-1,2-DCE; trans-1,2-DCE; or vinyl chloride are not present in the groundwater at this location. However, the presence of cis-1,2-DCE in subsurface soil (10 to 12 ft bgs) at a concentration of 251 µg/kg and the presence of vinyl chloride in a soil gas sample at a concentration of 78,000 $\mu g/m^3$ suggests TWP933 should be incorporated into the organic plume. Likewise, vinyl chloride could not be quantified in the groundwater sample collected at MW930 due to elevated detection limits associated with the presence of DNAPL. The groundwater plumes for cis-1,2-DCE and trans-1,2-DCE were developed using estimated values for these two VOCs at TWP933, as described below. Additionally, the groundwater plume for vinyl chloride was developed using estimated values for this VOC at TWP933 and MW930.

4.3.3.1 Estimation of cis-1,2-DCE in TWP933 Groundwater

The VOC, cis-1,2-DCE. was identified as a non-detect in TWP933 groundwater with a detection limit of 10,000,000 µg/L. Due to the high detection limit associated with this result, it cannot be assumed that cis-1,2-DCE is not present in the groundwater. Weights of evidence were reviewed to estimate what the actual cis-1,2-DCE concentration in TWP933 groundwater may have been if the detection limit was much lower.

A cis-1,2-DCE concentration of 251 µg/kg in the co-located subsurface soil sample (10-12 ft bgs) suggests that TWP933 should be incorporated into the groundwater plume (see Figure 4-10). Additionally, the PCE and TCE detections in groundwater at TWP933 are 134,000,000 and 9,500,000 µg/L, respectively, indicating that their decay product, cis-1,2-DCE, is very likely present in groundwater at this location.

To better estimate what the actual cis-1,2-DCE concentration in TWP933 groundwater may be, nearby groundwater location 415A was used for comparison. Since PCE and TCE concentrations from TWP933 groundwater (134,000,000 and 9,500,000 µg/L, respectively) are higher than PCE and TCE concentrations from 415A groundwater (103,000 and 21,200 µg/L, respectively), it was assumed that the cis-1,2-DCE concentration in TWP933groundwater would also be greater than that for 415A groundwater (14,800 µg/L). Therefore, the concentration of cis-1,2-DCE in TWP933 groundwater was assumed to be greater than 14,800 µg/L and TWP933 was incorporated into the "greater than 10,000 µg/L" isopleth of the cis-1,2-DCE groundwater plume depicted in Figure 4-10.

4.3.3.2 Estimation of trans-1,2-DCE in TWP933 Groundwater

The VOC, trans-1,2-DCE, was identified as a non-detect in TWP933 groundwater with a detection limit of 10,000,000 µg/L. Due to the high detection limit associated with this result, it cannot be assumed that trans-1,2-DCE is not present in the groundwater. Weights of evidence were reviewed to estimate what

the actual trans-1,2-DCE concentration in TWP933 groundwater may have been if the detection limit was much lower.

The PCE and TCE detections in groundwater at TWP933 are 134,000,000 and 9,500,000 µg/L, respectively, indicating that their decay product, trans-1,2-DCE, is very likely present in groundwater at this location.

To better estimate what the actual trans-1,2-DCE concentration in TWP933 groundwater may be, nearby groundwater location 415A was used for comparison. Since PCE and TCE concentrations from TWP933 groundwater (134,000,000 and 9,500,000 µg/L, respectively) are higher than PCE and TCE concentrations from 415A groundwater (103,000 and 21,200 µg/L, respectively), it was assumed that the trans-1,2-DCE concentration in TWP933 groundwater would also be greater than that for 415A groundwater (115 µg/L). Therefore, the concentration of trans-1,2-DCE in TWP933 groundwater was assumed to be greater than 115 µg/L and TWP933 was incorporated into the "greater than 100 µg/L" isopleth of the trans-1,2-DCE groundwater plume depicted in Figure 4-11.

4.3.3.3 Estimation of Vinyl Chloride in MW930 and TWP933 Groundwater

Vinyl chloride was identified as a non-detect in MW930 and TWP933 groundwater with detection limits of 1,000 µg/L and 10,000,000 µg/L, respectively. Due to the high detection limits associated with these results, it cannot be assumed that vinyl chloride is not present in the groundwater at these locations. Weights of evidence were reviewed to estimate what the actual vinyl chloride concentrations in MW930 and TWP933 groundwater may have been if the detection limits were much lower.

A vinyl chloride concentration of 78,000 µg/m^3 in the co-located soil gas sample suggests that TWP933 should be incorporated into the groundwater plume (see Figure 4-12). Additionally, the PCE and TCE detections in groundwater at MW930 (64,200 and 9,860 µg/L, respectively) and TWP933 (134,000,000 and 9,500,000 µg/L, respectively) indicate that their decay product, vinyl chloride, is very likely present in groundwater at these locations.

To better estimate what the actual vinyl chloride concentrations in MW930 and TWP933 groundwater may be, nearby groundwater location 415A was used for comparison. Since PCE and TCE concentrations from TWP933 groundwater (134,000,000 and 9,500,000 µg/L, respectively) are higher than PCE and TCE concentrations from 415A groundwater (103,000 and 21,200 µg/L, respectively), it was assumed that the vinyl chloride concentration in TWP933 groundwater would also be greater than that for 415A groundwater (1,760 µg/L). Therefore, the concentration of vinyl chloride in TWP933 groundwater was assumed to be greater than 1,760 µg/L and TWP933 was incorporated into the "greater than 1,000 µg/L" isopleth of the vinyl chloride groundwater plume depicted in Figure 4-12.

Since PCE and TCE concentrations from MW930 groundwater (64,200 and 9,860 µg/L, respectively) are approximately half of the PCE and TCE concentrations from 415A groundwater (103,000 and 21,200 µg/L, respectively), it was assumed that the vinyl chloride concentration in MW930 groundwater would also be approximately half that for 415A groundwater (1,760 µg/L). Therefore, the concentration of vinyl chloride in MW930 groundwater was assumed to be approximately half of 1,760 µg/L, and MW930 was incorporated into the "100-1,000 µg/L" isopleth of the vinyl chloride groundwater plume depicted in Figure 4-12.

4.3.3.4 Extent of Volatile Organic Groundwater Plume

The downgradient extent of the organic plume appears to be near sample location TWP928, where a PCE concentration of 2,380 µg/L was observed. TWP928 is situated within 150 ft of the northern property

boundary. This VOC groundwater plume is currently bounded on-site to the north and west by wells showing either dry conditions (TWP929) or no detections of VOCs (MW934, 411 and 411A).

According to the latest groundwater modeling results, only minor dispersion of this VOC plume is predicted over time, and despite the increased presence of sand lenses within EU 4, the plume is not predicted to extend off-site (UASCE 2011). Furthermore, the maximum on-site concentrations of PCE, TCE, cis-1,2-DCE, and vinyl chloride in the Brown Clay Till are all expected to biodegrade to concentrations below their respective screening level values within 300 years.

As a conservative measure and to account for the presence of DNAPL, the latest groundwater model also considers a fixed concentration or a continuous source of DNAPL for a 10,000 year simulation period, assuming that the DNAPL plume covers the area currently defined by the highest detected concentrations of PCE, TCE, and vinyl chloride. The results of the modeling showed that the chlorinated solvent plume reaches steady-state conditions after approximately 350 years and does not extend off-site (USACE 2011).

The Corps currently monitors the VOC plume through the Environmental Surveillance Program by collecting semi-annual groundwater samples for VOC analysis from bounding wells MW934 and 411A. It is important to note that groundwater is not used as a source of drinking water and CWM Chemical Services property is located downgradient of this plume where public access is restricted. The BOP FS will address the remedial alternatives for PCE and its degradation products present in EU 4 soil. Furthermore, the Corps will conduct additional field activities to address data gaps in support of the BOP FS, as warranted.

4.3.4 Evaluation of Potential Inhalation Risks from VOCs Sampled in EU 4 Groundwater and Soil Gas

Elevated concentrations of chlorinated VOCs (PCE, TCE, DCE, and vinyl chloride) were identified in EU 4 groundwater, soil and soil gas samples. Although the groundwater on the NFSS is not a source of drinking water, the presence of high levels of VOCs in the soil and groundwater could have the potential to pose an unacceptable risk to on-site personnel breathing the vapors near the source term, especially since a DNAPL was identified in EU 4 during the RIR Addendum sampling. Contact with vapors from the groundwater source term would require disturbance of the subsurface materials, such contact would be expected during construction or excavation work. An identification of unacceptable risk for potential future receptors would be considered in the development of remedial action objectives for EU 4 during the FS.

These potential inhalation pathway risks were estimated using a two part screening level approach. In the first part of the screening level risk assessment, concentrations of groundwater VOCs were modeled for volatilization to ambient air and compared to EPA and New York State screening and guideline levels for air concentrations. The second part of the screening level approach used soil gas sampling results to consider the potential for soil gas to impact a potential building as a result of vapor intrusion into the building. Soil gas concentrations were compared to New York State decision matrix action levels for vapor intrusion evaluations (NYSDOH 2006).

Modeling of volatilization of groundwater VOCs to ambient air was performed using the same method presented in the HHRA for the LOOW (USACE 2008b). As presented in Section 2.2.3.2 of the LOOW HHRA, the exposure point concentration (EPC) for contaminant concentrations in ambient air was determined from guidance provided in ASTM *Standard Guide for Risk-Based Corrective Action Applied at Petroleum Release Sites*, E 1739-95 (2002). The equation used for determining the ambient air concentration of VOCs from groundwater is:

$$C_{air} = Vf_{warnb} \times GW_{conc}$$

where:

C_{air} = Air concentration of VOCs (mg/m^3)
Vf_{warnb} = Volatilization factor groundwater to ambient outdoor vapors (mg/m^3)/(mg/L)
GW_{conc} = Concentration of contaminant in groundwater (mg/L)

The Vf_{warnb} is calculated based on contaminant-specific parameters. Groundwater VOC EPCs were determined with the use of the ProUCL software (Singh and Nocerino 2007). As recommended by the guidelines developed for using ProUCL, values for the 95th upper confidence limit (UCL) on the mean of the VOC censured data sets were used as groundwater EPCs. Detailed ambient air calculations for each VOC using these groundwater EPCs are provided in Appendix 4-B.

Results of the ambient air modeling and comparison of estimated ambient air concentrations to EPA and New York State screening and guideline levels are presented in Table 4-2. The estimated ambient air concentrations of both PCE and TCE are greater than EPA regional screening levels for a residential setting. The estimated ambient air concentration of PCE is also greater than its EPA screening level for an industrial setting. New York State air guideline levels are not exceeded for any VOC estimated air concentration.

The second part of the screening level approach considered the potential for soil gas to impact a potential building as a result of vapor intrusion into the building. Soil gas concentrations were compared to New York State decision matrix action levels for vapor intrusion evaluations (NYSDOH 2006). In Section 3.4 of New York State's *Guidance for Evaluating Soil Vapor Intrusion*, decision matrices are presented for determining appropriate action after evaluating the results of both soil gas (sub-slab vapor) and indoor air samples. Although no buildings are currently located within EU 4 of NFSS in the vicinity of the VOC groundwater plume, use of the vapor intrusion guidance may give some indication of the magnitude of any potential vapor intrusion if a building were to be built at that location. The two sides of the matrices present a range of potential indoor air concentrations and a range of sub-slab vapor concentrations. The resulting proposed actions range from no further action, to further sampling to better define the problem, to monitoring the identified vapor intrusion problem, to finally, mitigation. The soil gas samples obtained from TWP933 had concentrations of PCE and TCE in the highest range of concentrations presented in these decision matrices (over 250 $\mu g/m^3$ for TCE and over 1,000 $\mu g/m^3$ for PCE) (see Table 4-3). The decision matrices indicated that when sub-slab vapor concentrations were in the highest range presented, regardless of the corresponding indoor air sample concentrations, mitigation is the recommended action. This is an indication that sub-sample vapor results in the range detected in TWP933 have a high potential to have a negative impact on indoor air quality if a future building were to be built in that vicinity.

The screening methods used to evaluate risk due to the inhalation of VOCs indicate that the presence of VOCs in groundwater at EU4 has the potential to impact human health in an industrial setting or as the result of vapor intrusion into a building. However, both of the methods used include a high degree of uncertainty. Estimation of ambient air concentrations requires assumptions regarding ambient air mixing zone height, wind speed and effective diffusion between soil and groundwater. Details regarding these calculations are provided in Appendix 4-B. The screening for potential soil gas to impact to a building requires an assumption be made regarding a hypothetical building in the EU4 area, which currently does not exist.

In conclusion, groundwater and soil gas sampling results indicate that the presence of VOCs in groundwater has the potential to impact human health in an industrial setting, in either the presence or absence of a future building. Since this potential health impact is via the inhalation pathway, it could

occur even if the site groundwater is not used as a drinking water source. Exposure to VOCs in groundwater through inhalation is currently a potential risk only to on-site personnel, not to off-site receptors. The Corps is mitigating this potential risk by limiting access to this area of the NFSS until a long-term remedy is in place. As stated previously, the BOP FS will address the remedial alternatives for PCE and its degradation products present in EU 4 soil. Should data gaps be identified for this investigative area, the Corps will conduct additional field activities to address the data gaps in support of the BOP FS.

4.4 NATURE AND EXTENT OF CONTAMINANTS IN GROUNDWATER NEAR THE IWCS (EUS 7, 9, 10, AND 11)

For this RIR Addendum, the nature and extent of groundwater contamination in areas surrounding the IWCS were re-examined. This area includes EU 10, portions of EU 7 to the north, EU 9 to the west, and EU 11 to the south and east. The predominant feature in EU 10 is the IWCS. Prior to the construction of the IWCS, the LOOW freshwater treatment plant was located at the southern end of the EU. The Middlesex Sands, F-32, L-30, L-50, and K-65 residues are currently stored in the remnants of the freshwater treatment plant, which are now contained in the IWCS. Likewise, the R-10 pile, formerly unprotected and stored in the open for 36 years (from 1946 through 1982), north of the freshwater treatment plant, is also contained in the IWCS. Former Building 409, located south of the IWCS, was used for the storage of uranium scrap metals.

EU 7 is a large grassy area north of the IWCS; no buildings currently exist in this EU. During the remedial actions of the 1980s, several large temporary ponds, principally used for the management and storage of stormwater, were located in this area. EU 7 is also the location of the former DOE Organic Burial Area. Materials known to have been disposed in the area included roofing timbers, wooden debris, and organic material from clearing activities (BNI 1984 and BNI 1985). During the operation of the LOOW, a fire house was located in the central portion of EU 11 and a parking lot was located in the southern portion. Later, during the remedial actions of the 1980s, several temporary ponds used to hold treated slurry water, decontamination water, and stormwater prior to release were located here.

4.4.1 Potential Sources of Contamination

Findings of the RI indicate the presence of several dissolved total uranium groundwater plumes in the UWBZ on all sides of the IWCS. The uranium groundwater plumes may be associated with past AEC construction activities. Additionally, the slurry ponds that were used during dewatering of the residues may have contributed to the northern and northeastern groundwater plumes.

The most probable source of the contaminated groundwater to the north and west of the IWCS is storage of the R-10 residues. The R-10 residue was shipped to NFSS in 1946 from the Linde Ceramic Plant in Tonawanda, New York and placed on the ground north of Building 411. Erosion of the R-10 pile due to weather was documented as early as 1947. Between 1955 and 1958, nearly 1,300 acres of off-site properties (vicinity properties) were remediated by the DOE and placed atop the R-10 pile. The R-10 and contaminated soil pile remained unprotected (open to the elements) until the mid 1960s when the R-10 pile was covered with dirt and seeded to provide a grass covered sod layer. In 1972, nearly 20,000 yd^3 of contaminated soil and debris from previously owned land was transported to the NFSS and placed on top of the R-10 pile. In 1980, it was observed that the R-10 pile consisted of one large continuous pile of contaminated soils and airborne migration (or dispersion of contaminated soils via wind to adjacent areas) may have caused contamination to the area west of the R-10 pile. Site characterization efforts performed in 1981 indicated that the R-10 area had been fairly unstable, eroding east to the Central Drainage Ditch and eroding onto the area west of the site and into the WDD (Battelle 1981). In 1981, soil from a vicinity property found to be radioactively contaminated was excavated and placed on the NFSS with the R-10

pile. In 1982, a dike and cutoff wall were constructed for the R-10 pile area and the R-10 pile was covered with an ethylene propylene diene monomer (EPDM) liner. Therefore, the R-10 pile and general contaminated soils from vicinity properties were left open to the elements from 1946 through 1982 (36 years). The R-10 pile is now located inside the IWCS, along with other residues and wastes. The current configuration of uranium groundwater contamination to the north and west of the IWCS shown on the Figures 4-2 through 4-5 mimics historically contaminated areas associated with past waste storage, surface runoff, and airborne migration (see Figure 4-6). Figure 4-6 highlights "areas of known contamination" in 1981 that closely resemble total uranium contamination in groundwater measured over 20 years later.

The large uranium plume to the south of the IWCS may be related to the storage of uranium scrap at former Building 409 (USACE 2007a). Groundwater modeling conducted as part of the RI has indicated that groundwater plumes at the NFSS are static in nature; therefore the existing groundwater plumes in the IWCS area are not expected to migrate (USACE 2011).

4.4.2 Re-evaluation of Uranium Groundwater Plumes using RI and ESP Sampling Results

During RIR Addendum field activities, additional groundwater sampling was conducted to re-examine and update the understanding of nature and extent of groundwater contamination in the vicinity of the IWCS. All three RIR Addendum wells north and northwest of the IWCS contained concentrations of dissolved total uranium greater than the UTL (TWP935, MW936, and MW935); this suggests the dissolved total uranium groundwater plumes identified in the 2007 RIR north of the IWCS and along the western boundary of EU 7 are continuous (Figure 4-5). Concentrations of total uranium in subsurface soil within the plume north of the IWCS were detected at or below background concentrations. Two surface soil samples collected within the plume boundary (TWP936 and 8D003) exhibited total uranium concentrations up to 5.71 µg/g, which slightly exceeds the background concentration of 3.94 µg/g. Thus, concentrations of total uranium observed in RI soil samples collected from within the plume boundary do not appear to represent a source for current groundwater contamination in the area. As discussed above, the former lagoons and airborne migration and/or surface runoff from the R-10 pile represent likely sources of this contamination. RIR Addendum sampling indicates that concentrations of dissolved total uranium in groundwater are present above the background level (16.7 µg/L) west of EU 7 at MW935. Concentrations of dissolved total uranium in groundwater are also present above the background level in a small area west of EU 10 in EU 9 at MW938, which is located to the west of the northern portion of the IWCS and south of MW935. Concentrations of dissolved total uranium at these two locations, both just east of the WDD, are roughly two times greater than the background level. As stated above, MW935 is included in the plume north of the IWCS. MW938 is bound to the north by OW14B at a concentration below the UTL and should not be incorporated into the northern plume. Additionally, the uranium concentration observed at MW938 is bound to the west and southwest by two RI wells and one RIR Addendum well that exhibit concentrations of dissolved total uranium below the background level. This observation suggests that the plume on the west side of the IWCS has not migrated to the boundary of EU 10 and is, in fact, bounded to the west by multiple sampling points below the UTL.

To further address uncertainty associated with westward migration of the uranium plume west of the IWCS, and to investigate the potential for groundwater impacts to the WDD, three new surface water/sediment sampling locations in the WDD were added to the Corps' ESP in October 2008. These three sampling locations include WDD1 (located at the southern end of the National Grid property in EU 9), WDD2 (located at the northern end of the National Grid property in EU 9), and WDD3 (located adjacent to, and just south of the northern NFSS property boundary in EU 1). For an illustration of these sample point locations, refer to Figure 9-1 presented later in this document as part of the ESP description.

Surface water samples collected from the WDD during the RI (1999-2001) contained total uranium at levels above the NFSS background level for surface water (12.4 µg/L). Concentrations of total uranium at levels above background were observed at RI sampling locations 911 (21.9 µg/L) and 920 (18 µg/L), which were collocated with the new ESP sampling locations WDD1 and WDD2, respectively. During the RI, total uranium was detected in the WDD along the northern NFSS property boundary at sampling location 713 at a concentration of 7.67 µg/L, which is less than the UTL. RI sample location 713 is collocated with new ESP sampling location WDD3. RI results for these three locations are shown on Figure 4-13 in both graphic and tabular form. Using these three sampling points, Figure 4-13 illustrates that concentrations of total uranium decreased to levels below the UTL before reaching the northern NFSS property boundary.

Using the three collocated locations in the WDD, surface water sampling results from ESP sampling in 2008-2010 were compared to RI sampling results. To compare ESP analytical results to RI analytical results, the individual isotopic activities obtained from a particular surface water sample during ESP sampling were converted to a total uranium concentration in micrograms per liter using the steps described previously in this section.

ESP 2008-2010 surface water sampling results indicate that total uranium concentrations in the WDD are currently at levels below the background level of 12.4 µg/L at all three sampling locations along the ditch (see Figure 4-13). The observed decrease in total uranium distribution in the WDD surface water between the time of RI sampling and sampling conducted during 2008-2010 suggests that the WDD is not greatly impacted by groundwater contaminant transport. Concentrations of total uranium observed in the WDD surface water and sediment during the RI is likely more indicative of material entering the WDD due to historical soil erosion and turbid overland flow. The radioactive R-10 storage pile had been left uncovered and unprotected in this area for 36 years (from 1946 through 1982). Wind erosion and surface water runoff likely contributed to the contaminant migration to the west. The R-10 pile is now contained within the IWCS.

Additionally, the outer extent of the groundwater contamination along the west side of the IWCS is well characterized and delineated using densely spaced sampling points. The concentrations of uranium detected in wells and temporary well points between the IWCS and the WDD are less than or near background levels. These relatively low concentrations of uranium in groundwater strongly suggest that the source of uranium observed in the WDD is not from groundwater flow entering the ditch.

A few small, scattered areas showing elevated levels of dissolved uranium in groundwater are present on the east side of the IWCS. These areas exhibit concentrations of dissolved total uranium at, or slightly greater than, the background level. These areas of elevated uranium concentrations in groundwater may be related to former operation of the clarifier ponds in this area. Total uranium concentrations observed in RI surface and subsurface soil sampling results do not appear to represent a source for groundwater contamination observed along the eastern and western sides of the IWCS.

The dissolved total uranium groundwater plume located south-southeast of the IWCS, in the vicinity of former Building 409, was originally interpreted using pipeline water (refer to Figures 5-1 through 5-4 of the 2007 RIR). As previously explained, use of pipeline and manhole data to interpret groundwater plume configuration is now believed to be an overly conservative approach that inaccurately characterizes site groundwater conditions. Due to the likely absence of pipeline bedding material and the assumption that pipelines are not in constant contact with groundwater, analytical data collected from pipelines and manholes have been excluded from the current uranium plume configurations shown in Figures 4-2 through 4-5. Groundwater and soil contamination within pipelines will be addressed in the Feasibility Studies for the BOP and Groundwater OUs. The Corps will conduct additional field activities to address BOP data gaps, such as the integrity of the underground utility lines.

Through further research of the uranium plume located south of the IWCS, it was discovered that the highest dissolved total uranium concentration measured in the center of this plume had been misreported by the laboratory. In the 2007 RIR, the misreported value of 9,580 µg/L at sampling location TWP833 was used to delineate the dissolved total uranium groundwater plume south of the IWCS. The updated interpretation of this plume configuration reflects the lower concentration (958 µg/L) of dissolved total uranium at TWP833 (Figure 4-5).

By excluding pipeline data and correcting the concentration at TWP833, the dissolved total uranium plume south of the IWCS is now interpreted to be more constrained to the southern portion of the IWCS near Building 409 (Figure 4-5). Two RIR Addendum wells were installed to the west of the IWCS to better define the extent of this plume. Sampling results from TWP942, located in EU 10, indicate that the plume extends further to the northwest and connects to RI sampling location OW18B. However, the RI Addendum sampling location MW941 bounds the plume to the northwest. The plume south of the IWCS appears to extend to the northwest toward the WDD, although currently, dissolved total uranium concentrations in groundwater in this area are still less than the background level just west of the EU 10 boundary.

The total uranium contamination identified at TWP833 (958 µg/L) is believed to be associated with the Building 409 uranium plume, which was derived from both Building 409 operations and nearby radiologic materials storage. In the late 1940s, contaminated metal, concrete, lumber and reduction slag from other wartime plants were shipped to the NFSS and stored adjacent to Building 409 (National Lead Company 1979). The area south of Building 409 was reportedly used for the surface storage of crucibles, saw blades and other materials from metallurgical operations in the Niagara Falls area (BNI 1983). Included in this material was recoverable uranium adhering to graphite reduction bomb liners and crucibles used in the metal casting operations (The Aerospace Corporation 1982).

To investigate if observed soil concentrations may represent a source for current groundwater contamination near location TWP833, concentrations of total uranium observed in surface and subsurface soil near TWP833 were examined. RI and RIR Addendum sampling results indicate that total uranium was detected in surface soil at location TWP833 at a concentration of 40.2 µg/g, which is greater than the background concentration of 3.94 µg/g. The concentration of total uranium in subsurface soil at this location was 2.95 µg/g, which is less than the background concentration of 3.58 µg/g. Nearby sampling locations did not exhibit total uranium concentrations that exceeded background concentrations in surface or subsurface soil except sampling locations TWP943 and EU102 (just south of temporary well 831), which exhibited total uranium concentrations of 4.08 µg/g in surface soil and 69.4 µg/g in subsurface soil, respectively.

During remedial activities conducted during the 1980s, DOE used a cleanup criterion of 90 pCi/g for uranium (USACE 2007a). The uranium cleanup value of 90 pCi/g is approximately equal to 132 µg/g, which is much greater than the site-specific background criteria used for surface and subsurface soil (3.94 µg/g and 3.58 µg/g, respectively). Concentrations of total uranium observed in soil at TWP833 and EU102 are present at concentrations less than the DOE cleanup level. Concentrations of uranium observed above background levels in soils at TWP833 (40.2 µg/g) and EU102 (69.4 µg/g) could potentially contribute to groundwater contamination over time.

Some radiological constituents are still present in the surface and subsurface soil in the area south of the IWCS. However, a review of soil and groundwater data indicates that most observed total uranium concentrations in soil within the plume boundaries do not exceed background levels and do not account for observed groundwater concentrations. Available site operational information and environmental investigative data indicate that groundwater contamination surrounding the IWCS is the result of historic site operations and past waste storage practices. Most of the soil contamination that contributed to current

groundwater contamination was removed during the remedial efforts performed by the DOE in the 1980s. During the BOP FS, the Corps will conduct additional field activities to address any BOP data gaps. This additional field activity will include further investigation of the area surrounding TWP833.

In addition to the groundwater plume evaluations discussed above, groundwater data collected as part of the ESP and RI were used to study total uranium and radium-226 concentrations in groundwater at the NFSS over time. Historical trending data for uranium and radium-226 in groundwater were examined and are discussed in Section 5.4 of this RIR Addendum as part of the effort to evaluate the integrity of the IWCS. Section 5.0 of this RIR Addendum also presents a discussion of additional evidence that supports the conclusion that the structural integrity of the IWCS has not been compromised.

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SECTION 4

FIGURES

MW921 MW922 MW923 505 506 TWP924 TWP925 TWP926 823 810A 808A 504 822 404A MW934 411A 425 MW424 TWP928 TWP927 MW930 TWP931 TWP932 4D003 415A 4D005 422 313 835 821 837 MW935 836 820 MW936 838 BH49A TWP937 OW05B 839 OW04B A52 A45 842 OW14B OW08B MW938 103 OW02B TWP939 MW860 OW09B OW15B A42 OW01B 844 A50 OW16B A43 OW10B 845 TWP940 102 856 OW17B MW862 OW11B 101 MW941 OW18B OW12B TWP830 MW943 858 OW06B TWP942 859 831 834 833 852 855 853 832 854 846 847 OW13B 851 850 OW07B 849 813 830

1 2 3 4 5 6 7 8 9 10 11 12 13 14

MW=Monitoring Well
TWP=Temporary Well Point
RI=Remedial Investigation
RIR=Remedial Investigation Report Addendum

Legend

- Structure abandoned above grade
- Existing structure
- Former structure
- Acid sewer
- Water lines
- Fuel line
- Sanitary sewer
- Storm sewer
- Former K-65 transfer pipeline
- Surface water (inundated 50% of year)
- WCS cutoff wall
- Roads
- National Grid Boundary
- EU boundary
- Sitewide Groundwater Locations

0 150 300 450 600
Feet

N

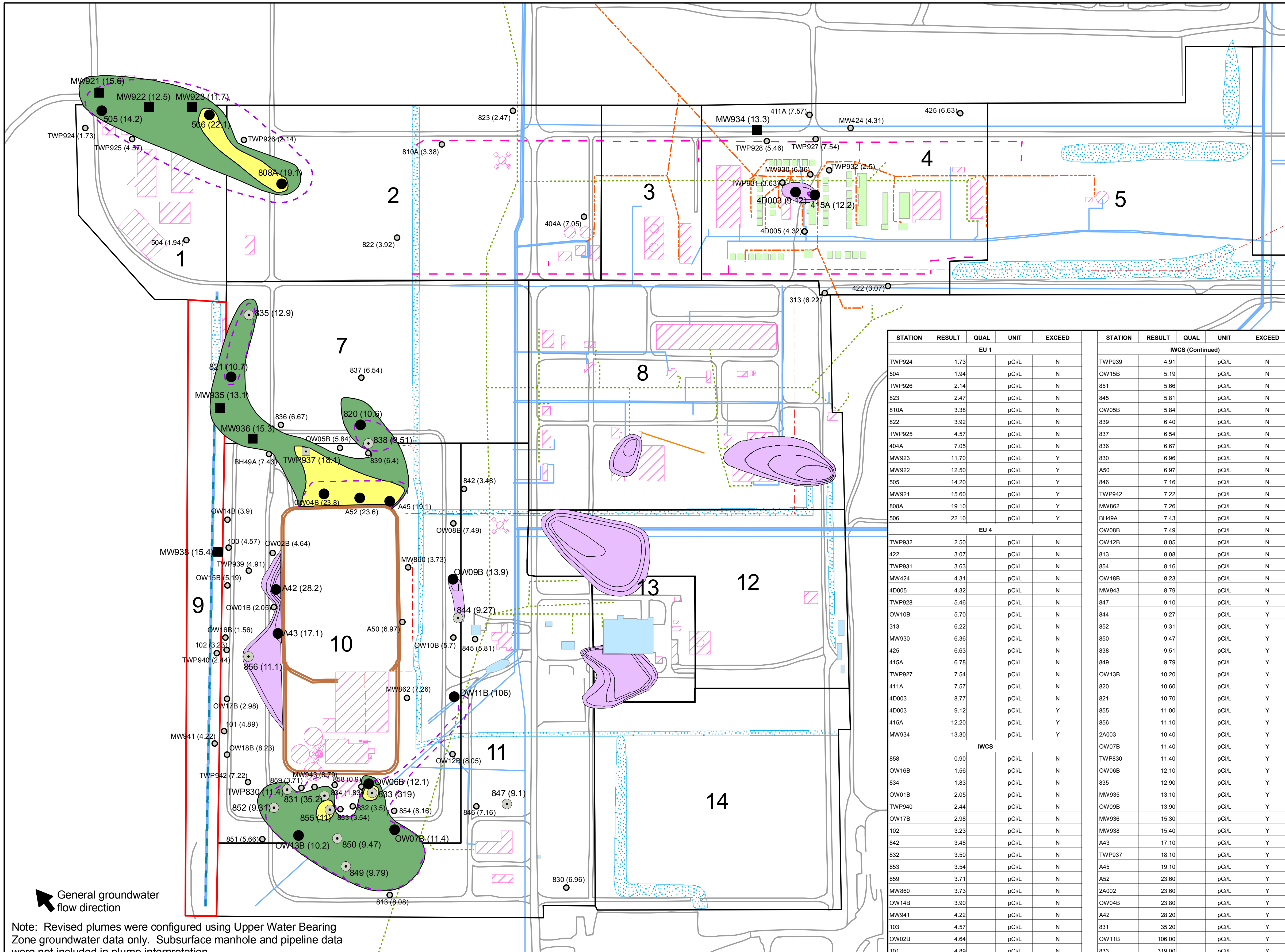
US Army Corps of Engineers
Buffalo District

Groundwater Plume Sample Locations
in the EU 1 Area, EU 4, and the IWCS Area

Sitewide

SAIC From Science to Solutions®
Science Applications International Corporation

Figure 4-1



STATION	RESULT	QUAL	UNIT	EXCEED
EU 1				
TWP924	1.73		pCi/L	N
504	1.94		pCi/L	N
TWP926	2.14		pCi/L	N
823	2.47		pCi/L	N
810A	3.38		pCi/L	N
822	3.92		pCi/L	N
TWP925	4.57		pCi/L	N
404A	7.05		pCi/L	N
MW923	11.70		pCi/L	Y
MW922	12.50		pCi/L	Y
505	14.20		pCi/L	Y
MW921	15.60		pCi/L	Y
808A	19.10		pCi/L	Y
506	22.10		pCi/L	Y
EU 4				
TWP932	2.50		pCi/L	N
422	3.07		pCi/L	N
TWP931	3.63		pCi/L	N
MW424	4.31		pCi/L	N
4D005	4.32		pCi/L	N
TWP928	5.46		pCi/L	N
OW10B	5.70		pCi/L	N
313	6.22		pCi/L	N
MW930	6.36		pCi/L	N
425	6.63		pCi/L	N
415A	6.78		pCi/L	N
TWP927	7.54		pCi/L	N
411A	7.57		pCi/L	N
4D003	8.77		pCi/L	N
4D003	9.12		pCi/L	Y
415A	12.20		pCi/L	Y
MW934	13.30		pCi/L	Y
IWCS				
858	0.90		pCi/L	N
OW16B	1.56		pCi/L	N
834	1.83		pCi/L	N
OW01B	2.05		pCi/L	N
TWP940	2.44		pCi/L	N
OW17B	2.98		pCi/L	N
102	3.23		pCi/L	N
842	3.48		pCi/L	N
832	3.50		pCi/L	N
853	3.54		pCi/L	N
859	3.71		pCi/L	N
MW860	3.73		pCi/L	N
OW14B	3.90		pCi/L	N
MW941	4.22		pCi/L	N
103	4.57		pCi/L	N
OW02B	4.64		pCi/L	N
101	4.89		pCi/L	N

STATION	RESULT	QUAL	UNIT	EXCEED
IWCS (Continued)				
TWP939	4.91		pCi/L	N
OW15B	5.19		pCi/L	N
851	5.66		pCi/L	N
845	5.81		pCi/L	N
OW05B	5.84		pCi/L	N
839	6.40		pCi/L	N
837	6.54		pCi/L	N
836	6.67		pCi/L	N
830	6.96		pCi/L	N
A50	6.97		pCi/L	N
846	7.16		pCi/L	N
TWP942	7.22		pCi/L	N
MW862	7.26		pCi/L	N
BH49A	7.43		pCi/L	N
OW08B	7.49		pCi/L	N
OW12B	8.05		pCi/L	N
813	8.08		pCi/L	N
854	8.16		pCi/L	N
OW18B	8.23		pCi/L	N
MW943	8.79		pCi/L	N
847	9.10		pCi/L	Y
844	9.27		pCi/L	Y
852	9.31		pCi/L	Y
850	9.47		pCi/L	Y
838	9.51		pCi/L	Y
849	9.79		pCi/L	Y
OW13B	10.20		pCi/L	Y
820	10.60		pCi/L	Y
821	10.70		pCi/L	Y
855	11.00		pCi/L	Y
856	11.10		pCi/L	Y
2A003	10.40		pCi/L	Y
OW07B	11.40		pCi/L	Y
TWP830	11.40		pCi/L	Y
OW06B	12.10		pCi/L	Y
835	12.90		pCi/L	Y
MW935	13.10		pCi/L	Y
OW09B	13.90		pCi/L	Y
MW936	15.30		pCi/L	Y
MW938	15.40		pCi/L	Y
A43	17.10		pCi/L	Y
TWP937	18.10		pCi/L	Y
A45	19.10		pCi/L	Y
A52	23.60		pCi/L	Y
2A002	23.60		pCi/L	Y
OW04B	23.80		pCi/L	Y
A42	28.20		pCi/L	Y
831	35.20		pCi/L	Y
OW11B	106.00		pCi/L	Y
833	319.00		pCi/L	Y

Note: Revised plumes were configured using Upper Water Bearing Zone groundwater data only. Subsurface manhole and pipeline data were not included in plume interpretation.

Uranium-234, Dissolved UTL=8.94 pCi/L

UTL=95% Upper Tolerance Limit (background screening level)
MW=Monitoring Well
TWP=Temporary Well Point
RI=Remedial Investigation
RIR=Remedial Investigation Report Addendum
MW934 (13.3)=Well identifier (concentration)

Legend

- National Grid Boundary
- EU boundary
- Structure abandoned above grade
- Existing structure
- Former structure
- Former K-65 transfer pipeline
- Acid sewer
- Water lines
- Fuel line
- Sanitary sewer
- Storm sewer
- WCS cutoff wall
- Roads
- West drainage ditch
- Surface water (inundated 50% of year)

U-234 Dissolved

- Non Exceedances
- RI MW Exceedances
- RI TWP Exceedances
- RIR MW Exceedances
- RIR TWP Exceedances
- RI Plumes unmodified by RIR
- RI Plumes modified by RIR

RIR U-234 Plumes

- 8.94 - 18.00 pCi/L
- >18.00 pCi/L

0 150 300 450 600
Feet
N

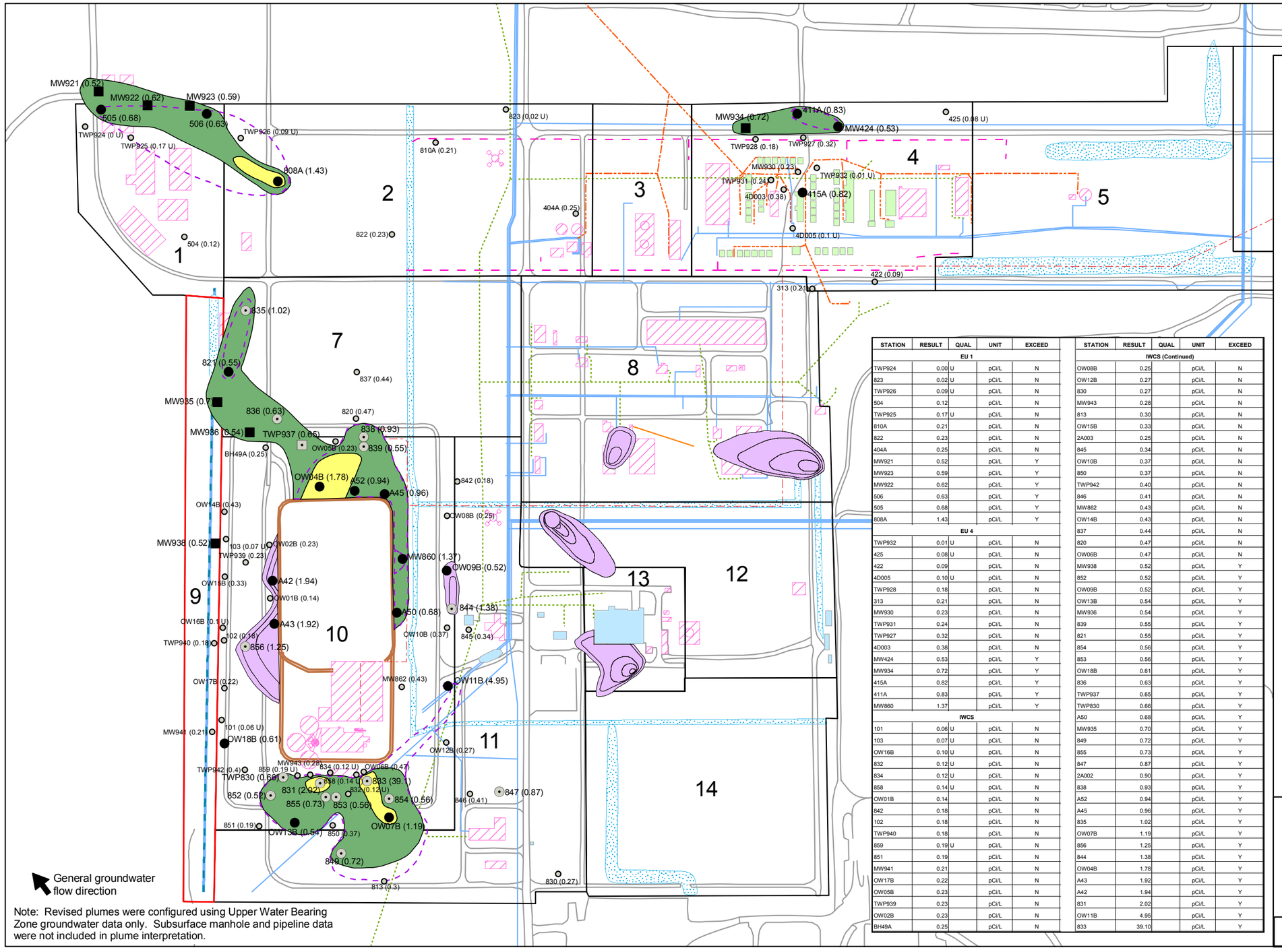
US Army Corps of Engineers
Buffalo District

Dissolved Uranium-234 Plumes, Sitewide Groundwater - UWBZ

Sitewide

Science Applications International Corporation

Figure 4-2



Note: Revised plumes were configured using Upper Water Bearing Zone groundwater data only. Subsurface manhole and pipeline data were not included in plume interpretation.

STATION	RESULT	QUAL	UNIT	EXCEED
EU 1				
TWP924	0.00	U	pCi/L	N
823	0.02	U	pCi/L	N
TWP926	0.09	U	pCi/L	N
504	0.12		pCi/L	N
TWP925	0.17	U	pCi/L	N
810A	0.21		pCi/L	N
822	0.23		pCi/L	N
404A	0.25		pCi/L	N
MW921	0.52		pCi/L	Y
MW923	0.59		pCi/L	Y
MW922	0.62		pCi/L	Y
506	0.63		pCi/L	Y
505	0.68		pCi/L	Y
808A	1.43		pCi/L	Y
EU 4				
TWP932	0.01	U	pCi/L	N
425	0.08	U	pCi/L	N
422	0.09		pCi/L	N
4D005	0.10	U	pCi/L	N
TWP928	0.18		pCi/L	N
313	0.21		pCi/L	N
MW930	0.23		pCi/L	N
TWP931	0.24		pCi/L	N
TWP927	0.32		pCi/L	N
4D003	0.38		pCi/L	N
MW424	0.53		pCi/L	Y
MW934	0.72		pCi/L	Y
415A	0.82		pCi/L	Y
411A	0.83		pCi/L	Y
MW860	1.37		pCi/L	Y
IWCS				
101	0.06	U	pCi/L	N
103	0.07	U	pCi/L	N
OW16B	0.10	U	pCi/L	N
832	0.12	U	pCi/L	N
834	0.12	U	pCi/L	N
858	0.14	U	pCi/L	N
OW01B	0.14		pCi/L	N
842	0.18		pCi/L	N
102	0.18		pCi/L	N
TWP940	0.18		pCi/L	N
859	0.19	U	pCi/L	N
851	0.19		pCi/L	N
MW941	0.21		pCi/L	N
OW17B	0.22		pCi/L	N
OW05B	0.23		pCi/L	N
TWP939	0.23		pCi/L	N
OW02B	0.23		pCi/L	N
BH49A	0.25		pCi/L	N

STATION	RESULT	QUAL	UNIT	EXCEED
IWCS (Continued)				
OW08B	0.25		pCi/L	N
OW12B	0.27		pCi/L	N
830	0.27		pCi/L	N
MW943	0.28		pCi/L	N
813	0.30		pCi/L	N
OW15B	0.33		pCi/L	N
2A003	0.25		pCi/L	N
845	0.34		pCi/L	N
OW10B	0.37		pCi/L	N
850	0.37		pCi/L	N
TWP942	0.40		pCi/L	N
846	0.41		pCi/L	N
MW862	0.43		pCi/L	N
OW14B	0.43		pCi/L	N
837	0.44		pCi/L	N
820	0.47		pCi/L	N
OW06B	0.47		pCi/L	N
MW938	0.52		pCi/L	Y
852	0.52		pCi/L	Y
OW09B	0.52		pCi/L	Y
OW13B	0.54		pCi/L	Y
MW936	0.54		pCi/L	Y
839	0.55		pCi/L	Y
821	0.55		pCi/L	Y
854	0.56		pCi/L	Y
853	0.56		pCi/L	Y
855	0.73		pCi/L	Y
849	0.72		pCi/L	Y
847	0.87		pCi/L	Y
2A002	0.90		pCi/L	Y
838	0.93		pCi/L	Y
A52	0.94		pCi/L	Y
A45	0.96		pCi/L	Y
835	1.02		pCi/L	Y
OW07B	1.19		pCi/L	Y
856	1.25		pCi/L	Y
844	1.38		pCi/L	Y
A43	1.92		pCi/L	Y
A42	1.94		pCi/L	Y
831	2.02		pCi/L	Y
833	39.10		pCi/L	Y

Uranium-235, Dissolved UTL=0.51 pCi/L

UTL=95% Upper Tolerance Limit (background screening level)
MW=Monitoring Well
TWP=Temporary Well Point
RI=Remedial Investigation
RIR=Remedial Investigation Report Addendum
MW934 (0.72)=Well identifier (concentration)

Data Qualifiers:
U=Non Detect

Legend

- National Grid Boundary
- EU boundary
- Structure abandoned above grade
- Existing structure
- Former structure
- Former K-65 transfer pipeline
- Acid sewer
- Water lines
- Fuel line
- Sanitary sewer
- Storm sewer
- WCS cutoff wall
- Roads
- Surface water (inundated 50% of year)
- West drainage ditch

U-235 Dissolved

- Non Exceedances
- RI MW Exceedances
- RI TWP Exceedances
- RIR MW Exceedances
- RIR TWP Exceedances
- RI Plumes unmodified by RIR
- RI Plumes modified by RIR

RIR U-235 Plumes

- 0.51 - 1.00 pCi/L
- >1.00 pCi/L

0 150 300 450 600 Feet

N

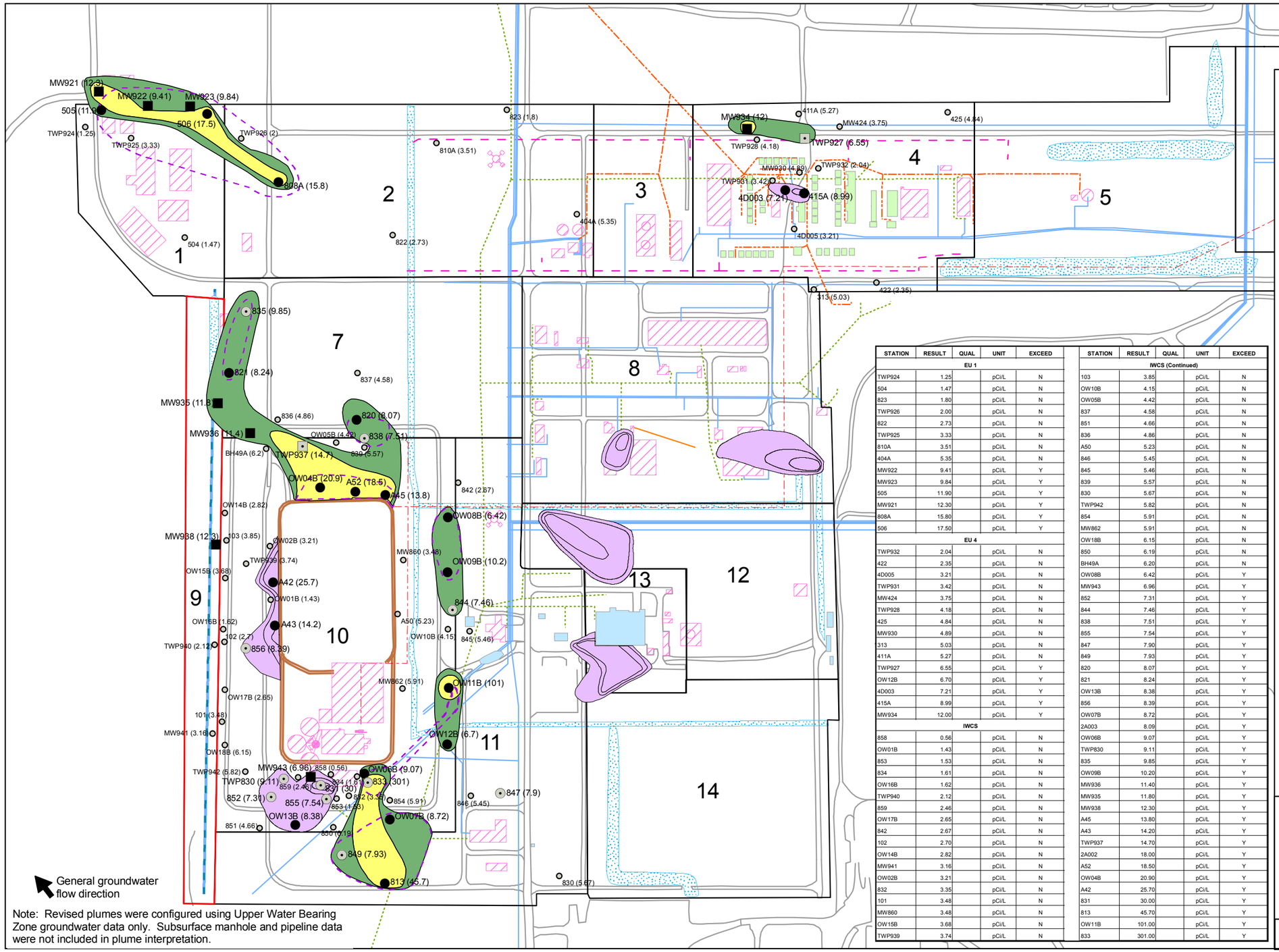
US Army Corps of Engineers
Buffalo District

Dissolved Uranium-235 Plumes,
Sitewide Groundwater - UWBZ

Sitewide

SAIC From Science to Solutions®
Science Applications International Corporation

Figure 4-3



STATION	RESULT	QUAL	UNIT	EXCEED
EU 1				
TWP924	1.25		pCi/L	N
504	1.47		pCi/L	N
823	1.80		pCi/L	N
TWP926	2.00		pCi/L	N
822	2.73		pCi/L	N
TWP925	3.33		pCi/L	N
810A	3.51		pCi/L	N
404A	5.35		pCi/L	N
MW922	9.41		pCi/L	Y
MW923	9.84		pCi/L	Y
505	11.90		pCi/L	Y
MW921	12.30		pCi/L	Y
808A	15.80		pCi/L	Y
506	17.50		pCi/L	Y
EU 4				
TWP932	2.04		pCi/L	N
422	2.35		pCi/L	N
4D005	3.21		pCi/L	N
TWP931	3.42		pCi/L	N
MW424	3.75		pCi/L	N
TWP928	4.18		pCi/L	N
425	4.84		pCi/L	N
MW930	4.89		pCi/L	N
313	5.03		pCi/L	N
411A	5.27		pCi/L	N
TWP927	6.55		pCi/L	Y
OW12B	6.70		pCi/L	Y
4D003	7.21		pCi/L	Y
415A	8.99		pCi/L	Y
MW934	12.00		pCi/L	Y
IWCS				
858	0.56		pCi/L	N
OW01B	1.43		pCi/L	N
853	1.53		pCi/L	N
834	1.61		pCi/L	N
OW16B	1.62		pCi/L	N
TWP940	2.12		pCi/L	N
859	2.46		pCi/L	N
OW17B	2.65		pCi/L	N
842	2.67		pCi/L	N
102	2.70		pCi/L	N
OW14B	2.82		pCi/L	N
MW941	3.16		pCi/L	N
OW02B	3.21		pCi/L	N
832	3.35		pCi/L	N
101	3.48		pCi/L	N
MW860	3.48		pCi/L	N
OW15B	3.68		pCi/L	N
TWP939	3.74		pCi/L	N

STATION	RESULT	QUAL	UNIT	EXCEED
IWCS (Continued)				
103	3.85		pCi/L	N
OW10B	4.15		pCi/L	N
OW05B	4.42		pCi/L	N
837	4.58		pCi/L	N
851	4.66		pCi/L	N
836	4.86		pCi/L	N
A50	5.23		pCi/L	N
846	5.45		pCi/L	N
845	5.46		pCi/L	N
839	5.57		pCi/L	N
830	5.67		pCi/L	N
TWP942	5.82		pCi/L	N
854	5.91		pCi/L	N
MW862	5.91		pCi/L	N
OW18B	6.15		pCi/L	N
850	6.19		pCi/L	N
BH49A	6.20		pCi/L	N
OW08B	6.42		pCi/L	Y
MW943	6.96		pCi/L	Y
852	7.31		pCi/L	Y
844	7.46		pCi/L	Y
838	7.51		pCi/L	Y
855	7.54		pCi/L	Y
847	7.90		pCi/L	Y
849	7.93		pCi/L	Y
820	8.07		pCi/L	Y
821	8.24		pCi/L	Y
OW13B	8.38		pCi/L	Y
856	8.39		pCi/L	Y
OW07B	8.72		pCi/L	Y
2A003	8.09		pCi/L	Y
OW06B	9.07		pCi/L	Y
TWP830	9.11		pCi/L	Y
835	9.85		pCi/L	Y
OW09B	10.20		pCi/L	Y
MW936	11.40		pCi/L	Y
MW935	11.80		pCi/L	Y
MW938	12.30		pCi/L	Y
A45	13.80		pCi/L	Y
A43	14.20		pCi/L	Y
TWP937	14.70		pCi/L	Y
2A002	18.00		pCi/L	Y
A52	18.50		pCi/L	Y
OW04B	20.90		pCi/L	Y
A42	25.70		pCi/L	Y
831	30.00		pCi/L	Y
813	45.70		pCi/L	Y
OW11B	101.00		pCi/L	Y
833	301.00		pCi/L	Y

Uranium-238, Dissolved UTL=6.32 pCi/L

UTL=95% Upper Tolerance Limit
(background screening level)
MW=Monitoring Well
TWP=Temporary Well Point
RI=Remedial Investigation
RIR=Remedial Investigation Report Addendum
MW934 (12)=Well identifier (concentration)

Legend

- National Grid Boundary
- EU boundary
- Structure abandoned above grade
- Existing structure
- Former structure
- Former K-65 transfer pipeline
- Acid sewer
- Water lines
- Fuel line
- Sanitary sewer
- Storm sewer
- WCS cutoff wall
- Roads
- Surface water (inundated 50% of year)
- West drainage ditch

U-238 Dissolved

- Non Exceedances
- RI MW Exceedance
- RI TWP Exceedance
- RIR MW Exceedance
- RIR TWP Exceedance
- RI Plumes unmodified by RIR
- RI Plumes modified by RIR

RIR U-238 Plumes

- 6.32 - 12.00 pCi/L
- >12.00 pCi/L

0 150 300 450 600 Feet

N

US Army Corps of Engineers
Buffalo District

Dissolved Uranium-238 Plumes,
Sitewide Groundwater - UWBZ

Sitewide

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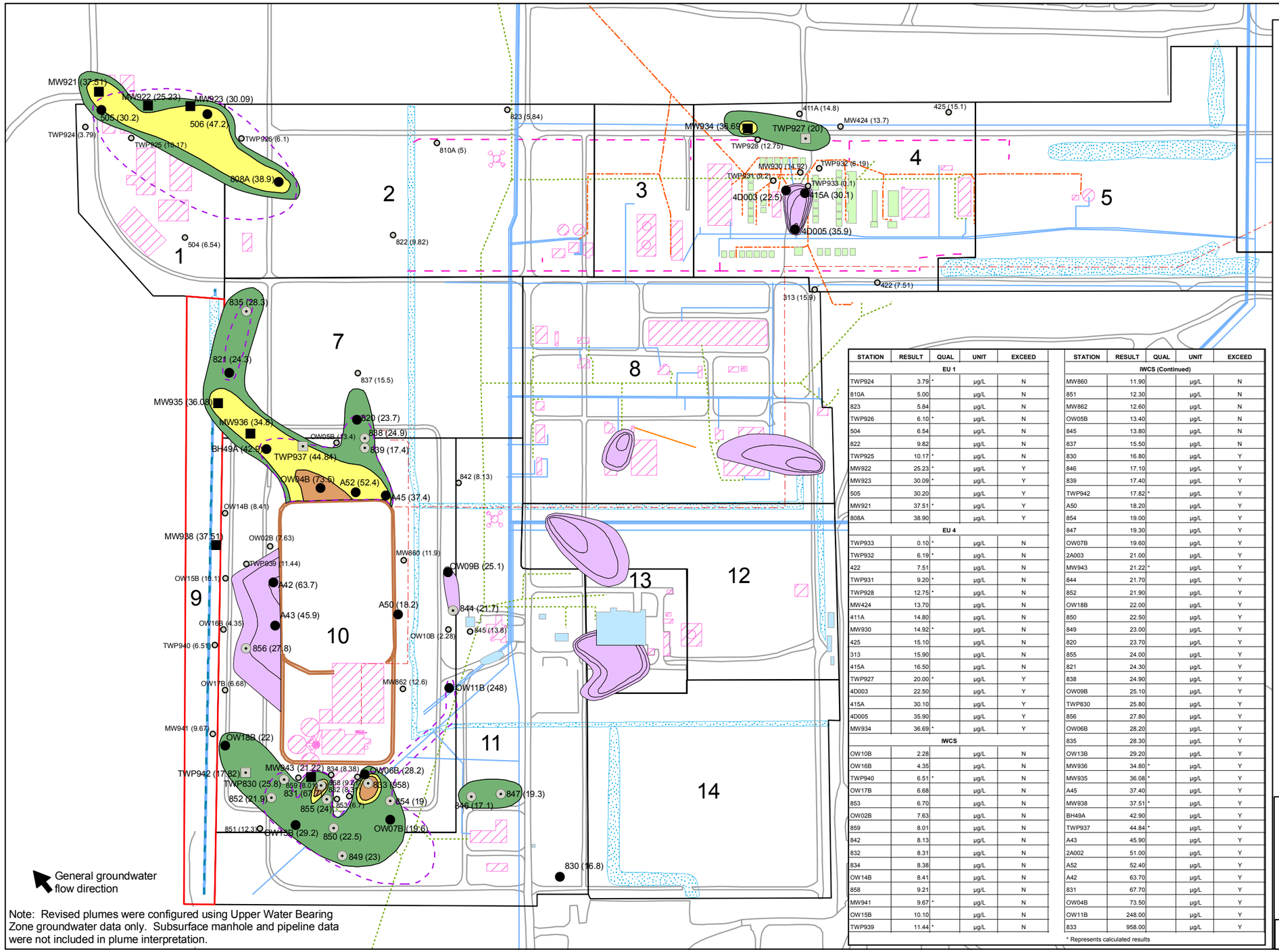
Figure 4-4



Note: Revised plumes were configured using Upper Water Bearing Zone groundwater data only. Subsurface manhole and pipeline data were not included in plume interpretation.

STATION	RESULT	QUAL	UNIT	EXCEED
EU 1				
TWP924	3.79	*	µg/L	N
810A	5.00		µg/L	N
823	5.84		µg/L	N
TWP926	6.10	*	µg/L	N
504	6.54		µg/L	N
822	9.82		µg/L	N
TWP925	10.17	*	µg/L	N
MW922	25.23	*	µg/L	Y
MW923	30.09	*	µg/L	Y
505	30.20		µg/L	Y
MW921	37.51	*	µg/L	Y
808A	38.90		µg/L	Y
EU 4				
TWP933	0.10	*	µg/L	N
TWP932	6.19	*	µg/L	N
422	7.51		µg/L	N
TWP931	9.20	*	µg/L	N
TWP928	12.75	*	µg/L	N
MW424	13.70		µg/L	N
411A	14.80		µg/L	N
MW930	14.92	*	µg/L	N
425	15.10		µg/L	N
313	15.90		µg/L	N
415A	16.50		µg/L	N
TWP927	20.00	*	µg/L	Y
4D003	22.50		µg/L	Y
415A	30.10		µg/L	Y
4D005	35.90		µg/L	Y
MW934	36.69	*	µg/L	Y
IWCS				
OW10B	2.28		µg/L	N
OW16B	4.35		µg/L	N
TWP940	6.51	*	µg/L	N
OW17B	6.68		µg/L	N
853	6.70		µg/L	N
OW02B	7.63		µg/L	N
859	8.01		µg/L	N
842	8.13		µg/L	N
832	8.31		µg/L	N
834	8.38		µg/L	N
OW14B	8.41		µg/L	N
858	9.21		µg/L	N
MW941	9.67	*	µg/L	N
OW15B	10.10		µg/L	N
TWP939	11.44	*	µg/L	N

STATION	RESULT	QUAL	UNIT	EXCEED
IWCS (Continued)				
MW860	11.90		µg/L	N
851	12.30		µg/L	N
MW862	12.60		µg/L	N
OW05B	13.40		µg/L	N
845	13.80		µg/L	N
837	15.50		µg/L	N
830	16.80		µg/L	Y
846	17.10		µg/L	Y
839	17.40		µg/L	Y
TWP942	17.82	*	µg/L	Y
A50	18.20		µg/L	Y
854	19.00		µg/L	Y
847	19.30		µg/L	Y
OW07B	19.60		µg/L	Y
2A003	21.00		µg/L	Y
MW943	21.22	*	µg/L	Y
844	21.70		µg/L	Y
852	21.90		µg/L	Y
OW18B	22.00		µg/L	Y
850	22.50		µg/L	Y
849	23.00		µg/L	Y
820	23.70		µg/L	Y
855	24.00		µg/L	Y
821	24.30		µg/L	Y
838	24.90		µg/L	Y
OW09B	25.10		µg/L	Y
TWP830	25.80		µg/L	Y
856	27.80		µg/L	Y
OW06B	28.20		µg/L	Y
835	28.30		µg/L	Y
OW13B	29.20		µg/L	Y
MW936	34.80	*	µg/L	Y
MW935	36.08	*	µg/L	Y
A45	37.40		µg/L	Y
MW938	37.51	*	µg/L	Y
BH49A	42.90		µg/L	Y
TWP937	44.84	*	µg/L	Y
A43	45.90		µg/L	Y
2A002	51.00		µg/L	Y
A52	52.40		µg/L	Y
A42	63.70		µg/L	Y
831	67.70		µg/L	Y
OW04B	73.50		µg/L	Y
OW11B	248.00		µg/L	Y
833	958.00		µg/L	Y

* Represents calculated results

Total Uranium, Dissolved UTL=16.7 µg/L

Total Uranium, MCL = 30 µg/L

UTL=95% Upper Tolerance Limit
(background screening level)
MCL = Maximum Contaminant Level
MW=Monitoring Well
TWP=Temporary Well Point
RI=Remedial Investigation
RIR=Remedial Investigation Report Addendum
MW934 (36.69) = Well identifier (concentration)

Legend

- Structure abandoned above grade
- Existing structure
- Former structure
- Acid sewer
- Water lines
- Fuel line
- Sanitary sewer
- Storm sewer
- Former K-65 transfer pipeline
- Surface water (inundated 50% of year)
- WCS cutoff wall
- Roads
- National Grid Boundary
- EU boundary
- West drainage ditch

Total Uranium, Dissolved

- Non Exceedances
- RI MW Exceedances
- RI TWP Exceedances
- RIR MW Exceedances
- RIR TWP Exceedances
- RI Plumes unmodified by RIR
- RI Plumes modified by RIR

RIR Total Uranium Plumes

- 16.7 - 30.0 µg/L
- 30.1 - 60.0 µg/L
- >60.0 µg/L

0 150 300 450 600
Feet

N

US Army Corps of Engineers
Buffalo District

Dissolved Total Uranium Plumes,
Sitewide Groundwater - UWBZ

Sitewide

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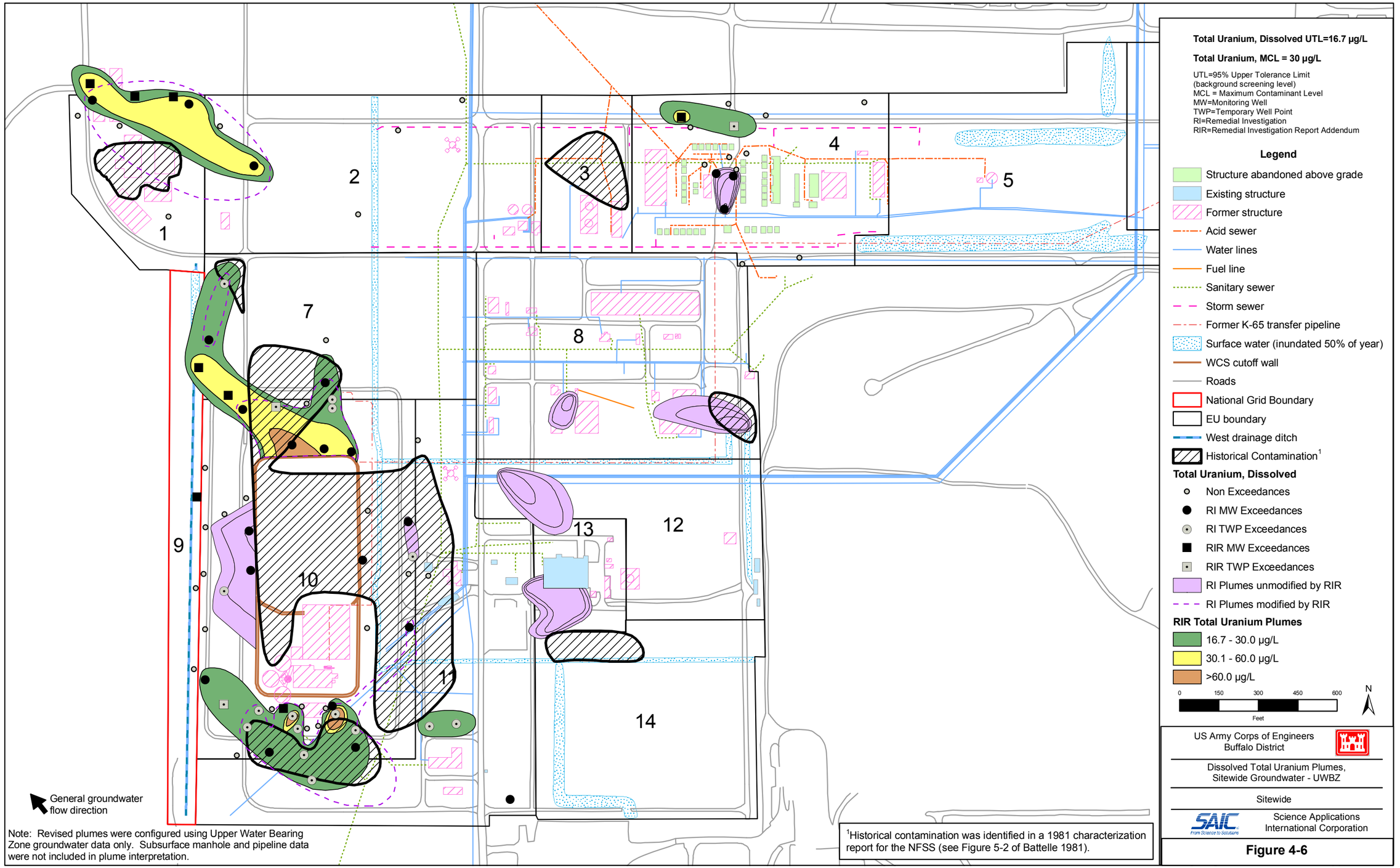
Figure 4-5



Note: Revised plumes were configured using Upper Water Bearing Zone groundwater data only. Subsurface manhole and pipeline data were not included in plume interpretation.

[1]Historical contamination was identified in a 1981 characterization report for the NFSS (see Figure 5-2 of Battelle 1981).

Total Uranium, Dissolved UTL=16.7 µg/L

Total Uranium, MCL = 30 µg/L

UTL=95% Upper Tolerance Limit
(background screening level)
MCL = Maximum Contaminant Level
MW=Monitoring Well
TWP=Temporary Well Point
RI=Remedial Investigation
RIR=Remedial Investigation Report Addendum

Legend

- Structure abandoned above grade
- Existing structure
- Former structure
- Acid sewer
- Water lines
- Fuel line
- Sanitary sewer
- Storm sewer
- Former K-65 transfer pipeline
- Surface water (inundated 50% of year)
- WCS cutoff wall
- Roads
- National Grid Boundary
- EU boundary
- West drainage ditch
- Historical Contamination[1]

Total Uranium, Dissolved

- Non Exceedances
- RI MW Exceedances
- RI TWP Exceedances
- RIR MW Exceedances
- RIR TWP Exceedances
- RI Plumes unmodified by RIR
- RI Plumes modified by RIR

RIR Total Uranium Plumes

- 16.7 - 30.0 µg/L
- 30.1 - 60.0 µg/L
- >60.0 µg/L

0 150 300 450 600
Feet

N

US Army Corps of Engineers
Buffalo District

Dissolved Total Uranium Plumes,
Sitewide Groundwater - UWBZ

Sitewide

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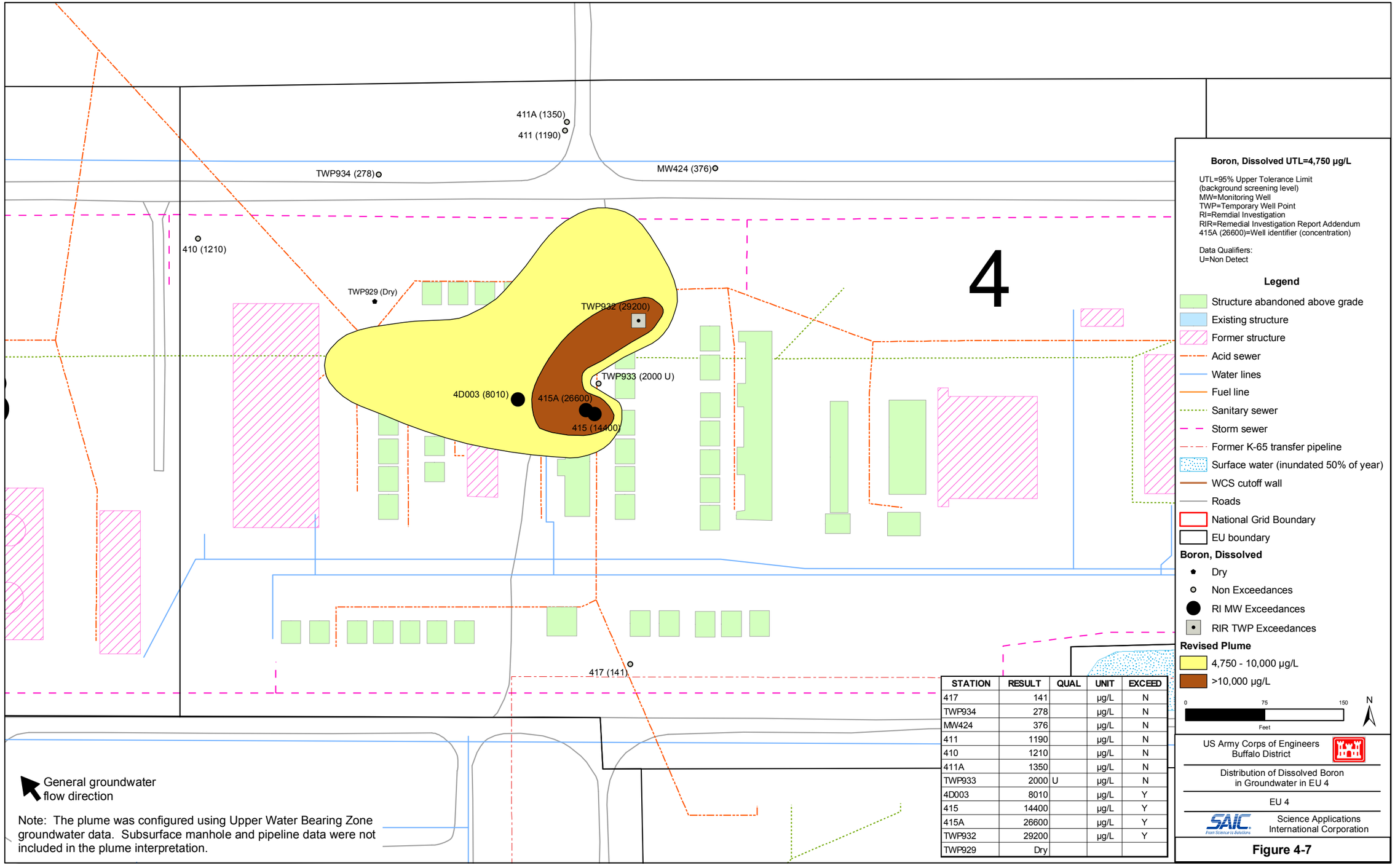
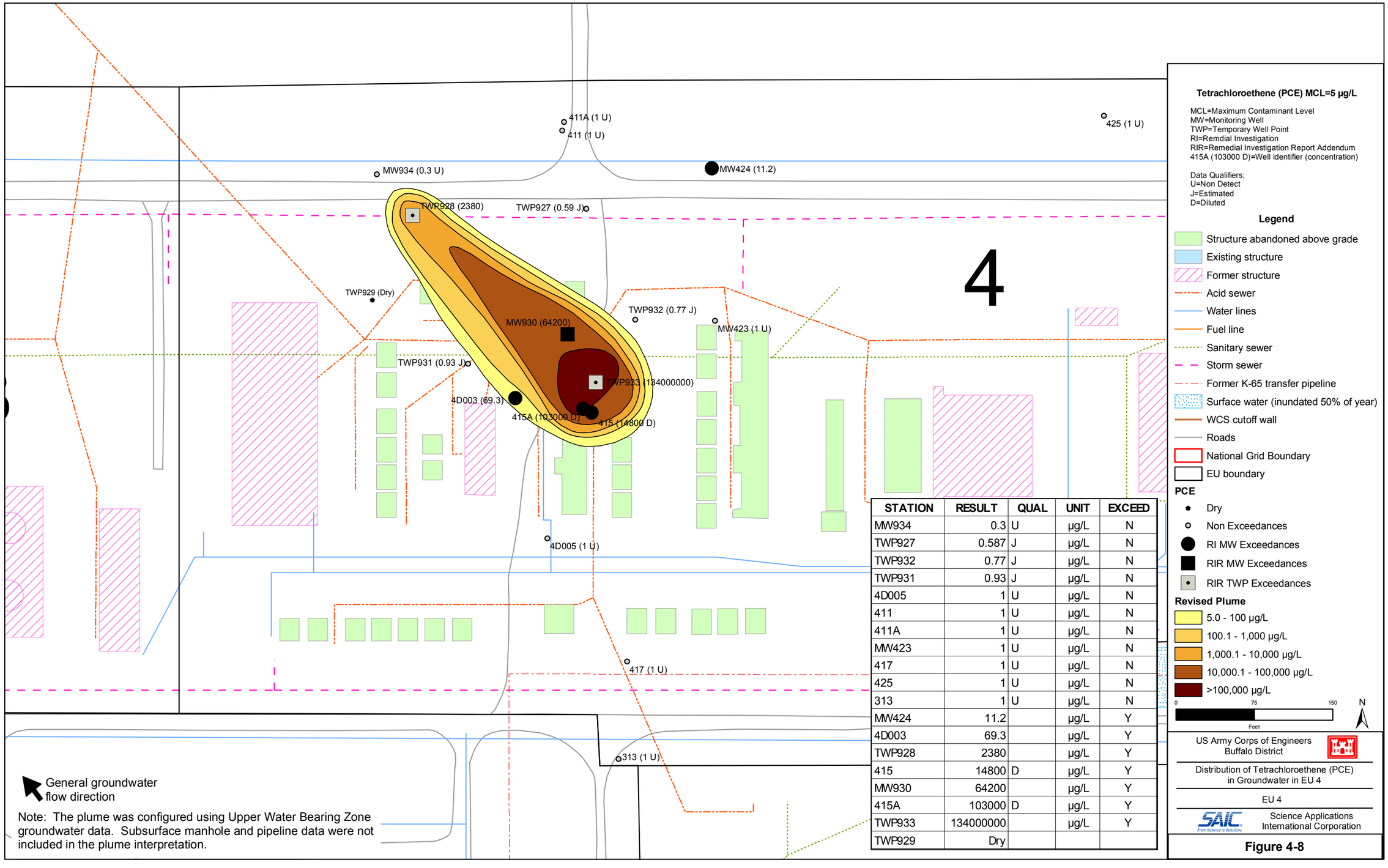
Figure 4-6



STATION	RESULT	QUAL	UNIT	EXCEED
417	141		µg/L	N
TWP934	278		µg/L	N
MW424	376		µg/L	N
411	1190		µg/L	N
410	1210		µg/L	N
411A	1350		µg/L	N
TWP933	2000	U	µg/L	N
4D003	8010		µg/L	Y
415	14400		µg/L	Y
415A	26600		µg/L	Y
TWP932	29200		µg/L	Y
TWP929	Dry			

Figure 4-7



STATION	RESULT	QUAL	UNIT	EXCEED
MW934	0.3	U	µg/L	N
TWP927	0.587	J	µg/L	N
TWP932	0.77	J	µg/L	N
TWP931	0.93	J	µg/L	N
4D005	1	U	µg/L	N
411	1	U	µg/L	N
411A	1	U	µg/L	N
MW423	1	U	µg/L	N
417	1	U	µg/L	N
425	1	U	µg/L	N
313	1	U	µg/L	N
MW424	11.2		µg/L	Y
4D003	69.3		µg/L	Y
TWP928	2380		µg/L	Y
415	14800	D	µg/L	Y
MW930	64200		µg/L	Y
415A	103000	D	µg/L	Y
TWP933	134000000		µg/L	Y
TWP929	Dry			

Tetrachloroethene (PCE) MCL=5 µg/L

MCL=Maximum Contaminant Level
MW=Monitoring Well
TWP=Temporary Well Point
RI=Remdial Investigation
RIR=Remedial Investigation Report Addendum
415A (103000 D)=Well identifier (concentration)

Data Qualifiers:
U=Non Detect
J=Estimated
D=Diluted

Legend

- Structure abandoned above grade
- Existing structure
- Former structure
- Acid sewer
- Water lines
- Fuel line
- Sanitary sewer
- Storm sewer
- Former K-65 transfer pipeline
- Surface water (inundated 50% of year)
- WCS cutoff wall
- Roads
- National Grid Boundary
- EU boundary

PCE

- Dry
- Non Exceedances
- RI MW Exceedances
- RIR MW Exceedances
- RIR TWP Exceedances

Revised Plume

- 5.0 - 100 µg/L
- 100.1 - 1,000 µg/L
- 1,000.1 - 10,000 µg/L
- 10,000.1 - 100,000 µg/L
- >100,000 µg/L

0 75 150 Feet

N

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Buffalo District

Distribution of Tetrachloroethene (PCE) in Groundwater in EU 4

EU 4

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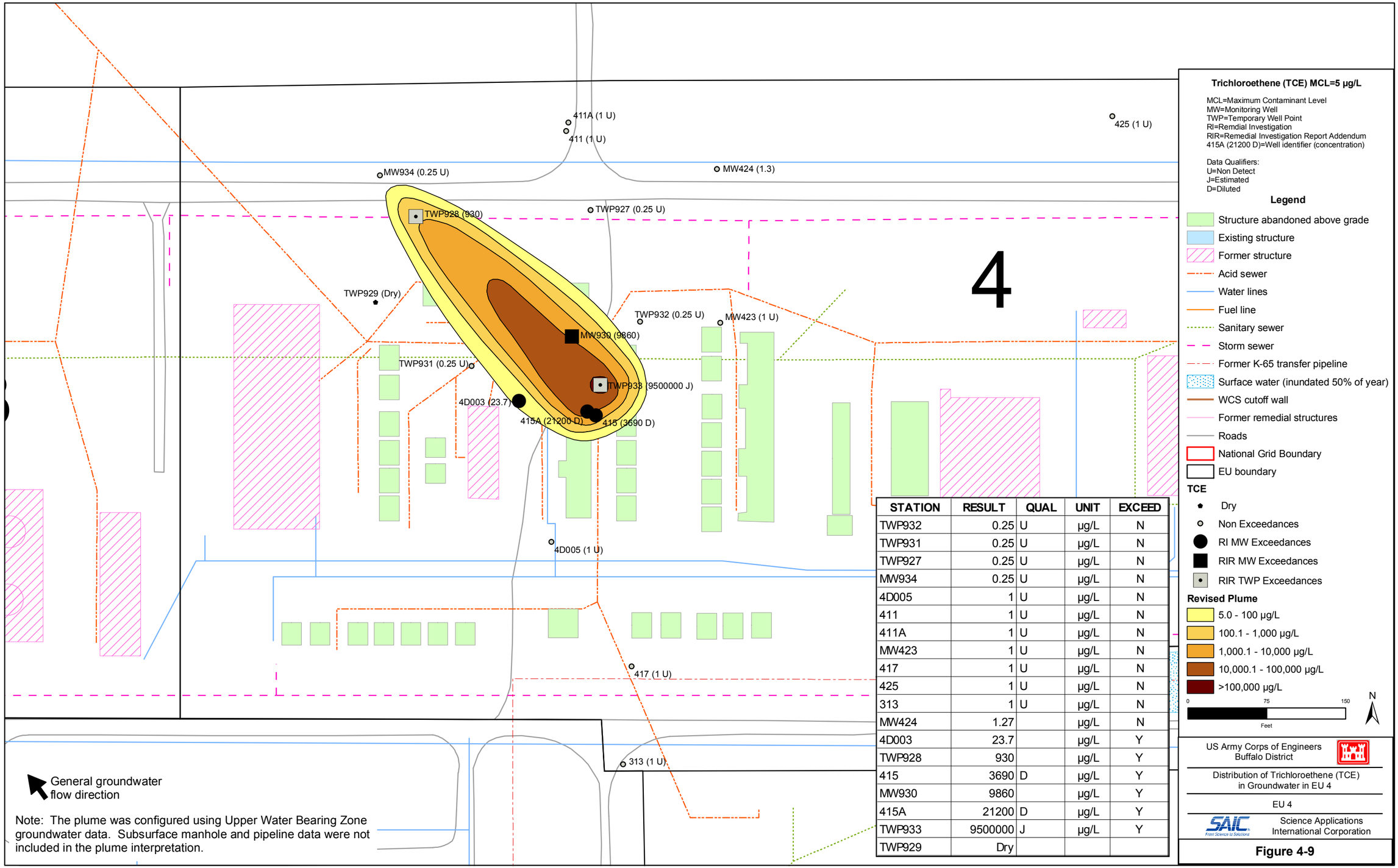
Figure 4-8



STATION	RESULT	QUAL	UNIT	EXCEED
TWP932	0.25	U	µg/L	N
TWP931	0.25	U	µg/L	N
TWP927	0.25	U	µg/L	N
MW934	0.25	U	µg/L	N
4D005	1	U	µg/L	N
411	1	U	µg/L	N
411A	1	U	µg/L	N
MW423	1	U	µg/L	N
417	1	U	µg/L	N
425	1	U	µg/L	N
313	1	U	µg/L	N
MW424	1.27		µg/L	N
4D003	23.7		µg/L	Y
TWP928	930		µg/L	Y
415	3690	D	µg/L	Y
MW930	9860		µg/L	Y
415A	21200	D	µg/L	Y
TWP933	9500000	J	µg/L	Y
TWP929	Dry			

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Distribution of Trichloroethene (TCE) in Groundwater in EU 4

EU 4

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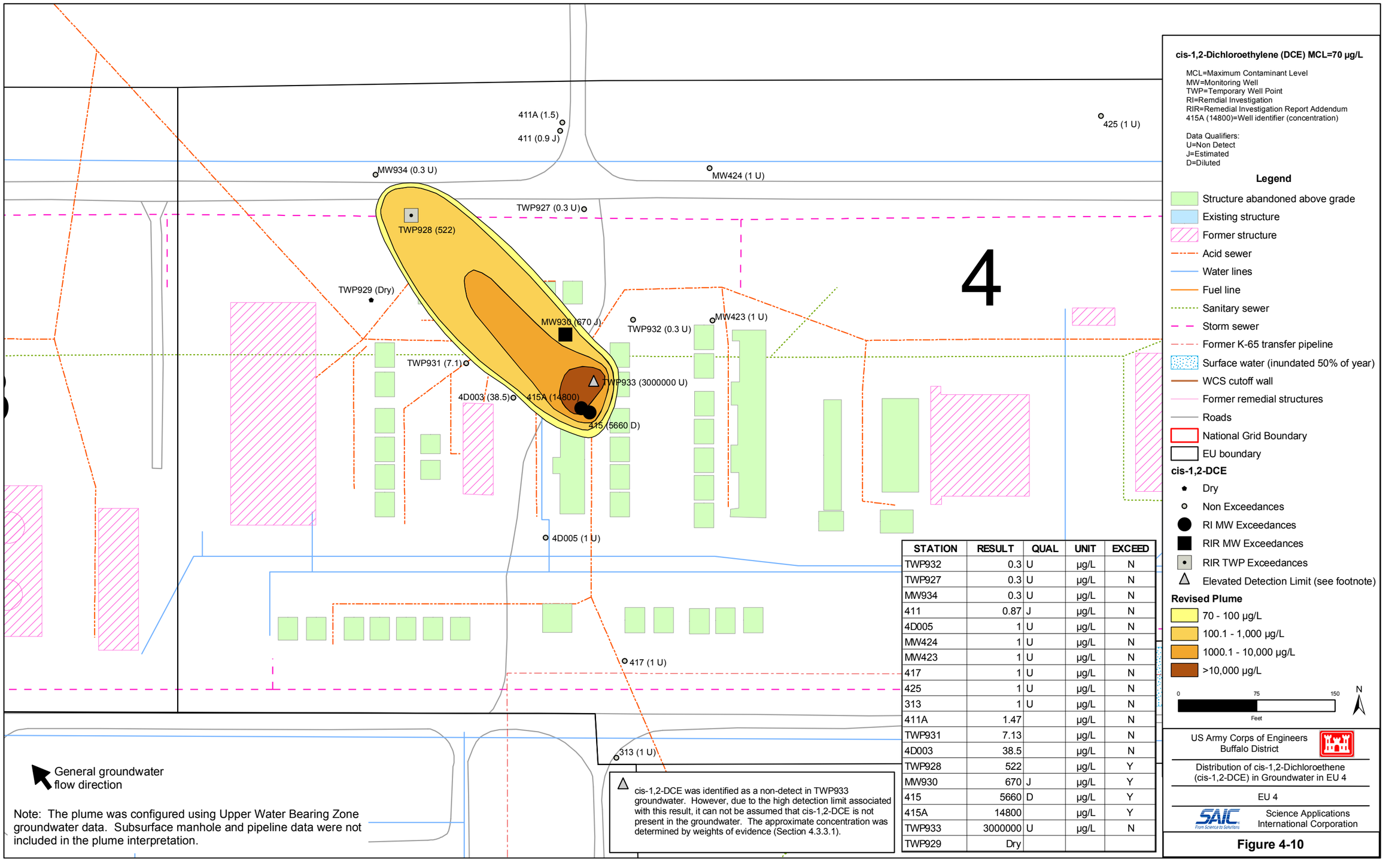
Figure 4-9



STATION	RESULT	QUAL	UNIT	EXCEED
TWP932	0.3	U	µg/L	N
TWP927	0.3	U	µg/L	N
MW934	0.3	U	µg/L	N
411	0.87	J	µg/L	N
4D005	1	U	µg/L	N
MW424	1	U	µg/L	N
MW423	1	U	µg/L	N
417	1	U	µg/L	N
425	1	U	µg/L	N
313	1	U	µg/L	N
411A	1.47		µg/L	N
TWP931	7.13		µg/L	N
4D003	38.5		µg/L	N
TWP928	522		µg/L	Y
MW930	670	J	µg/L	Y
415	5660	D	µg/L	Y
415A	14800		µg/L	Y
TWP933	3000000	U	µg/L	N
TWP929	Dry			

△ cis-1,2-DCE was identified as a non-detect in TWP933 groundwater. However, due to the high detection limit associated with this result, it can not be assumed that cis-1,2-DCE is not present in the groundwater. The approximate concentration was determined by weights of evidence (Section 4.3.3.1).

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Distribution of cis-1,2-Dichloroethene (cis-1,2-DCE) in Groundwater in EU 4

EU 4

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Figure 4-10

411A (1 U)
411 (1 U)
425 (1 U)
MW934 (0.3 U)
MW424 (1 U)
TWP927 (0.3 U)
TWP928 (6.9)
4
TWP929 (Dry)
TWP932 (0.3 U)
MW423 (1 U)
MW930 (300 U)
TWP931 (0.3 U)
TWP933 (3000000 U)
415A (115 E)
4D003 (0.4 J)
415 (355 J)
4D005 (1 U)
417 (1 U)
313 (1 U)

General groundwater flow direction

Note: The plume was configured using Upper Water Bearing Zone groundwater data. Subsurface manhole and pipeline data were not included in the plume interpretation.

△ Note: trans-1,2-DCE was not detected at TWP933. However, due to the high detection limit associated with this result, it can not be assumed that trans-1,2-DCE is not present in the groundwater. The approximate concentration was determined by weights of evidence (Section 4.3.3.2).

STATION	RESULT	QUAL	UNIT	EXCEED
TWP932	0.3	U	µg/L	N
TWP931	0.3	U	µg/L	N
TWP927	0.3	U	µg/L	N
MW934	0.3	U	µg/L	N
4D003	0.42	J	µg/L	N
411	1	U	µg/L	N
411A	1	U	µg/L	N
417	1	U	µg/L	N
313	1	U	µg/L	N
4D005	1	U	µg/L	N
MW423	1	U	µg/L	N
MW424	1	U	µg/L	N
425	1	U	µg/L	N
TWP928	6.9		µg/L	N
415A	115	E	µg/L	Y
MW930	300	U	µg/L	N
415	355	J	µg/L	Y
TWP933	3000000	U	µg/L	N
TWP929	Dry			

trans-1,2-Dichloroethylene (DCE) MCL=100 µg/L

MCL=Maximum Contaminant Level
MW=Monitoring Well
TWP=Temporary Well Point
RI=Remdial Investigation
RIR=Remedial Investigation Report Addendum
415A (115 E)=Well identifier (concentration)

Data Qualifiers:
U=Non Detect
J=Estimated
E=Exceeds Instrumentation Limit

Legend

- Structure abandoned above grade
- Existing structure
- Former structure
- Acid sewer
- Water lines
- Fuel line
- Sanitary sewer
- Storm sewer
- Former K-65 transfer pipeline
- Surface water (inundated 50% of year)
- WCS cutoff wall
- Roads
- National Grid Boundary
- EU boundary

trans-1,2-DCE

- Dry
- Non Exceedances
- RI MW Exceedances
- Elevated Detection Limit (see footnote)
- >100 µg/L

0 75 150 Feet N

US Army Corps of Engineers
Buffalo District

Distribution of trans-1,2-Dichloroethene (trans-1,2-DCE) in Groundwater in EU 4

EU 4

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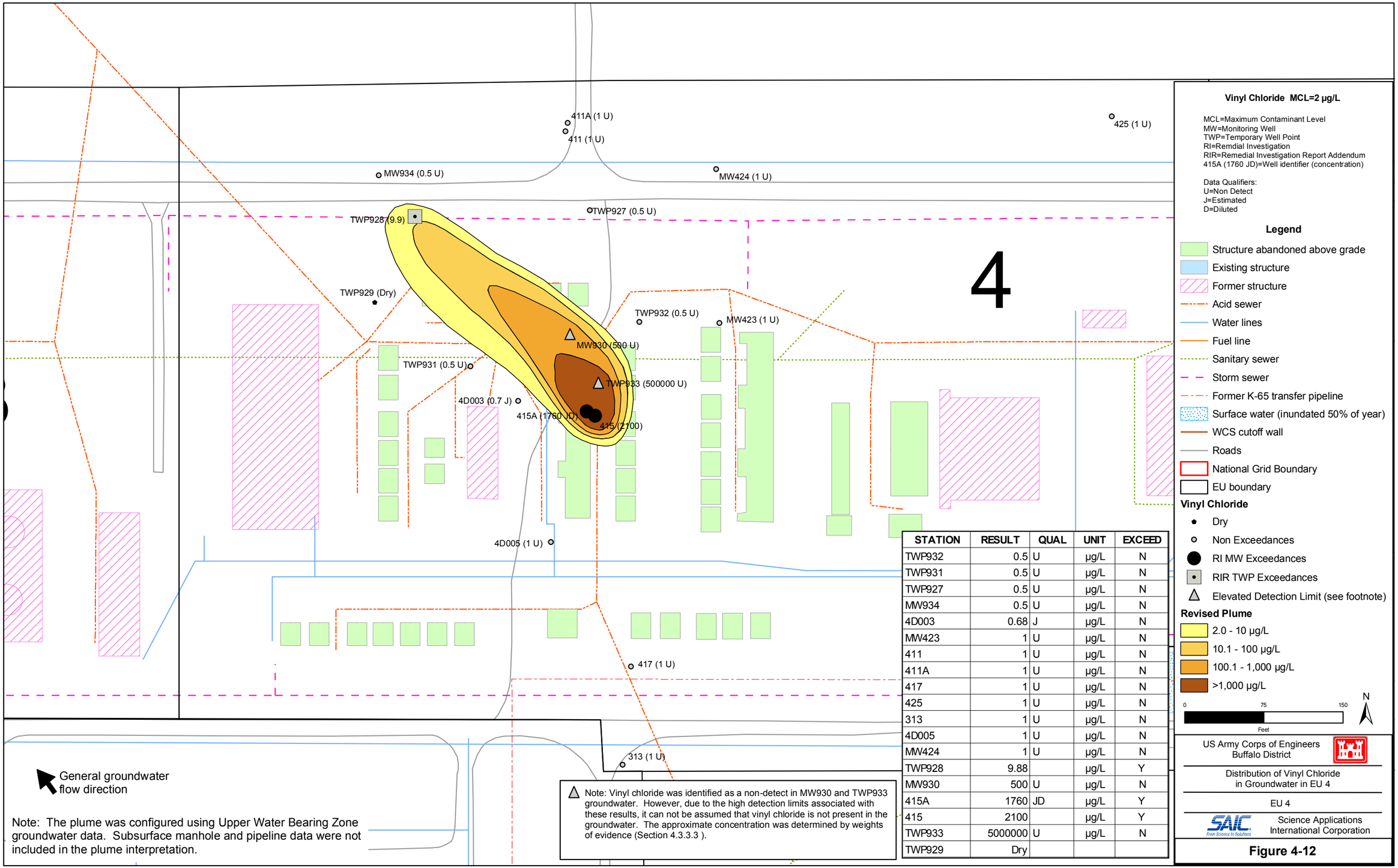
Figure 4-11



STATION	RESULT	QUAL	UNIT	EXCEED
TWP932	0.5	U	µg/L	N
TWP931	0.5	U	µg/L	N
TWP927	0.5	U	µg/L	N
MW934	0.5	U	µg/L	N
4D003	0.68	J	µg/L	N
MW423	1	U	µg/L	N
411	1	U	µg/L	N
411A	1	U	µg/L	N
417	1	U	µg/L	N
425	1	U	µg/L	N
313	1	U	µg/L	N
4D005	1	U	µg/L	N
MW424	1	U	µg/L	N
TWP928	9.88		µg/L	Y
MW930	500	U	µg/L	N
415A	1760	JD	µg/L	Y
415	2100		µg/L	Y
TWP933	5000000	U	µg/L	N
TWP929	Dry			

Vinyl Chloride MCL=2 µg/L

MCL=Maximum Contaminant Level
MW=Monitoring Well
TWP=Temporary Well Point
RI=Remdial Investigation
RIR=Remedial Investigation Report Addendum
415A (1760 JD)=Well identifier (concentration)

Data Qualifiers:
U=Non Detect
J=Estimated
D=Diluted

Legend

- Structure abandoned above grade
- Existing structure
- Former structure
- Acid sewer
- Water lines
- Fuel line
- Sanitary sewer
- Storm sewer
- Former K-65 transfer pipeline
- Surface water (inundated 50% of year)
- WCS cutoff wall
- Roads
- National Grid Boundary
- EU boundary

Vinyl Chloride

- Dry
- Non Exceedances
- RI MW Exceedances
- RIR TWP Exceedances
- Elevated Detection Limit (see footnote)

Revised Plume

- 2.0 - 10 µg/L
- 10.1 - 100 µg/L
- 100.1 - 1,000 µg/L
- >1,000 µg/L

0 75 150 Feet

N

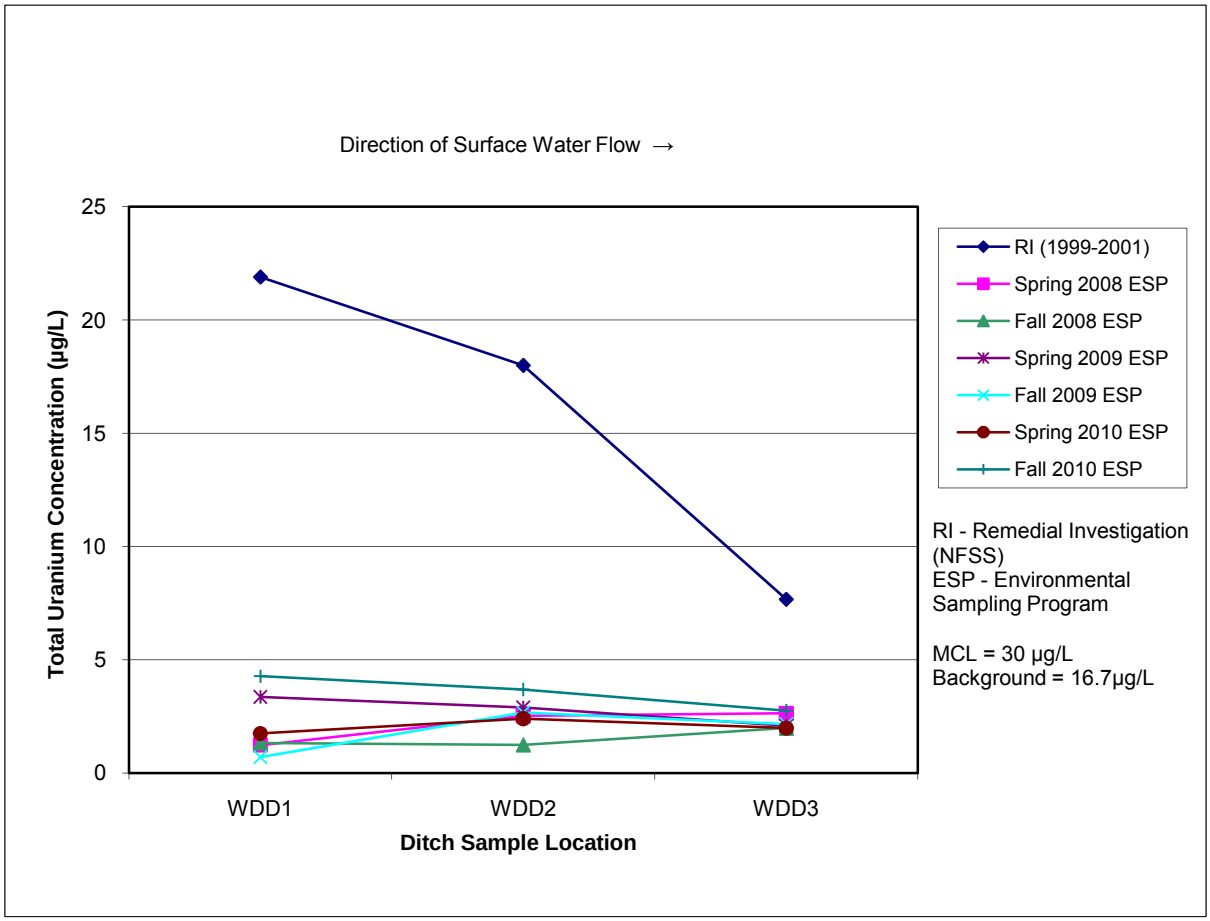
US Army Corps of Engineers
Buffalo District

Distribution of Vinyl Chloride in Groundwater in EU 4

EU 4

Science Applications International Corporation

Figure 4-12



Surface Water Location	Total U Result (µg/L)	Sampling Event
WDD1 (RI Location 911)	21.9	RI (1999-2001)
WDD2 (RI Location 920)	18	RI (1999-2001)
WDD3 (RI Location 713)	7.67	RI (1999-2001)
WDD1	1.23	Spring 2008 ESP
WDD2	2.52	Spring 2008 ESP
WDD3	2.63	Spring 2008 ESP
WDD1	1.32	Fall 2008 ESP
WDD2	1.24	Fall 2008 ESP
WDD3	1.98	Fall 2008 ESP
WDD1	3.36	Spring 2009 ESP
WDD2	2.89	Spring 2009 ESP
WDD3	2.09	Spring 2009 ESP
WDD1	0.7	Fall 2009 ESP
WDD2	2.66	Fall 2009 ESP
WDD3	2.16	Fall 2009 ESP
WDD1	1.74	Spring 2010 ESP
WDD2	2.4	Spring 2010 ESP
WDD3	1.98	Spring 2010 ESP
WDD1	4.27	Fall 2010 ESP
WDD2	3.68	Fall 2010 ESP
WDD3	2.75	Fall 2010 ESP

Figure 4-13. Comparison of Total Uranium Concentrations in West Drainage Ditch Surface Water during RI Sampling (1999-2001) and Spring/Fall 2008-2010, Niagara Falls Storage Site, Lewiston, New York

SECTION 4

TABLES

Table 4-1. Calculated Dissolved Total Uranium Concentrations for RIR Addendum Wells and Temporary Well Points

Station	Sample Number	Total Dissolved Uranium (µg/L)
MW921	921GW0001F-0110	37.51
MW922	922GW0001F-0112	25.23
MW923	923GW0001F-0114	30.09
MW930	930GW0001F-0116	14.92
MW934	934GW0001F-0118	36.69
MW935	935GW0001F-0120	36.08
MW936	936GW0001F-0122	34.80
MW938	938GW0001F-0124	37.51
MW941	941GW0001F-0126	9.67
MW943	943GW0001F-0128	21.22
TWP924	924TW0001F-0016	3.79
TWP925	925TW0001F-0020	10.17
TWP926	926TW0001F-0024	6.10
TWP927	927TW0001F-0028	20.00
TWP928	928TW0001F-0032	12.75
TWP931	931TW0001F-0044	9.20
TWP932	932TW0001F-0048	6.19
TWP937	937TW0001F-0068	44.84
TWP939	939TW0001F-0076	11.44
TWP940	940TW0001F-0080	6.51
TWP942	942TW0001F-0088	17.82

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Table 4-2. Summary of Groundwater to Ambient Air Volatilization Modeling and Comparison to Screening Levels, EU 4 95th Upper Confidence Limit on the Mean Groundwater Concentrations, Niagara Falls Storage Site

Volatiles	Groundwater Concentration EPC [1] for plume (mg/L)	Henry's Law Constant [2]	Diffusion Coeffiecent in Air [2] (cm^2/s)	Diffusion Coeffiecent in Water [2] (cm^2/s)	Ambient Air Concentration (mg/m^3)	Ambient Air Concentration ($\mu g/m^3$)	EPA Residential Air Screening Level [2] ($\mu g/m^3$)	EPA Industrial Air Screening Level [2] ($\mu g/m^3$)	NY Air Guideline Level [4] ($\mu g/m^3$)
Cis-1,2-Dichloroethene	2.34E+00	1.70E-01	8.80E-02	1.10E-05	8.95E-07	8.95E-04	NA[3]	NA[3]	NA[3]
Trans-1,2-Dichloroethene	1.38E-01	1.70E-01	8.80E-02	1.20E-05	5.53E-08	5.53E-05	NA[3]	NA[3]	NA[3]
Tetrachloroethene	6.89E+04	7.20E-01	5.00E-02	9.50E-06	4.22E-02	4.22E+01	4.10E-01	2.10E+00	1.00E+02
Trichloroethene	4.89E+03	4.00E-01	6.90E-02	1.00E-05	2.54E-03	2.54E+00	1.20E+00	6.10E+00	5.00E+00
Vinyl Chloride	4.23E-01	1.10E+00	1.10E-01	1.20E-05	7.17E-07	7.17E-04	1.60E-01	2.80E+00	NA[3]

Notes:

1 Groundwater EPCs (95th upper confidence limit on the mean concentration) were developed using sample results obtained during RI Addendum sampling, using recommended values from ProUCL version 4.02 calculations, including consideration of non-detected results

2 Chemical Physical parameters and Screening Levels obtained from the EPA Regional Screening Levels, December 2009 version. http://www.epa.gov/reg3hwmd/risk/human/rb-concentration_table/Generic_Tables/index.htm

3 No screening or guideline levels developed by this agency for this compound

4 NYSDOH Final Guidance for Evaluating Soil Vapor Intrusion in the State of New York. October 2006 http://www.health.state.ny.us/environmental/indoors/vapor_intrusion/

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Table 4-3. VOC Concentrations Detected in Soil Gas Sample Obtained from TWP933 (Maximum Detection)
Niagara Falls Storage Site

Volatiles	Soil Gas Concentration ($\mu g/m^3$)
Cis-1,2-Dichloroethene	6.10E+04
Trans-1,2-Dichloroethene	not detected
Tetrachloroethene	4.40E+05
Trichloroethene	3.90E+05
Vinyl Chloride	7.80E+04

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5.0 SUPPLEMENTAL ASSESSMENT OF THE INTEGRITY OF THE IWCS

This section presents the results of additional assessments of the IWCS integrity conducted to supplement findings previously presented in the 2007 RIR (USACE 2007a). These assessments include an examination of topographic survey information to assess potential settlement of the IWCS cap, an overview of the IWCS cap maintenance procedures and ESP monitoring techniques, a review of aerial photos and assessment of groundwater plumes in the vicinity of the IWCS, and a review of information regarding the potential for building pipelines within the IWCS to provide a pathway for release from the IWCS to the environment.

5.1 INTRODUCTION

Several questions raised by the public regarding the integrity of the IWCS formed the basis for the evaluations presented in this section. The questions included the following:

- Is the IWCS cap settling?
- How is the cap maintained to ensure minimal impacts to the environment from radon releases and rainwater infiltration?
- Are the groundwater contamination plumes observed outside of the IWCS the result of the IWCS leaking?
- Do the underground pipelines connecting buildings located within the IWCS present a pathway for release of the high-activity residues stored in those buildings or other radiological materials placed in the IWCS?

According to Table 3-2 of the *Design Report for the IWCS at NFSS (Bechtel National for DOE, 1986)*, the design life of the dike and cutoff walls around and natural glacio-lucustrine clay under the IWCS have a design service life between 200 to 1,000 years (which is consistent with the Corps groundwater modeling results for the IWCS (USACE 2011)). According to the same design report, the three (3)-foot thick compact clay cap atop the IWCS is sufficient to control infiltration for the 25 to 50 year design life of the cap. Since the IWCS was originally constructed in 1986 (and later added to in 1991), the design life of the IWCS cap is ensured through 2011 and possibly as long as 2036, according to this study. The evaluations presented in this section focus on addressing questions raised by the public regarding the integrity of the IWCS. Evaluations used to assess the integrity of the IWCS include:

- Examination of topographic survey information to assess potential settling of the IWCS cap material,
- Overview of the IWCS cap maintenance procedures and environmental surveillance program monitoring techniques,
- Review of aerial photos and assessment of groundwater plumes in the vicinity of the IWCS, and
- Assessment of potential for pipelines to provide a pathway for releases from the IWCS to the environment.

5.2 EXAMINATION OF TOPOGRAPHIC SURVEY INFORMATION TO ASSESS POTENTIAL SETTLING OF THE IWCS CAP MATERIAL

Ground surface elevation data for the IWCS was collected during four separate topographic survey events over the past 18 years. Topographic survey information obtained in 1991, 1996, and 1999 was presented and discussed in the 2007 RIR. The most recent topographic survey of the IWCS was conducted in June 2009 (Gourdie-Fraser 2009). Surface elevation data from all four survey events were summarized and compared to identify potential changes in surface elevation across the IWCS that could indicate settling of the cap material or the IWCS contents.

The methodology utilized for surveys conducted prior to 2009 was discussed in Section 3.2 of the 2007 RIR (USACE 2007a). Details of the methodology for conducting the June 2009 topographic survey is presented in the survey report included in Appendix 12-F of this RIR Addendum. To briefly summarize, horizontal control for the 2009 survey was based on the NAD83 and vertical control was based on the NGVD29. Survey coordinates were transformed to match the local site coordinate system, and elevation data was reported in U.S. Survey feet.

The topographic surveys of the IWCS provided information relative to horizontal and vertical datum. A horizontal datum is a reference point for a grid system across the ground surface and a vertical datum is an elevation reference point, relative to distance above mean sea level (amsl). The IWCS surveys were performed at grid nodes originally established by the DOE (USACE 2007a). Figure 5-1 illustrates the layout of the grid coordinate system used for the topographic surveys of the IWCS. Selected survey points are located on this grid across the IWCS with east stations ranging numerically from 0 to 375, and south stations ranging numerically from 700 to 1800. Surface elevation data for four east stations (75, 175, 275, 375) along the vertical extent of the IWCS (700 to 1800) are shown in Tables 5-1a, 5-1b, 5-1c and 5-1d for survey years 1991, 1996, 1999 and 2009, respectively. Tables 5-1e, 5-1f, 5-1g and 5-1h show the change in elevation between control points for years 1991-1996, 1996-1999, 1999-2009 and 1991-2009, respectively. Figures 5-2 through 5-13 illustrate the elevation profiles along each of the south stations for the four survey events.

Surface elevations measured across the IWCS between 1991 (when the configuration of the IWCS was finalized after a 1991 addition) and 2009 exhibited an average change in magnitude of only 0.1 ft (or 1.2 inches) with respect to both positive and negative elevation changes. The maximum positive and negative elevation changes were 0.34 ft at E275:S700 and negative 0.25 at E275:S1100. These values exclude an anomaly in the far northwest corner of the IWCS at location E75:S700. Surface elevations were reported to 0.01 ft. An increase in elevation of approximately 1 foot was observed at this location between 1991 and 2009. This survey point is located along the margin of the IWCS cap near an existing road where additional gravel was placed for grading purposes.

Minor positive changes appear to occur along the fringes of the IWCS, although no explanation for these positive changes is evident except that they may be due to regrading or filling of low spots near the IWCS perimeter. Table 5-1h shows that, in general, minor increases in elevation, usually less than a tenth of a foot, were observed along the northern and southern margins of the IWCS (east-west along S700-900 and S1600-1800) and along the eastern and western margins of the IWCS (north-south along E75 and E375).

Figures 5-3 through 5-10 illustrate that surface elevations along south stations 700 – 1500 are similar for all four survey events and show little fluctuation between 1991 and 2009. Slightly greater fluctuations in elevation were observed for south stations 700 – 800 and 1600 – 1800 (Figures 5-2, 5-3, 5-11, 5-12 and 5-13) over the same time period, although these fluctuations were still relatively minor considering the changes in elevation were generally less than 0.2 ft.

Between 1991 and 2009, negative elevation changes were most commonly observed in the center of the IWCS at the highest elevations, generally greater than 344 ft amsl. These elevation points correspond to east stations 175-275 and south stations 1000-1300 (Table 5-1h). The average negative change in surface elevation for this area of the IWCS during this same time period was negative 0.14 ft, with a range of negative 0.05 to negative 0.25 ft. These negative changes in surface elevation indicate that minor settling of the IWCS cap material has occurred in this central area. The central portion of the IWCS cap corresponds to the area of the original R-10 pile and where approximately 60 drums containing contaminated soils and resin, 4 steel tanks, approximately 900 boxes of soil samples, tarps, geotextiles, and other miscellaneous debris were added to trenches cut into the IWCS in 1991. Localized areas of settling greater than 1 inch, in this area were previously noted in the 2007 RIR (USACE 2007a).

In summary, topographic survey data from four survey events conducted between 1991 and 2009 indicate that the average change in elevation across the surface of the IWCS between 1991 and 2009 is approximately +/-0.1 ft. Very minor settling is evident in the central portion of the IWCS cap where the former R-10 pile was located and where waste drums and miscellaneous debris were added to the IWCS in 1991. The average negative change in surface elevation for this area of the IWCS between 1991 and 2009 was negative 0.14 ft, with a range of negative 0.05 to negative 0.25 ft.

5.3 OVERVIEW OF THE IWCS CAP MAINTENANCE PROCEDURES AND ENVIRONMENTAL SURVEILLANCE PROGRAM MONITORING TECHNIQUES

The IWCS cap consists of various layers of materials including clay, designed to minimize rainwater infiltration and minimize the potential for release of radon. Surveillance and maintenance of the cap is currently provided by the Corps as part of the ESP. Cap maintenance efforts are conducted by the Corps and its on-site grounds crew subcontractor, who are present at the site year-round, five days a week, excluding holidays. IWCS cap maintenance procedures are presented in *Turf Management Program for Waste Containment Structure* (BNI 1993) which is included here as Appendix 5-A.

Inspection and maintenance procedures conducted to ensure the integrity of the cap include:

- Monthly walkovers and visual inspections of the cap; and
- Maintaining of the cap vegetative cover.

Visual inspections are conducted on a monthly basis (at a minimum) to assess whether there is ponded water, apparent settling, cracking, excessive weeds, insects or pests, or burrowing small animals. Desiccation cracks and the growth of deep-rooting plants could provide a potential pathway for rainwater infiltration and/or release of radon gas from the IWCS. Should any such issues be discovered, corrective actions would be taken immediately. To date, no such issues have been discovered.

Maintenance of the cap vegetative cover is achieved through aeration, dethatching, fertilization, irrigation, filling ruts, mowing, pest control, pH adjustment, rolling and weed-control. Figures 5-14 through 5-17 are photographs of some of these IWCS cap maintenance activities. Accurate records for all turf management field operations involving the grass on top of the IWCS as well as the area immediately surrounding the IWCS are kept by field personnel. The IWCS turf is fertilized using commercially available, slow-release, granular or pelletized nutrients. Application rates for fertilizer, lime, sulfur and other soil amendments are based on the results of soil testing. The schedule and specific instruction for soil testing are determined by a turf management consultant as described in the *Turf Management Program for Waste Containment Structure* (BNI 1993). The IWCS turf is irrigated during periods of drought or when less than 1 inch of precipitation occurs in ten days (Figures 5-14 and 5-15). Irrigation, including natural precipitation, is at the minimum rate of 1 inch of water per week. Irrigation promotes a healthy grass cover and minimizes the potential for the cap materials at the surface to dry out and crack.

Watering is accomplished using automatic watering devices that are connected to a water source which automatically traverses across the cap, watering as it goes. Grass mowing begins in the spring and continues through to the fall. The frequency of mowing depends on the growth rate of the grass (Figure 5-16). The grass is cut when it reaches 4½ inches and is cut to approximately 2½ inches. This could result in more than one mowing per week. Aeration is performed annually before the autumn over-seed to increase the rate of air and water transfer to the grass roots. Dethatching is scheduled based on the recommendations of a turf management consultant (Figure 5-17). During fertilization, watering and mowing, field personnel visually inspect the cap for signs of cracking, settling, deep-rooted plants or burrowing animals. This is in addition to the regularly scheduled visual inspections.

Key components of the ESP that monitor the performance and integrity of the IWCS cap include:

- *Radon-222 Flux Monitoring:* Annually 180 radon flux canisters are placed on the IWCS cap to measure the release of radon-222.

- *External Gamma Radiation Monitoring:* External gamma radiation monitors are located around the IWCS and at the perimeter of the site to measure external gamma radiation dose rates.

- *Radon Gas Monitoring:* Breathing zone air surveillance is conducted to determine the concentration of radon gas at NFSS.

The ESP monitoring of radon and gamma radiation is a direct indicator of cap performance and integrity. The most direct measurement of cap performance is radon flux monitoring which is measured directly on top of the cap. Radon flux monitoring is the primary indicator of ongoing releases from the IWCS through the cap. External gamma radiation measurement taken at the site perimeter provides information regarding the magnitude of any releases, should they occur. Based on the radioactive constituents in the residues contained in the IWCS, and the isotope's short half life, it is unlikely that radon-220 would be emitted from the IWCS; however, it is possible that radon-222 would be emitted. Air surveillance is conducted to determine the concentration of both radon-220 and radon-222 gas at NFSS. The following sections contain details on each of these monitoring techniques and a discussion of the latest ESP results published in November 2009 for the 2008 ESP effort (USACE 2009e).

5.3.1 Radon-222 Flux Monitoring

Measuring radon-222 flux provides an indication of the rate of radon-222 emission from the surface of the IWCS cap (USACE 2009e). Radon-222 flux is measured with activated charcoal canisters placed at 49.2 ft (15 meters) grid across a surface for a 24-hour exposure period. At the NFSS, 180 radon flux monitors are placed on top of the IWCS cap as shown in Figure 5-18.

Measured results for 2008 ranged from non-detect to 0.23490 $pCi/m^2/s$, with an average (of detects and non-detects) result of 0.05368 $pCi/m^2/s$ (USACE 2009e). Background measured results indicated one finding of 0.05763 $pCi/m^2/s$ and two non-detect findings at 0.01054 and 0.02055 $pCi/m^2/s$ (USACE 2009e). As in previous years, these results are well below the 20.0 $pCi/m^2/s$ standard specified in 40 Code of Federal Regulations (CFR) Part 61, Subpart Q, are comparable to background levels and demonstrate the effectiveness of the IWCS cap in reducing the potential for radon-222 migration and exposure.

5.3.2 External Gamma Radiation Monitoring

External gamma radiation monitoring and radon gas measurements are taken at fence line locations surrounding the NFSS as well as interior portions of the site, including the perimeter of the IWCS.

External gamma radiation dose rates are measured using optically stimulated luminescence (OSL) dosimeters placed continuously for the year (USACE 2009e). OSL dosimeters replaced thermo luminescent dosimeters (TLDs) for 2008. Results for the IWCS perimeter, external gamma radiation monitoring for years 1998 through 2008 are summarized in Figure 5-19. Figure 5-19 shows that external gamma radiation monitoring results have typically been at or near background levels and are well below the DOE guideline of 100 millirem (mrem)/year for all pathways, excluding radon.

5.3.3 Radon Gas Monitoring

Radon monitoring at NFSS is performed at 5.6 ft or 1.7 meters above ground level which is a height that is representative of the human breathing zone. Radon concentration diminishes significantly as distance from the ground increases and mixing with ambient air takes place.

Based on the radioactive constituents in the wastes contained in the IWCS, and the isotopes short half-life, it is unlikely that radon-220 would be emitted from the IWCS; however, it is possible. NFSS air surveillance is conducted to determine the concentration of radon gas using Radtrak® detectors that are designed to measure alpha particle emissions from both radon-220 and radon-222 and to collect passive, integrated data throughout the period of exposure. However, because radon-220 is not a COC at NFSS (due to the relatively low concentrations of radium-228 in the residues and the short half-life of radon-220), all concentrations measured are conservatively assumed to be radon-222. Results of semiannual radon gas monitoring for 2008 are presented in Appendix A of the 2008 Environmental Surveillance Technical Memorandum (USACE 2009e).

Consistent with results from previous years, all radon-222 results from the 2008 ESP were well below the DOE off-site limit of 3.0 pCi/L above background. Results for the radon concentrations at all of the IWCS perimeter sample location (8RN through 24RN) for the 1st and 2nd half of the year for years 1998 through 2008 are presented by Figures 5-20 and 5-21, respectively (USACE 2009e). Without subtracting background levels the results for year 2008 ranged from non-detect (less than 0.2 pCi/L) to 0.2 pCi/L (USACE 2009e).

5.4 REVIEW OF AERIAL PHOTOS AND ASSESSMENT OF GROUNDWATER PLUMES IN THE VICINITY OF THE IWCS

The possibility that current groundwater contamination in the vicinity of the IWCS may be due to ongoing releases rather than historic releases that occurred prior to completion of the IWCS has been further evaluated through reviews of historic aerial photographs and groundwater trending data. The following discussion presents information supporting the conclusion that groundwater plumes in the vicinity of the IWCS were established prior to IWCS construction, and were truncated by construction of the cut-off wall. Additionally, long-term trends in the RI and ESP groundwater data for wells surrounding the IWCS show steady-state to declining contaminant concentration levels for total uranium suggesting that the IWCS is performing as designed. An exception to this observation is well OW11B, which exhibits an increasing trend in uranium concentrations. However, this well is near a former pipeline east of the IWCS and is no longer considered to be part of the groundwater plume. Possible reasons for the increasing trend at well OW11B are discussed below. Additionally, trending analysis of radium-226 concentrations in groundwater indicate that, on a 95% confidence level, only the ESP background well (B02W20S), which is not located within a groundwater plume area, exhibits an increasing trend of radium-226. Wells surrounding the IWCS exhibited no trends of radium-226, but four wells were identified with possible upward trends of radium-226 that are not definitive due a lack of statistical strength (e.g., a small number of available sample results). Full details of the trending analyses are provided in the discussion below.

Figure 5-22 compares historical site operations documented by a 1956 aerial photo of the IWCS area with current levels of dissolved total uranium in groundwater in this same area. One of the key features in the 1956 aerial photo is the radioactive R-10 storage pile which was left uncovered and unprotected in this area for a number of years. The uranium groundwater plumes west of the IWCS correspond to the location of the former radioactive R-10 storage pile that is now enclosed with the IWCS. Groundwater plumes may appear to be emanating from the IWCS, however, aerial photos showing historic site operations, the RI data, and longer-term ESP data trends do not support this conclusion.

The uranium groundwater plumes south of the IWCS are believed to be associated with former Building 409 and nearby residue storage activities. The 1956 aerial photo also shows material piles located south of the IWCS that correspond to elevated concentrations of dissolved total uranium observed in area groundwater. Historical documentation and analysis of aerial photos indicates that in the late 1940s, contaminated metal, concrete, lumber and reduction slag from other wartime plants were shipped to the NFSS and stored adjacent to Building 409, which was located just south of the IWCS, prior to and during IWCS construction. As with other documented storage areas on-site, there is localized groundwater contamination in this area, which may be due to leaching from contaminated soil associated with this temporary storage, as well as historic use of Building 409 prior to IWCS construction. The R-10 pile and the material storage piles evident in the 1956 aerial photograph are now contained within the IWCS.

If a release from the IWCS to surrounding soil and groundwater was occurring, groundwater sampling results at wells used to monitor cell integrity would be expected to show increasing concentrations of radionuclides over time. Because total uranium and radium-226 are primary radiological contaminants associated with the wastes and residues stored within the IWCS, these two constituents were selected for evaluation of concentration trends to further assess the integrity of the IWCS. Groundwater sampling results from wells located near the perimeter of the IWCS were examined for evidence of increasing or decreasing trends of uranium and radium-226. Groundwater data collected from 1997 through 2010 were used to perform trend analyses at single well locations using the Mann-Kendall Test, a non-parametric statistical test routinely used to assess trends in groundwater concentration data. Fourteen wells were used for evaluation of uranium trends, while ten wells were used for evaluation of radium-226 trends. One well, B02W20S, located in the northeastern portion of the NFSS, was selected to represent on-site background concentrations because it is upstream from site impacted groundwater (USACE 2010). Because site-specific background data compiled for the RI were found to be comparable to historic groundwater concentrations from B02W20S, this well was verified to be representative of on-site background conditions (USACE 2010). Well B02W20S in the ESP dataset is also known as well OW20S in the RI and shown in EU 5 on Figure 1-5. A complete list of wells and summary statistics of the groundwater data used in the trend analyses are included in Appendix 5-C.

No increasing or decreasing trends in total uranium concentrations were identified in 10 of 13 wells used for analysis of trending near the IWCS. A decreasing trend in total uranium concentrations was identified at wells A45 and OW06B, while an increasing trend was identified at well OW11B. Due to a small number of available sample results, a non-definitive increasing trend was determined for well OW7B. The increasing trend in total uranium at well OW11B was further examined by considering the location of the well with respect to subsurface utilities and by reviewing soil and groundwater sampling results from nearby sample locations. OW11B is located to the east of the IWCS near multiple underground pipelines. Portions of these pipelines, which extended from former Building 410 across the dike area, were removed during construction of the IWCS. Therefore, a direct pathway for contaminant migration no longer exists from the IWCS via these pipelines. A surface soil sample collected from boring 857, which is located immediately adjacent to OW11B, exhibited a total uranium concentration of 24.3 µg/g. This concentration is greater than the surface soil background concentration of 3.94 µg/g; however, the total uranium concentration in subsurface soil from this same location at a depth of 11 ft (1.11 µg/g) did not exceed the subsurface soil background concentration of 3.58 µg/g. Additionally, concentrations of

radium-226 in surface and subsurface soil at location 857 did not exceed background concentrations. These soil results indicate that there was no significant soil contamination in this area at the time the samples were collected. Soil samples were collected at sampling location 857 during the RI in 2003 (USACE 2007a). A steady increase in total uranium concentrations in groundwater has been observed at well OW11B since this time, suggesting that RI activities conducted near this well may have compromised the integrity of the pipeline. The presence of a crack in a pipeline near well OW11B could allow contaminants within the pipeline to be released to groundwater, which could explain the increasing trend of total uranium concentrations observed at this well location. To address this uncertainty, the Corps will conduct additional field activities during the BOP FS, including investigation of the integrity of the underground utility lines south and east of the IWCS.

Groundwater trending results indicate that, at a 95% confidence level, the ESP background well, B02W20S, which is not located within a groundwater plume area, is the only well that definitively exhibits an increasing trend of radium-226. However, wells A50, OW06B, OW15B, OW17B were identified with possible upward trends of radium-226 that are not definitive due a lack of statistical strength (e.g., a small number of available sample results). Additionally, wells OW04B and OW13B have positive correlation coefficients. This suggests that the concentration of radium-226 in groundwater could be increasing with time overall. Radium-226 was widely detected in surface soil across much of the NFSS at concentrations greater than the background concentration of 0.92 pCi/g. Site-wide concentrations of radium-226 in subsurface soil were also detected above the background concentration of 1.2 pCi/g, but at a much smaller frequency than for surface soil. Soil data in the area of the ESP background well is limited; therefore, the reason for the observed increasing trend of radium-226 in this well cannot be determined at this time. Analytical results for this well are mostly non-detect with the greatest detected concentration being 0.765 pCi/L, which is well below the MCL of 5 pCi/L. The increasing trend of radium-226 in ESP background well B02W20S will be further investigated during the BOP FS. However, observed radium-226 concentrations in surface and subsurface soil in groundwater plume areas do not appear to represent a source for current groundwater contamination observed in these areas.

Section 4 of this RIR Addendum includes a review of soil data to determine if potential contaminant sources lie within the surface and subsurface soil in the proximity of the uranium groundwater contamination surrounding the IWCS. This review indicated that some radiological constituents are present above background levels in surface and subsurface soil in the area south of the IWCS and could potentially contribute to groundwater contamination over time. For example, concentrations of uranium were observed above background levels in soils at TWP833 (40.2 µg/g) and EU102 (69.4 µg/g). The review of soil and groundwater data also indicates that most observed total uranium concentrations in soil within the plume boundary do not exceed background levels and therefore, the current elevated soil results do not account for the magnitude of radiological groundwater contamination observed near the IWCS. Most contaminated site soils that contributed to existing groundwater contamination were removed during remedial activities conducted during the 1980s. Total uranium contamination identified in groundwater at TWP833 (958 µg/L) is believed to be associated with the uranium plume near Building 409, which was derived from historic Building 409 operations and nearby radiologic materials storage. Additionally, well OW6B, located north of TWP833 and closer to the south end of the IWCS, does not demonstrate an increasing trend in uranium concentration. Uranium concentrations observed in well OW6B are also much lower than concentrations detected in TWP833. These results support the conclusion that the IWCS is functioning as designed and is not a source for contamination currently observed in this area.

Thus, historical evidence and on-going site sampling data suggest that the groundwater plumes adjacent to the IWCS are artifacts of past contamination prior to installing the cut-off walls and constructing the IWCS, and not the result of leakage from the IWCS. However, the Corps will continue to maintain and

monitor the site and evaluate, in the IWCS FS, long-term remedies to ensure future protectiveness of human health and the environment. Additionally, during the BOP FS, the Corps will conduct additional field activities to address BOP data gaps, such as the integrity of the underground utility lines south and east of the IWCS.

5.5 ASSESSMENT OF POTENTIAL FOR PIPELINES TO PROVIDE A PATHWAY FOR RELEASES FROM THE IWCS TO THE ENVIRONMENT

During the public information session held in September 2008, following release of the 2007 RIR, concern was expressed that pipelines within the IWCS that connected former freshwater treatment plant buildings might allow for contaminant migration to groundwater. The possibility of contaminant transport via pipeline bedding material exists, but due to the absence or discontinuous nature of bedding material in the majority of the underground utility lines investigated at the former LOOW, this threat is reduced. The potential for these pipelines to act as preferential pathways for contaminant flow is very low for the following reasons:

- As-built drawings reviewed during the RI for former LOOW freshwater treatment plant buildings do not indicate the use of any bedding material for pipelines. As-built drawings for former LOOW freshwater treatment plant buildings also show that the building foundations and the connecting pipelines are located in the brown clay layer, which, due to the clay's low permeability, reduces the potential for contaminant migration surrounding the pipelines. Furthermore, approximately 18 ft of low-permeability gray clay, which underlies the brown clay layer, inhibits potential vertical groundwater flow and contaminant transport from the pipelines.

- Results of the UURI indicated that the 42-inch diameter water supply line that traverses from the LOOW fresh water treatment plant (located on the NFSS) was not underlain by bedding material.

- Pipelines connecting the former LOOW freshwater treatment plant buildings were removed or filled and the ends plugged (USDOE 1986).

During the RI, hundreds of geologic logs for monitoring wells or boreholes that fully penetrate the upper clay till were used to construct three-dimensional structure maps of the glacial deposits at the NFSS to provide an understanding of what things look like underground. Figure 5-23 presents a cross-section through the IWCS showing building foundations and the subsurface lithology. Updated IWCS cross-sections drawn to evaluate the presence of sand lenses in the vicinity of the IWCS are presented in Appendix 12-J of this report. One important feature of the NFSS lithology is the presence of a low-permeability gray clay layer that occurs approximately between 285 and 303 ft amsl. The building foundations of the former LOOW freshwater treatment plant, and the pipelines that connected them were placed within brown clay, which lies over the low-permeability gray clay unit into which the IWCS cut-off wall is keyed.

The IWCS was constructed with a compacted clay cap and cut-off walls keyed into low-permeability gray clay to minimize the likelihood of contaminant movement within the structure. The clay cap was designed, and is maintained, to minimize rainwater infiltration and minimize the potential for release of radon. Low rainwater infiltration reduces that amount of groundwater available inside the IWCS for contaminant transport.

Historical documents and as-built construction drawings indicate that subsurface piping within the planned confines of the IWCS were to be excavated from building perimeters to an area immediately outside the planned cut-off wall. Pipelines that connected the former LOOW freshwater treatment plant buildings (including Buildings 409, 410, 411, 412, 413 and 414 and the 42-inch intake line) that were

filled, removed or plugged are shown on Figure 5-24 which is a poster that was presented at the NFSS Public Workshop held September 10, 2008. Figure 5-24 is based on the South Dike Piping Plan and Schedule the *Design Report for the Interim Waste Containment Facility* (USDOE 1986). Pipelines within the IWCS were removed or filled and the ends plugged, to eliminate possible pathways for the migration of radionuclides and to prevent future subsidence of compacted wastes. Details for IWCS pipe plugging and cut-off wall elevations are included in the *Design Report for the Interim Waste Containment Facility* (USDOE 1986). Drawings documenting pipeline removal and sealing activities from this report are presented in Appendix 5-B (USDOE 1986). The pipelines were capped or plugged with concrete. Pipelines less than 10 inches in diameter were opened by breaking with a hydraulic hammer and were sealed by placing concrete into the lines. Pipelines greater than 10 inches in diameter were sealed by insertion of a wooden plug matching the diameter of the pipeline to hold the concrete in place. Pipelines opened by drilling a hole in the top were plugged by placing a wooden plug into the hole and applying concrete around the base of the plug to seal it (EA 2006). Liquid was encountered in the sanitary sewer line extending north from the NFSS, the sanitary sewer line was plugged on the NFSS and the associated manhole located north of the NFSS was plugged. The sanitary sewer line and associated manhole was sealed with 9.5 yards of 4000 psi cement with 1.5% Daraccel (to reduce the amount of water required and reduce shrinkage (EA 2008). Pipeline removal, filling and sealing further reduced the possibility of contaminant transport from the pipelines within the IWCS. During the BOP FS, the Corps will conduct additional field activities to address BOP data gaps, such as the integrity of the underground utility lines south and east of the IWCS.

Further documentation regarding the configuration of pipes and drains in the former LOOW water treatment and distribution system (Buildings 409-415) is provided in Section 4.2 of the *Comprehensive Characterization and Hazard Assessment of the DOE-Niagara Falls Storage Site* (Battelle 1981). This report includes a summary of pipes and connections between the residue storage buildings, as well as the 42-inch supply line, along with documentation regarding the condition of the pipeline (i.e. functional, sealed, severed, plate sealed, etc.). This report notes that the 42-inch water line originally designed to bring water from the Niagara River had been severed by the Town of Lewiston, near Pletcher Road.

5.6 SUMMARY

Through the completion of three investigative phases of the RI and regular monitoring of radon levels near the IWCS, as part of the ongoing ESP, it has been determined that the IWCS is functioning as designed and does not pose an immediate threat to human health and the environment near the NFSS.

During the RI, non-intrusive means were used to assess the integrity of the IWCS in its current state in order to maintain the protectiveness of the cover and cutoff walls. The IWCS cap maintenance procedures ensure the continuing physical integrity of the IWCS cap, while RI and ESP monitoring results demonstrate the effectiveness of the cap in reducing the release of radioactive contaminants from the IWCS. Pipeline removal, filling and sealing further reduced the possibility of contaminant transport from the pipelines within the IWCS. However, during the BOP FS, the Corps will conduct additional field activities to address BOP data gaps, such as the integrity of the underground utility lines south and east of the IWCS.

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SECTION 5

FIGURES

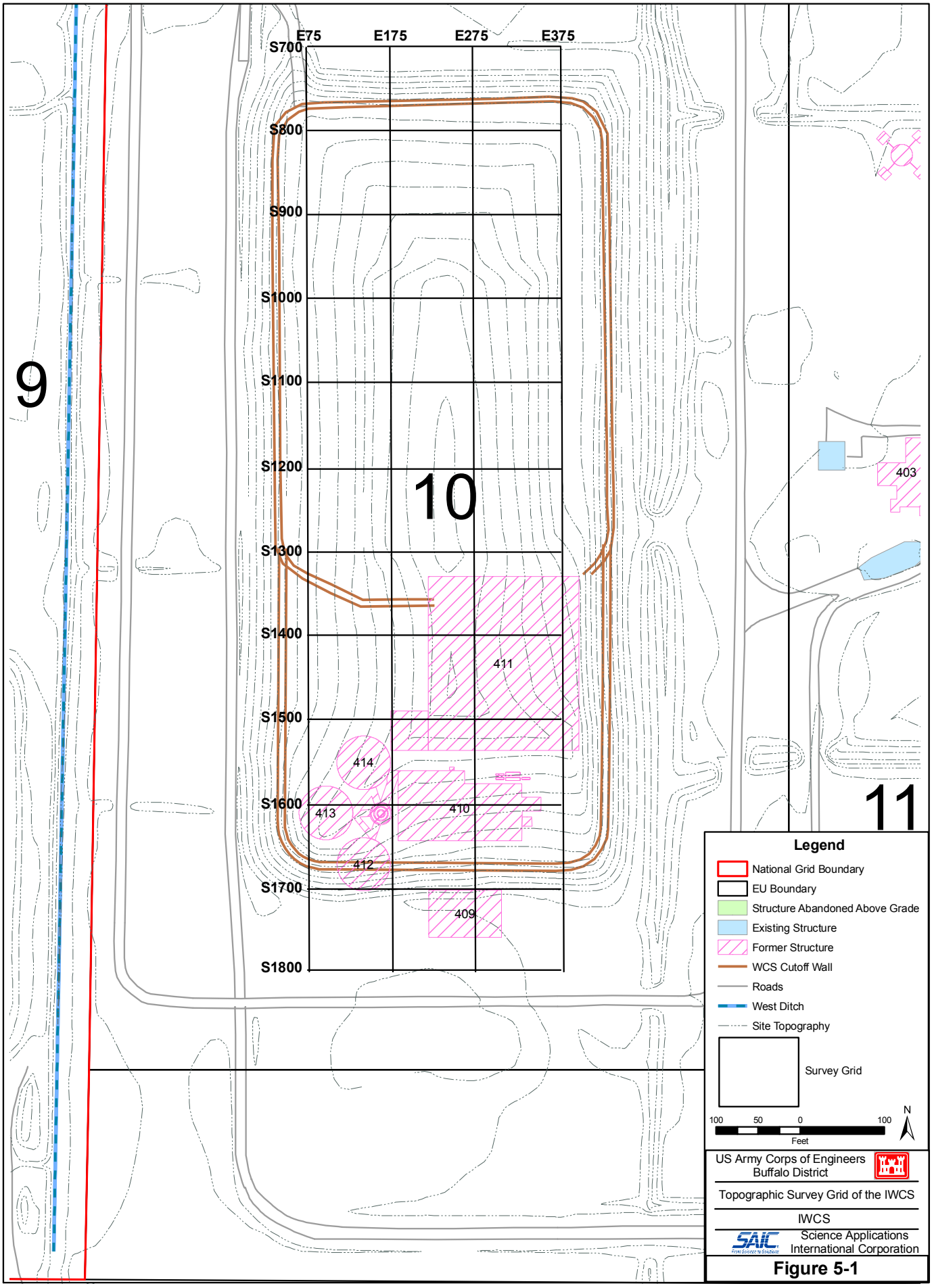

E75
E175
E275
E375
S700
S800
S900
S1000
S1100
S1200
S1300
S1400
S1500
S1600
S1700
S1800
9
10
11
403
411
414
413
410
412
409
Legend
National Grid Boundary
EU Boundary
Structure Abandoned Above Grade
Existing Structure
Former Structure
WCS Cutoff Wall
Roads
West Ditch
Site Topography
Survey Grid
100 50 0 100
Feet
N
US Army Corps of Engineers
Buffalo District
Topographic Survey Grid of the IWCS
IWCS
SAIC
Science Applications
International Corporation

Figure 5-1

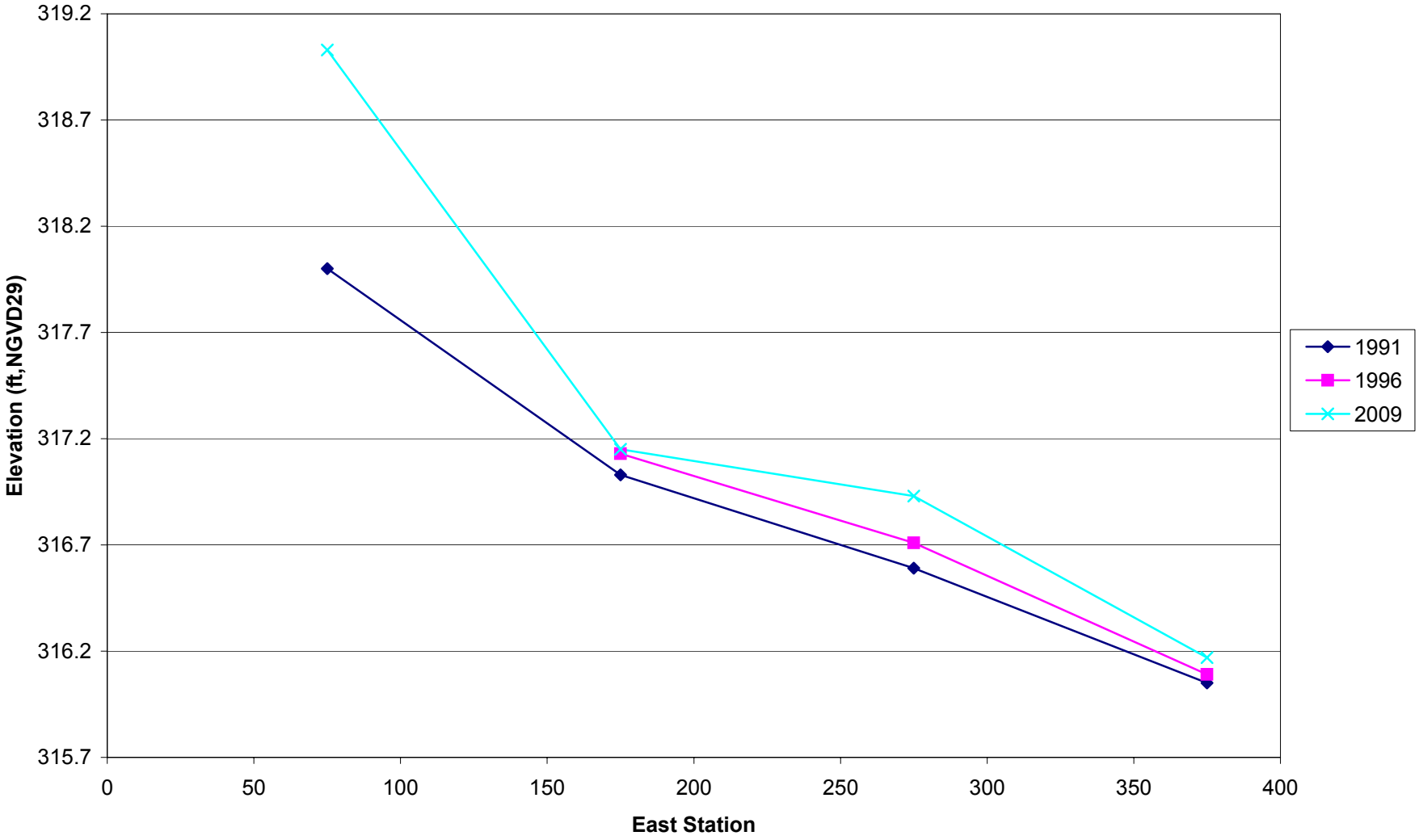


Figure 5-2. IWCS Topographic Survey South Station 700 Surface Elevation Profile

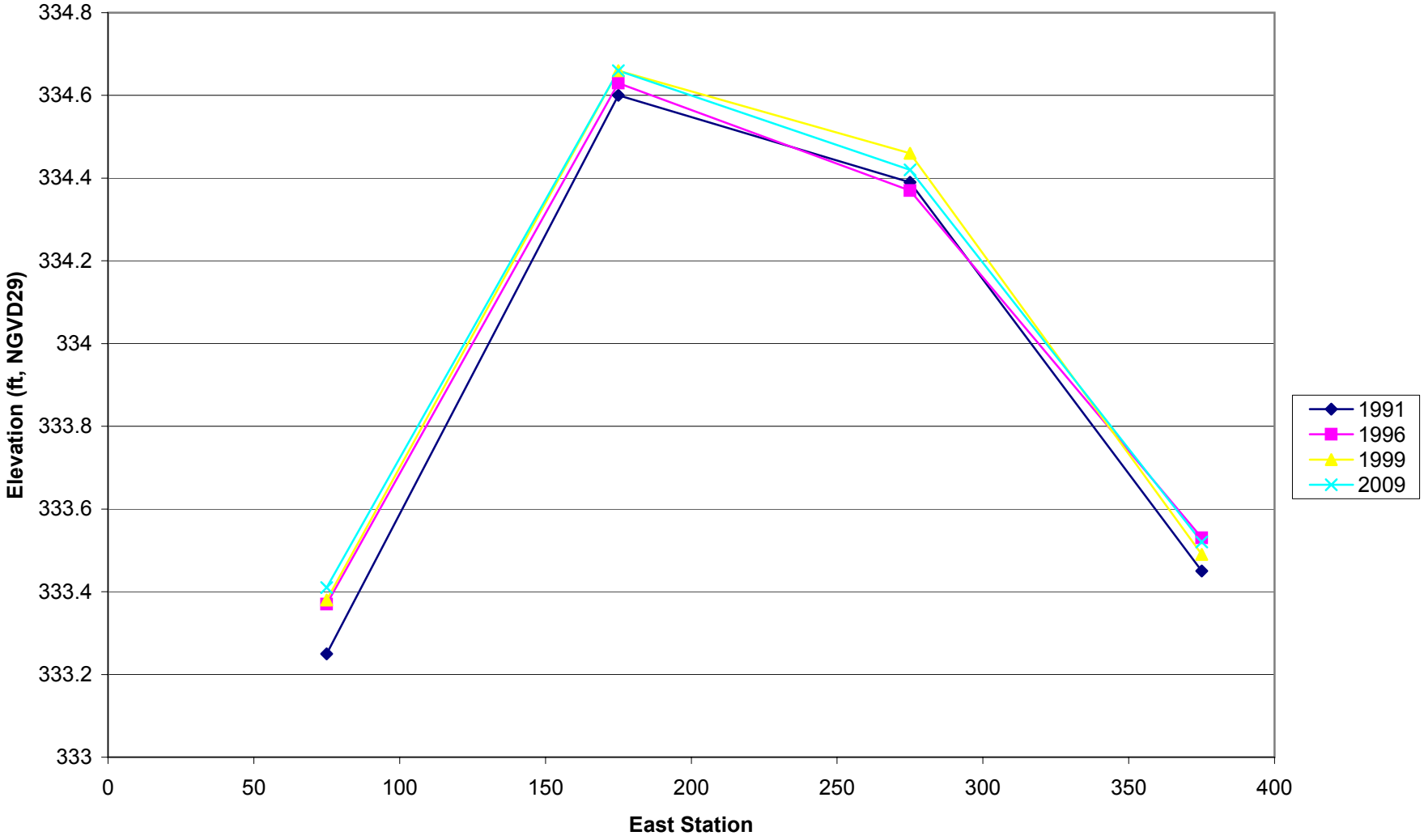


Figure 5-3. IWCS Topographic Survey South Station 800 Surface Elevation Profile

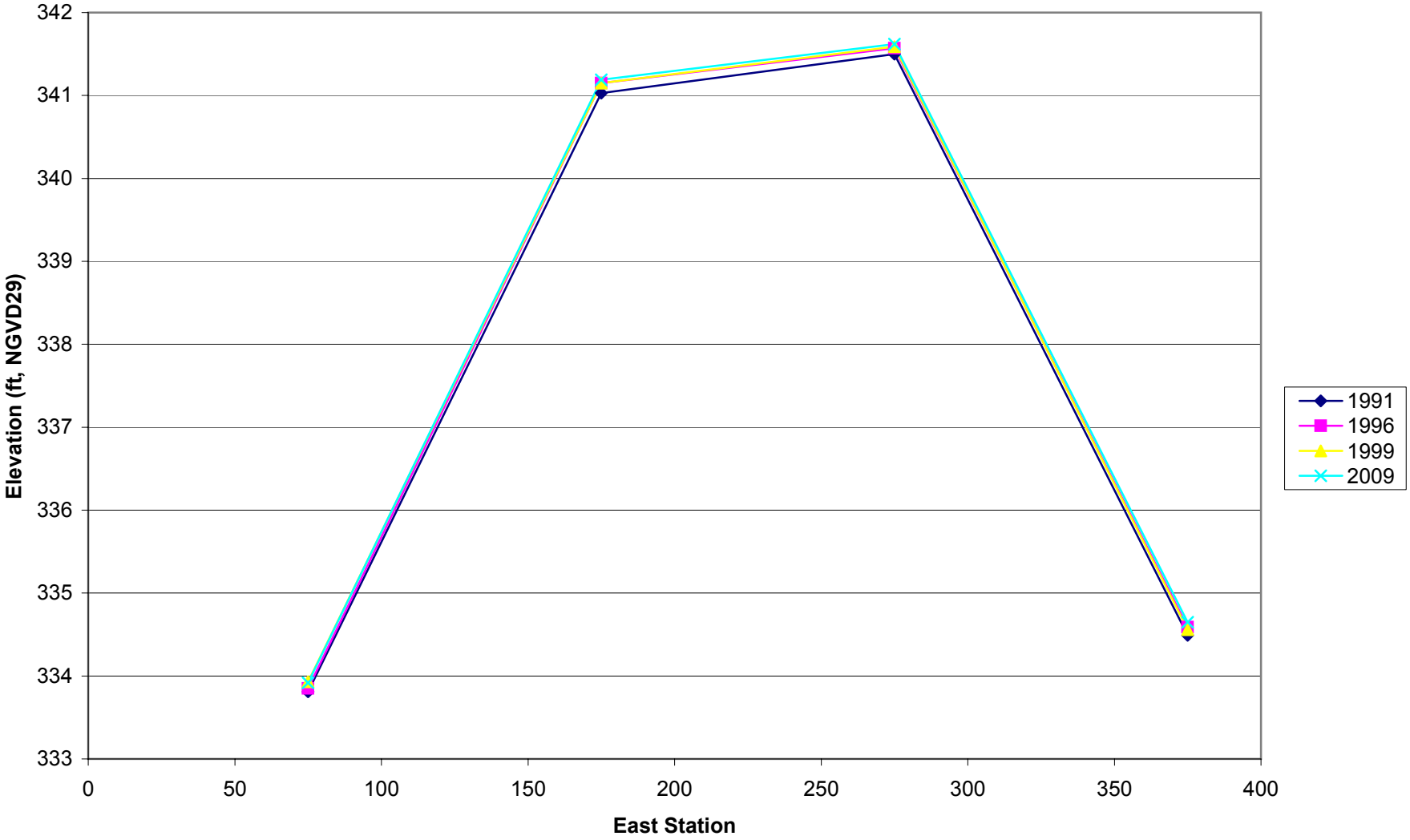


Figure 5-4. IWCS Topographic Survey South Station 900 Surface Elevation Profile

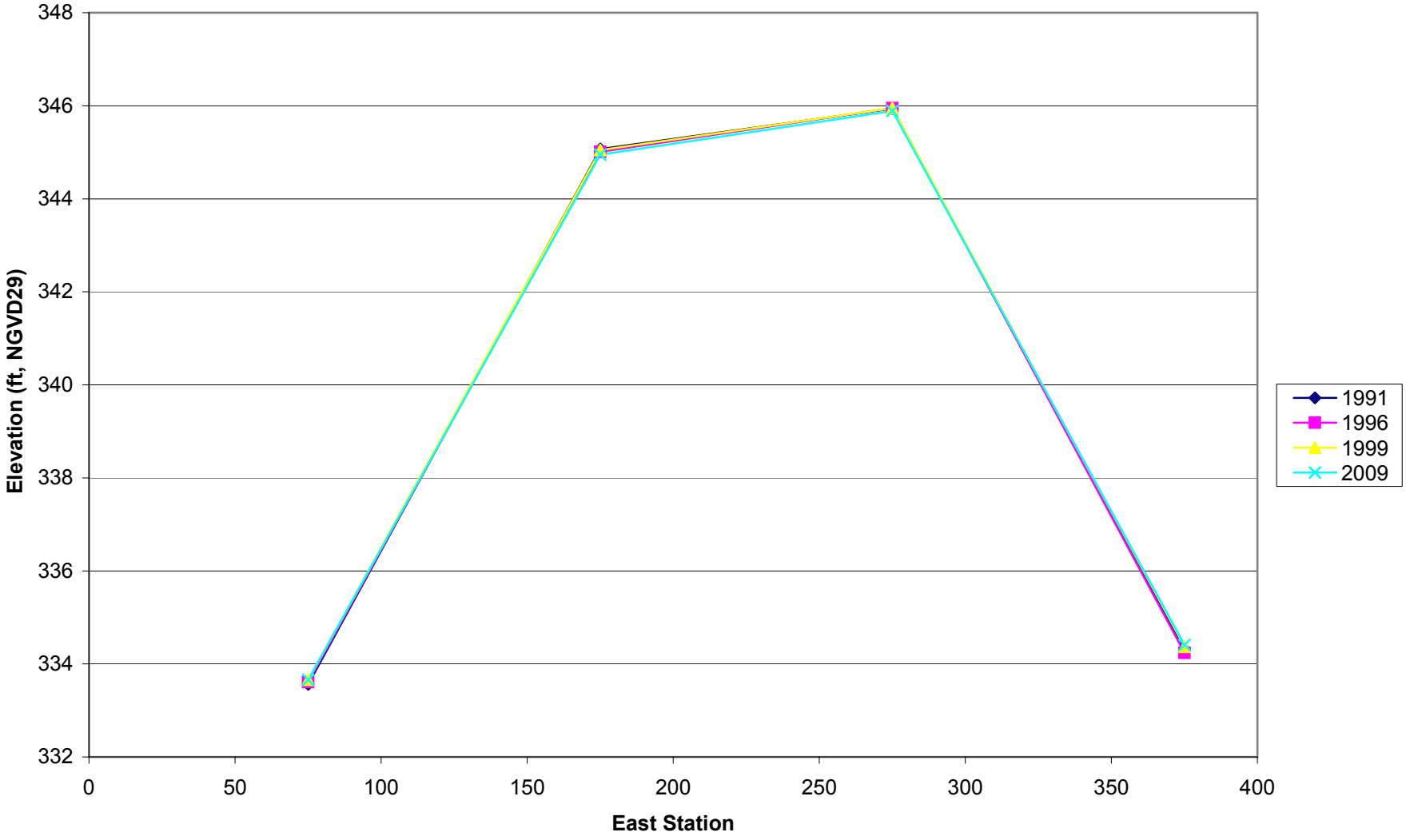


Figure 5-5. IWCS Topographic Survey South Station 1000 Surface Elevation Profile

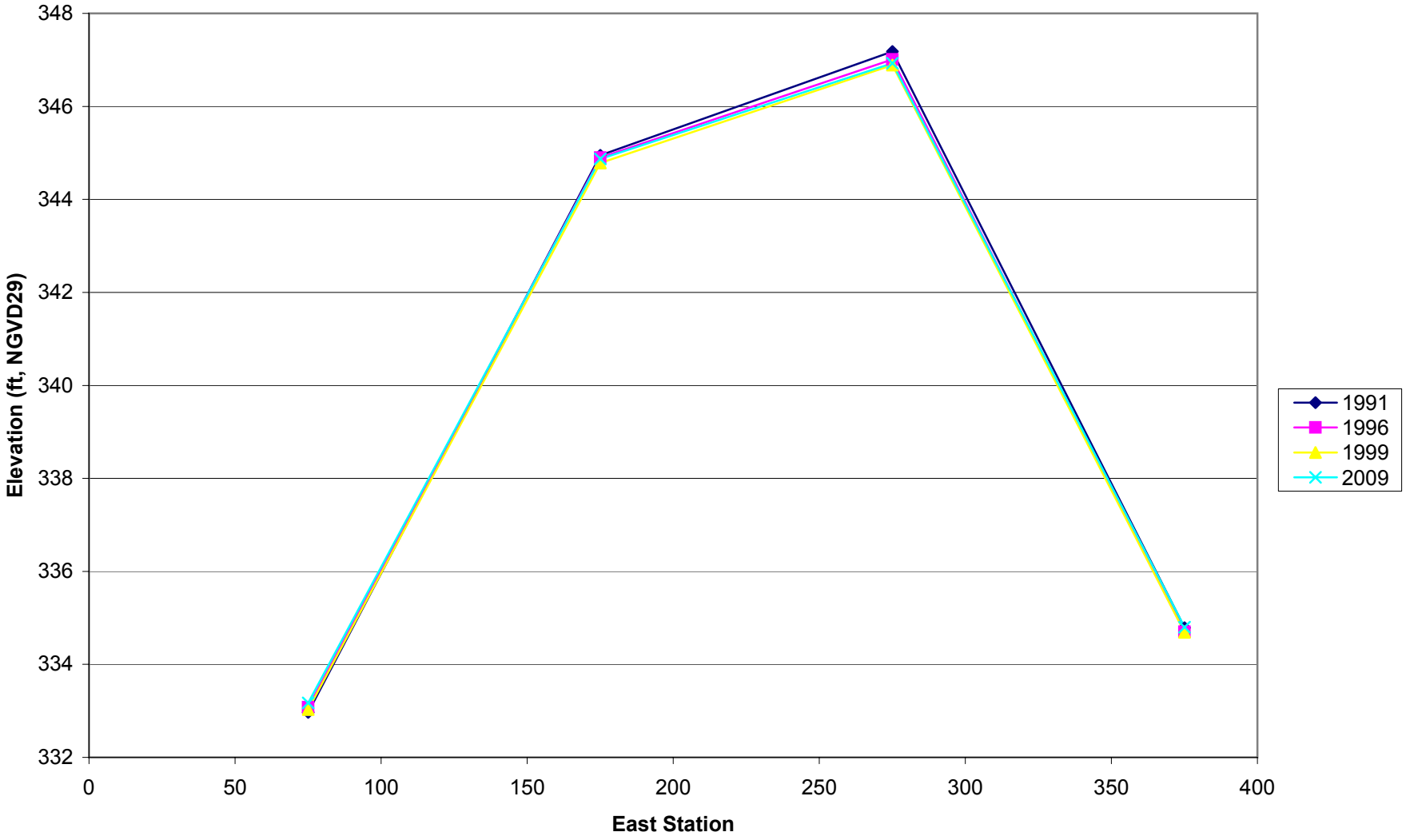


Figure 5-6. IWCS Topographic Survey South Station 1100 Surface Elevation Profile

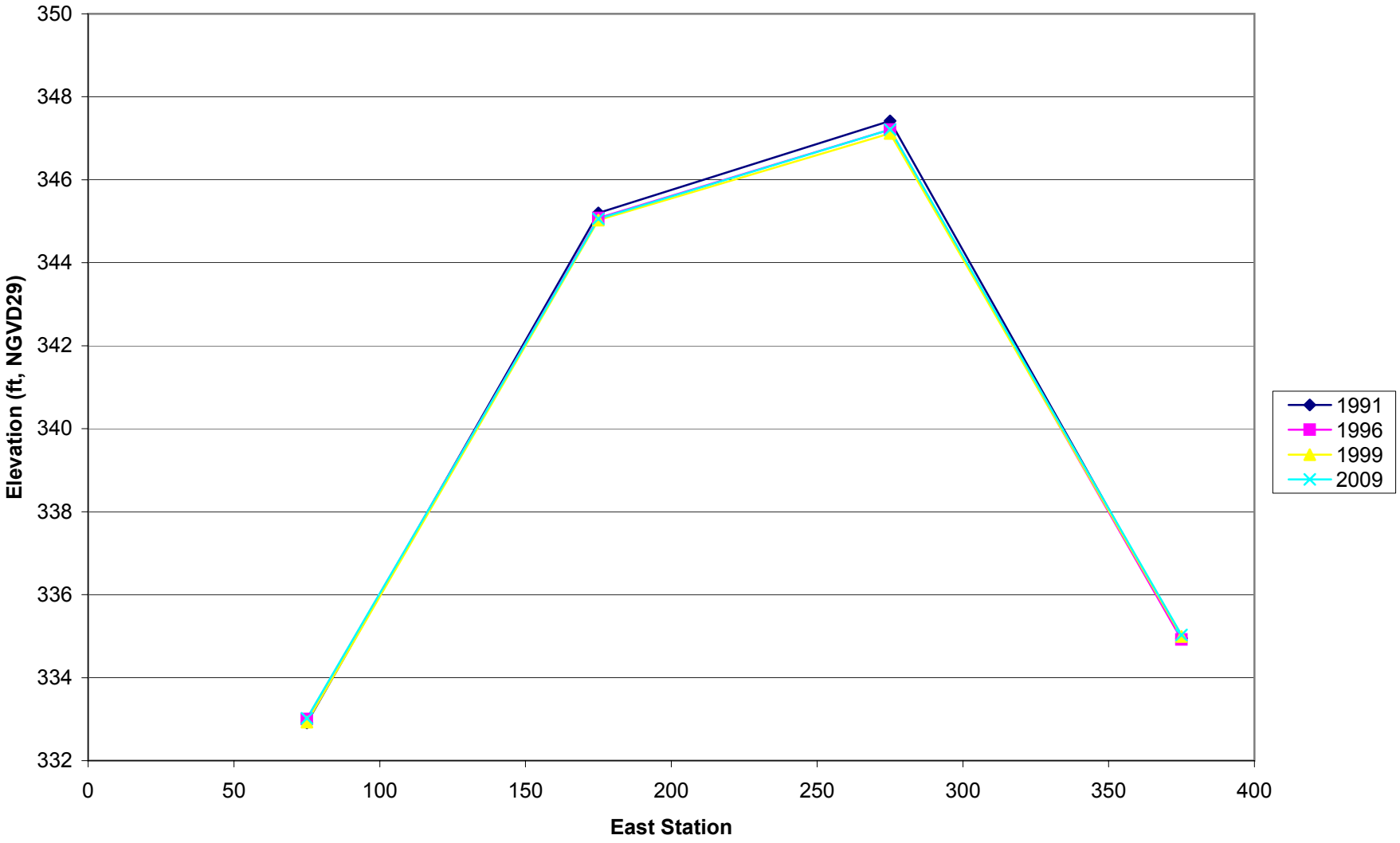


Figure 5-7. IWCS Topographic Survey South Station 1200 Surface Elevation Profile

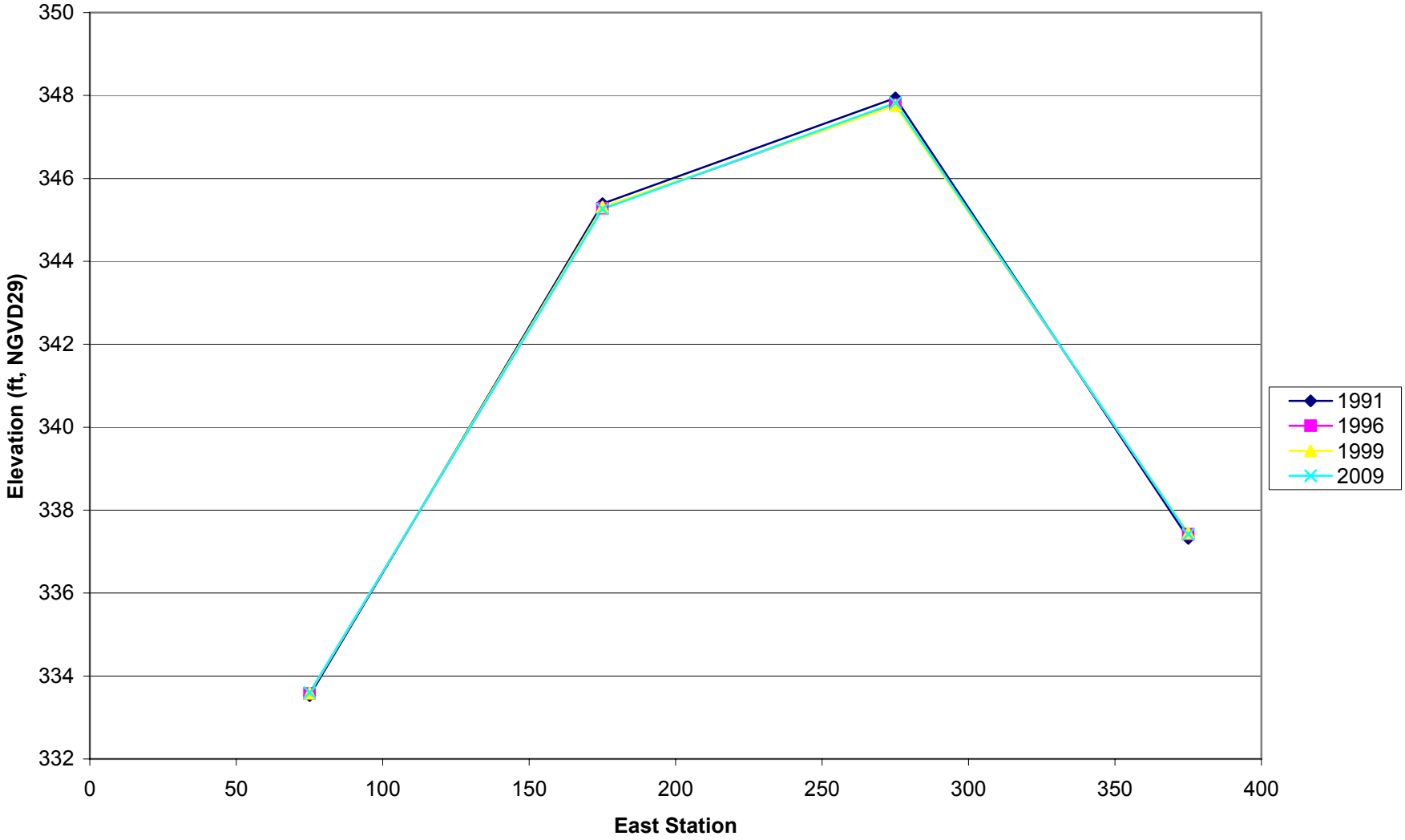


Figure 5-8. IWCS Topographic Survey South Station 1300 Surface Elevation Profile

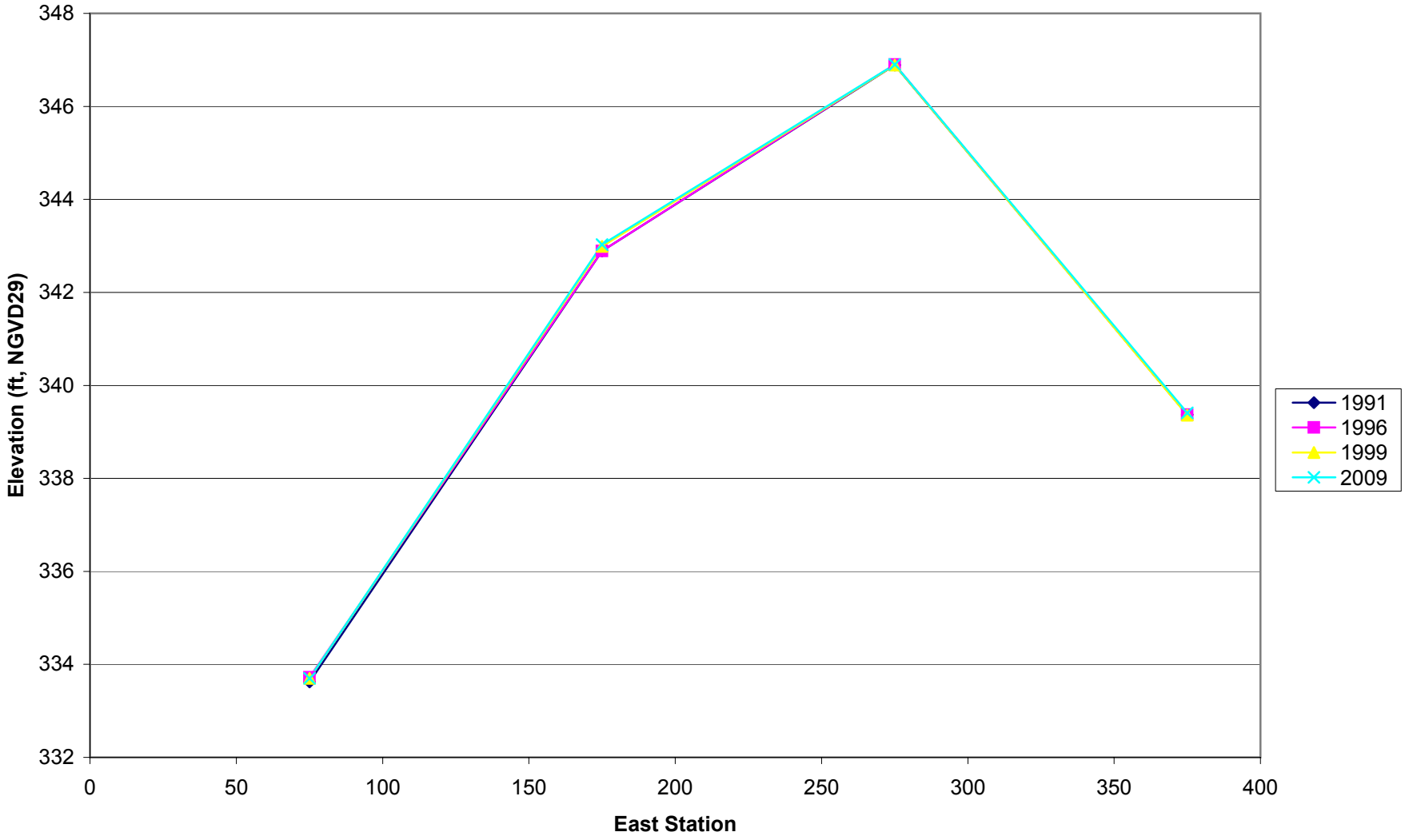


Figure 5-9. IWCS Topographic Survey South Station 1400 Surface Elevation Profile

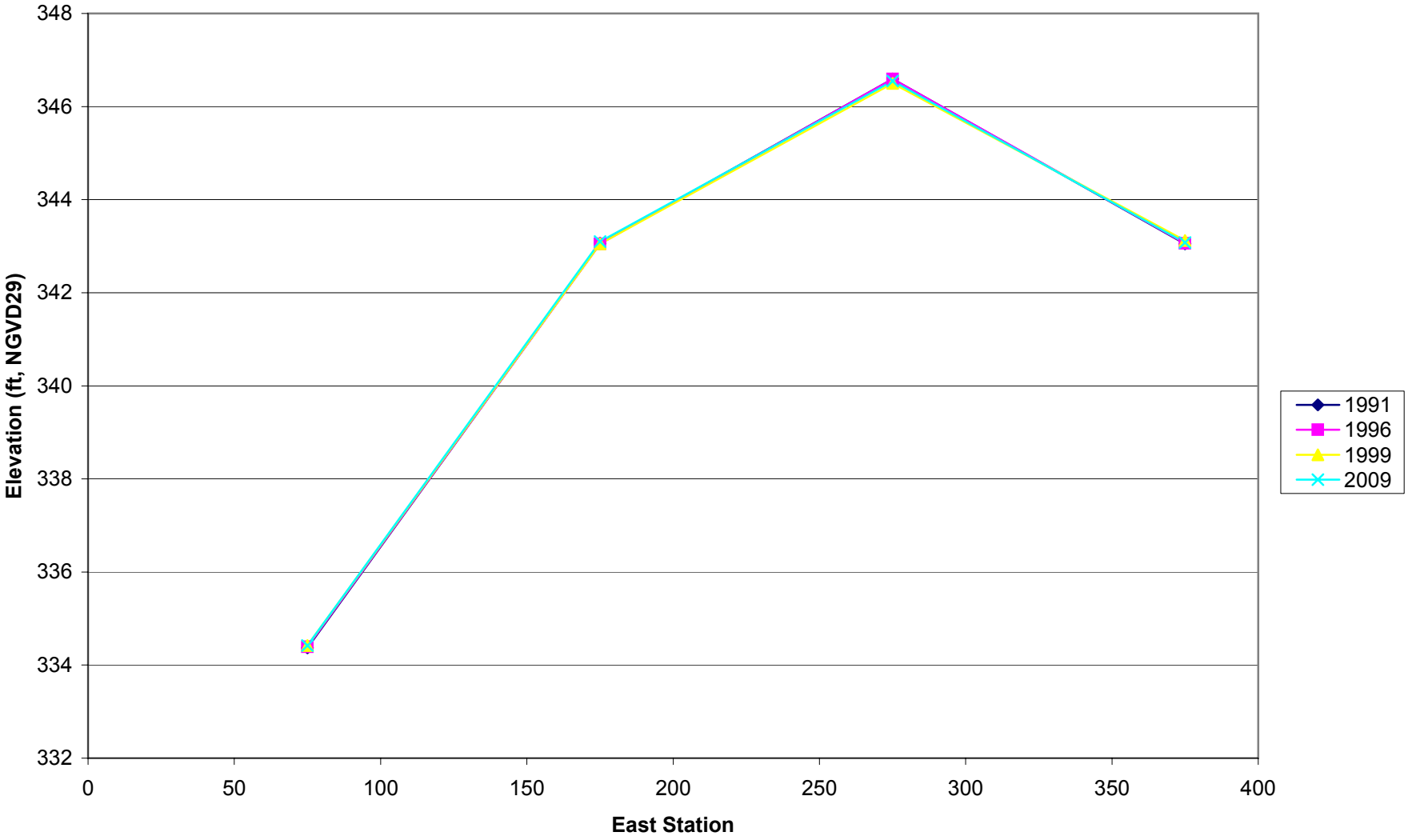


Figure 5-10. IWCS Topographic Survey South Station 1500 Surface Elevation Profile

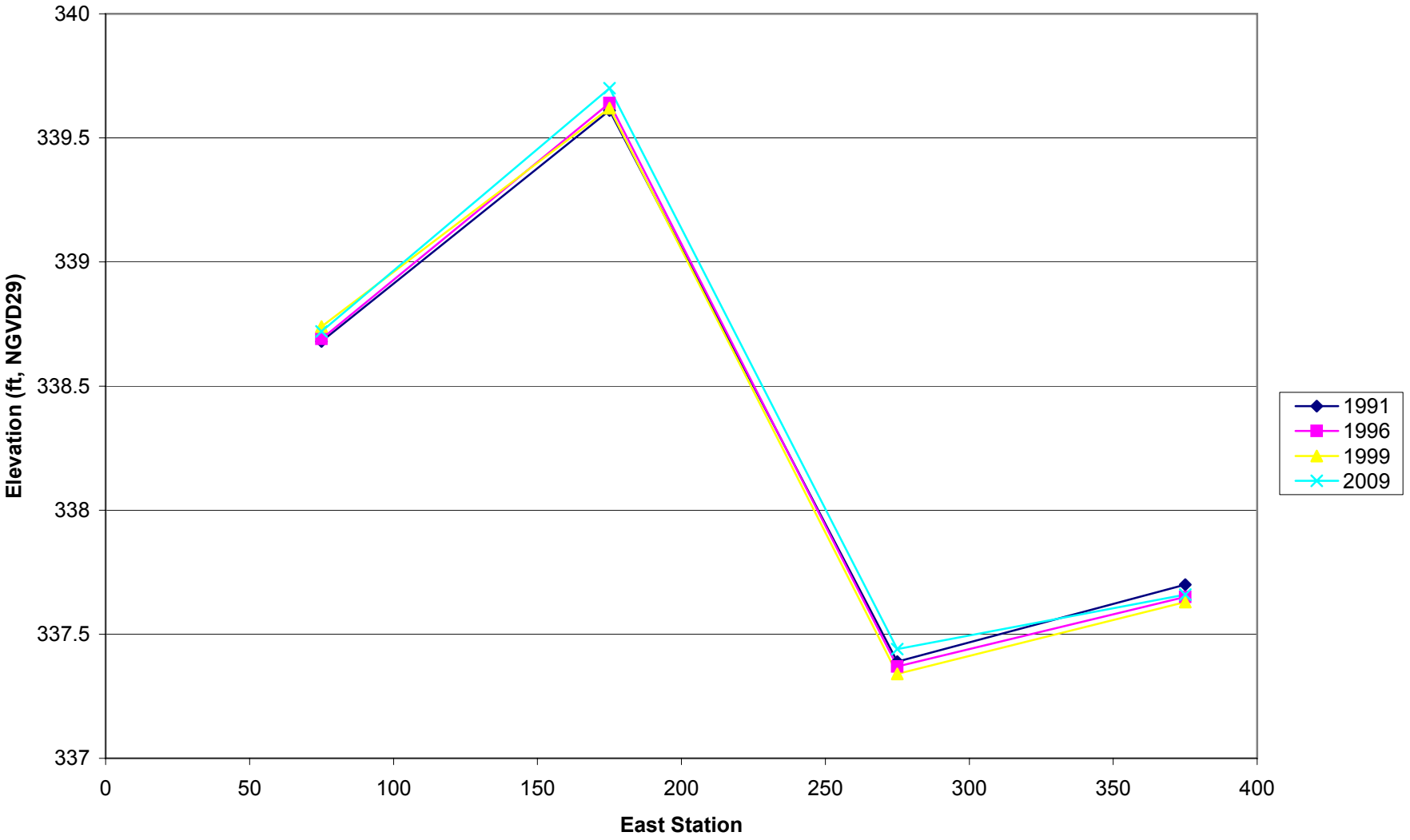


Figure 5-11. IWCS Topographic Survey South Station 1600 Surface Elevation Profile

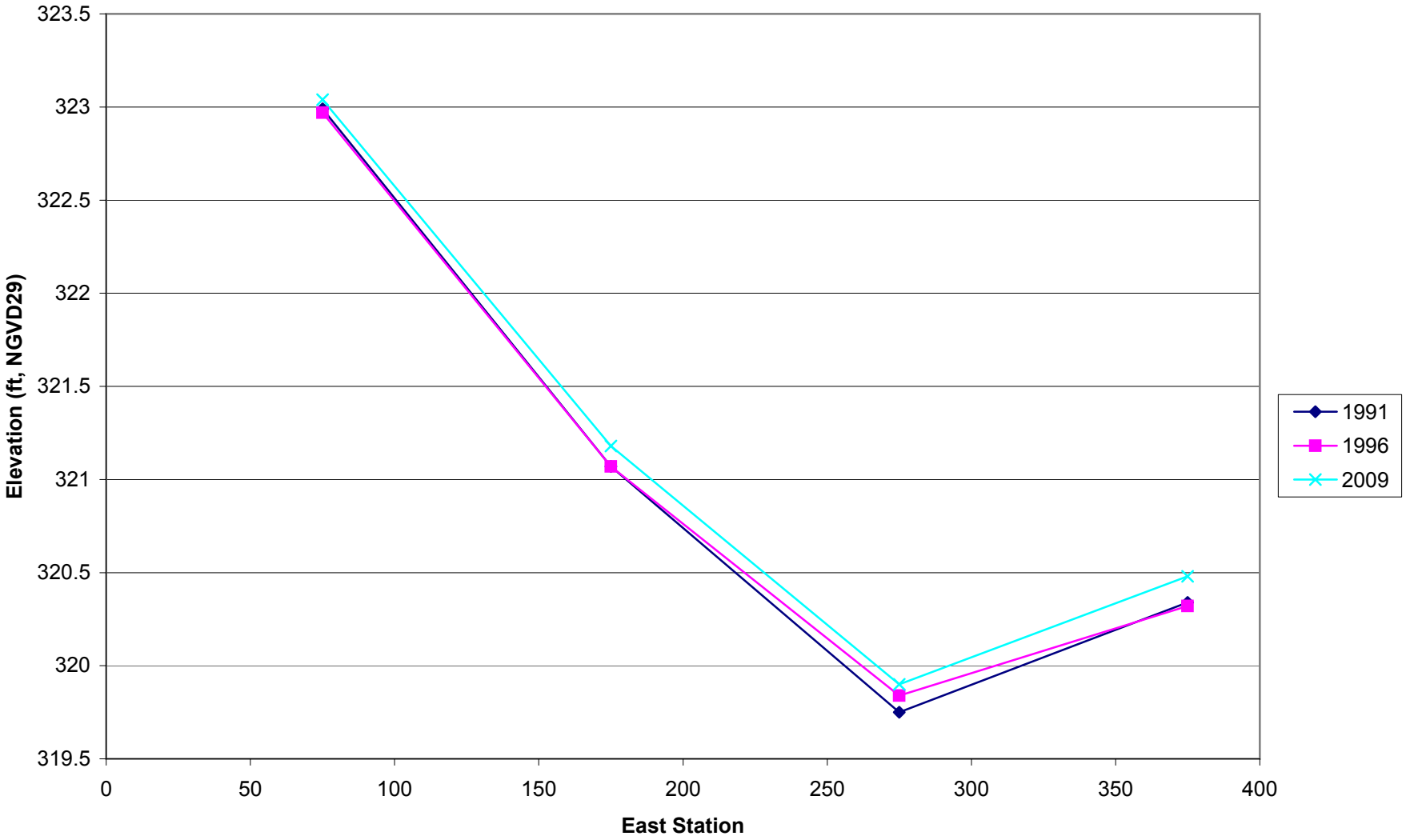


Figure 5-12. IWCS Topographic Survey South Station 1700 Surface Elevation Profile

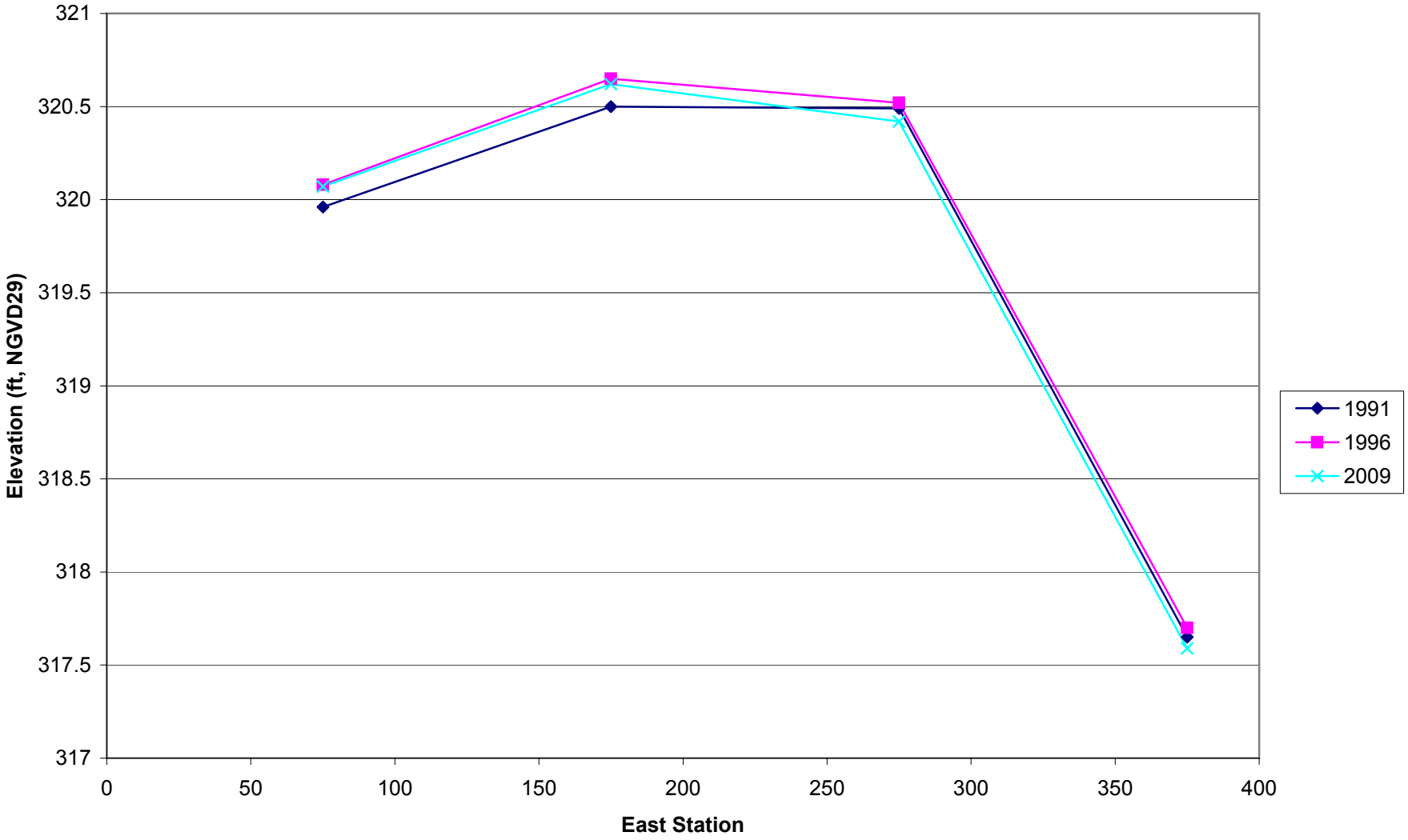


Figure 5-13. IWCS Topographic Survey South Station 1800 Surface Elevation Profile

Figure 5-14. Irrigating the IWCS Cap

Figure 5-15. Irrigating the IWCS Cap

Figure 5-16. Mowing the IWCS Cap

Figure 5-17. Rolling and Aerating the IWCS Cap

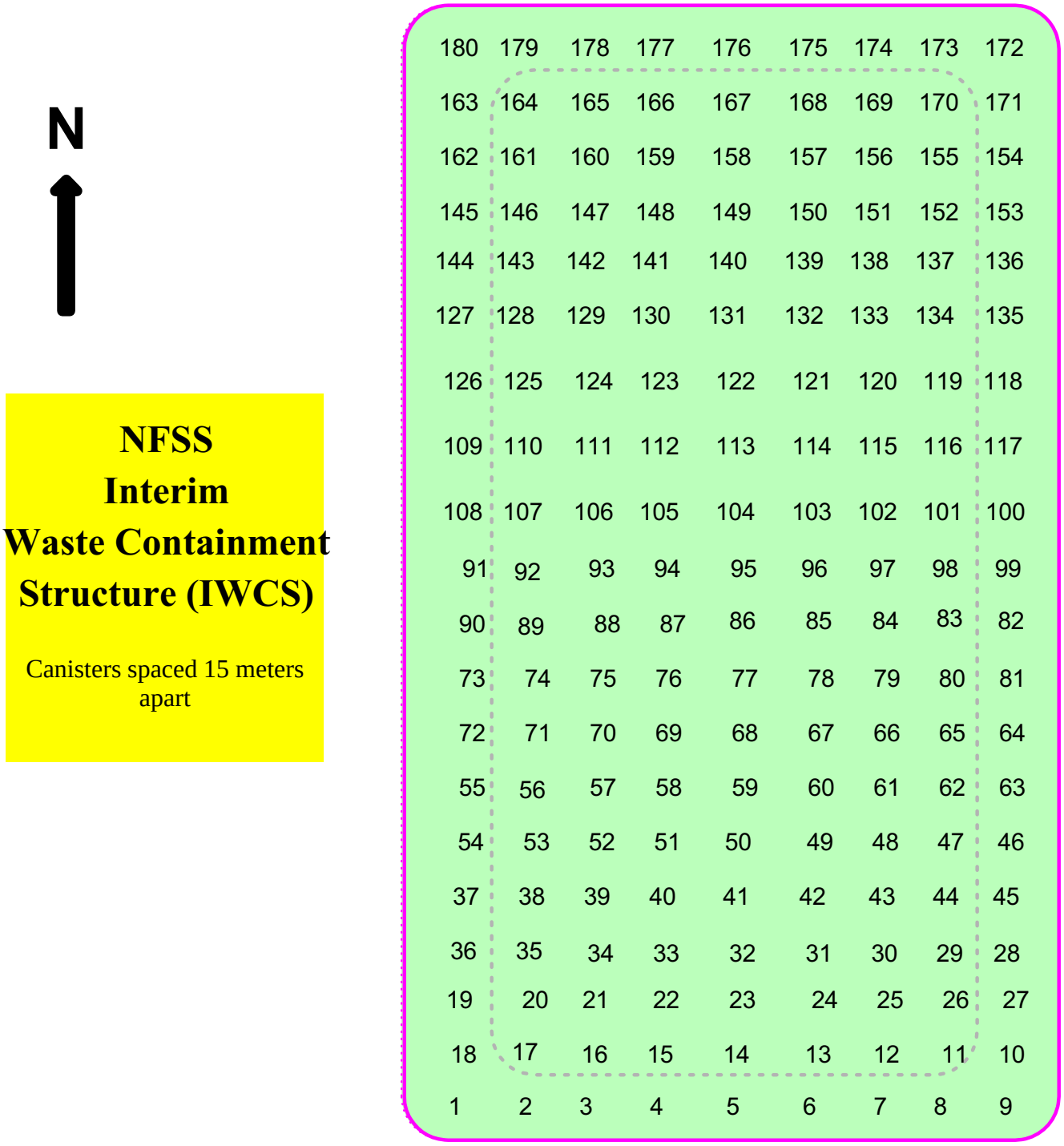
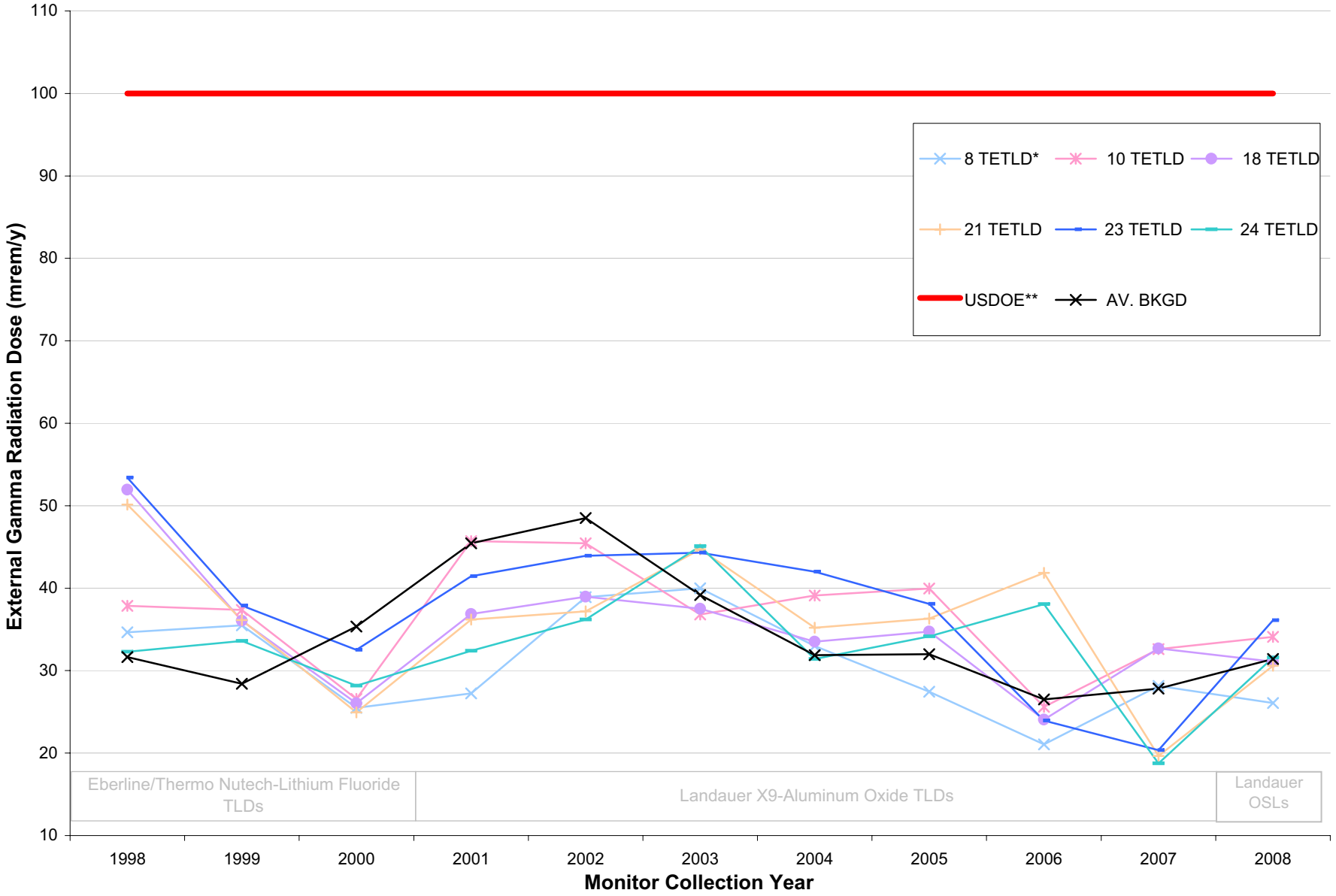
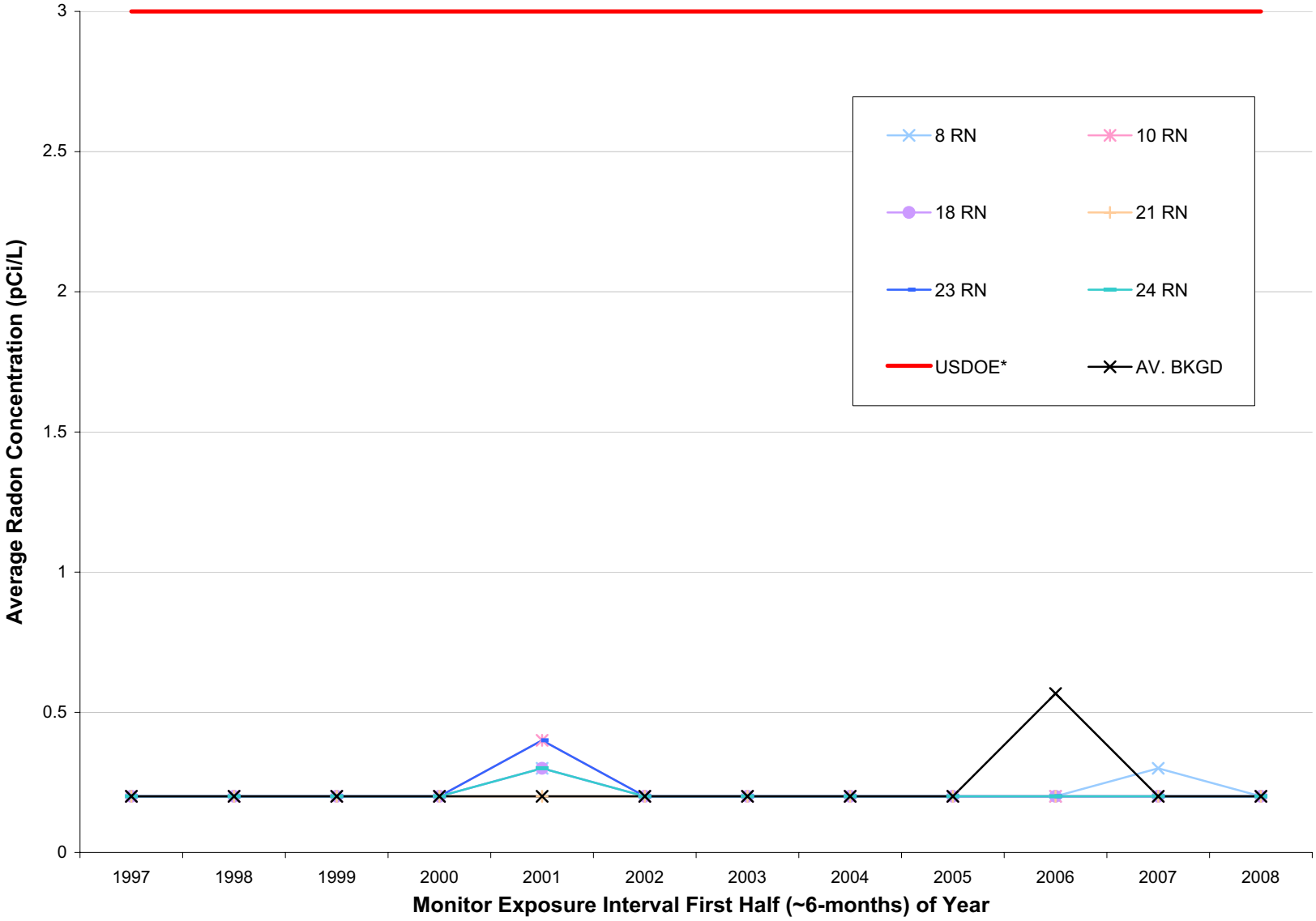


Figure 5-18. Location of Radon Flux Canisters on the IWCS



*Location numbers for each Tissue-Equivalent Thermo Luminescence Dosimeter (TETLD)
**The United States Department of Energy (USDOE) limit for external gamma radiation is 100 mrem/year above background.

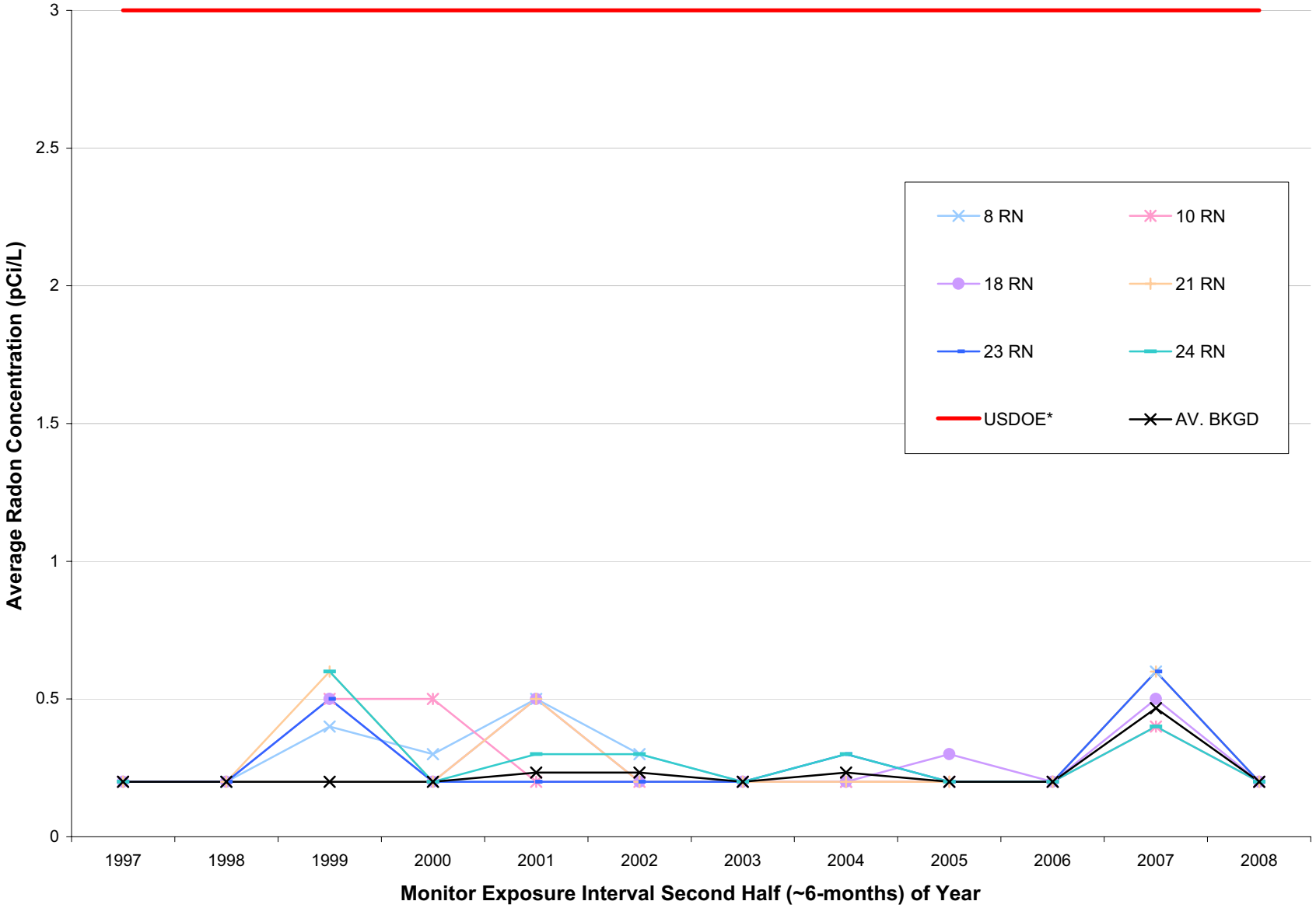
Figure 5-19. External Gamma Radiation Dose Rates at IWCS Perimeter



*The United States Department of Energy (USDOE) off-site limit for radon gas is 3.0 pCi/L above background.

Note: Above values contain detects and non-detects (detection limit is 0.2 pCi/L) for each of the sample locations (8RN through 24RN) indicated above.

Figure 5-20. Radon Gas Concentration at IWCS Perimeter (Jan-July Interval)



*The United States Department of Energy (USDOE) off-site limit for radon gas is 3.0 pCi/L above background.

Note: Above values contain detects and non-detects (detection limit is 0.2 pCi/L) for each of the sample locations (8RN through 24RN) indicated above.

Figure 5-21. Radon Gas Concentration at IWCS Perimeter (July-Jan Interval)

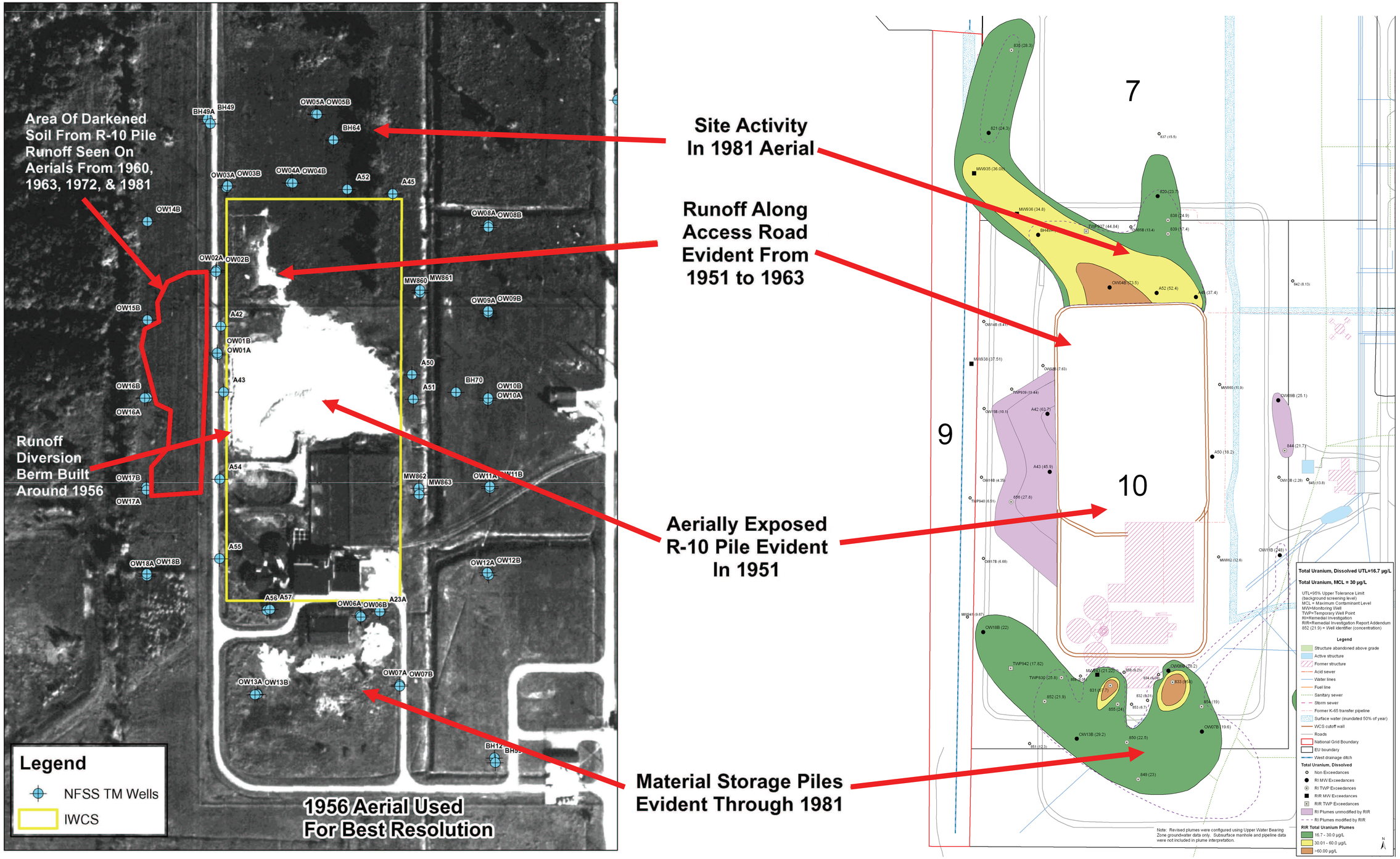


Figure 5-22. Comparison of Historical Site Operations Near the IWCS with Current Groundwater Contamination (Dissolved Total Uranium)

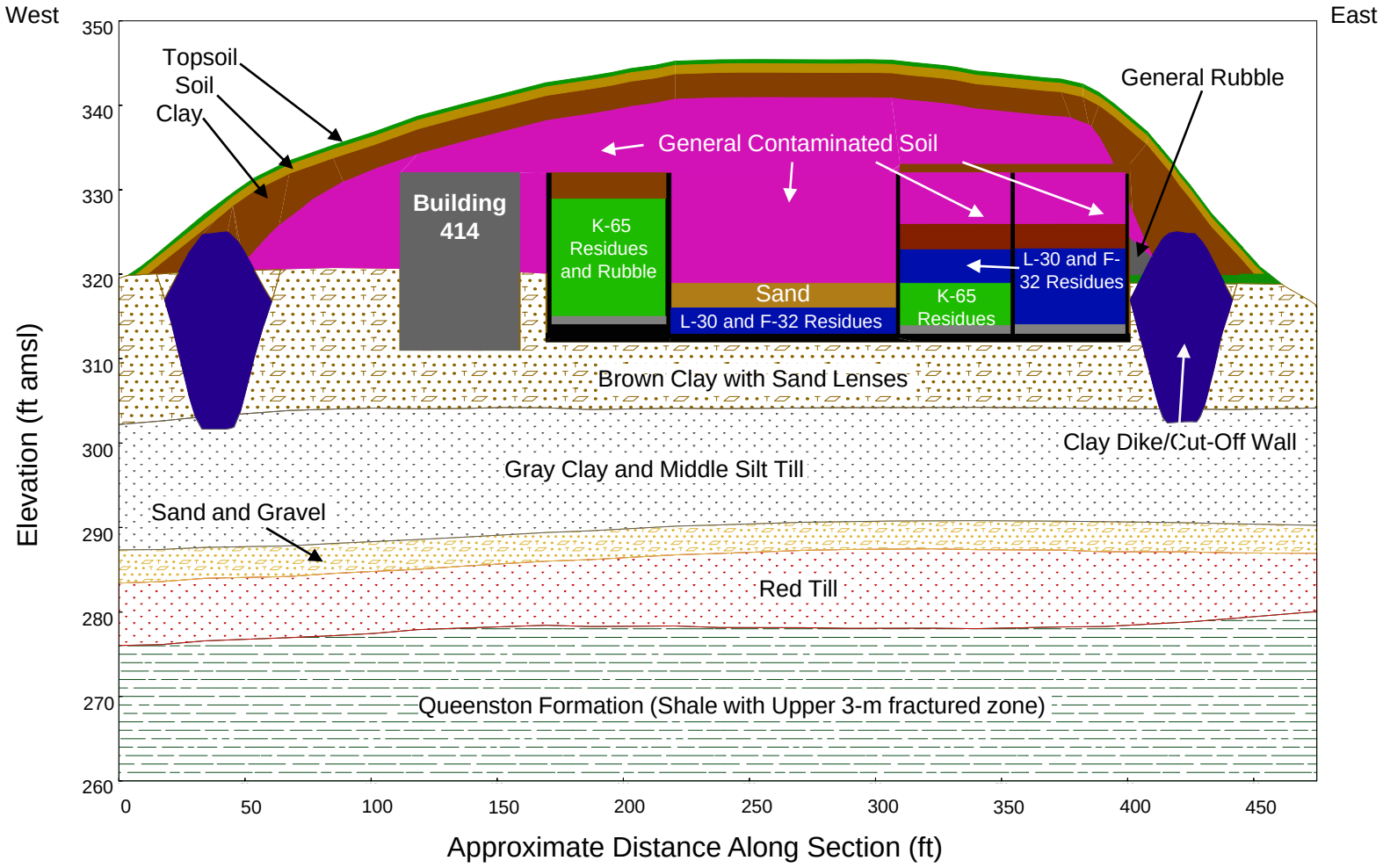


Figure 5-23. Cross-Section Through the IWCS Showing Building Foundations and Subsurface Lithology

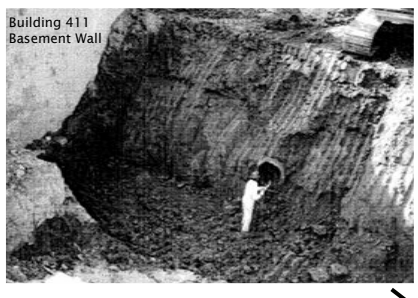
US Army Corps of Engineers
Buffalo District

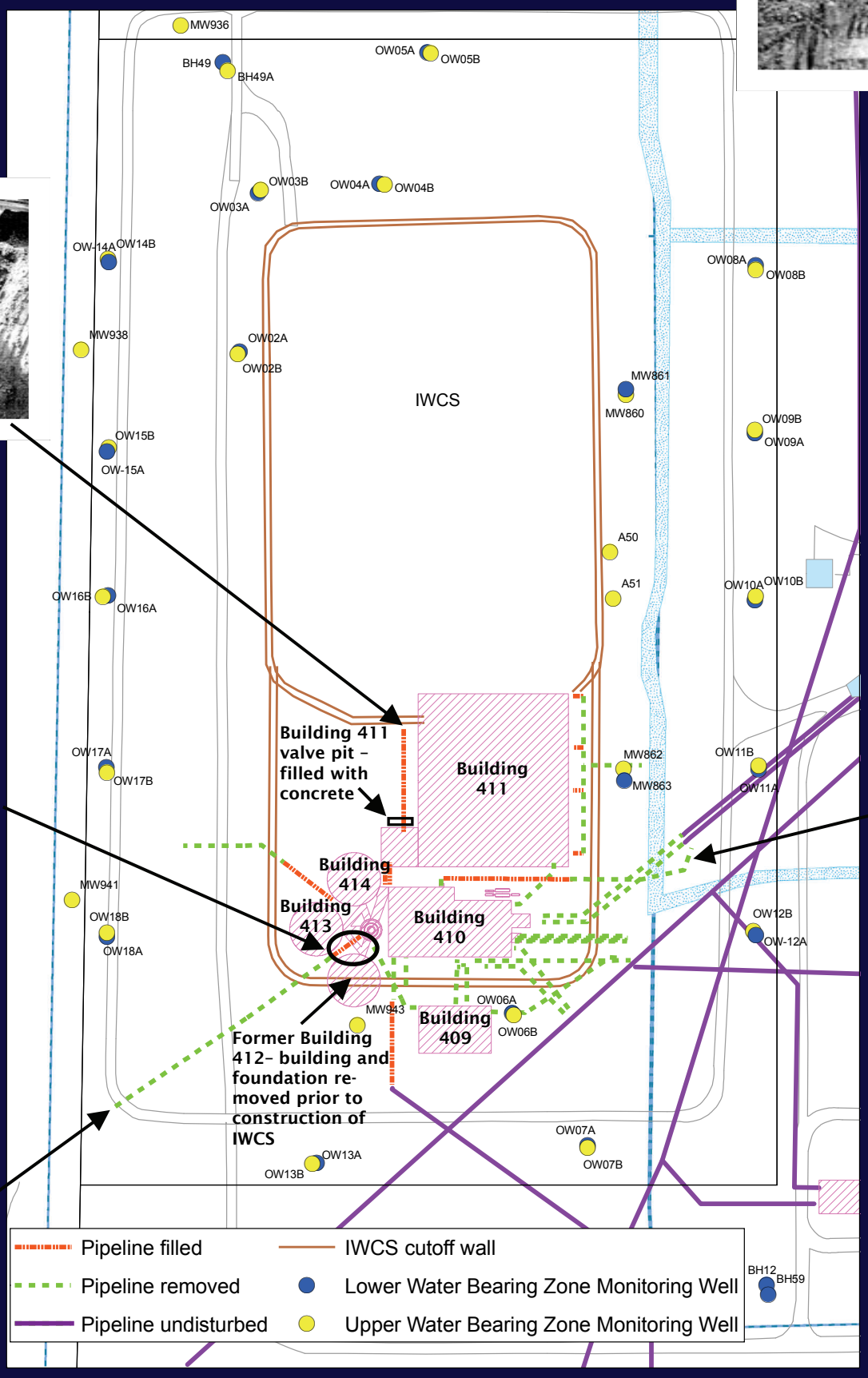
Pipelines and Utilities

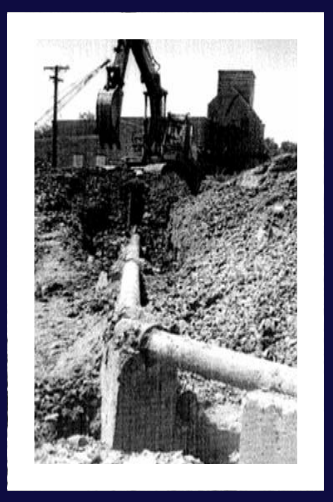
Location of IWCS Pipelines and Utilities

Excavation of the south cut-off wall (looking east between Building 410 and Building 409)

Excavation at the cut-off wall north-west of Building 411 exposing a 30 inch reinforced concrete pipe (looking south)







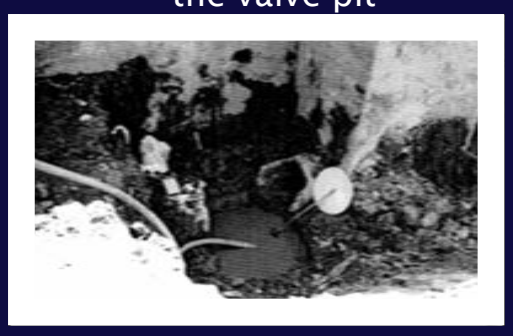
10 inch cast iron pipe running east from Building 410 (looking west from Central Ditch to-ward Building 410)

Portion of the wood-encased 42 inch water supply line filled dur-ing construction of the IWCS

Former 42 inch diameter concrete water supply line that was severed near Pletcher Road by the Town of Lewiston

Excavated trench at Building 411's valve pit showing the 30 inch reinforced concrete pipe which had sections removed for sealing (looking south)

Excavated trench showing the 30 inch reinforced concrete pipe at Building 411 on the east side of the valve pit



Photos: DOE 1982 – 1983

SAIC® From Science to Solutions

Figure 5-24. Pipelines and Utilities, Location of IWCS Pipelines and Utilities (Poster Presented as Public Meeting in September 2008; updated with RIR Monitoring Wells)

SECTION 5

TABLES

Tables 5-1a through 5-1h. 1991, 1996, 1999 and 2009 Topographic Survey Results for the IWCS
Niagara Falls Storage Site, Lewiston, New York

IWCS Surface Elevation Measurements (feet above mean sea level)

Table 5-1a

1991	East Station			
South Station	75	175	275	375
700	318	317.03	316.59	316.05
800	333.25	334.6	334.39	333.45
900	333.81	341.03	341.5	334.49
1000	333.56	345.07	345.94	334.32
1100	332.97	344.95	347.18	334.79
1200	332.91	345.2	347.42	334.95
1300	333.53	345.39	347.94	337.32
1400	333.62	342.89	346.89	339.37
1500	334.37	343.06	346.59	343.05
1600	338.68	339.61	337.39	337.7
1700	322.99	321.07	319.75	320.34
1800	319.96	320.5	320.49	317.65

Table 5-1b

1996	East Station			
South Station	75	175	275	375
700		317.13	316.71	316.09
800	333.37	334.63	334.37	333.53
900	333.85	341.15	341.57	334.59
1000	333.61	345.01	345.95	334.24
1100	333.08	344.9	347.01	334.7
1200	333	345.08	347.21	334.92
1300	333.58	345.28	347.78	337.42
1400	333.72	342.89	346.9	339.37
1500	334.39	343.05	346.59	343.06
1600	338.69	339.64	337.37	337.65
1700	322.97	321.07	319.84	320.32
1800	320.08	320.65	320.52	317.7

Table 5-1c

1999	East Station			
South Station	75	175	275	375
700				
800	333.38	334.66	334.46	333.49
900	333.93	341.15	341.59	334.56
1000	333.66	345.05	345.95	334.37
1100	333.03	344.78	346.89	334.69
1200	332.93	345.03	347.12	334.99
1300	333.59	345.31	347.76	337.45
1400	333.7	342.99	346.89	339.36
1500	334.42	343.05	346.5	343.12
1600	338.74	339.62	337.34	337.63
1700				
1800				

Table 5-1d

2009	East Station			
South Station	75	175	275	375
700	319.03	317.15	316.93	316.17
800	333.41	334.66	334.42	333.52
900	333.92	341.19	341.62	334.65
1000	333.66	344.95	345.89	334.41
1100	333.17	344.87	346.93	334.8
1200	333.02	345.06	347.21	335.03
1300	333.6	345.26	347.82	337.42
1400	333.7	343.03	346.9	339.41
1500	334.42	343.1	346.55	343.08
1600	338.72	339.7	337.44	337.66
1700	323.04	321.18	319.9	320.48
1800	320.07	320.62	320.42	317.59

Change in Elevation (feet)

Table 5-1e

1991-1996	East Station			
South Station	75	175	275	375
700		0.1	0.12	0.04
800	0.12	0.03	-0.02	0.08
900	0.04	0.12	0.07	0.1
1000	0.05	-0.06	0.01	-0.08
1100	0.11	-0.05	-0.17	-0.09
1200	0.09	-0.12	-0.21	-0.03
1300	0.05	-0.11	-0.16	0.1
1400	0.1	0	0.01	0
1500	0.02	-0.01	0	0.01
1600	0.01	0.03	-0.02	-0.05
1700	-0.02	0	0.09	-0.02
1800	0.12	0.15	0.03	0.05

Table 5-1f

1996-1999	East Station			
South Station	75	175	275	375
700				
800	0.01	0.03	0.09	-0.04
900	0.08	0	0.02	-0.03
1000	0.05	0.04	0	0.13
1100	-0.05	-0.12	-0.12	-0.01
1200	-0.07	-0.05	-0.09	0.07
1300	0.01	0.03	-0.02	0.03
1400	-0.02	0.1	-0.01	-0.01
1500	0.03	0	-0.09	0.06
1600	0.05	-0.02	-0.03	-0.02
1700				
1800				

Table 5-1g

1999-2009	East Station			
South Station	75	175	275	375
700				
800	0.03	0	-0.04	0.03
900	-0.01	0.04	0.03	0.09
1000	0	-0.1	-0.06	0.04
1100	0.14	0.09	0.04	0.11
1200	0.09	0.03	0.09	0.04
1300	0.01	-0.05	0.06	-0.03
1400	0	0.04	0.01	0.05
1500	0	0.05	0.05	-0.04
1600	-0.02	0.08	0.1	0.03
1700				
1800				

Table 5-1h

1991-2009	East Station			
South Station	75	175	275	375
700	1.03	0.12	0.34	0.12
800	0.16	0.06	0.03	0.07
900	0.11	0.16	0.12	0.16
1000	0.1	-0.12	-0.05	0.09
1100	0.2	-0.08	-0.25	0.01
1200	0.11	-0.14	-0.21	0.08
1300	0.07	-0.13	-0.12	0.1
1400	0.08	0.14	0.01	0.04
1500	0.05	0.04	-0.04	0.03
1600	0.04	0.09	0.05	-0.04
1700	0.05	0.11	0.15	0.14
1800	0.11	0.12	-0.07	-0.06

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6.0 RE-EXAMINATION AND JUSTIFICATION OF THE NFSS GROUNDWATER BACKGROUND DATA SET

This section presents a re-examination of the NFSS groundwater background data set and the effects of combining data from the UWBZ and the LWBZ to determine sitewide groundwater SRCs. Additionally, a comparison of NFSS radionuclide concentrations in background groundwater to radionuclide concentrations in national and New York State drinking water sources is discussed.

6.1 INTRODUCTION

There are two water-bearing zones present at the NFSS: the UWBZ and the LWBZ. Because the UWBZ and LWBZ are separated by a low-permeability clay unit, which impedes interaction between the two water-bearing units, the appropriateness of combining the UWBZ and LWBZ data to determine sitewide SRCs in groundwater has been questioned. To address these concerns, an evaluation was performed to determine if splitting the background groundwater data into separate data sets for the UWBZ and the LWBZ could affect the identification of SRCs in groundwater. Additionally, radionuclide levels observed in the existing NFSS background groundwater data set have been compared to national and New York State drinking water radionuclide levels to further address concerns that NFSS background groundwater may have been impacted by previous LOOW and NFSS site operations. The main concern of potential groundwater impacts from previous site operations is that the background data set may not be appropriate for assessing current groundwater conditions for the NFSS. The evaluation of combining data from the UWBZ and the LWBZ, and the comparison of radionuclide levels in background groundwater to other drinking water source data are presented in the following sections.

6.2 EVALUATION OF COMBINING DATA FROM THE UPPER AND LOWER WATER-BEARING ZONES TO DETERMINE SITE-SPECIFIC GROUNDWATER BACKGROUND LEVELS

The following discussion includes a description of the RI groundwater background data as well as results of a comparison of NFSS RI groundwater background levels to UWBZ and LWBZ background levels.

6.2.1 Description of RI Groundwater Background Data

A total of 26 wells and piezometers, located within the Modern Landfill property boundaries, were sampled to characterize background groundwater quality. The wells are located off-site and upgradient from the NFSS. Eight wells are installed in the UWBZ and 18 wells are installed in the LWBZ. Four additional wells (MW7A, MW8B, MW9A and MW18) were sampled in July 1998 during the LOOW RI and were included in the background groundwater data set. These wells are completed in the UWBZ and were analyzed for metals only.

The potential for site impact to the background sample locations was examined by reviewing the historical property use and statistical outlier testing. Modern Landfill was a vicinity property, located within the boundaries of the former LOOW but outside the boundary of what is now the NFSS. There is little evidence that radiological materials were stored in this area. The presence of all of constituents that were identified as being outliers in the background data set could be explained based on previous site use. Outliers were removed from the data set. As previously explained in the 2007 RIR (USACE 2007a), groundwater data from two background monitoring wells (PZ-21S and PZ-25S) were removed from the background data set. These two wells are located near a rail bed on the Modern Landfill property. Although analyte concentrations from these wells were below MCLs, data from these wells were removed

from the background data set due to noticeably high total and dissolved isotopic uranium values derived from ballast leaching and nearby disturbed soil. Not only did these two samples have elevated concentrations of uranium isotopes, but also had uranium isotopic ratios indicating that they may have been impacted by site contaminants (Rhodes et al 2006).

Groundwater background levels are described using the lower of the maximum detected concentration or the 95% UTL. Background levels were developed for the 2007 RIR using a single database of all NFSS groundwater results, including data from both UWBZ and LWBZ wells. Background levels for combined UWBZ and LWBZ data were used to determine groundwater SRCs and to facilitate the risk calculations during the BRA.

As previously stated, the UWBZ and LWBZ are separated by a low-permeability clay unit, which impedes interaction between the two water-bearing units. Because of the presence of the clay unit, concerns were raised as to whether separate data sets for the UWBZ and LWBZ should be used to determine sitewide SRCs for both water-bearing units, rather than combining the data into one data set, as was done for the 2007 RIR. To determine if similarities or correlation exists between the UWBZ and LWBZ data, the UWBZ and LWBZ data were divided into two separate data sets. Separate background levels were then developed for each of the two water-bearing zones.

Background levels for the UWBZ and LWBZ were developed using ProUCL. ProUCL is a statistical software package developed by EPA (2009a) that includes methods to estimate exposure point concentration terms, "not-to-exceed" values, and background threshold values for data sets with and without nondetect observations. Using ProUCL, statistics were obtained for the minimum and maximum detected observations, the 95% normal UTL, the 95% lognormal UTL, and the 95% gamma UTL, if appropriate. UTLs were identified for normal, lognormal, or gamma distributions only if the data were appropriately distributed at a 5% level of significance. To be consistent with the methodology used to determine background levels in the 2007 RIR, no distribution of the data was determined for analytes with less than 50% detected concentrations or with less than eight detected concentrations. Additionally, background levels for analytes in the UWBZ and LWBZ were designated as the lower, and most conservative, of the maximum detected value, the 95% normal UTL, the 95% lognormal UTL, and the 95% gamma UTL.

6.2.2 Comparison of NFSS RI Groundwater Background Levels to UWBZ and LWBZ Background Levels

NFSS site-specific groundwater background levels developed for the 2007 RIR using combined UWBZ and LWBZ data were compared to background levels developed for the UWBZ and the LWBZ separately. Tables 6-1 and 6-2 demonstrate the selection of the background levels for the UWBZ and the LWBZ, respectively. Additionally, these tables provide a comparison to the NFSS site-specific groundwater background levels developed for the 2007 RIR. Results of this comparison are briefly described below.

As shown on Tables 6-1 and 6-2, over half of the background levels for both the filtered (dissolved) and unfiltered (total) metals in the UWBZ and LWBZ are less than the NFSS site-specific background levels developed for the 2007 RIR. Metal background levels developed for the LWBZ were far more likely to be less than the corresponding NFSS site-specific background level than were metal background levels developed for the UWBZ. Approximately half of the background levels for both the filtered and unfiltered radionuclides in the UWBZ and LWBZ are less than the NFSS site-specific background levels developed for the 2007 RIR. No background levels for organic compounds detected in UWBZ background samples were less than the NFSS site-specific background levels developed for the 2007 RIR.

Acetone was the only organic compound detected in LWBZ background samples that had a background level less than the NFSS site-specific background level.

It is evident from the evaluation presented in Tables 6-1 and 6-2 that the background levels developed for the UWBZ and the LWBZ are often less than the combined data set background levels developed for the 2007 RIR. This is true for both filtered and unfiltered metals and radionuclides. However, in many cases, there is relatively little difference in magnitude between the background levels developed for the combined data set and the background levels developed for the split data sets (UWBZ and LWBZ). To further compare the background levels developed for the UWBZ and LWBZ to the combined data set background levels, the correlation and statistical strength of the data sets were examined, as described below.

An appropriate background data set should represent a single population. For both water-bearing units, wells were selected to provide a good spatial representation of the background area. The selected background wells were finished in subsurface materials that were similar to what was encountered at the NFSS. The graph shown in Figure 6-1 illustrates the close correlation that exists between the UWBZ, LWBZ, and combined background groundwater data set for the site. The close trending pattern for all three data sets shown in Figure 6-1 suggests that all three data sets represent essentially the same population. This visual test supports the use of one combined data set for the UWBZ and the LWBZ, and suggests that no advantage is gained by dividing the data set into separate data sets for the two water-bearing zones.

Additionally, an appropriate background data set must be of a reasonable size to characterize a background area and compute reliable background levels. Per methodology established for the RI, eight detected samples (i.e., positive analytical results) must be available in a data set to calculate a representative background level. Dividing the UWBZ and LWBZ into two separate data sets frequently results in an inadequate number of values to determine a data set distribution and compute a representative background level. As a result, the maximum detected analytical result for a chemical is often used as a default background value. Combining the UWBZ and LWBZ data into one background data set makes it more likely that an acceptable number of positive results are available to determine data distributions and perform reliable statistical computations.

Finally, dividing the combined background groundwater data set into separate data sets for the two water-bearing zones was examined to determine the effect on the identification of groundwater SRCs. To determine SRCs for each water-bearing unit, the site-wide groundwater data set was also divided into separate data sets for the two water-bearing units. In this way, the site-wide groundwater data can be compared to the background levels developed for the UWBZ and LWBZ. Table 6-3 lists the site-specific groundwater SRCs identified in the 2007 RIR and compares this list to SRCs identified for the UWBZ and LWBZ using background levels from Tables 6-1 and 6-2. Of the site-specific groundwater SRCs identified in the 2007 RIR, eleven analytes were not identified as SRCs in the UWBZ. These analytes mainly include a few metals and several VOCs. In contrast, 31 analytes identified as site-specific groundwater SRCs in the 2007 RIR were not identified as SRCs in the LWBZ. These analytes mainly include pesticides, VOCs, metals, and radionuclides. Thus, the list of site-specific SRCs for the combined data set is most similar to the list of SRCs identified for the UWBZ. This indicates that the concentrations of chemicals in the UWBZ are a greater determining factor for the identification of SRCs in the combined data set than are the concentrations of chemicals in the LWBZ. Using the combined background data set will ensure a conservative approach for evaluating potential contamination in the LWBZ.

Dividing the combined background groundwater data set into separate data sets for the two water-bearing zones resulted in the identification of only a small number of SRCs for the UWBZ and LWBZ that were

not identified as SRCs in the 2007 RIR. As shown on Table 6-3, one PAH, one radionuclide, and five VOCs were identified as additional SRCs for the UWBZ. Three VOCs, one metal, and one radionuclide were identified as additional SRCs for the LWBZ. A closer examination of these additional SRCs suggests that conclusions of the 2007 RIR and plans for future work during the FS would remain unaffected by the identification of these additional SRCs. Reasons to support this opinion are provided below.

- Most of these additional SRCs have been identified because the detection frequency is greater in the smaller data sets created by splitting the 2007 RIR background groundwater data set into separate data sets for the UWBZ and LWBZ. In most cases, the number of sample results that exceed the background level is less than five for any of these additional SRCs.

- Although the majority of these additional SRCs represent exceedances of the UWBZ and LWBZ background levels in scattered locations across the site, the VOC exceedances were generally observed in EU 4, where the nature, extent, and potential risk of a known VOC plume is currently being evaluated.

- Dissolved silver was identified as an additional SRC in the LWBZ. The background level for dissolved silver in the LWBZ is very conservative (0.003 µg/L). Multiple exceedances of this background level were observed in the LWBZ; however, the maximum exceedance of this value was 0.995 µg/L, which is less than 0.1 mg/L (100 µg/L), the secondary MCL for silver.

Because the presence of chemicals in the UWBZ are a determining factor for the identification of SRCs at the site, and because the identification of additional SRCs for the UWBZ and LWBZ would not be expected to greatly influence site cleanup strategies, combining data from the UWBZ and LWBZ to evaluate background groundwater levels ensures a conservative approach to determine SRCs and review potential risks from groundwater exposure at the NFSS.

6.3 COMPARISON OF NFSS RADIONUCLIDE CONCENTRATIONS IN BACKGROUND GROUNDWATER TO RADIONUCLIDE CONCENTRATIONS IN NATIONAL AND NEW YORK STATE DRINKING WATER SOURCES

To address concerns that background groundwater sampling locations on the nearby Modern Landfill property may have been affected by previous site operations, radionuclide levels observed in the existing NFSS background groundwater data set have been compared to national drinking water radionuclide levels. Although groundwater at the NFSS and in its vicinity is not used as a drinking water source, this review was performed to provide a qualitative comparison of NFSS groundwater background quality to expected radionuclide levels in natural and un-impacted groundwater sources. Three literature sources for national drinking water levels were used to provide a basis of comparison to NFSS background levels for radionuclides, even though the sizes of the data sets vary greatly. The NFSS data set contains only 24 results for radionuclides as opposed to the nationwide data sets that contain hundreds or thousands of data results. A brief summary of each literature source used for comparison is provided below.

1. *Radionuclides Notice of Data Availability, Technical Support Document (EPA 2000a)*

   In 1985, the EPA released results of the National Inorganics and Radionuclide Survey (NIRS), a nationwide occurrence study of radon and other naturally occurring radionuclides in public water supplies. The objective of the NIRS was to characterize the occurrence of a variety of constituents present in community groundwater supplies in the United States, and its territories. The survey included a random sample from 990 collection sites.

According to this study, the national median activity (of positives) for radium-226 was 0.39 pCi/L and the maximum was 15.1 pCi/L. Approximately, 1 percent of the samples were above the MCL of 5 pCi/L for radium. The median activity (of positives) for radium-228 was 1.47 pCi/L and the maximum was 12.1 pCi/L. About 90 percent of the samples were below the minimum reporting level (1 pCi/L) and about 1.7 percent exceeded 3.0 pCi/L.

The NIRS database indicated that 1 percent of the public water systems exhibited uranium activities that exceeded a level of 30 pCi/L; 3 percent exceeded 10 pCi/L; and 72 percent exceeded 0.8 pCi/L. Another EPA study (EPA 2000a) cited in this document indicated uranium levels in domestic groundwater sources ranged from 0.07 – 653 pCi/L, with an average of 1.73 pCi/L.

2. *Drinking Water Treatment Wastes (EPA 2009b)*

   This article, posted on the EPA website, focuses on the handling and disposition of drinking water wastes that contain technologically-enhanced, naturally-occurring radioactive material (TNORM). TNORM is NORM that has become concentrated due to human activity. For example, small amounts of NORM may become concentrated in sediment or sludges left over from drinking water treatment processes.

   As part of this website discussion, EPA presents radiation levels commonly observed in public water sources due to NORM. Radionuclides (mainly radium, thorium, uranium, and their decay products) may accumulate in drinking water sources that come in contact with a NORM-bearing rocks. According to this article, radium levels in groundwater typically range from 0.5 – 25 pCi/L. The Ra-226 average concentration in community drinking water supplies is estimated to range from 0.3 – 0.8 pCi/L; however, results of the NIRS, performed by the EPA's Office of Drinking Water, indicate a higher weighted average of 0.905 pCi/L. The average uranium concentration in groundwater is estimated to be 3 pCi/L.

3. *Occurrence of Uranium and ^{222}Radon in Glacial and Bedrock Aquifers in the Northern United States, 1993-2003 (Ayotte, J.D. et al. 2007)*

   This study focused on the regional occurrence and distribution of uranium and radon-222 in groundwater in the glacial aquifer system of the United States as well as in the Cambrian-Ordovician and the New York and New England crystalline aquifer systems that underlie the glacial aquifer system. The authors of this study presented summary statistics for nine aquifer groups. The glacial aquifer groups were identified to account for the geologic source material of the glacial aquifers and to differentiate surficial geology, bedrock geology, and late Wisconsinan glacial lobe potions and flow directions. The NFSS lies in the region covered by the East-Central glacial aquifer group, which included 283 samples. This aquifer group contains deposits of the Lake Michigan, Huron, and Huron-Erie glacial lobes, and is characteristic of glacial sediments overlying predominantly dolomites, shale and sandstone. The largest withdrawals of groundwater from this system are from coarse-grained glacial deposits. The hydrogeologic setting at NFSS is similar to this description as the glacial till units observed at the NFSS (Glacio-Lacustrine Clay Unit and Upper Clay Till) are underlain by shale and sandstone of the Queenston Formation. However, the glacial till units contain heterogeneous material of clay, silt and sand, and while some sand lenses containing groundwater are present, the glacial till at the NFSS is not usually very productive.

Summary statistics from this study indicated a maximum uranium concentration of 21.1 µg/L for the East-Central glacial aquifer group. The 90th percentile of the data was 3.3 µg/L. The median and the minimum concentrations were each <1 µg/L.

Table 6-4 summarizes the results of these three studies and, for comparison purposes, provides similar statistics for radium and uranium levels observed in background groundwater at the NFSS.

The levels of radium-226 in background groundwater at the NFSS appear to be similar to levels of radium-226 in domestic groundwater sources as reported in EPA studies (2000a and 2009b). The maximum activity reported for radium-226 in background groundwater at the NFSS was 1.76 pCi/L for total radium-226 and 1.31 pCi/L for dissolved radium-226. These values are less than the maximum radium-226 activity of 15.1 pCi/L reported in the EPA Technical Support Document (2000a). Additionally, the maximum values for total and dissolved radium-226 in background groundwater at the NFSS fall within the typical range of radium-226 activity in groundwater (0.5 – 25 pCi/L) as reported by the EPA 2009 website. The mean values for total and dissolved radium-226 in NFSS background groundwater fall within the range of 0.3 – 0.8 pCi/L, the average activity of radium-226 in community drinking water supplies as reported by EPA (2009b).

Likewise, the levels of radium-228 in background groundwater at the NFSS appear to be comparable to levels of radium-228 in domestic groundwater sources as reported in EPA studies (2000a and 2009b). The maximum activity reported for radium-228 in background groundwater at the NFSS was 1.67 pCi/L for total radium-228 and 1.6 pCi/L for dissolved radium-228. These values are less than the maximum radium-228 activity of 12.1 pCi/L reported in the EPA Technical Support Document (2000a). However, the maximum values for total and dissolved radium-228 in background groundwater at the NFSS fall within the typical range of radium-228 activity in groundwater (0.5 – 25 pCi/L) as reported by the EPA 2009 website.

The EPA Technical Support Document (2000a) provides a range of 0.07 – 653 pCi/L [approximately 0.08 – 726 µg/L, using a conversion factor of 0.9 pCi/µg (EPA 2000b)] for uranium in domestic groundwater sources, with an average of 1.73 pCi/L (approximately 1.9 µg/L). The concentration range of uranium in NFSS background groundwater for both total uranium (0.3 – 15.6 µg/L) and dissolved uranium (0.24 – 16.7 µg/L) falls well within the range reported by the EPA Technical Support Document (2000a). The mean concentration for total and dissolved uranium in NFSS background groundwater, 5.13 µg/L and 5.24 µg/L, respectively, are slightly greater than the mean value reported in the EPA Technical Support Document (2000a). The mean values for total and dissolved uranium in NFSS background groundwater are more similar to an average activity of 3 pCi/L (approximately 3.3 µg/L) for uranium in groundwater, as reported in the EPA website article (2009b).

The NFSS site-specific background levels for total and dissolved uranium are equal to the maximum detected values of these radionuclides in the background groundwater data set. These maximum values for total and dissolved uranium are slightly less than the maximum concentration of uranium observed in groundwater of the East-Central Glacial aquifer group (Ayotte et al. 2007).

Comparison of radium-226, radium-228 and uranium levels in NFSS background groundwater to values of these radionuclides typically observed in other U.S. drinking water sources provides a qualitative indication that, in general, NFSS background groundwater values for these radionuclides are comparable to expected levels in domestic groundwater sources.

6.4 SUMMARY

A review of background groundwater data from the UWBZ and LWBZ suggests that dividing the combined background groundwater data set into separate data sets for the two water-bearing zones does not result in more descriptive background statistics or more reliable delineation of SRCs. Furthermore, this evaluation supports the continued use of a combined background data set to determine site-specific groundwater background levels and SRCs, as was done for the 2007 RIR (USACE 2007a). Key findings of this evaluation are listed below.

- Combining the UWBZ and LWBZ data into one background data set makes it more likely that an acceptable number of positive results are available to determine data distributions and perform reliable statistical computations.

- For many constituents, there is relatively little difference between the background levels developed for the combined background groundwater data set and the background levels developed for the separate UWBZ and LWBZ data sets.

- Visual interpretation of data trending graphs suggests that the combined background groundwater data set and the data sets for the UWBZ and the LWBZ represent essentially the same population.

- Because the presence of chemicals in the UWBZ are a determining factor for the identification of SRCs at the site, combining data from the UWBZ and LWBZ to evaluate background groundwater levels ensures a conservative approach to determine SRCs for both the UWBZ and LWBZ, and review potential risks from groundwater exposure at the NFSS.

Additionally, a review of mean and maximum values for radium-226, radium-228 and uranium levels in NFSS background groundwater data provides a qualitative indication that NFSS background groundwater levels for these radionuclides are comparable to typical levels observed in domestic groundwater sources. Thus, according to results of this review, NFSS background groundwater does not appear to have been impacted by previous LOOW or NFSS site operations, and is appropriate for assessing current groundwater conditions at the NFSS.

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SECTION 6

FIGURE

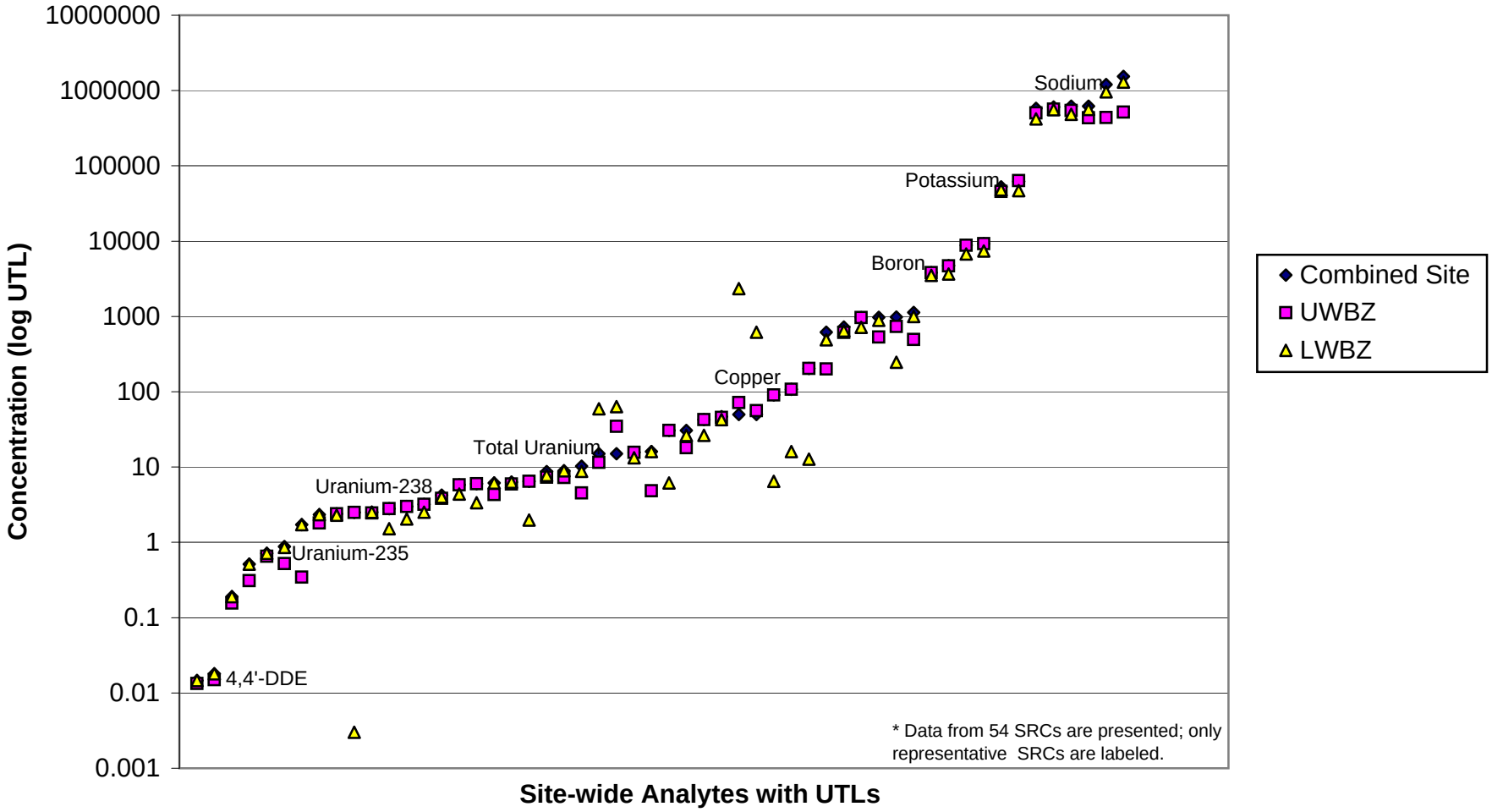

Figure 6-1. Correlation of UTLs for the Combined Site Groundwater Data Set and for the UWBZ and LWBZ Data Sets

SECTION 6

TABLES

Table 6-1. Comparison of RI Groundwater Background Levels to Background Levels Developed for the Upper Water-Bearing Zone
Niagara Falls Storage Site, Lewiston, New York

	NFSS Background Data Statistics						UWBZ Data Statistics							Comparison of Background Levels
Analyte	Unit	Results >Detection Limit	Minimum Detect	Maximum Detect	95% UTL	Site-specific Background Level	Frequecy of Detects	Minimum Detect	Maximum Detect	95% Normal UTL	95% Lognormal UTL	95% Gamma UTL	UWBZ Background Level [a]	UWBZ Background Level < Site Specific Background Level?
Aluminum	µg/L	23/ 28	3.94	979	1180	979	8/ 11	9.26	979	---	735.9	853.6	735.9	YES
Aluminum, Dissolved	µg/L	11/ 28	9.99	616	616	616	2/ 11	139	200	---	---	---	200	YES
Antimony	µg/L	13/ 28	0.099	2.34	2.34	2.34	4/ 11	0.099	1.8	---	---	---	1.8	YES
Antimony, Dissolved	µg/L	6/ 28	0.056	2.4	2.4	2.4	2/ 11	1.7	2.4	---	---	---	2.4	no
Arsenic	µg/L	23/ 28	3.3	30.6	30.6	30.6	8/ 11	3.3	20.5	17.96	34.31	19.68	17.96	YES
Arsenic, Dissolved	µg/L	13/ 28	3.6	25.7	25.7	25.7	4/ 11	3.6	11	---	---	---	11	YES
Barium	µg/L	28/ 28	5.69	46.8	46.8	46.8	11/ 11	5.79	46.8	45.57	56.94	53.16	45.57	YES
Barium, Dissolved	µg/L	28/ 28	4.13	42.8	42.8	42.8	11/ 11	5.96	42.8	---	---	47.03	42.8	no
Beryllium, Dissolved	µg/L	2/ 28	0.156	0.190	0.190	0.190	1/ 11	0.156	0.156	---	---	---	0.156	YES
Boron	µg/L	28/ 28	67.9	3820	3820	3820	11/ 11	67.9	3820	---	5415	3963	3820	no
Boron, Dissolved	µg/L	28/ 28	63.2	4750	4750	4750	11/ 11	63.2	4750	---	6475	4685	4685	YES
Cadmium	µg/L	26/ 28	0.90	2.51	2.51	2.51	8/ 11	0.9	2.45	---	---	---	2.45	YES
Cadmium, Dissolved	µg/L	16/ 28	0.270	2.32	2.32	2.32	7/ 11	0.27	1.8	---	---	---	1.8	YES
Calcium	µg/L	28/ 28	50400	620000	639000	620000	11/ 11	50400	434000	502521	---	---	434000	YES
Calcium, Dissolved	µg/L	28/ 28	49400	603000	673000	603000	11/ 11	49400	568000	587232	911271	748987	568000	YES
Chromium	µg/L	14/ 28	1.03	3.19	3.19	3.19	6/ 11	1.27	3.19	---	---	---	3.19	no
Chromium, Dissolved	µg/L	9/ 28	1.1	16	16	16	4/ 11	1.1	4.85	---	---	---	4.85	YES
Cobalt	µg/L	6/ 28	0.468	2.8	2.8	2.8	3/ 11	0.468	2.8	---	---	---	2.8	no
Cobalt, Dissolved	µg/L	4/ 28	0.545	3	3	3	3/ 11	0.545	3	---	---	---	3	no
Copper	µg/L	18/ 28	1.66	204	204	204	7/ 11	1.66	204	---	---	---	204	no
Copper, Dissolved	µg/L	11/ 28	2.42	90.9	90.9	90.9	3/ 11	3.08	90.9	---	---	---	90.9	no
Iron	µg/L	26/ 27	28.1	8810	8810	8810	9/ 10	57.8	8810	---	15122	8986	8810	no
Iron, Dissolved	µg/L	24/ 26	7.62	9280	9280	9280	7/ 9	10.5	9280	---	---	---	9280	no
Lead	µg/L	24/ 28	0.017	5.99	10.80	5.99	7/ 11	0.117	5.99	---	---	---	5.99	no
Lead, Dissolved	µg/L	6/ 28	0.012	0.935	0.935	0.935	1/ 11	0.124	0.124	---	---	---	0.124	YES
Lithium	µg/L	27/ 28	3.5	1130	1130	1130	10/ 11	3.5	495	494	---	994.4	494	YES
Lithium, Dissolved	µg/L	27/ 28	3.9	978	972	972	10/ 11	3.9	531	535	---	1068	531	YES
Magnesium	µg/L	28/ 28	25900	580000	580000	580000	11/ 11	25900	580000	505933	818630	629555	505933	YES
Magnesium, Dissolved	µg/L	28/ 28	25100	618000	618000	618000	11/ 11	25100	618000	543630	927955	689523	543630	YES
Manganese	µg/L	28/ 28	2.97	722	722	722	11/ 11	4.32	722	614.8	1302	784	614.8	YES
Manganese, Dissolved	µg/L	27/ 28	5.86	966	966	966	10/ 11	15	966	---	4746	1294	966	no
Mercury	µg/L	2/ 28	0.150	0.170	0.170	0.170	2/ 11	0.15	0.17	---	---	---	0.17	no
Mercury, Dissolved	µg/L	2/ 28	0.150	0.150	0.150	0.150	2/ 11	0.15	0.15	---	---	---	0.15	no
Nickel	µg/L	4/ 28	0.831	6.480	6.48	6.48	2/ 11	3.4	6.48	---	---	---	6.48	no
Nickel, Dissolved	µg/L	12/ 28	0.734	6.15	6.15	6.15	7/ 11	0.734	4.3	---	---	---	4.3	YES
Potassium	µg/L	28/ 28	712	63600	62100	62100	11/ 11	712	63600	---	90963	67074	63600	no
Potassium, Dissolved	µg/L	28/ 28	715	52400	57700	52400	11/ 11	715	45800	---	82809	58332	45800	YES
Selenium	µg/L	23/ 28	1.79	4.24	4.62	4.24	8/ 11	2.2	4.24	4.069	5.145	3.833	3.833	YES
Selenium, Dissolved	µg/L	15/ 28	2.27	10.3	10.3	10.3	4/ 11	2.3	4.52	---	---	---	4.52	YES
Silver	µg/L	9/ 28	0.006	0.018	1.100	0.018	3/ 11	0.006	0.015	---	---	---	0.015	YES
Silver, Dissolved	µg/L	4/ 28	0.003	2.50	2.5	2.5	3/ 11	0.009	2.5	---	---	---	2.5	no
Sodium	µg/L	28/ 28	17700	1200000	1200000	1200000	11/ 11	17700	439000	522030	1123528	---	439000	YES
Sodium, Dissolved	µg/L	28/ 28	17600	1540000	1540000	1540000	11/ 11	17600	516000	605607	---	871403	516000	YES
Thallium	µg/L	16/ 28	0.014	1.72	1.72	1.72	5/ 11	0.014	0.345	---	---	---	0.345	YES
Thallium, Dissolved	µg/L	3/ 28	0.063	0.222	1.2	0.222	1/ 11	0.114	0.114	---	---	---	0.114	YES
Vanadium	µg/L	9/ 28	0.323	2.8	2.8	2.8	5/ 11	0.457	2.8	---	---	---	2.8	no
Vanadium, Dissolved	µg/L	3/ 28	0.309	2.6	2.6	2.6	2/ 11	0.309	2.6	---	---	---	2.6	no

Table 6-1. Comparison of RI Groundwater Background Levels to Background Levels Developed for the Upper Water-Bearing Zone
Niagara Falls Storage Site, Lewiston, New York

	NFSS Background Data Statistics						UWBZ Data Statistics							Comparison of Background Levels
Analyte	Unit	Results >Detection Limit	Minimum Detect	Maximum Detect	95% UTL	Site-specific Background Level	Frequecy of Detects	Minimum Detect	Maximum Detect	95% Normal UTL	95% Lognormal UTL	95% Gamma UTL	UWBZ Background Level [a]	UWBZ Background Level < Site Specific Background Level?
Zinc	µg/L	20/ 28	0.350	131	131	131	7/ 11	0.35	131	---	---	---	131	no
Zinc, Dissolved	µg/L	11/ 28	0.852	108	108	108	6/ 11	1.19	108	---	---	---	108	no
Benzo(k)fluoranthene	µg/L	1/ 24	0.0334	0.0334	0.0334	0.0334	1/ 7	0.0334	0.0334	---	---	---	0.0334	no
4,4'-DDE	µg/L	7/ 24	0.0045	0.0146	0.0146	0.0146	2/ 7	0.00935	0.0133	---	---	---	0.0133	YES
4,4'-DDT	µg/L	9/ 24	0.0134	0.0413	0.0413	0.0413	4/ 7	0.0134	0.0298	---	---	---	0.0298	YES
Alpha	pCi/L	6/ 24	5.91	59.2	59.2	15	2/ 7	5.91	11.5	---	---	---	11.5	YES
Alpha, Dissolved	pCi/L	6/ 24	9.29	63.6	63.6	15	3/ 7	13	34.6	---	---	---	34.6	no
Americium-241	pCi/L	1/ 24	12.2	12.2	13.6	12.2	0/ 7	---	---	---	---	---	---	---
Beta	pCi/L	23/ 24	11.3	2340	2340	50	7/ 7	12	71.8	---	---	---	71.8	no
Beta, Dissolved	pCi/L	23/ 24	6.5	617	617	50	7/ 7	6.5	56.1	---	---	---	56.1	no
Radium-226	pCi/L	20/ 24	0.308	1.76	1.76	1.76	7/ 7	0.315	0.908	---	---	---	0.908	YES
Radium-226, Dissolved	pCi/L	14/ 23	0.362	1.55	1.31	1.31	4/ 6	0.418	0.965	---	---	---	0.965	YES
Radium-228	pCi/L	11/ 24	0.569	1.67	1.67	1.67	2/ 7	0.724	0.98	---	---	---	0.98	YES
Radium-228, Dissolved	pCi/L	14/ 23	0.885	1.6	1.83	1.6	2/ 6	1.21	1.41	---	---	---	1.41	YES
Thorium-228	pCi/L	1/ 24	0.250	0.250	0.324	0.250	0/ 7	---	---	---	---	---	---	---
Thorium-228, Dissolved	pCi/L	2/ 23	0.152	0.162	0.162	0.162	0/ 6	---	---	---	---	---	---	---
Thorium-230	pCi/L	23/ 24	0.285	0.877	0.878	0.877	7/ 7	0.41	0.521	---	---	---	0.521	YES
Thorium-230, Dissolved	pCi/L	16/ 23	0.174	0.388	0.418	0.388	2/ 6	0.208	0.253	---	---	---	0.253	YES
Thorium-232	pCi/L	9/ 24	0.046	0.229	0.264	0.229	3/ 7	0.0456	0.1	---	---	---	0.1	YES
Total Uranium	µg/L	24/ 24	0.295	15.6	50	15.6	7/ 7	0.55	15.6	---	---	---	15.6	no
Total Uranium, Dissolved	µg/L	24/ 24	0.242	16.7	57.9	16.7	7/ 7	0.535	16.7	---	---	---	16.7	no
Uranium-234	pCi/L	23/ 24	0.210	8.73	21.3	8.73	6/ 7	0.539	7.32	---	---	---	7.32	YES
Uranium-234, Dissolved	pCi/L	23/ 23	0.177	8.94	25.6	8.94	6/ 6	0.409	7.23	---	---	---	7.23	YES
Uranium-235	pCi/L	5/ 24	0.188	0.715	0.715	0.715	2/ 7	0.188	0.651	---	---	---	0.651	YES
Uranium-235, Dissolved	pCi/L	10/ 23	0.077	0.512	0.512	0.512	3/ 6	0.0975	0.31	---	---	---	0.31	YES
Uranium-238	pCi/L	19/ 24	0.116	5.79	28.2	5.79	5/ 7	0.247	5.79	---	---	---	5.79	no
Uranium-238, Dissolved	pCi/L	21/ 23	0.109	6.32	23	6.32	6/ 6	0.195	5.93	---	---	---	5.93	YES
1,1,1-Trichloroethane	µg/L	1/ 24	0.435	0.435	0.435	0.435	1/ 7	0.435	0.435	---	---	---	0.435	no
2-Butanone	µg/L	1/ 24	4.49	4.49	4.49	4.49	1/ 7	4.49	4.49	---	---	---	4.49	no
Acetone	µg/L	4/ 24	3.96	30.5	30.5	30.5	2/ 7	3.96	30.5	---	---	---	30.5	no
Benzene	µg/L	1/ 24	0.366	0.366	0.366	0.366	1/ 7	0.366	0.366	---	---	---	0.366	no
Chlorobenzene	µg/L	1/ 24	0.387	0.387	0.387	0.387	1/ 7	0.387	0.387	---	---	---	0.387	no
Ethylbenzene	µg/L	1/ 24	0.297	0.297	0.297	0.297	1/ 7	0.297	0.297	---	---	---	0.297	no
Toluene	µg/L	2/ 24	0.438	4.45	4.45	4.45	2/ 7	0.438	4.45	---	---	---	4.45	no
trans-1,3-Dichloropropene	µg/L	1/ 24	0.495	0.495	0.495	0.495	1/ 7	0.495	0.495	---	---	---	0.495	no
Vinyl chloride	µg/L	1/ 24	1.48	1.48	1.48	1.48	1/ 7	1.48	1.48	---	---	---	1.48	no
Xylenes (total)	µg/L	1/ 24	0.958	0.958	0.958	0.958	1/ 7	0.958	0.958	---	---	---	0.958	no

a - For the purposes of this comparison, the UWBZ Background Level was determined to be the lesser of the maximum detected value, the 95% normal UTL, the 95% lognormal UTL, and the 95% gamma UTL.
UWBZ - upper water bearing zone
UTL - upper tolerance limit
µg/L - micrograms per liter
pCi/L - picocuries per liter
--- - Data not found to be distributed as noted at a 5% level of significance, or data not applicable. No distriubtution was determined for analytes with <50% detects or with <8 dectected results.

Table 6-2. Comparison of RI Groundwater Background Levels to Background Levels Developed for the Lower Water-Bearing Zone
Niagara Falls Storage Site, Lewiston, New York

	NFSS Background Data Statistics						LWBZ Data Statistics							Comparison of Background Levels
Analyte	Unit	Results >Detection Limit	Minimum Detect	Maximum Detect	95% UTL	Site-specific Background Level	Frequecy of Detects	Minimum Detect	Maximum Detect	95% Normal UTL	95% Lognormal UTL	95% Gamma UTL	LWBZ Background Level [a]	LWBZ Background Level < Site Specific Background Level?
Aluminum	µg/L	23/ 28	3.94	979	1180	979	15/17	3.94	686	---	247.2	---	247.2	YES
Aluminum, Dissolved	µg/L	11/ 28	9.99	616	616	616	9/ 17	9.99	616	---	---	491.9	491.9	YES
Antimony	µg/L	13/ 28	0.099	2.34	2.34	2.34	8/17	0.146	2.34	---	---	---	2.34	no
Antimony, Dissolved	µg/L	6/ 28	0.056	2.4	2.4	2.4	4/ 17	0.056	2.3	---	---	---	2.3	YES
Arsenic	µg/L	23/ 28	3.3	30.6	30.6	30.6	15/17	3.34	30.6	---	26.54	26.45	26.45	YES
Arsenic, Dissolved	µg/L	13/ 28	3.6	25.7	25.7	25.7	9/ 17	4.55	25.7	21.7	22.99	24.76	21.7	YES
Barium	µg/L	28/ 28	5.69	46.8	46.8	46.8	17/17	5.69	42.6	---	---	---	42.6	YES
Barium, Dissolved	µg/L	28/ 28	4.13	42.8	42.8	42.8	17/ 17	4.13	26.3	---	---	---	26.3	YES
Beryllium, Dissolved	µg/L	2/ 28	0.156	0.19	0.19	0.19	1/ 17	0.19	0.19	---	---	---	0.19	no
Boron	µg/L	28/ 28	67.9	3820	3820	3820	16/17	193	3670	3514	4969	4160	3514	YES
Boron, Dissolved	µg/L	28/ 28	63.2	4750	4750	4750	17/ 17	181	3760	3668	---	4338	3668	YES
Cadmium	µg/L	26/ 28	0.90	2.51	2.51	2.51	16/17	1.67	2.51	2.542	2.579	2.593	2.51	no
Cadmium, Dissolved	µg/L	16/ 28	0.270	2.32	2.32	2.32	7/ 17	1.37	2.32	---	---	---	2.32	no
Calcium	µg/L	28/ 28	50400	620000	639000	620000	17/17	97100	620000	560732	665298	627215	560732	YES
Calcium, Dissolved	µg/L	28/ 28	49400	603000	673000	603000	16/ 17	97900	603000	557503	669340	627905	557503	YES
Chromium	µg/L	14/ 28	1.03	3.19	3.19	3.19	8/17	1.03	2.52	---	---	---	2.52	YES
Chromium, Dissolved	µg/L	9/ 28	1.1	16	16	16	5/ 17	1.16	16	---	---	---	16	no
Cobalt	µg/L	6/ 28	0.468	2.8	2.8	2.8	3/17	0.539	1.52	---	---	---	1.52	YES
Cobalt, Dissolved	µg/L	4/ 28	0.545	3	3	3	1/ 17	2.05	2.05	---	---	---	2.05	YES
Copper	µg/L	18/ 28	1.66	204	204	204	11/17	1.74	12.7	---	---	---	12.7	YES
Copper, Dissolved	µg/L	11/ 28	2.42	90.9	90.9	90.9	8/ 17	2.42	6.44	---	---	---	6.44	YES
Iron	µg/L	26/ 27	28.1	8810	8810	8810	17/17	28.1	6890	6755	---	9330	6755	YES
Iron, Dissolved	µg/L	24/ 26	7.62	9280	9280	9280	17/ 17	7.62	7520	7415	---	11287	7415	YES
Lead	µg/L	24/ 28	0.017	5.99	10.80	5.99	17/17	0.017	3.8	---	4.954	3.35	3.35	YES
Lead, Dissolved	µg/L	6/ 28	0.012	0.935	0.935	0.935	5/ 17	0.012	0.935	---	---	---	0.935	no
Lithium	µg/L	27/ 28	3.5	1130	1130	1130	17/17	102	1130	---	1054	998.2	998.2	YES
Lithium, Dissolved	µg/L	27/ 28	3.9	978	972	972	17/ 17	92.4	978	891.6	1084	998.5	891.6	YES
Magnesium	µg/L	28/ 28	25900	580000	580000	580000	17/17	106000	536000	---	420903	423816	420903	YES
Magnesium, Dissolved	µg/L	28/ 28	25100	618000	618000	618000	16/ 17	111000	606000	---	485534	485123	485123	YES
Manganese	µg/L	28/ 28	2.97	722	722	722	17/17	2.97	715	642.3	---	825.1	642.3	YES
Manganese, Dissolved	µg/L	27/ 28	5.86	966	966	966	17/ 17	5.86	799	714.1	1432	906.7	714.1	YES
Mercury	µg/L	2/ 28	0.15	0.17	0.17	0.17	0/17	---	---	---	---	---	---	---
Mercury, Dissolved	µg/L	2/ 28	0.15	0.15	0.15	0.15	0/ 17	---	---	---	---	---	---	---
Nickel	µg/L	4/ 28	0.831	6.480	6.48	6.48	2/17	0.831	1.98	---	---	---	1.98	YES
Nickel, Dissolved	µg/L	12/ 28	0.734	6.15	6.15	6.15	5/ 17	1.76	6.15	---	---	---	6.15	no
Potassium	µg/L	28/ 28	712	63600	62100	62100	17/17	4380	48200	46891	60184	54022	46891	YES
Potassium, Dissolved	µg/L	28/ 28	715	52400	57700	52400	17/ 17	4770	52400	47879	60351	54687	47879	YES
Selenium	µg/L	23/ 28	1.79	4.24	4.62	4.24	14/17	1.79	4.01	3.987	4.538	4.095	3.987	YES
Selenium, Dissolved	µg/L	15/ 28	2.27	10.3	10.3	10.3	11/ 17	2.27	10.3	8.785	9.193	9.949	8.785	YES
Silver	µg/L	9/ 28	0.006	0.018	1.100	0.018	5/17	0.007	0.018	---	---	---	0.018	no
Silver, Dissolved	µg/L	4/ 28	0.003	2.50	2.5	2.5	1/ 17	0.003	0.003	---	---	---	0.003	YES
Sodium	µg/L	28/ 28	17700	1200000	1200000	1200000	17/17	68500	1200000	961177	1245194	1094677	961177	YES
Sodium, Dissolved	µg/L	28/ 28	17600	1540000	1540000	1540000	17/ 17	72400	1540000	---	1470274	1295738	1295738	YES
Thallium	µg/L	16/ 28	0.014	1.72	1.72	1.72	11/17	0.02	1.72	---	---	---	1.72	no
Thallium, Dissolved	µg/L	3/ 28	0.063	0.222	1.200	0.222	2/ 17	0.063	0.222	---	---	---	0.222	no
Vanadium	µg/L	9/ 28	0.323	2.8	2.8	2.8	4/17	0.323	0.893	---	---	---	0.893	YES
Vanadium, Dissolved	µg/L	3/ 28	0.309	2.6	2.6	2.6	1/ 17	0.844	0.844	---	---	---	0.844	YES

Table 6-2. Comparison of RI Groundwater Background Levels to Background Levels Developed for the Lower Water-Bearing Zone
Niagara Falls Storage Site, Lewiston, New York

	NFSS Background Data Statistics						LWBZ Data Statistics							Comparison of Background Levels
Analyte	Unit	Results >Detection Limit	Minimum Detect	Maximum Detect	95% UTL	Site-specific Background Level	Frequecy of Detects	Minimum Detect	Maximum Detect	95% Normal UTL	95% Lognormal UTL	95% Gamma UTL	LWBZ Background Level [a]	LWBZ Background Level < Site Specific Background Level?
Zinc	µg/L	20/ 28	0.350	131	131	131	13/17	0.647	16.7	---	30.16	20.83	16.7	YES
Zinc, Dissolved	µg/L	11/ 28	0.852	108	108	108	5/ 17	0.852	16.1	---	---	---	16.1	YES
Benzo(k)fluoranthene	µg/L	1/ 24	0.033	0.033	0.033	0.033	0/17	---	---	---	---	---	---	---
4,4'-DDE	µg/L	7/ 24	0.0045	0.0146	0.0146	0.0146	5/17	0.00447	0.0146	---	---	---	0.0146	no
4,4'-DDT	µg/L	9/ 24	0.0134	0.0413	0.0413	0.0413	5/17	0.0158	0.0413	---	---	---	0.0413	no
Alpha	pCi/L	6/ 24	5.91	59.2	59.2	15	4/17	10.3	59.2	---	---	---	59.2	no
Alpha, Dissolved	pCi/L	6/ 24	9.29	63.6	63.6	15	3/ 17	9.29	63.6	---	---	---	63.6	no
Americium-241	pCi/L	1/ 24	12.2	12.2	13.6	12.2	1/17	12.2	12.2	---	---	---	12.2	no
Beta	pCi/L	23/ 24	11.3	2340	2340	50	16/17	11.3	2340	---	---	---	2340	no
Beta, Dissolved	pCi/L	23/ 24	6.5	617	617	50	16/ 17	7.42	617	---	---	---	617	no
Radium-226	pCi/L	20/ 24	0.308	1.76	1.76	1.76	13/17	0.308	1.76	---	---	---	1.76	no
Radium-226, Dissolved	pCi/L	14/ 23	0.362	1.55	1.31	1.31	10/ 17	0.362	1.55	1.127	2.274	1.108	1.108	YES
Radium-228	pCi/L	11/ 24	0.569	1.67	1.67	1.67	9/17	0.569	1.67	1.377	1.728	1.386	1.377	YES
Radium-228, Dissolved	pCi/L	14/ 23	0.885	1.6	1.83	1.6	12/ 17	0.885	1.6	1.67	2.441	1.511	1.511	YES
Thorium-228	pCi/L	1/ 24	0.25	0.25	0.324	0.25	1/17	0.25	0.25	---	---	---	0.25	no
Thorium-228, Dissolved	pCi/L	2/ 23	0.152	0.162	0.162	0.162	2/ 17	0.152	0.162	---	---	---	0.162	no
Thorium-230	pCi/L	23/ 24	0.285	0.877	0.878	0.877	16/17	0.285	0.877	0.855	0.994	0.898	0.855	YES
Thorium-230, Dissolved	pCi/L	16/ 23	0.174	0.388	0.418	0.388	14/ 17	0.174	0.388	0.406	0.406	0.391	0.388	no
Thorium-232	pCi/L	9/ 24	0.046	0.229	0.264	0.229	6/17	0.0482	0.229	---	---	---	0.229	no
Total Uranium	µg/L	24/ 24	0.295	15.6	50	15.6	17/17	0.295	13.3	---	19.85	15.41	13.3	YES
Total Uranium, Dissolved	µg/L	24/ 24	0.242	16.7	57.9	16.7	16/ 17	0.242	16.1	---	22.56	16.55	16.1	YES
Uranium-234	pCi/L	23/ 24	0.210	8.73	21.3	8.73	17/17	0.21	8.73	---	8.971	7.74	7.74	YES
Uranium-234, Dissolved	pCi/L	23/ 23	0.177	8.94	25.6	8.94	17/ 17	0.177	8.94	---	11.42	9.093	8.94	no
Uranium-235	pCi/L	5/ 24	0.188	0.715	0.715	0.715	3/17	0.191	0.715	---	---	---	0.715	no
Uranium-235, Dissolved	pCi/L	10/ 23	0.077	0.512	0.512	0.512	7/ 17	0.0765	0.512	---	---	---	0.512	no
Uranium-238	pCi/L	19/ 24	0.116	5.79	28.2	5.79	14/17	0.116	4.36	---	9.479	7.556	4.36	YES
Uranium-238, Dissolved	pCi/L	21/ 23	0.109	6.32	23	6.32	15/ 17	0.109	6.32	---	10.24	8.264	6.32	no
1,1,1-Trichloroethane	µg/L	1/ 24	0.435	0.435	0.435	0.435	0/17	---	---	---	---	---	---	---
2-Butanone	µg/L	1/ 24	4.49	4.49	4.49	4.49	0/17	---	---	---	---	---	---	---
Acetone	µg/L	4/ 24	3.96	30.5	30.5	30.5	2/17	4.32	6.13	---	---	---	6.13	YES
Benzene	µg/L	1/ 24	0.366	0.366	0.366	0.366	0/17	---	---	---	---	---	---	---
Chlorobenzene	µg/L	1/ 24	0.387	0.387	0.387	0.387	0/17	---	---	---	---	---	---	---
Ethylbenzene	µg/L	1/ 24	0.297	0.297	0.297	0.297	0/17	---	---	---	---	---	---	---
Toluene	µg/L	2/ 24	0.438	4.45	4.45	4.45	0/17	---	---	---	---	---	---	---
trans-1,3-Dichloropropene	µg/L	1/ 24	0.495	0.495	0.495	0.495	0/17	---	---	---	---	---	---	---
Vinyl chloride	µg/L	1/ 24	1.48	1.48	1.48	1.48	0/17	---	---	---	---	---	---	---
Xylenes (total)	µg/L	1/ 24	0.958	0.958	0.958	0.958	0/17	---	---	---	---	---	---	---

a - For the purposes of this comparison, the LWBZ Background Level was determined to be the lesser of the maximum detected value, the 95% normal UTL, the 95% lognormal UTL, and the 95% gamma UTL.

LWBZ - lower water bearing zone

UTL - upper tolerance limit

µg/L - micrograms per liter

pCi/L - picocuries per liter

--- - Data not found to be distributed as noted at a 5% level of significance, or data not applicable. No distriubtution was determined for analytes with <50% detects or with <8 dectected results.

Table 6-3. Comparison of Site-Specific SRCs to SRCs Identified for the Upper and Lower Water-Bearing Zones
Niagara Falls Storage Site, Lewiston, New York

NFSS Site-specific SRC in Site-wide Groundwater (EU 17)	UWBZ SRC	LWBZ SRC
Aluminum	Yes	Yes
Aluminum, Dissolved	Yes	Yes
Antimony	Yes	Yes
Antimony, Dissolved	Yes	Yes
Arsenic	Yes	**No**
Arsenic, Dissolved	Yes	Yes
Barium	Yes	Yes
Barium, Dissolved	Yes	Yes
Beryllium	**No**	**No**
Beryllium, Dissolved	Yes	Yes
Boron	Yes	Yes
Boron, Dissolved	Yes	**No**
Cadmium	Yes	**No**
Cadmium, Dissolved	**No**	Yes
Calcium	Yes	Yes
Calcium, Dissolved	Yes	Yes
Chromium	Yes	Yes
Chromium, Dissolved	Yes	Yes
Cobalt	Yes	Yes
Cobalt, Dissolved	Yes	Yes
Copper	Yes	Yes
Copper, Dissolved	Yes	Yes
Iron	Yes	Yes
Iron, Dissolved	Yes	Yes
Lead	Yes	Yes
Lead, Dissolved	Yes	**No**
Lithium	Yes	Yes
Lithium, Dissolved	**No**	Yes
Magnesium	Yes	**No**
Magnesium, Dissolved	Yes	**No**
Manganese	Yes	Yes
Manganese, Dissolved	Yes	Yes
Mercury	Yes	Yes
Nickel	Yes	Yes
Nickel, Dissolved	Yes	Yes
Potassium	Yes	Yes
Potassium, Dissolved	Yes	Yes
Selenium	Yes	Yes
Selenium, Dissolved	Yes	Yes
Silver	Yes	Yes
Sodium	Yes	Yes
Sodium, Dissolved	Yes	Yes
Thallium	Yes	Yes
Thallium, Dissolved	Yes	Yes
Total Uranium	Yes	**No**
Total Uranium, Dissolved	Yes	**No**
Vanadium	Yes	Yes
Vanadium, Dissolved	Yes	Yes
Zinc	Yes	Yes
Zinc, Dissolved	Yes	Yes

Table 6-3. Comparison of Site-Specific SRCs to SRCs Identified for the Upper and Lower Water-Bearing Zones
Niagara Falls Storage Site, Lewiston, New York

NFSS Site-specific SRC in Site-wide Groundwater (EU 17)	UWBZ SRC	LWBZ SRC
4,4'-DDE	Yes	**No**
4,4'-DDT	Yes	**No**
Alpha	Yes	**No**
Alpha, Dissolved	Yes	**No**
Beta	Yes	**No**
Beta, Dissolved	Yes	**No**
Cesium-137	**No**	**No**
Potassium-40, Dissolved	**No**	**No**
Radium-226	Yes	Yes
Radium-226, Dissolved	Yes	**No**
Radium-228	Yes	Yes
Radium-228, Dissolved	Yes	Yes
Thorium-228	Yes	Yes
Thorium-230	Yes	Yes
Thorium-230, Dissolved	Yes	Yes
Thorium-232	Yes	**No**
Uranium-234	Yes	**No**
Uranium-234, Dissolved	Yes	**No**
Uranium-235	Yes	**No**
Uranium-235, Dissolved	Yes	**No**
Uranium-238	Yes	**No**
Uranium-238, Dissolved	Yes	**No**
2-Butanone	Yes	Yes
1,2-Dichloroethene	**No**	**No**
Acetone	Yes	Yes
bis(2-Ethylhexyl)phthalate	**No**	**No**
Di-n-butylphthalate	**No**	**No**
Methylene chloride	**No**	**No**
Phenol	**No**	**No**
Tetrachloroethene	**No**	**No**
Analytes Identified as potential SRCs in the UWBZ or LWBZ, but not Identified as SRCs in EU17 (Site Groundwater) in the RIR		
Silver, Dissolved	**No**	Yes
Benzo(k)fluoranthene	Yes	**No**
Thorium-228, Dissolved	Yes	Yes
1,1,1-Trichloroethane	Yes	**No**
Benzene	Yes	Yes
Ethylbenzene	Yes	Yes
Toluene	**No**	Yes
Vinyl chloride	Yes	Yes
Xylenes (total)	Yes	**No**

Table 6-4. Comparison of NFSS Radionuclide Concentrations in Background Groundwater to Radionuclide Concentrations in National and New York State Drinking Water Sources
Niagara Falls Storage Site, Lewiston, New York

Analyte	Unit	NFSS Range	NFSS Mean	NFSS Site-specific Background Level	MCL[a]	U.S. EPA Technical Support Document Results (2000)[b]	Drinking Water Treatment Wastes U.S. EPA 2009 [c, d]	USGS 2007 Uranium and Radon in Glacial and Bedrock Aquifers Report (East-Central Glacial Region)
Size of Data Set		Approximately 24 samples for each radionuclide sampled in background groundwater at the NFSS				990 drinking water collection sites	Thousands of public water systems monitored by the U.S. EPA.	283 samples (filtered water samples)
Radium-226	pCi/L	0.31 - 1.76	0.55	1.76	5	Median activity: 0.39 Maximum activity: 15.1	Typical activity of radium in groundwater: 0.5-25 Average activity (Ra-226) in community drinking water supplies: 0.3 - 0.8 [c] (0.905 [d])	---
Radium-226, Dissolved	pCi/L	0.36 - 1.55	0.5	1.31	5			
Radium-228	pCi/L	0.57 - 1.67	0.76	1.67	5	Median activity: 1.47 Maximum activity: 12.1	Typical activity of radium in groundwater: 0.5-25	---
Radium-228, Dissolved	pCi/L	0.89 - 1.6	0.95	1.6	5			
Total Uranium	µg/L	0.3 - 15.6	5.13	15.6	30	Range in domestic groundwater sources: 0.07-653 pCi/L (0.08 - 726 ug/L) [e] Average: 1.73 pCi/L (1.9 ug/L) [e]	Average activity in groundwater sources: 3 pCi/L [c] (3.33 ug/L) [e]	
Total Uranium, Dissolved	µg/L	0.24 - 16.7	5.24	16.7	30			Maximum Conc.: 21.1 90th percentile: 3.3 Median and Minimum Conc.: <1

a - The Maximum Contamiant Level (MCL) are included for comparative purposes only since groundwater is not a source of drinking water at NFSS.
The MCL for radium is for radium-226 and -228 combined.
b - Technical Support Document; Radionuclides Notice of Data Availability (USEPA 2000)
c - Estimated national average activity in community drinking water suppplies. Values as cited from U.S. EPA webpage:
www.epa.gov/radiation/tenorm/drinking-water.html, last updated March 2009.
d - Weighted average indicated by the National Inorganics and Radionuclide Survey, as cited on the U.S. EPA webpage:
www.epa.gov/radiation/tenorm/drinking-water.html, last updated March 2009.
e - Activities converted to an estimated concentration in µg/L using a conversion factor of 0.9 pCi/µg (USEPA 2000).
Use of this conversion factor is consistent with information presented in other NFSS documents.
LWBZ - lower water bearing zone
USGS - United States Geological Survey
µg/L - micrograms per liter
pCi/L - picocuries per liter
--- - Data not available

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7.0 COMPARISON OF NFSS SOIL BACKGROUND LEVELS TO UNITED STATES AND NEW YORK AREA SOIL BACKGROUND LEVELS

This section presents a comparison of the NFSS soil background levels to other background levels from data collected for the United States, New York State and the Tonawanda, New York area. Results of this comparison were used to address the appropriateness of applying NFSS soil background data to define the nature and extent of contaminants at the NFSS.

7.1 INTRODUCTION

Background sampling is conducted as part of site characterization activities to distinguish site-related contamination from naturally-occurring or other non-site related levels of chemicals or radionuclide activities. Background samples are collected at or near the investigative site in areas not influenced by site operations. Additionally, background samples are collected from each sample medium of concern (e.g., soil, groundwater, sediment, surface water) at selected locations that have the same basic characteristics as the medium of concern at the site (EPA 1989).

Background soil samples collected for chemical analysis during the LOOW RI were used to characterize background levels for the NFSS RI. The LOOW included approximately 7,500 acres of land in Niagara County, New York. TNT production operations were conducted on approximately 2,500 acres and the remaining 5,000 acres were left undeveloped. Background sampling locations were located along the inside perimeter of the undeveloped area of the former LOOW. Additional background samples from undeveloped areas of the LOOW were later collected to establish background levels for radionuclides. These areas were considered to be representative background sampling locations, since they are close to NFSS, and are presumably un-impacted by LOOW or NFSS site-related activities. To address public comments concerning the appropriateness of using this background data set to identify the nature and extent of contaminants at the NFSS, an evaluation was performed to compare the NFSS soil background levels to other soil background levels from data collected for the United States, New York State and the Tonawanda, New York area.

7.2 DETERMINATION OF BACKGROUND LEVELS

The determination of background levels for the NFSS involved the establishment of a background data set for each medium and the calculation of a background value for each analyte within each medium. Soil background levels were determined for surface soil (0 to 0.5 ft bgs) and for subsurface soil (0 to 10 ft bgs).

Background samples for the NFSS were collected along the inside perimeter of the boundary of the former LOOW site. Because the potential for impact to these sample locations could not be absolutely eliminated, an outlier test was used in conjunction with a review of the historical use of these properties. All of the constituents that were identified as being outliers in the background data sets could be explained based on previous site use and were removed from the background data set.

A standard 95% UTL (Gilbert 1987) was calculated for data that was determined to be normally distributed. Similarly, log transformed data were used to calculate a UTL for lognormally distributed data. The maximum detected concentration was used as a surrogate for the UTL when the data distribution was determined to be neither normal nor lognormal. The maximum detected concentration was also used as a surrogate for the UTL when less than three sample results were available for any

medium-specific analyte. The result of these data evaluations is a set of background screening values representing either the UTL or maximum detected concentration for each analyte within each medium. A background screening value was defined to be the lower of the 95% background UTL or the maximum value in the background data set. Using this method, the background level of many analytes was described using the maximum detected concentration.

7.3 UNITED STATES AND NEW YORK AREA SOIL BACKGROUND LEVEL DATA SOURCES

Data sources used during this comparison of background levels are listed below. Data from these sources are initially discussed with respect to a broad regional coverage (the 48 coterminous states) and then narrowed to include background soil data for the nearby Tonawanda Sites (Linde, Ashland 1, Ashland 2 and Seaway) in Tonawanda, New York. Tables 7-1 through 7-5 present the comparison of NFSS soil background levels to other background soil concentrations, as reported in the following sources. Further explanation of each data source is provided in the discussions to follow.

- Article by Myrick, T.E. et. al. 1983, titled Determination of Concentrations of Selected Radionuclides in Surface Soil in the U.S; data presented in Tables 7-1a and 7-1b.

- New York State Brownfield Cleanup Program Technical Document for Development of Soil Cleanup Objectives, prepared in 2006 by the NYSDEC and the New York State Department of Health (NYSDOH); data presented in Tables 7-2 through 7-4.

- Remedial Investigation Report for the Tonawanda Site, Tonawanda, New York (USDOE 1993); data presented in Table 7-5.

- 1981 United States Geological Survey (USGS) study titled, *Chemical Analyses of Soils and Other Surficial Materials of the Coterminous United States;* data presented in Table 7-5.

Analytical soil results from the above sources were used in this evaluation as reported in the original document. This evaluation did not consider or review methodologies for collection or analysis of soil samples, other than to note that standard methods were generally employed during the studies. Direct comparisons of reported analytical concentrations to existing NFSS background criteria were made as appropriate, and only if data was available. Comparisons were only presented for analytes detected in NFSS soil background samples.

7.4 COMPARISON OF NEW YORK STATE SOIL BACKGROUND LEVELS AND U.S. SOIL BACKGROUND LEVELS TO NFSS SITE-SPECIFIC SOIL BACKGROUND LEVELS FOR RADIUM-226, THORIUM-232, AND URANIUM-238

The following discussion presents a description of the New York State and U.S. background data for radium-226, thorium-232 and uranium-238. Also presented are the results of a comparison of New York State soil background levels and U.S. soil background levels to NFSS site-specific soil background levels for radium-226, thorium-232 and uranium-238.

7.4.1 Description of New York State and U.S. Background Data for Radium-226, Thorium-232 and Uranium-238

The ORNL determined background radionuclide concentrations in surface soil at inactive uranium mills and sites formerly utilized for MED and early AEC projects throughout the United States (Myrick et al.

1983). This study determined surface soil background concentrations for radium-226, thorium-232 and uranium-238 for comparative purposes to determine the extent of contamination present at the survey sites and surrounding off-site areas. Samples were collected from the top 6 cm (2.4 inches) of soil. Sampling results reported by Myrick et al. (1983) included information obtained from 356 locations in 33 states. The locations of the background soil samples were nonrandom and positioned along major highways (Myrick et al. 1983). The locations were selected by several considerations:

- Proximity to or along a route to a site undergoing a radiological survey;
- Accessibility (i.e., closeness to highway); and
- The degree to which the location was undisturbed.

The study concluded that regional differences in radium-226, thorium-232, and uranium-238 concentrations in surface soil are evident. The study also indicated that in undisturbed areas the U.S. average concentrations of radium-226 and uranium-238 show a nearly 1:1 correlation, suggesting that a rough, radioactive equilibrium exists (Myrick et al. 1983).

For comparison to NFSS background levels, radionuclide background concentrations reported for New York State and the entire U.S. have been reviewed and are included in Tables 7-1a and 7-1b.

7.4.2 Results of Comparison of New York State Soil Background Levels and U.S. Soil Background Levels to NFSS Site-specific Soil Background Levels for Radium-226, Thorium-232, and Uranium-238

NFSS background levels for radionuclides (radium-226, thorium-232, and uranium-238) in surface soil were compared to the New York State subset of surface soil background concentrations reported in Myrick et al. (1983) (Table 7-1a). The background levels for these radionuclides represent maximum observed activities in NFSS background surface soils. The maximum concentrations for thorium-232 and uranium-238 in NFSS background surface soils were greater than the corresponding maximum concentrations for these radionuclides in New York State surface soils. Additionally, the mean activity for thorium-232 in NFSS background surface soil was greater than the corresponding arithmetic and geometric mean activities reported for this radionuclide in New York State surface soils. However, the differences between the maximum and mean values in the two data sets are small in magnitude and a closer examination of the statistics shown in Table 7-1a indicates that the maximum and mean background values in the NFSS and New York State surface soil data sets are similar.

NFSS background levels for radionuclides (radium-226, thorium-232, and uranium-238) in surface soil were also compared to U.S. surface soil background concentrations reported in Myrick et al. (1983) (Table 7-1b). The background levels for these three radionuclides at the NFSS represent the maximum observed activities for these radionuclides in background surface soils. These maximum activities were less than the corresponding maximum activities reported for these radionuclides in U.S. surface soils. The NFSS mean activity for thorium-232 in background surface soil was greater than the geometric mean reported for thorium-232 in U.S. surface soil. However, as with the New York State statistics, the differences between the maximum and mean values in the NFSS and U.S. data sets are small and the statistics shown in Table 7-1b indicate that the maximum and mean background values in the NFSS and U.S. surface soil data sets are similar.

7.5 COMPARISON OF NFSS RI SURFACE SOIL BACKGROUND DATA TO NEW YORK STATE BROWNFIELD PROGRAM SOIL CLEANUP OBJECTIVES

The following discussion presents a description of soil cleanup objective development sampling for the New York State Brownfield Program. Also presented are results of a comparison of New York State Brownfield Program rural soil concentrations to NFSS site-specific soil background levels.

7.5.1 Description of New York State Brownfield Program - Soil Cleanup Objective Development Sampling

The NYSDEC and the NYSDOH conducted a survey to define chemical background concentration ranges in rural surface soil. Rural locations used in this study were those so designated by the United States census for the year 2000 (NYSDEC and NYSDOH 2006). "Rural" areas, as defined by the Census Bureau, consisted of all territory, population, and housing units located outside of urbanized areas and urban clusters.

At least two types of surface soil samples were collected at each randomly selected rural property. "Source-distant" samples were obtained from areas that were reasonable points of human contact with soil, such as yards and trails, but at least 5 meters distant from potential pollution sources such as trash, roads, driveways, or structures. "Remote" samples were collected from areas that were at least 20 paces (approximately 15 meters) distant from margins of human activity. Additionally, a "near source" soil sample, collected near a roadway or driveway, was obtained at randomly selected properties. Following completion of the sampling effort, NYSDEC identified a subset of remote samples collected from habitat areas marginally influenced by human activities. (NYSDEC and NYSDOH 2006)

The statistical data set contained analytical results for select VOCs, SVOCs, PAHs, pesticides, PCBs, metals, and cyanide from a total of 242 samples (NYSDEC and NYSDOH 2006). Distribution-free analyte concentration percentiles (quantiles) were used to define background levels. The 95th percentile concentration for each analyte in this study was used for comparison to NFSS surface soil background levels.

7.5.2 Results of Comparison of New York State Brownfield Program Rural Soil Concentrations to NFSS Site-specific Soil Background Levels

NFSS background levels were compared to analyte concentrations in rural New York State surface soils in source-distant, habitat, and near-source areas, as defined by NYSDEC and NYSDOH (2006). Tables 7-2, 7-3, and 7-4 show these comparisons for these three areas, respectively. Comparisons were only performed for analytes detected in NFSS background soil samples.

7.5.2.1 Source-Distant Area Soils

NFSS background levels in soil were compared to the 95th percentile for source distant area soils (Table 7-2). The NFSS background level was less than or equal to the New York State 95th percentile concentration for 9 of 22 metals and 0 of 8 PAHs. No other organic compounds were detected in source-distant area soils for comparison to detected analytes in NFSS background samples.

7.5.2.2 Habitat Area Soils

NFSS background levels in soil were compared to the 95th percentile for habitat area soils (Table 7-3). The NFSS background level was less than or equal to the New York State 95th percentile concentration for

8 of 22 metals and 0 of 8 PAHs. No other organic compounds were detected in habitat area soils for comparison to detected analytes in NFSS background samples.

7.5.2.3 Near Source Area Soils

NFSS background levels in soil were compared to the 95th percentile for near source area soils (Table 7-4). The NFSS background level was less than or equal to the New York State 95th percentile concentration for 10 of 21 metals and all eight PAHs. No other organic compounds were detected in near source area soils for comparison to detected analytes in NFSS background samples.

7.5.2.4 Summary

The NFSS background levels in surface soil are greater than both the New York State source-distant and habitat area 95th percentile surface soil concentrations for essentially the same metals and PAHs. Comparisons of NFSS background levels to New York State source-distant and habitat area soils indicate the following:

- Several metals and PAHs are present in NFSS background surface soils at concentrations greater than the New York source-distant and habitat area soil background levels, indicating that the NFSS background levels for some metals and PAHs are greater than the concentrations found in other rural New York soils.

- NFSS background surface soils exhibited levels of PAHs that were greater than PAH levels observed in both source-distant and habitat area surface soils.

Due to the industrial history of the NFSS and adjacent properties, it can be concluded that comparison of NFSS background soils to New York State near source area soils is more appropriate than comparison to either source-distant or habitat area soils. With this in mind, the following can be noted:

- Of the three rural soil source areas, near source area soils exhibited the most metals that were present at concentrations greater than NFSS background levels.

- A total of 8 of 11 metals whose background levels were greater in NFSS background surface soils, exhibited a percent difference of less than 50% when compared to the background level in near source area soils. This indicates that although some NFSS background levels appear to be greater than New York State near source area background levels, the differences in the background values for some metals are small.

- PAH levels in NFSS background surface soils were consistently lower than PAH levels in near-source area soils.

7.6 COMPARISON OF ASHLAND 2 SOUTH AND OTHER TONAWANDA AREA SOIL BACKGROUND CONCENTRATIONS TO NFSS SITE-SPECIFIC SOIL BACKGROUND LEVELS

This section presents a description of Ashland 2 South and Tonawanda area soil background data as well as the results of a comparison of Ashland 2 South and Tonawanda area soil background levels to NFSS site-specific soil background levels.

7.6.1 Description of Ashland 2 South and Tonawanda Area Soil Background Data

In support of the 1993 Remedial Investigation Report for the Tonawanda Sites (Linde, Ashland 1, Ashland 2 and Seaway), soil background criteria from five soil background studies were examined. These values are included in Table 7-5 and were compared to NFSS subsurface soil background concentrations. The Tonawanda Sites are located approximately 22 miles southeast of the NFSS. Locations for these five soil background studies near Tonawanda include: (1) Ashland 2 South FUSRAP site, (2) Erie County, New York, (3) rural and (4) urban areas of West Seneca, New York, and (5) a study area near the Tonawanda site selected by Oak Ridge Associated Universities (ORAU). Background levels for these five locations were obtained from the Remedial Investigation Report for the Tonawanda Site, Tonawanda, New York (USDOE 1993). A brief description of the data obtained from these locations is provided below; however, the data presented in Table 7-5 is as published in Table 4-3 of the Tonawanda Site RI (USDOE 1993). Sampling and statistical methodology for the background data from each of the five Tonawanda area locations have not been fully reviewed for this evaluation.

The Ashland 2 FUSRAP site was contaminated with radionuclide and inorganic constituents similar to that of NFSS. Soil containing MED-related low-level radioactive residues and inorganic constituents were moved to the Ashland 2 site in 1974. Other general plant refuse and chemical by-products were also deposited on this property in an industrial landfill that was closed and covered in 1982. In the southern portion of Ashland 2 (referred to as the Ashland 2 South area), background levels were characterized using samples collected from undisturbed areas and analyzed for metals and radiological parameters. This sample area was not located near the Ashland 2 site area where the MED-related materials were placed. For the Tonawanda Site RI, site-specific background levels of radionuclides and metals were determined based on concentrations in samples collected from Ashland 2 South. Ten samples were analyzed for radionuclides and nine samples were analyzed for metals. Samples were collected at depths of 0 to 2 ft and 2 to 6 ft. The background sampling locations at Ashland 2 South are representative of the natural Tonawanda site soils because the samples were collected from undisturbed soils. Additionally, the sampling locations were remote from areas of radioactive and chemical contamination, and did not include areas of stormwater runoff or any areas of contamination. (USDOE 1993)

Soil data for Erie County was obtained from a USGS study (USGS 1981) that included geochemical data from soil collected and analyzed by Hans Shacklette and colleagues from 1958 to 1976. The Erie County data is from a national geochemical data set collected and analyzed according to standardized protocols, and the data are most appropriately used to provide information on background concentrations of elements in soil. The national data set contains 1,323 samples for a sampling density of approximately one sample per 6,000 square kilometers (USGS 1981) Samples for this study were collected at a depth of about 20 cm (7.9 inches) from sites that had surficial materials that were little altered from their natural condition and that supported native plants.

Rural and urban soil background concentrations from West Seneca, New York and Buffalo, New York are presented in Table 7-5, as published in the Tonawanda Site RI (USDOE 1993). Citations for these data were not provided in the RI document, thus no further information is provided here.

In 1981, the ORAU conducted an investigation to determine background concentrations for radionuclides in soil in the Tonawanda area. This study did not address metals. Radionuclide soil background concentrations from this study, as noted on Table 7-5, were collected from the banks of Ellicott Creek and an unnamed creek, both located in the Tonawanda area. Soil samples were collected at depths of 5 cm (2 inches) and from a depth between 10 cm and 15 cm (4 to 6 inches) (ORAU 1981).

7.6.2 Results of Comparison of Ashland 2 South and Tonawanda Area Soil Background Levels to NFSS Site-specific Soil Background Levels

Maximum and mean concentrations for metals and radionuclides in NFSS background subsurface soil were compared to the maximum concentrations observed in Ashland 2 South soils (Table 7-5). For roughly half of the metals and all of the radionuclides listed on Table 7-5, the maximum concentration in NFSS background soils was less than the maximum concentration detected at Ashland 2 South. Additionally, mean values for all radionuclides and all except three metals (cobalt, copper and manganese) were less in NFSS background soils than in Ashland 2 South background soils. The NFSS mean background concentration for cobalt, copper and manganese was slightly greater than the mean concentration for these metals in Ashland 2 South background soils. For the radionuclides, the NFSS site-specific background levels are all less than the maximum concentrations and are approximately the same or less than the mean concentrations reported for Ashland 2 South background soils. These comparisons suggests that concentrations of metals and radionuclides in NFSS background soils may generally be less than background concentrations reported for Ashland 2 South background soils.

The NFSS site-specific background levels were also compared to background levels reported for Erie County soils, and soils in the Tonawanda area (rural, urban, ORAU study) (Table 7-5). The background levels reported for approximately half of the metals listed on Table 7-5 were less in NFSS background soils than in Erie County soils. This indicates that background levels for some metals in Erie County soils are lower than corresponding NFSS background levels. Likewise, background concentrations determined for metals in rural and urban soils near West Seneca, New York and Buffalo, New York, respectively, are less than some NFSS soil background levels. For both rural and urban soil samples collected near West Seneca, New York, approximately half had background values that were less than corresponding NFSS site-specific background levels.

No radionuclide soil background criteria were reported for Erie County, or rural and urban soils near West Seneca and Buffalo. The ORAU study (1981) presented background levels for radionuclides. Background values for three out of four of the radionuclides included in the ORAU study (radium-226, thorium-230, and thorium-232) had background levels that were less than corresponding NFSS background levels.

7.7 SUMMARY

The comparison of the maximum, mean, and UTL values for parameters in the NFSS soil background data set to other background soil data set statistics indicate that, in many cases, the NFSS background levels appear to be less than background levels observed in U.S., New York State and Tonawanda area background soils. In cases where NFSS background levels appear to be greater than other soil background levels, the differences in the background values are often relatively small. These observations suggest that the NFSS soil background data is similar to U.S., New York State and Tonawanda area soil background data.

Therefore, the comparison of NFSS soil background levels to other soil background levels from data collected for the U.S, New York State and the Tonawanda, New York area supports the conclusion that the NFSS soil background data set is appropriate for evaluating the nature and extent of contaminants at the NFSS.

Additionally, Myrick et al (1983) indicated that in undisturbed areas, the U.S. average concentrations of radium-226 and uranium-238 show a nearly 1:1 correlation. Very similar background levels and mean activities are observed for radium-226 and uranium-238 in NFSS subsurface soil (see Table 7-5). The mean activities for these two radionuclides are 0.81 pCi/g and 0.80 pCi/g, respectively. The site-specific

background levels for these two radionuclides are 1.2 pCi/g and 1.34 pCi/g, respectively. The similarity of these values suggests that radium-226 and uranium-238 exist in radioactive equilibrium in NFSS background soils. This close relationship between radium-226 and uranium-238 activities observed in NFSS subsurface background soil lends credence to the opinion that NFSS background soil locations are from an undisturbed area not affected by previous site operations.

SECTION 7

TABLES

Tables 7-1a and 7-1b. Comparison of NFSS Surface Soil Background Concentrations to New York State Background Concentrations and United States Background Concentrations for Radium-226, Thorium-232, and Uranium-238

Table 7-1a

		NFSS Surface Soil (0-6" bgs) Background Data Statistics						New York State Background Concentrations[a]							Comparison of Data		
Analyte	Unit	Results >Detection Limit	Minimum Detect	Maximum Detect	Mean	95% UTL	Site-specific Background Level	Number of Samples	Min	Max	Arithmetic Mean	Standard Deviation	Geometric Mean	Stadard Deviation	NFSS Mean < or = NY State Arithmetic Mean?	NFSS Mean < or = NY State Geometric Mean?	NFSS Site-specific Background Level < or = NY Max?
Radium-226	pCi/g	15/ 15	0.394	0.921	0.74	1.11	0.921	6	0.48	1.2	0.85	0.51	0.81	1.4	YES	YES	YES
Thorium-232	pCi/g	15/ 15	0.473	1.24	0.88	1.46	1.24	6	0.4	1.1	0.71	0.52	0.67	1.5	no	no	no
Uranium-238	pCi/g	15/ 15	0.367	1.36	0.86	1.62	1.36	6	0.76	1.2	0.95	0.26	0.94	1.2	YES	YES	no

Table 7-1b

		NFSS Surface Soil (0-6" bgs) Background Data Statistics						U.S. Background Concentrations[a]							Comparison of Data		
Analyte	Unit	Results >Detection Limit	Minimum Detect	Maximum Detect	Mean	95% UTL	Site-specific Background Level	Number of Samples	Min	Max	Arithmetic Mean	Standard Deviation	Geometric Mean	Stadard Deviation	NFSS Mean < or = U.S. Arithmetic Mean?	NFSS Mean < or = U.S. Geometric Mean?	NFSS Site-specific Background Level < or = U.S. Max?
Radium-226	pCi/g	15/ 15	0.394	0.921	0.74	1.11	0.921	327	0.48	4.2	1.1	0.48	1	1.6	YES	YES	YES
Thorium-232	pCi/g	15/ 15	0.473	1.24	0.88	1.46	1.24	331	0.1	3.4	0.98	0.46	0.87	1.7	YES	no	YES
Uranium-238	pCi/g	15/ 15	0.367	1.36	0.86	1.62	1.36	355	0.12	3.8	1	0.83	0.96	1.6	YES	YES	YES

a - Data obtained from Myrick, T.E. et. al., Determination of Concentrations of Selected Radionuclides in Surface Soil in the U.S., published in *Health Physics*, Vol. 45, No. 3 (September), ppp. 6331-642, 1983.
UTL - upper tolerance limit
pCi/g - picocuries per gram

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Table 7-2. Comparison of NFSS Background Surface Soil Data to New York State Rural Surface Soil Data - Source-Distant Area

NFSS Background Analytes in Surface Soil		NFSS Background Surface Soil Statistics 0-6" bgs					New York State Surface Soil Values for source-distant data set 0-2" bgs (Table 6a of Appendix D, NYSDEC 2006)						Comparison of NFSS Site-specific Background Level and New York State Surface Soil Criteria	
Analyte	Unit	Results >Detection Limit	Minimum Detect	Maximum Detect	95% UTL	Site-specific Background Level	Sample Size N	Percent Detected		Minimum Conc.	Maximum Conc.	95th Percentile [a]	NFSS Site-specific Background Level < or = NY 95th Perc.?	Relative Percent Difference [b]
Aluminum	mg/kg	16/ 16	4380	18400	21800	18400	118	100.0		561.0	20000	15800	no	15
Antimony	mg/kg	6/ 16	0.26	0.94	0.94	0.94	118	5.1		0.6	5.0	*< 2.4	YES	87
Arsenic	mg/kg	15/ 15	2.3	11.4	11.3	11.3	118	91.5	<	0.2	69	12	YES	6
Barium	mg/kg	16/ 16	45.2	279	375	279	118	100.0		4.0	743	165	no	51
Beryllium	mg/kg	16/ 16	0.18	1	1.21	1	118	100.0		0.1	2.5	1.0	YES	0
Boron	mg/kg	12/ 16	1.7	10.1	15.8	10.1	---	---		---	---	---	---	---
Cadmium	mg/kg	8/ 16	0.04	0.53	1.21	0.53	118	78.0	<	0.05	4.2	2.4	YES	128
Calcium	mg/kg	16/ 16	994	45200	60300	45200	118	100.0		245.0	74500	9190	no	132
Chromium	mg/kg	16/ 16	5.3	24.3	29.9	24.3	118	100.0		1.0	36	20	no	19
Cobalt	mg/kg	16/ 16	2.2	57.4	65.5	57.4	118	98.3		0.3	15.1	13.3	no	125
Copper	mg/kg	16/ 16	4.4	34.7	43.1	34.7	118	100.0		2.0	98	32	no	8
Iron	mg/kg	16/ 16	6240	36400	43500	36400	118	100.0		783.0	29500	25600	no	35
Lead	mg/kg	15/ 15	4.7	55.2	66.4	55.2	118	100.0		3.0	110	72	YES	26
Lithium	mg/kg	16/ 16	4.6	27.9	34.4	27.9	---	---		---	---	---	---	---
Magnesium	mg/kg	16/ 16	931	10200	11500	10200	118	100.0		177.0	46000	5130	no	66
Manganese	mg/kg	16/ 16	70	6650	5630	5630	118	100.0		13.0	4550	1610	no	111
Mercury	mg/kg	9/ 16	0.029	0.27	0.27	0.27	118	99.2	**	0.01	0.34	0.2	no	30
Nickel	mg/kg	16/ 16	5.8	37.5	41	37.5	118	100.0		0.0	49	25	no	40
Potassium	mg/kg	16/ 16	138	1820	2050	1820	118	100.0		116.0	2440	1890	YES	4
Selenium	mg/kg	7/ 15	0.21	0.37	0.37	0.37	118	95.8	<	0.4	6.5	3.7	YES	164
Silver	mg/kg	2/ 16	0.27	0.27	0.27	0.27	118	18.6	<	0.1	1.6	0.6	YES	76
Sodium	mg/kg	16/ 16	51.7	286	286	286	118	78.0	<	39.0	422	211	no	30
Vanadium	mg/kg	16/ 16	9.9	34	40.3	34	118	100.0		2.0	38	31	no	9
Zinc	mg/kg	16/ 16	23.1	78	92	78	118	100.0		10.0	454	140	YES	57
Benzo(a)anthracene	µg/kg	2/ 16	208	284	284	284	118	10.2	<	5.0	2600	160	no	56
Benzo(a)pyrene	µg/kg	1/ 16	313	313	313	313	118	10.2	<	6.0	3400	120	no	89
Benzo(b)fluoranthene	µg/kg	3/ 16	2.5	396	396	396	118	13.6	<	18.0	4600	360	no	10
Benzo(k)fluoranthene	µg/kg	3/ 16	0.74	322	322	322	118	10.2	<	12.0	1700	100	no	105
Chrysene	µg/kg	2/ 16	303	378	378	378	118	12.7	<	11.0	2400	230	no	49
Fluoranthene	µg/kg	3/ 16	2.3	889	889	889	118	21.2	<	5.0	1800	630	no	34
Phenanthrene	µg/kg	1/ 16	538	538	538	538	118	14.4	<	8.0	1100	359	no	40
Pyrene	µg/kg	3/ 16	1.5	716	716	716	118	25.4	<	6.0	2900	640	no	11

Only parameters that were detected in NFSS background soils are shown in the table.
New York State surface soil data is from the publication, "New York State Brownfield Cleanup Program, Development of Soil Cleanup Objectives, Technical Support Document", prepared by NYSDEC and NYSDH (September 2006).
"Source-Distant" areas were locations that were considered reasonable points of human contact, at least five meters from any potential pollution source.
a - represents a distribution free percentile, outliers included
b - Releative Percent Difference calculated using the following formula: |A-B|/((A+B)/2))*100
< - Non-detected value (Method detection limit of non-detected value.) The detection limit for non-detect UTLs was used as a default value for UTL comparison.
* - Actual non-detected value; other detected readings had lower values.
** - Actual detected value; other non-detected readings had higher values.
bgs - below ground surface
mg/kg - milligrams per kilogram
µg/kg - micrograms per kilogram
pCi/g - picocuries per gram

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Table 7-3. Comparison of NFSS Background Surface Soil Data to New York State Rural Surface Soil Data - Habitat Area

NFSS Background Analytes in Surface Soil		NFSS Background Surface Soil Statistics 0-6" bgs					New York State Surface Soil Values for Habitat area data set 0-6" bgs (Table 6b of Appendix D, NYSDEC 2006)						Comparison of NFSS Site-specific Background Level and New York State Surface Soil Criteria	
Analyte	Unit	Results >Detection Limit	Minimum Detect	Maximum Detect	95% UTL	Site-specific Background Level	Sample Size N	Percent Detected		Minimum Conc.	Maximum Conc.	95th Percentile [a]	NFSS Site-specific Background Level < or = NY 95th Perc.?	Relative Percent Difference [b]
Aluminum	mg/kg	16/ 16	4380	18400	21800	18400	96	100.0		906.0	21800	16400	no	11
Antimony	mg/kg	6/ 16	0.26	0.94	0.94	0.94	96	2.1	<	0.6	5.8	< 2.0	YES	72
Arsenic	mg/kg	15/ 15	2.3	11.4	11.3	11.3	96	89.6	<	0.3	28.1	13.0	YES	14
Barium	mg/kg	16/ 16	45.2	279	375	279	96	100.0		6.0	278	176	no	45
Beryllium	mg/kg	16/ 16	0.18	1	1.21	1	96	100.0		0.1	3.8	1.1	YES	10
Boron	mg/kg	12/ 16	1.7	10.1	15.8	10.1	---	---		---	---	---	---	---
Cadmium	mg/kg	8/ 16	0.04	0.53	1.21	0.53	96	72.9	<	0.1	3.6	2.1	YES	119
Calcium	mg/kg	16/ 16	994	45200	60300	45200	96	100.0		113.0	19800	6100	no	152
Chromium	mg/kg	16/ 16	5.3	24.3	29.9	24.3	96	100.0		1.3	24.4	19.1	no	24
Cobalt	mg/kg	16/ 16	2.2	57.4	65.5	57.4	96	100.0		0.5	16.9	12.8	no	127
Copper	mg/kg	16/ 16	4.4	34.7	43.1	34.7	96	100.0		2.0	101	33	no	5
Iron	mg/kg	16/ 16	6240	36400	43500	36400	96	100.0		1190.0	29800	26200	no	33
Lead	mg/kg	15/ 15	4.7	55.2	66.4	55.2	96	100.0		3.0	112	63	YES	13
Lithium	mg/kg	16/ 16	4.6	27.9	34.4	27.9	---	---		---	---	---	---	---
Magnesium	mg/kg	16/ 16	931	10200	11500	10200	96	100.0		105.0	10100	5150	no	66
Manganese	mg/kg	16/ 16	70	6650	5630	5630	96	100.0		17.0	147	1600	no	111
Mercury	mg/kg	9/ 16	0.029	0.27	0.27	0.27	96	100.0		0.0	0.3	0.2	no	40
Nickel	mg/kg	16/ 16	5.8	37.5	41	37.5	96	100.0		1.0	50.0	25.0	no	40
Potassium	mg/kg	16/ 16	138	1820	2050	1820	96	100.0		126.0	2440	1700	no	7
Selenium	mg/kg	7/ 15	0.21	0.37	0.37	0.37	96	95.8		0.4	5.1	3.9	YES	165
Silver	mg/kg	2/ 16	0.27	0.27	0.27	0.27	96	18.8	<	0.1	1.2	0.7	YES	89
Sodium	mg/kg	16/ 16	51.7	286	286	286	96	74	<	39	627	251	no	13
Vanadium	mg/kg	16/ 16	9.9	34	40.3	34	96	100		3	44	33	no	3
Zinc	mg/kg	16/ 16	23.1	78	92	78	96	100		11	242	109	YES	33
Benzo(a)anthracene	µg/kg	2/ 16	208	284	284	284	95	5.3	<	5	1500	62	no	128
Benzo(a)pyrene	µg/kg	1/ 16	313	313	313	313	95	4.2	<	6	1100	< 46	no	149
Benzo(b)fluoranthene	µg/kg	3/ 16	2.5	396	396	396	95	5.3	<	18	1300	96	no	122
Benzo(k)fluoranthene	µg/kg	3/ 16	0.74	322	322	322	95	5.3	<	12	590	66	no	132
Chrysene	µg/kg	2/ 16	303	378	378	378	95	5.3	<	11	1900	71	no	137
Fluoranthene	µg/kg	3/ 16	2.3	889	889	889	95	13.7	<	5	3200	87	no	164
Phenanthrene	µg/kg	1/ 16	538	538	538	538	95	6.3	<	8	2700	75	no	151
Pyrene	µg/kg	3/ 16	1.5	716	716	716	95	18.9	<	6	4600	170	no	123

Only parameters that were detected in NFSS background soils are shown in the table.

New York State surface soil data is from the publication, "New York State Brownfield Cleanup Program, Development of Soil Cleanup Objectives, Technical Support Document", prepared by NYSDEC and NYSDOH (September 2006).

"Habitat" areas were locations that provided environmental conditions that could sustain plant and animal life and were at least 15 meters distant from the edge of areas of regular human activity, such as yards, golf courses, farms, athletic fields, areas of fill, etc. (NYSDEC and NYSDOH 2006)

a - represents a distribution free percentile, outliers included

b - Releative Percent Difference calculated using the following formula: |A-B|/((A+B)/2))*100

< - Non-detected value (Method detection limit of non-detected value.) The detection limit for non-detect UTLs was used as a default value for UTL comparison.

* - Actual non-detected value; other detected readings had lower values.

** - Actual detected value; other non-detected readings had higher values.

bgs - below ground surface

mg/kg - milligrams per kilogram

µg/kg - micrograms per kilogram

pCi/g - picocuries per gram

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Table 7-4. Comparison of NFSS Background Surface Soil Data to New York State Rural Surface Soil Data - Near Source Area

NFSS Background Analytes in Surface Soil		NFSS Background Surface Soil Statistics 0-6" bgs					New York State Surface Soil Values for near source data set 0-2" bgs (Table 6c of Appendix D, NYSDEC 2006)					Comparison of NFSS Site-specific Background Level and New York State Surface Soil Criteria	
Analyte	Unit	Results >Detection Limit	Minimum Detect	Maximum Detect	95% UTL	Site-specific Background Level	Sample Size N	Percent Detected	Minimum Conc.	Maximum Conc.	95th Percentile [a]	NFSS Site-spefic Background Level < or = NY 95th Perc.?	Relative Percent Difference [b]
Aluminum	mg/kg	16/ 16	4380	18400	21800	18400	28.0	100.0	1860.0	14400	13700	no	29
Antimony	mg/kg	6/ 16	0.26	0.94	0.94	0.94	---	---	---	---	---	---	---
Arsenic	mg/kg	15/ 15	2.3	11.4	11.3	11.3	28.0	96.4	< 0.3	14.1	12.8	YES	12
Barium	mg/kg	16/ 16	45.2	279	375	279	28.0	100.0	11.0	188	156	no	57
Beryllium	mg/kg	16/ 16	0.18	1	1.21	1	28.0	100.0	0.2	1.3	1.0	YES	0
Boron	mg/kg	12/ 16	1.7	10.1	15.8	10.1	---	---	---	---	---	---	---
Cadmium	mg/kg	8/ 16	0.04	0.53	1.21	0.53	28.0	75.0	< 0.1	2.3	2.1	YES	119
Calcium	mg/kg	16/ 16	994	45200	60300	45200	28.0	100.0	465.0	56500	53900	YES	18
Chromium	mg/kg	16/ 16	5.3	24.3	29.9	24.3	28.0	100.0	1.3	17.5	16.0	no	41
Cobalt	mg/kg	16/ 16	2.2	57.4	65.5	57.4	28.0	96.4	< 0.2	24.1	13.4	no	124
Copper	mg/kg	16/ 16	4.4	34.7	43.1	34.7	28.0	100.0	3.4	29.6	25.9	no	29
Iron	mg/kg	16/ 16	6240	36400	43500	36400	28.0	100.0	3090.0	25700	23200	no	44
Lead	mg/kg	15/ 15	4.7	55.2	66.4	55.2	28.0	100.0	9.0	133	84	YES	41
Lithium	mg/kg	16/ 16	4.6	27.9	34.4	27.9	---	---	---	---	---	---	---
Magnesium	mg/kg	16/ 16	931	10200	11500	10200	28.0	100.0	220.0	31400	13700	YES	29
Manganese	mg/kg	16/ 16	70	6650	5630	5630	28.0	100.0	17.0	1560	1290	no	125
Mercury	mg/kg	9/ 16	0.029	0.27	0.27	0.27	28.0	96.4	< 0.01	0.28	0.19	no	35
Nickel	mg/kg	16/ 16	5.8	37.5	41	37.5	28.0	100.0	1.2	29.5	24.9	no	40
Potassium	mg/kg	16/ 16	138	1820	2050	1820	28.0	100.0	122.0	1660	1560	no	15
Selenium	mg/kg	7/ 15	0.21	0.37	0.37	0.37	28.0	89.3	< 0.4	4.4	4.2	YES	168
Silver	mg/kg	2/ 16	0.27	0.27	0.27	0.27	28.0	17.9	< 0.12	0.40	0.37	YES	31
Sodium	mg/kg	16/ 16	51.7	286	286	286	28.0	92.9	** 53.0	806	295	YES	3
Vanadium	mg/kg	16/ 16	9.9	34	40.3	34	28.0	100.0	4.0	25.9	22.7	no	40
Zinc	mg/kg	16/ 16	23.1	78	92	78	28.0	100.0	15.0	109	107	YES	31
Benzo(a)anthracene	µg/kg	2/ 16	208	284	284	284	28.0	35.7	< 6.0	2900	1200	YES	123
Benzo(a)pyrene	µg/kg	1/ 16	313	313	313	313	28.0	32.1	< 7.0	2400	1100	YES	111
Benzo(b)fluoranthene	µg/kg	3/ 16	2.5	396	396	396	28.0	42.9	< 20.0	3300	1200	YES	101
Benzo(k)fluoranthene	µg/kg	3/ 16	0.74	322	322	322	28.0	25.0	< 13.0	1500	740	YES	79
Chrysene	µg/kg	2/ 16	303	378	378	378	28.0	39.3	< 12.0	1300	630	YES	50
Fluoranthene	µg/kg	3/ 16	2.3	889	889	889	28.0	46.4	< 5.0	7400	2800	YES	104
Phenanthrene	µg/kg	1/ 16	538	538	538	538	28.0	42.9	< 9.0	8500	1600	YES	99
Pyrene	µg/kg	3/ 16	1.5	716	716	716	28.0	50.0	< 7.0	8700	2800	YES	119

Only parameters that were detected in NFSS background soils are shown in the table.
New York State surface soil data is from the publication, "New York State Brownfield Cleanup Program, Development of Soil Cleanup Objectives, Technical Support Document", prepared by NYSDEC and NYSDH (September 2006).
"Near Source" areas were locations typically two meters distant form a road or driveway. In some cases, near source samples were collected up to three meters from a road or driveway.
a - represents a distribution free percentile, outliers included
b - Releative Percent Difference calculated using the following formula: |A-B|/((A+B)/2))*100
< - Non-detected value (Method detection limit of non-detected value.) The detection limit for non-detect UTLs was used as a default value for UTL comparison.
* - Actual non-detected value; other detected readings had lower values.
** - Actual detected value; other non-detected readings had higher values.
bgs - below ground surface
mg/kg - milligrams per kilogram
µg/kg - micrograms per kilogram
pCi/g - picocuries per gram

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Table 7-5. Comparison of NFSS Soil Background Concentrations to Soil Background Concentrations at Ashland 2 South and Tonawanda Area

		NFSS Subsurface Soil Background Data Statistics						Ashland 2 South [a]												
Analyte	Unit	Results >Detection Limit	Minimum Detect	Maximum Detect	Mean	95% UTL	Site-specific Background Level	Min	Max	Mean	Standard Dev	USGS Erie Co. [b]		Rural Value [c]		Urban Value [d]	ORAU [e]	NFSS Max < or = Ashland 2 Max?	NFSS Mean < or = Ashland 2 Mean?	NFSS Site-specific Background Level < or = USGS Erie	NFSS Site-specific Background Level < or = Rural Value?	NFSS Site-specific Background Level < or = Urban	NFSS Site-specific Background Level < or = ORAU?
Aluminum	mg/kg	34/ 34	4380	19100	11300	20600	19100	9280	18600	13975.56	3324.21	30000		18,300		10,500	na	no	YES	YES	no	no	---
Antimony	mg/kg	13/ 34	0.26	0.94	0.30	0.94	0.94	6.6	10	8.24	1.21	nd	<	60	<	20	na	YES	YES	---	YES	YES	---
Arsenic	mg/kg	33/ 33	1.7	11.4	4.11	8.73	8.73	16.5	25.1	20.47	2.95	13		3.2		7	na	YES	YES	YES	no	no	---
Barium	mg/kg	34/ 34	45.2	279	111	263	263	80.2	165	112.81	27.77	500		49.1		246	na	no	YES	YES	no	no	---
Beryllium	mg/kg	34/ 34	0.12	1	0.59	1.11	1	0.83	1.4	1.08	0.18	nd	<	0.8		0.7	na	YES	YES	---	no	no	---
Boron	mg/kg	29/ 34	1.4	10.1	3.96	10.1	10.1	16.5	25.1	20.47	2.95	70		na		na	na	YES	YES	YES	---	---	---
Cadmium	mg/kg	13/ 34	0.04	0.53	0.07	0.53	0.53	0.83	1.3	1.03	0.16	nd	<	4		2.3	na	YES	YES	---	YES	YES	---
Calcium	mg/kg	34/ 34	994	58900	25200	58900	58900	1490	66100	32876.67	26798.81	2800		2520		26800	na	YES	YES	no	no	no	---
Chromium	mg/kg	34/ 34	5.3	25.8	16.7	29	25.8	17.2	27.4	21.48	3.73	30		12.5		31	na	YES	YES	YES	no	YES	---
Cobalt	mg/kg	34/ 34	2.2	57.4	11.4	36.7	36.7	8.3	12.5	10.53	1.36	15	<	4		7.8	na	no	no	no	no	no	---
Copper	mg/kg	34/ 34	4.1	49.3	23.7	53.5	49.3	14	25.8	18.28	3.73	20		15.3		65	na	no	no	no	no	YES	---
Iron	mg/kg	34/ 34	6240	36400	21500	38600	36400	16400	31500	23,700	4816.12	30000		15300		24700	na	no	YES	no	no	no	---
Lead	mg/kg	33/ 33	2.8	55.2	10.8	37.6	37.6	24.1	48.4	36	9.78	30		41.4		557	na	no	YES	no	YES	YES	---
Magnesium	mg/kg	34/ 34	931	14800	7220	15800	14800	3020	18400	10421.11	5807.47	7000		1840		11300	na	YES	YES	no	no	no	---
Manganese	mg/kg	34/ 34	70	6650	751	6650	6650	224	1060	542.56	251.93	300		107		489	na	no	no	no	no	no	---
Nickel	mg/kg	34/ 34	5.8	38	20.5	38.9	38	18	29	22.52	4.14	15		14.1		26	na	no	YES	no	no	no	---
Potassium	mg/kg	34/ 34	138	3200	1270	2860	2860	1050	2710	1625.56	627.26	16600		5330		923	na	no	YES	YES	YES	no	---
Selenium	mg/kg	8/ 33	0.21	0.37	0.16	0.37	0.37	96.4	192	149.16	33.36	0.4	<	0.5		na	na	YES	YES	YES	YES	---	---
Silver	mg/kg	2/ 34	0.27	0.27	0.09	0.27	0.27	1.7	5.3	2.91	1.33	nd	<	8	<	4	na	YES	YES	---	YES	YES	---
Sodium	mg/kg	34/ 34	51.7	331	170	388	331	826	1250	1023	146.25	7000	<	400	<	400	na	YES	YES	YES	YES	YES	---
Thallium	mg/kg	0/ 34	---	---	0.12	---	---	34.3	68.3	48.36	10.71	nd	<	10	<	10	na	no	YES	---	---	---	---
Vanadium	mg/kg	34/ 34	9.9	35.2	22.1	38.7	35.2	19.5	31.8	24.51	3.58	70		22.9		39	na	no	YES	YES	no	YES	---
Zinc	mg/kg	34/ 34	23.1	266	57.5	266	266	66.1	102	84.77	15.36	63		73	<	20	na	no	YES	no	no	no	---
Radium-226	pCi/g	30/ 30	0.39	1.3	0.81	1.2	1.2	1	1.6	1.1	0.2	na		na		na	0.64	YES	YES	---	---	---	no
Thorium-230	pCi/g	30/ 30	0.44	1.62	0.89	1.39	1.39	1.1	1.8	1.4	0.3	na		na		na	0.73	YES	YES	---	---	---	no
Thorium-232	pCi/g	30/ 30	0.37	1.24	0.91	1.4	1.24	1	1.6	1.2	0.3	na		na		na	0.56	YES	YES	---	---	---	no
Uranium-238	pCi/g	30/ 30	0.37	1.36	0.80	1.34	1.34	2	4	3.1	0.6	na		na		na	2.8	YES	YES	---	---	---	YES

Note:
nd - not detected
na - not analyzed
--- - insufficient data to make comparison
mg/kg - milligrams per kilograms
pCi/g - picocuries per gram
ORAU - Oak Ridge Associated Universities
a The background samples for the Tonawanda Sites (Linde, Ashland 1, Ashland 2 and Seaway) were taken from an area in the southern portion of Ashland 2 and are designated as Ashland 2 South.
Ashland 2 South and Tonawanda Area data obtained from the Remedial Investigation Report for the Tonawanda Site, Tonawanda, New York (DOE 1993). Other references noted in this table were also obtained from this report.
b USGS 1981
c Samples taken in West Seneca, New York, approximately 24 km (15 mi) southeast of Tonawanda, on Reserve Road (New York Department of Health data; considered background fro hazardous waste site evaluations).
d Samples from Buffalo residential area (New York Department of Environmental Conservation Kingsley Park Investigation).
e ORAU 1981

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8.0 CHARACTERIZATION OF REMEDIAL INVESTIGATION BUILDING CORE, RAILROAD BALLAST AND ROAD CORE SAMPLES

To further characterize radiological contamination at the NFSS, a review was conducted of Building 401 floor core and underlying soil samples, railroad ballast samples, and core samples of road pavement from across the site. Details of this review are discussed in this section.

8.1 INTRODUCTION

The identity, amount, and location of SRCs at the NFSS was evaluated as part of the RI to provide primary data for the FS, which will be used to identify and evaluate various remedial action alternatives and assist in the development of a protective and cost-effective remedy for the site. SRCs are chemicals or radionuclides present in a given medium and EU at concentrations statistically greater than the corresponding background concentrations. The focus of this evaluation was to further characterize radiological contamination at the NFSS; however, chemical analysis for building cores, railroad ballast, or road core materials was also conducted to characterize the nature and extent of contamination at the site and to provide information for health and safety purposes, or for waste characterization prior to disposal. Since this evaluation utilized existing analytical results, the DQOs for the analysis were presented in the NFSS RIR (USACE 2007a).

Because no suitable background data sets for building cores, railroad ballast, or road core materials are available, it was not possible to determine if any parameter found in these media exceeded background. For this reason, the NFSS RI did not identify SRCs for these media. Although the materials used to construct the NFSS roadways and railroad bedding are not directly comparable to surface soil, to ensure that no SRCs were missed, it was decided that the road core and railroad ballast samples should be screened using the NFSS site-specific background levels for surface soil. Additional SRCs identified in BOP material will be addressed by the NFSS FS. Because Building 401 is a steel-framed multi-story structure with poured-concrete floors, building cores bear little resemblance to naturally-occurring materials and so were not compared to surface soil background levels. Demolition of Building 401 is scheduled for 2010. Following demolition a radiological survey of the building's concrete slab surface and surrounding work areas will be conducted and an attempt will be made to decontaminate the building slab to meet free release limits for removable radioactive surface contamination. Any residual contamination present under or within the Building 401 floor slab will be addressed by the BOP FS.

During the CERCLA process, the FS is used to evaluate remedial options. Typically, the FS is not available to the public for review until the entire document is completed and released. To allow greater opportunities for public input, the Corps has decided to break the NFSS FS into three OUs: the IWCS; the BOP; and Groundwater. The IWCS FS will be completed first because it poses the greatest potential risk due to the radioactive residues stored within the structure. The BOP FS will address remaining buildings and structures within the IWCS, remaining cap material and other soils within the IWCS, the IWCS dike, surface and subsurface soils across the rest of the site, surface water, sediment, railroad ballast, roads, and pipelines, etc. The Groundwater FS will address groundwater remaining in both the upper and lower water-bearing zone if needed after implementation of the selected remedial actions for the IWCS and BOP OUs.

This section also presents an assessment of radiological constituents present in railroad ballast and road materials. The ratio of various radionuclides in these materials will be assessed to determine whether they are at, or near, secular equilibrium, meaning that the material has not been processed to remove radium or uranium. In naturally-occurring earthen materials, radium and uranium are present at roughly

equal levels on a picocurie per gram basis. Since the Manhattan Project involved uranium enrichment and extraction processes, materials associated with the MED/AEC operations have concentrations of uranium relative to radium that would be significantly different from naturally occurring material. (See Section 8.7.2 for further discussion of this point.) Therefore, the ratio of radium and uranium in railroad ballast and road materials was used to determine whether these materials may have been impacted by MED/AEC activities, or whether they represent naturally-occurring materials with elevated levels of radiation (NORM).

8.2 SAMPLE LOCATION DESCRIPTION

To characterize radiological contamination at the NFSS, environmental investigations included the collection of core samples from the floor of Building 401 and samples from the underlying soil, railroad ballast samples, and core samples of asphalt road pavement collected across the site.

The Building 401 core samples and the underlying soils were collected from locations where contamination was most likely to be present based on the building's operational history or physical signs of potential impacts (i.e., floor staining), and were analyzed for both chemical and radiological contaminants. The Building 401 floors are approximately 0.75 ft thick. At some locations, the coring was terminated due to refusal, and at some locations there were two layers including a thin asphalt layer on top of a thicker concrete layer. Railroad ballast and road core samples were collected to evaluate potential impacts due to the transportation of radiologically-contaminated materials, to, and across the site. Many of these samples were collected at locations exhibiting higher gamma readings than the surrounding soil. Railroad ballast and road core samples were analyzed for radiological parameters. Additional information regarding the characterization of Building 401 materials, railroad ballast and road pavement samples follows.

8.3 BUILDING 401 CORE CHARACTERIZATION

Building 401 initially served as the boiler house, generating steam for the production of TNT at LOOW. Between 1953 and 1959, the building was renovated for the construction of a non-radioactive boron-10 isotope separation plant. The building was also used to store radioactive materials in support of MED activities during and after World War II. In 1971, the interior of Building 401 was gutted and its instrumentation and hardware were disposed of as surplus materials. The building has been largely inactive since, but it has been used to temporarily store and stage investigation-derived and radioactive waste. Although Building 401 is currently structurally stable, the dilapidated state of the building, limited radiological contamination on some beams, and its location on an active FUSRAP site warrant demolition of the building. Demolition is scheduled to commence in 2010.

8.3.1 Building 401 Core and Sub-Slab Soil Sample Collection

During the NFSS RI field investigations, ten core samples were collected from the floor slab inside Building 401. Soil immediately underlying the location of the core samples was also collected and was used in the RI to delineate site contamination. The Building 401 core and soil samples were collected near former laboratory and loading areas, locations of floor staining, or from other locations where radiological or chemical contamination was most likely to be present such as discussed below. To investigate whether previous activities that occurred inside Building 401 had resulted in building contamination, the core samples were analyzed for a broad range of chemical and radiological parameters.

The locations of the Building 401 core samples are shown on Figure 8-1. Table 8-1 presents the location of building core samples, the analytes selected for each sample, and the reason why the location was selected. The Building 401 core samples were collected with a concrete coring machine. The coring

machine and bit were decontaminated before each use. Each sample was removed from the bit, examined and surveyed with a sodium-iodide detector. If the sample contained distinct layers, each layer was surveyed separately and the portion of the core with the highest gamma reading was submitted for sample preparation and analysis.

Building 401 core sample locations were initially selected to investigate areas of floor staining. Other locations were selected to investigate cracks in the concrete that could serve as migration routes to soil. Still other locations were selected to investigate areas of former rooms or work spaces. In addition to building core samples, soil samples were collected immediately below the floor slab at each of the building core locations.

Because of the varied past uses of Building 401, core and soil samples were analyzed for the following:

- Metals;
- SVOCs;
- PAHs;
- VOCs;
- Pesticides;
- PCBs; and
- Radionuclides.

8.4 RAILROAD BALLAST CHARACTERIZATION

Several rail lines served the NFSS. These railroad lines were used both during the operational period of the LOOW and the period during which radioactive materials were transported to the NFSS, but are no longer in use. During the RI, soil samples were collected near these lines and analyzed for chemical and radiological parameters. While performing the field gamma survey prior to collecting these soil samples, it was discovered that the ballast material exhibited higher gamma readings than the surrounding soil. To further evaluate these elevated field readings, five additional railroad ballast samples were collected. Two of the ballast samples were collected from rail lines near Building 401.

8.4.1 Railroad Ballast Sample Collection

The railroad ballast samples were collected in a manner similar to surface soil samples. A limited gamma survey was performed in the vicinity of the proposed sample locations and the location with the highest gamma reading was selected for collection. Approximately 1 kilogram of railroad ballast material was then containerized and shipped to a geotechnical laboratory, where the sample was crushed to pass a number 20 sieve. The crushed samples were then submitted for radiological analysis.

Railroad ballast samples were analyzed for the following:

- Actinium-227, americium-241, cesium-137, cobalt-60, protactinium-231, radium-226, radium-228, thorium-228, thorium-230, thorium-232, uranium-235, uranium-238, uranium-233/234, and uranium-235/236;

- Gross alpha/beta; and

- Total uranium.

A summary of railroad ballast sample locations and justification for their selection is presented in Table 8-2. Railroad ballast sample locations are shown on Figure 8-2.

8.5 ROAD CORE CHARACTERIZATION

Gamma survey activities detected gamma readings above background at several locations on the NFSS roadways. Asphalt road core samples were submitted for radiological analysis to investigate the presence of radionuclides associated with the NFSS roadways.

8.5.1 Road Core Sample Collection

Following a gamma survey conducted within 30 ft of the proposed road core sample locations, the surveyed location with the highest gamma reading was cored using a concrete coring machine. The coring machine and bit were decontaminated before each use. The portion of the core with the highest gamma reading was submitted for sample preparation and analysis. Road core samples were prepared for analysis by crushing the sample to pass a number 20 sieve prior to submittal to the laboratory for analysis. The cores were submitted for radiological analysis.

The road core samples were analyzed for the following:

- Actinium-227, americium-241, cesium-137, cobalt-60, protactinium-231, radium-226, radium-228, thorium-228, thorium-230, thorium-232, uranium-235, uranium-238, uranium-233/234, and uranium-235/236;

- Gross alpha/beta; and

- Total uranium.

A total of 19 road core samples were collected during the RI. Table 8-3 presents rationale for the selection of road core sample locations along with collection dates and the analytes selected at each sample location. The locations of the road core samples are shown on Figure 8-2.

8.6 DETERMINATION OF SRCS

Tables 8-4 and 8-5 present screening results for existing railroad ballast and road pavement samples. Samples were screened against the NFSS site-specific background levels for surface soil. This screening was conducted to determine whether the analytes detected in these media should be considered SRCs. Building 401 core samples were not screened against NFSS site-specific background levels for surface soil as explained below.

For comparison, radiological SRCs previously identified in the NFSS RI for site wide surface soil include:

- Actinium-227;
- Cesium-137;
- Radium-226 and radium-228;
- Thorium-228, thorium-230 and thorium-232;
- Total uranium; and
- Uranium-234, uranium-235 and uranium-238.

8.6.1 Building 401 Core Samples

Although Building 401 is currently structurally stable, the dilapidated state of the building, limited radiological contamination present on some beams, and its location on an active FUSRAP site has lead to a decision by the Corps to demolish the building. This work is scheduled to begin in 2010. The demolition, transportation, and disposal work is scheduled to be complete in 2011. Information on the current radiological contamination status of Building 401 and the areal extent of radiological contamination of the soil outside the building have been identified and will be used to guide actions during demolition and post-remedial action (BNI 1998).

Building 401 core samples consist of poured-concrete flooring material. Given that poured concrete bears little resemblance to surface soil and that removal of Building 401 is imminent, building core samples were not screened against surface soil background levels. Following demolition a radiological survey of the building's concrete slab surface and surrounding work areas will be conducted and an attempt will be made to decontaminate the building slab to meet free release limits for removable radioactive surface contamination. Any residual contamination present under or within the Building 401 floor slab will be addressed by the BOP FS.

The radiological analysis of Building 401 core and soil samples was examined for evidence of potential impacts due to the storage of MED/AEC-related materials in the building. These results are discussed later in this section.

8.6.2 Railroad Ballast Samples

Radiological SRCs identified for the five railroad ballast samples are summarized in Table 8-4 and include:

- Radium-226;
- Thorium-230;
- Total uranium; and
- Uranium-234, uranium-235 and uranium-238.

SRCs previously identified in the NFSS RI for site-wide surface soil includes a variety of isotopes. No new SRCs were identified in the railroad ballast samples.

8.6.3 Road Core Samples

Radiological SRCs identified for the 19 road core samples are summarized in Table 8-5 and include:

- Radium-226;
- Thorium-230;
- Total uranium; and
- Uranium-234, uranium-235 and uranium-238.

No new SRCs were identified in the road core samples.

8.7 DELINEATION OF NORM

The following discussion presents a definition of NORM as well as a comparison of NORM and MED/AEC-related materials at the NFSS.

8.7.1 Definition of NORM

NORM are found throughout the earth's crust and they are part of the natural background of radiation to which all humans are exposed (NAS 1999). Many human activities—such as mining and milling of ores, alter the natural background of radiation either by moving naturally-occurring radionuclides from inaccessible locations to locations where humans are present or by concentrating the radionuclides in the environment. NORM consists primarily of material containing potassium-40 or isotopes belonging to the primordial series. The principal primordial radionuclides are isotopes of heavy elements belonging to the radioactive series headed by the three long-lived isotopes; uranium-238 (uranium series), uranium-235 (actinium series), and thorium-232 (thorium series). All three of these series have numerous radionuclides in their decay chains before reaching a stable end point, lead (NAS 1999).

The ultimate sources of NORM in the environment are the earth's crust and its underlying mantle. Redistribution of NORM has occurred as a result of weathering, sedimentation, and chemical interactions in the crust. As a consequence of these processes, potassium-40 and the uranium and thorium series nuclides have tended to concentrate in certain minerals and certain geologic formations (NAS 1999). The concentrations of primordial radionuclides present in NORM, while elevated, have relative abundance similar to those found in natural background. In naturally-occurring earthen materials, uranium and radium are present at roughly equal levels on a picocurie per gram basis (NAS 1999).

One example of NORM is elevated concentrations of uranium associated with phosphate ores. A phosphate slag material, identified as cyclowollastonite, was used throughout the Niagara Falls area for bedding under asphalt and for general gravel applications (ORNL 1986). Cyclowollastonite was once involved in the electrochemical production of elemental phosphorous using uranium-bearing raw materials and reportedly originated from the former Oldbury Furnace in Niagara Falls, New York (ORNL 1986). Cyclowollastonite may have been used as railroad ballast or roadway construction at the NFSS.

8.7.2 NORM versus MED/AEC-Related Materials

In 1984, the ORNL conducted a radiological survey in the Niagara Falls, New York area to determine whether elevated levels of gamma radiation could be related to the transportation of radioactive waste material to the NFSS for storage, or whether the material was NORM (ORNL 1986). A majority of the radiation anomalies presented in this report (62 out of 100 locations) were associated with asphalt driveways and parking lots that were constructed using a phosphate slag material identified as cyclowollastonite. This porous slag material was used throughout the Niagara Falls area for bedding under asphalt and for general gravel applications (ORNL 1986). It is distinct from the radiological materials connected with the NFSS because it contains approximately equal concentrations of radium-226 and uranium-238.

In naturally-occurring earthen materials, uranium and radium are present at roughly equal levels on a picocurie per gram basis (NAS 1999). At the NFSS, roughly equal concentrations of radium-226 and uranium-228 in slag materials associated with railroad ballast and road cores indicates that these materials are most likely from a natural source. By contrast, the MED/AEC-related materials located at the NFSS are residues resulting from uranium extraction processes conducted at other locations. Therefore, the concentration of uranium-238 in MED/AEC-related materials is expected to be significantly lower than the concentration of radium-226 on a picocurie per gram basis. Therefore, the relative abundance of

radium-226 and uranium-238 can be used to distinguish MED/AEC-related materials from slag or other naturally-occurring materials with elevated radiation levels. It should be noted that the Corps is authorized to address MED/AEC-related contamination under FUSRAP, but it is not authorized to address NORM.

8.7.3 Building 401 Core Samples

The ratio of radium-226 to uranium-238 detected in the NFSS background soil samples are presented in Table 8-6. This same information for Building 401 core samples and the underlying soils are presented in Tables 8-7 and 8-8, respectively. These results are presented graphically in Figure 8-3. Since the Manhattan Project involved uranium enrichment and extraction processes, materials associated with the MED/AEC operations could have higher or lower ratios of radium-226 to uranium-238, but would be significantly different from naturally occurring material. The mean ratio of radium-226 to uranium-238 was 1.04 for background soil, 0.63 for the Building 401 core samples and 0.86 for soil samples underlying Building 401. These ratios indicate that levels of uranium-238 in these data sets are not generally lower than radium-226 levels, as would be expected in MED/AEC-related materials. The uniformity of the Building 401 core and underlying soil samples and their similarity to the NFSS background soil samples suggests that these locations have not been impacted by MED/AEC-related materials. Since Building 401 was built prior to the start of MED/AEC operations, it is not surprising that the background soil data and the underlying Building 401 soil data exhibit the most similarity in radionuclide ratios.

One core sample from location CORE03, exhibited a plutonium-239 concentration of 5.72 pCi/g. This sample result is not discussed as part of this MED/AEC-related material evaluation, although it cannot be considered NORM. An evaluation of plutonium analytical results for the NFSS is presented in Section 11 of this RIR Addendum. In addition to plutonium, cesium-137 was detected in 3 out of 10 Building 401 core samples with a maximum detection 0.374 pCi/g. Cesium-137 is a non-NORM radionuclide; however, it is a common radionuclide present in fallout from aboveground nuclear weapons testing and it can be ubiquitous in the environment. Cesium-137 was one of the most common radionuclides detected at the NFSS and the concentrations detected exceeded background UTLs in various media at the NFSS. Cesium-137 was identified as an ROC and will be included in the FS evaluation and in remedial design efforts.

8.7.4 Railroad Ballast Samples

The relative abundance of radium-226 to uranium-238 detected in the NFSS railroad ballast samples is presented in Table 8-9. These results are presented graphically in Figure 8-3. The mean ratio of radium-226 to uranium-238 in railroad ballast samples was 0.99 which is consistent with NFSS background soil which had a mean ratio of radium-226 to uranium-238 of 1.04. Once again, the uniformity in the levels of uranium and radium on a picocurie per gram basis, found in railroad ballast samples, and their similarity to the NFSS background soil samples, suggests that these locations have not been impacted by MED/AEC-related materials.

8.7.5 Road Core Samples

The relative abundance of radium-226 to uranium-238 detected in the NFSS road core samples is presented in Table 8-10. These results are presented graphically in Figure 8-3. The mean ratio of radium-226 to uranium-238 detected in road core samples was 4.84, which is considerably higher than 1.04, the ratio found in background soil. This elevated ratio is driven by samples RC05-969, RC17-2448, RC18-2449, and RC19-2450, where radium-226 was detected at 11 to 26 times the concentration of uranium-

238. Without these samples included the ratio of radium-226 to uranium-238 is 1.16 which is much closer to the ratio noted for background soils.

Road core samples with elevated ratios of radium-226 to uranium-238 occur at four separate areas of the NFSS and coincide with areas of elevated activity identified during a gamma walkover survey of the site. All four of these locations represent areas that may be impacted by MED/AEC related materials. Ten road core sample locations (RC01-964, RC02-965, RC03-966, RC08-972, RC09-973, RC14-979, RC16-2447, RC17-2448, RC18-2449 and RC19-2450) contain radium-226 at concentrations greater than 5 pCi/g. The Applicable or Relevant and Appropriate Requirements (ARARs) for the NFSS have not yet been determined, however 5 pCi/g is the cleanup criterion for radium-226 in surface soil listed in 40 CFR 192 (EPA 1983). It is presented here for comparative purposes only. Road core sample locations with elevated ratios of radium-226 to uranium-238, or with elevated radiological concentrations will be re-examined during the FS.

8.8 SUMMARY

SRCs previously identified in the NFSS RI for site-wide surface soil includes a variety of isotopes. No new SRCs were identified for railroad ballast and road core samples during screening of existing analytical results for these media using background surface soil levels.

The delineation of MED/AEC-materials at the NFSS was complicated by the presence of a phosphate slag material with elevated radiological activity that was used throughout the Niagara Falls area for bedding under asphalt and for general gravel applications (ORNL 1986). Since naturally-occurring earthen materials, like phosphate slag, contain roughly equivalent levels of uranium and radium on a picocurie per gram basis, while MED/AEC-materials are expected to have higher levels of radium, the ratio of radium-226 to uranium-238 was used to assess whether the materials found were MED-related. At the NFSS, similar concentrations of radium-226 and uranium-238, were found in Building 401 core samples, the soil underlying the Building 401 core sample and in slag materials associated with railroad ballast. Additionally, radium/uranium ratios in these data sets were similar to ratios observed in the site-specific soil background data set. This suggests that these materials are most likely from a natural source. While many of the road core samples had comparable levels of radium-226 and uranium-238, several locations were identified with elevated ratios. The concentration of uranium-238 in these samples was significantly lower than the concentration of radium-226 on a picocurie per gram basis, suggesting that these locations may contain MED/AEC-related materials.

The analysis of railroad ballast and road core samples also revealed several locations with concentrations of radium-226 above 5 pCi/g. BOP materials with an elevated ratio of radium-226 to uranium-238, and with radium-226 concentrations greater than the ARARs-based action level will be re-examined during the FS.

SECTION 8

FIGURES

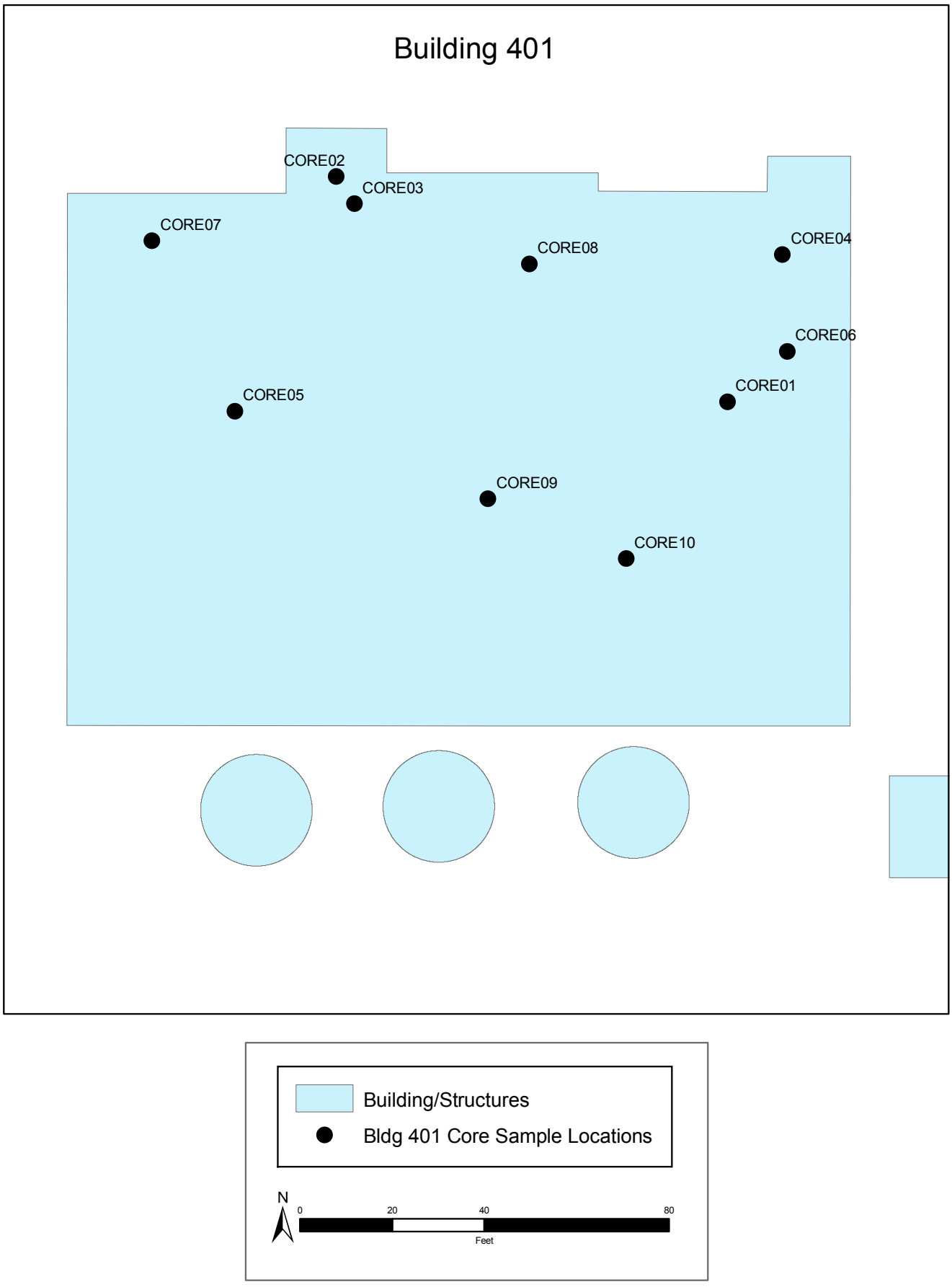
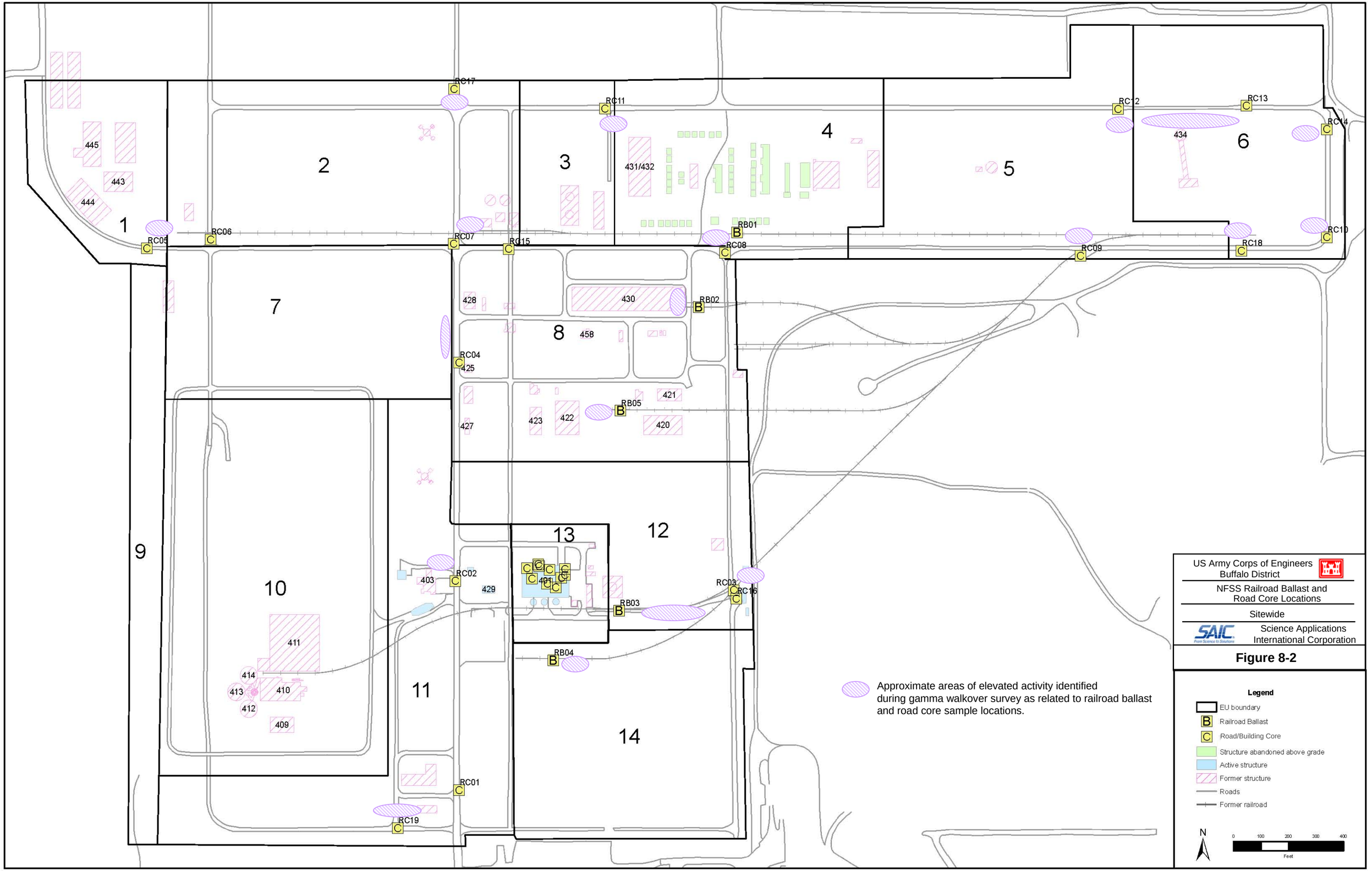


Figure 8-1. Building 401 Sample Locations


RC17
RC11
RC12
RC13
RC14
RC06
RC05
RC07
RC15
RB01
RC08
RC09
RC18
RC10
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RB05
RC02
RC03
RC16
RB03
RB04
RC01
RC19
1
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431/432
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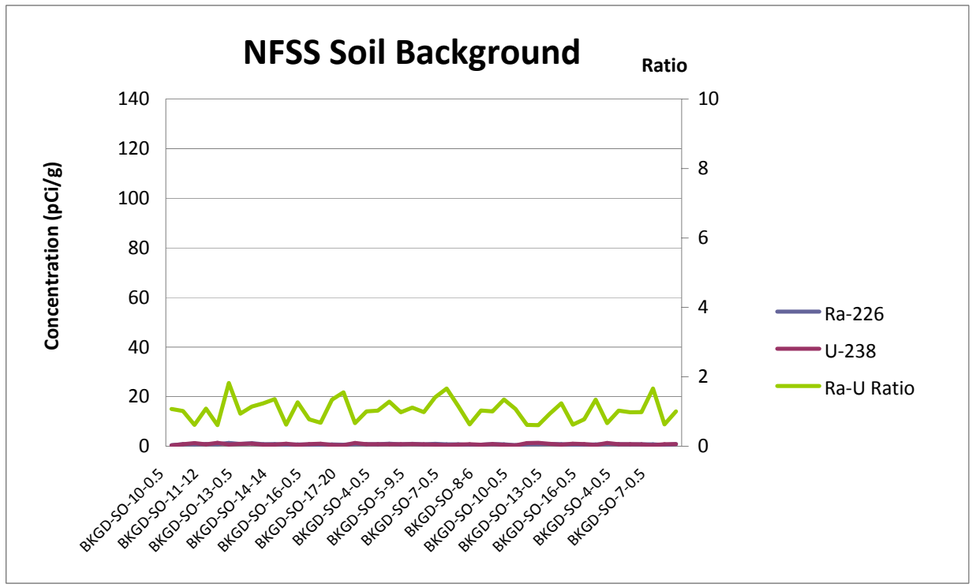
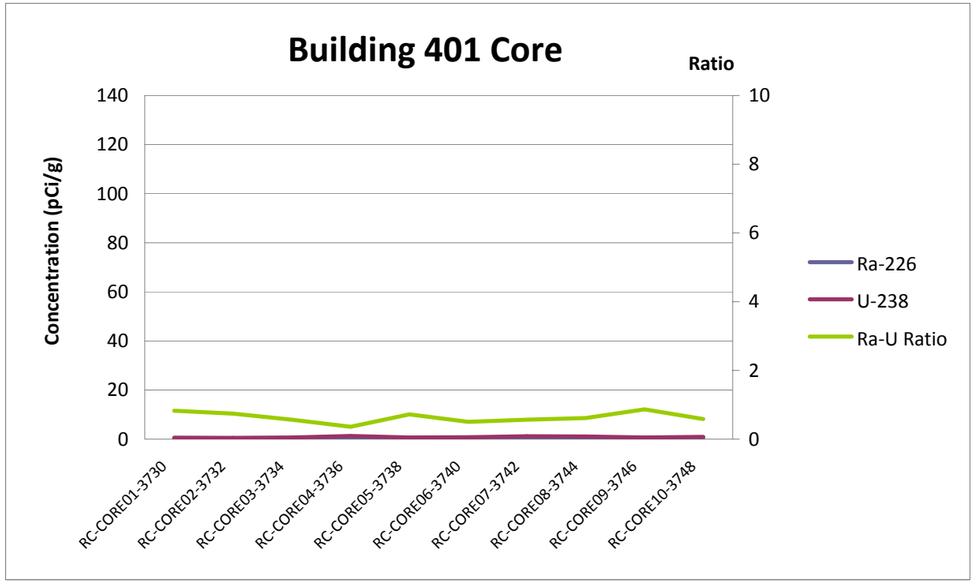
US Army Corps of Engineers
Buffalo District
NFSS Railroad Ballast and
Road Core Locations
Sitewide
Science Applications
International Corporation
Figure 8-2
Approximate areas of elevated activity identified during gamma walkover survey as related to railroad ballast and road core sample locations.
Legend
EU boundary
Railroad Ballast
Road/Building Core
Structure abandoned above grade
Active structure
Former structure
Roads
Former railroad
N
0
100
200
300
400
Feet





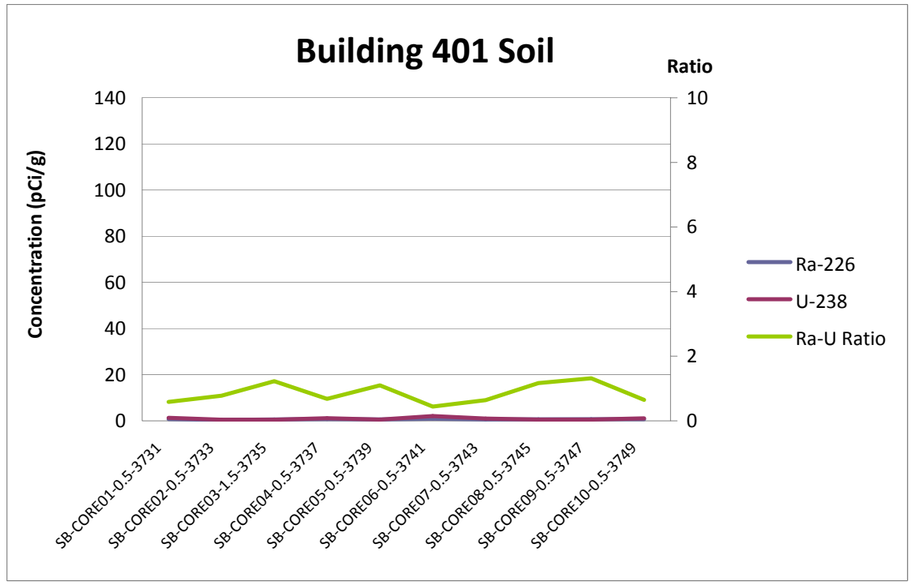
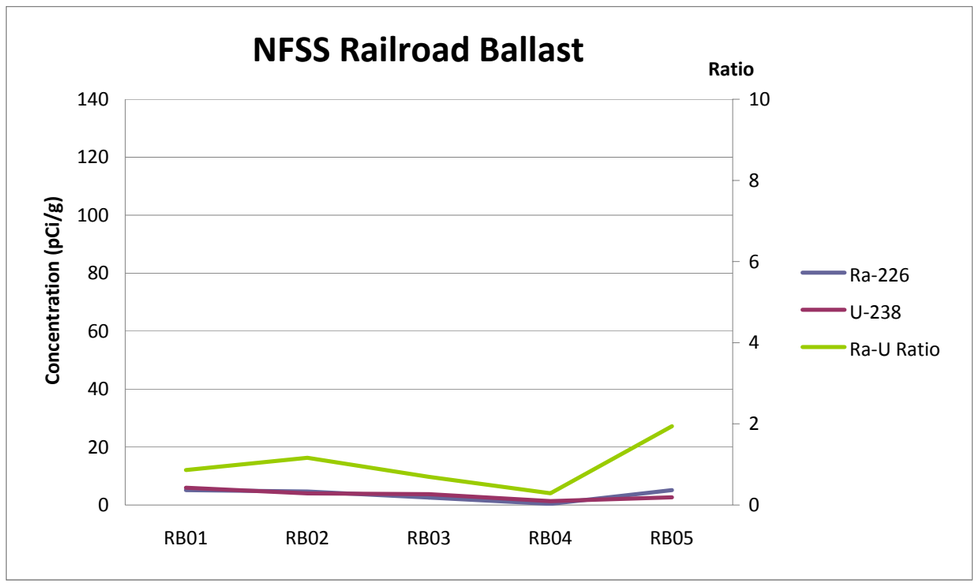


Figure 8-3. Radium-226 and Uranium-238 Concentrations and Ratios in Soil Background, Building 401 Core and Underlying Soil Samples, Road Core, and Railroad Ballast



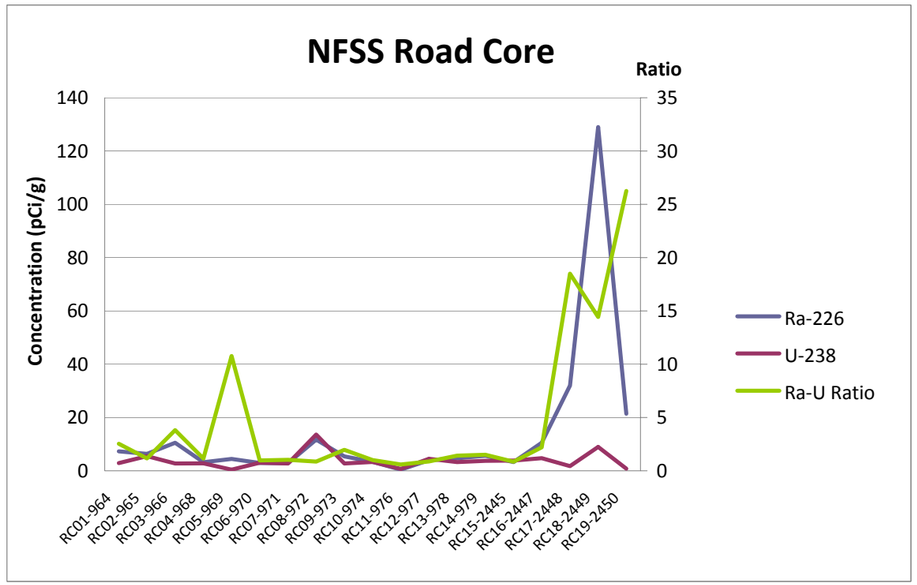


Figure 8-3. Radium-226 and Uranium-238 Concentrations and Ratios in Soil Background, Building 401 Core and Underlying Soil Samples, Road Core, and Railroad Ballast

SECTION 8

TABLES

Table 8-1. Summary of Building 401 Core Samples Collected during the Niagara Falls Storage Site Remedial Investigation

Sample ID	Collection Date	Location	Parameters	Justification/Remarks
RC-CORE01-3730	10/14/2003	Inside Building 401	*Radionuclides, Total Metals, SVOC, PAHs, VOCs, Pest/PCB	Room 131 at location of floor stain.
RC-CORE02-3732	10/14/2003	Inside Building 401	*Rad, Total Metals, SVOC, PAHs, VOCs, Pest/PCB	Room 131 at location of electrical transformers.
RC-CORE03-3734	10/14/2003	Inside Building 401	*Radionuclides, Total Metals, SVOC, PAHs, VOCs, Pest/PCB	Room 120 at location of electrical transformers.
RC-CORE04-3736	10/15/2003	Inside Building 401	*Radionuclides, Total Metals, SVOC, PAHs, VOCs, Pest/PCB	Room 121 at loading ramp.
RC-CORE05-3738	10/15/2003	Inside Building 401	*Radionuclides, Total Metals, SVOC, PAHs, VOCs, Pest/PCB	Room 108, suspected laboratory area, at location of floor stain.
RC-CORE06-3740	10/13/2003	Inside Building 401	*Radionuclides, Total Metals, SVOC, PAHs, VOCs, Pest/PCB	Room 122, next to a sieve shaker.
RC-CORE07-3742	10/13/2003	Inside Building 401	*Radionuclides, Total Metals, SVOC, PAHs, VOCs, Pest/PCB	Room 101, in a suspected laboratory area.
RC-CORE08-3744	10/13/2003	Inside Building 401	*Radionuclides, Total Metals, SVOC, PAHs, VOCs, Pest/PCB	In loading area.
RC-CORE09-3746	10/13/2003	Inside Building 401	*Radionuclides, Total Metals, SVOC, PAHs, VOCs, Pest/PCB	Room 119, near transformers.
RC-CORE10-3748	10/13/2003	Inside Building 401	*Radionuclides, Total Metals, SVOC, PAHs, VOCs, Pest/PCB	Room 122, located in area of patched concrete.

*Radiological parameters analyzed for using gamma spectroscopy based on 100 g sample weight and 8 hour count time.
Analytes include: actinium-227, americium-241, cesium-137, cobalt-60, protactinium-231, radium-226, radium-228, alpha/gamma thorium-228, uranium-235 (gamma), alpha/gamma uranium-238, thorium-230, thorium-232, uranium-233/234, uranium-235/236, total uranium, and gross alpha/beta.

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Table 8-2. Summary of Railroad Ballast Samples Collected during the Niagara Falls Storage Site Remedial Investigation

Sample Number*	Area of Investigation/ Exposure Unit (EU)	Collection Date	Justification
RB01	Acid Area, EU 4	10/3/00, Phase 2	During the field gamma survey at BH417, railroad ballast at this location exhibited higher gamma readings than the surrounding soil.
RB02	Shops Area, EU 8	10/3/00, Phase 2	During the field gamma survey at BH306, railroad ballast at this location exhibited higher gamma readings than the surrounding soil.
RB03	Southeast of Building 401, EU 12	10/3/00, Phase 2	Along the rail line that serviced Building 401.
RB04	South of Building 401, EU 14	10/3/00, Phase 2	Along the rail line that serviced Building 401, at the location at which coal was off-loaded to the storage silos.
RB05	Shops Area, EU 8	10/3/00, Phase 2	During the field gamma survey at BH304, railroad ballast at this location exhibited higher gamma readings than the surrounding soil.

* Radiological parameters analyzed for using gamma spectroscopy based on 100 g sample weight and 8 hour count time.
All railroad ballast samples were analyzed for: actinium-227, americium-241, cesium-137, cobalt-60, protactinium-231, radium-226, radium-228, alpha/gamma thorium-228, uranium-235 (gamma), alpha/gamma uranium-238, thorium-230, thorium-232, uranium-233/234, uranium-235/236, total uranium, and gross alpha/beta.

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Table 8-3. Summary of Road Core Samples Collected during the Niagara Falls Storage Site Remedial Investigation

Sample ID	Collection Date	Location/Exposure Unit (EU)	Parameters	Justification/Remarks
RC01-964	9/15/2000	Campbell Street near site entrance. (EU 11)	Rad*	Near 50,000 cpm gamma reading found at location of nearby former guard shack.
RC02-965	9/15/2000	Campbell Street between Buildings 429 and 403. (EU 11)	Rad*	Near 70,000 cpm gamma reading in nearby ditch.
RC03-966	9/16/2000	Castle Garden Road at Vine Street. (EU 12)	Rad*	At former railroad crossing, reported to have been used as temporary storage of drummed radioactive residues.
RC04-968	9/15/2000	Campbell Street north of Z Street. (EU 8)	Rad*	Along suspected haul route used for past remedial actions.
RC05-969	9/15/2000	West Patrol Road at suspected entrance to Baker-Smith Area. (EU 1)	Rad*	Along suspected haul route used to transport radioactive residues to the Baker-Smith Area for storage.
RC06-970	9/15/2000	Lutts Road north of O Street. (EU 2)	Rad*	Former railroad crossing located here. This track lead to the unloading platforms north of the Baker-Smith Area.
RC07-971	9/15/2000	Campbell Street at O Street. (EU 8)	Rad*	Along suspected haul route used for past remedial actions.
RC08-972	9/15/2000	Campbell Street south of O Street at railroad crossing. (EU 4)	Rad*	The rail line carried radioactive residues to in the combined shops building, located to the west, for storage.
RC09-973	9/15/2000	O Street at Vine Street. (EU 5)	Rad*	This area was the location of a former railroad crossing, reported to have been used as temporary storage of drummed residues.
RC10-974	9/14/2000	MacArthur Street north of O Street. (EU 6)	Rad*	This area was reported to be used for temporary storage of drummed radioactive residues.
RC11-976	9/14/2000	N Street at the driveway to the former radium vault. (EU 3)	Rad*	Along suspected haul route used for past remedial actions.
RC12-977	9/14/2000	N Street, near Building 434, where the pavement was removed during a past remedial action. (EU 6)	Rad*	This area was reportedly remediated, but no confirmatory sample data was available.
RC13-978	9/14/2000	N Street, near Building 434, where the pavement was removed during a past remedial action. (EU 5)	Rad*	This area was reportedly remediated, but no confirmatory sample data was available.
RC14-979	9/14/2000	MacArthur Street south of N Street at former railroad crossing. (EU 6)	Rad*	This area was reported to be used for temporary storage of drummed radioactive residues.
RC15-2445	11/14/2001	200 feet east of intersection of Campbell Street and O Street. (EU 8)	Rad*	Gamma reading of 15,000 cpm at this location
RC16-2447	11/14/2001	Castle Garden Road at Vine Street, approximately 30 feet south of RC03-966. (EU 12)	Rad*	Gamma reading of 26,000 cpm at this location
RC17-2448	11/13/2001	20 feet north of the intersection of Campbell Street and N Street. (EU 2)	Rad*	Gamma reading of 40,000 cpm at this location
RC18-2449	11/14/2001	O Street, approximately 500 feet east of RC09-973. (EU 6)	Rad*	Gamma reading of 82 KCPM at this location
RC19-2450	11/14/2001	R Street, approximately 250 feet west of Campbell Street. (EU 11)	Rad*	Gamma reading of 22,000 cpm at this location

*Radiological parameters analyzed for using gamma spectroscopy based on 100 g sample weight and 8 hour count time. Radiological parameters were selected based on the activities previously performed throughout the NFSS, and previous results presented in the LOOW RI. Radiological parameters analyzed for include: actinium-227, americium-241, cesium-137, cobalt-60, protactinium-231, radium-226, radium-228, alpha/gamma thorium-228, uranium-235 (gamma), alpha/gamma uranium-238, thorium-230, thorium-232, uranium-233/234, uranium-235/236, total uranium, and gross alpha/beta.

cpm = counts per minute

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Table 8-4. Railroad Ballast SRC Summary
Niagara Falls Storage Site

Parameter	Units	Background Screening Value*	Samples That Exceed Background Screening Value	Concentration
Radionuclides				
Radium-226	pCi/g	0.921	RB01	5.13
			RB02	4.67
			RB03	2.59
			RB05	5.13
Thorium-230	pCi/g	1.6	RB01	6.48
			RB02	5.71
			RB03	3.28
			RB05	5.01
Total Uranium	µg/g	3.94	RB01	19.4
			RB02	25.3
			RB03	7.63
			RB04	4.15
			RB05	11.6
Uranium-234	pCi/g	1.68	RB01	5.79
			RB02	4.98
			RB03	2.9
			RB05	3.65
Uranium-235	pCi/g	0.0847	RB01	0.177
			RB02	0.287
			RB05	0.21
Uranium-238	pCi/g	1.36	RB01	5.96
			RB02	4.01
			RB03	3.74
			RB05	2.64

*Background screening values for soil 0-0.5 feet below ground surface are described using a standard 95% Upper Tolerance Limit (UTL) for normally distributed data, the 95% UTL of log transformed data for log normally distributed data or the maximum detected concentration when the data distribution was determined to be neither normal nor lognormal or had less than three detections.

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Table 8-5. Road Core SRC Summary
Niagara Falls Storage Site

Parameter	Unit	Background Screening Value*	Samples That Exceed Background Screening Value	Concentration
Radionuclides				
Actinium-227	pCi/g	0.08	RC01-964	0.504
			RC03-966	0.738
			RC08-972	0.75
			RC17-2448	1.59
			RC18-2449	5.06
Radium-226	pCi/g	0.921	RC01-964	7.31
			RC02-965	6.34
			RC03-966	10.5
			RC04-968	3.2
			RC05-969	4.47
			RC06-970	2.92
			RC07-971	2.85
			RC08-972	11.7
			RC09-973	5.42
			RC10-974	3.37
			RC12-977	3.96
			RC13-978	4.67
			RC14-979	5.66
			RC15-2445	3.27
			RC16-2447	10.5
			RC17-2448	32
			RC18-2449	129
			RC19-2450	21.4
Thorium-230	pCi/g	1.6	RC01-964	5.28
			RC02-965	7.11
			RC03-966	3.24
			RC04-968	3.27
			RC05-969	5.74
			RC06-970	4.08
			RC07-971	2.81
			RC08-972	14
			RC09-973	2.89
			RC10-974	4.15
			RC12-977	4.55
			RC13-978	4.83
			RC14-979	3.59
			RC15-2445	5.36
			RC16-2447	6.66
			RC17-2448	2.52
			RC18-2449	34.4
			RC19-2450	25.9
Thorium-232	pCi/g	1.24	RC15-2445	1.27
Total Uranium	µg/g	3.94	RC01-964	12.6
			RC02-965	22.3
			RC03-966	9.43
			RC04-968	9.33
			RC06-970	9.69
			RC07-971	6.52
			RC08-972	37
			RC09-973	8.89
			RC10-974	8.03
			RC12-977	10.8

Table 8-5. Road Core SRC Summary
Niagara Falls Storage Site

Parameter	Unit	Background Screening Value*	Samples That Exceed Background Screening Value	Concentration
			RC13-978	13.1
			RC14-979	8.07
			RC15-2445	7.67
			RC16-2447	12.7
			RC17-2448	5.19
			RC18-2449	24.9
Uranium-234	pCi/g	1.68	RC01-964	4.02
			RC02-965	7.02
			RC03-966	2.44
			RC04-968	3.27
			RC06-970	3.04
			RC07-971	2.67
			RC08-972	14.4
			RC09-973	2.71
			RC10-974	2.93
			RC12-977	3.93
			RC13-978	5.09
			RC14-979	3.41
			RC15-2445	3.72
			RC16-2447	5
			RC18-2449	9.99
Uranium-235	pCi/g	0.0847	RC01-964	0.225
			RC02-965	0.348
			RC03-966	0.138
			RC07-971	0.228
			RC08-972	0.697
			RC12-977	0.148
			RC13-978	0.183
			RC14-979	0.207
			RC15-2445	0.355
			RC16-2447	0.261
			RC18-2449	0.462
Uranium-238	pCi/g	1.36	RC01-964	2.88
			RC02-965	5.48
			RC03-966	2.75
			RC04-968	2.78
			RC06-970	3.02
			RC07-971	2.77
			RC08-972	13.6
			RC09-973	2.76
			RC10-974	3.33
			RC12-977	4.52
			RC13-978	3.28
			RC14-979	3.76
			RC15-2445	3.82
			RC16-2447	4.76
			RC17-2448	1.73
			RC18-2449	8.94

* Background screening values for soil 0-0.5 feet below ground surface are described using a standard 95% Upper Tolerance Limit (UTL) for normally distributed data, the 95% UTL of log transformed data for log normally distributed data or the maximum detected concentration when the data distribution was determined to be neither normal nor lognormal or had less than three detections.

Table 8-6. Relative Abundance of Radium-226 and Uranium-238 Detected in Background Soil Samples at the Niagara Falls Storage Site

Background Soil Sample ID	Radium-226 (pCi/g)	Uranium-238 (pCi/g)	Ratio
BKGD-SO-10-0.5	0.394	0.367	1.07
BKGD-SO-10-20	0.832	0.821	1.01
BKGD-SO-11-0.5	0.767	1.25	0.61
BKGD-SO-11-12	0.855	0.788	1.09
BKGD-SO-12-0.5	0.827	1.36	0.61
BKGD-SO-12-11.5	1.3	0.713	1.82
BKGD-SO-13-0.5	0.921	0.981	0.94
BKGD-SO-13-7	1.2	1.05	1.14
BKGD-SO-14-0.5	0.831	0.671	1.24
BKGD-SO-14-14	0.889	0.656	1.36
BKGD-SO-15-0.5	0.648	1.04	0.62
BKGD-SO-15-17	0.707	0.558	1.27
BKGD-SO-16-0.5	0.679	0.877	0.77
BKGD-SO-16-16	0.676	0.997	0.68
BKGD-SO-17-0.5	0.691	0.515	1.34
BKGD-SO-17-20	0.618	0.398	1.55
BKGD-SO-3-0.5	0.867	1.3	0.67
BKGD-SO-3-11.5	0.838	0.835	1.00
BKGD-SO-4-0.5	0.831	0.81	1.03
BKGD-SO-4-10.5	1.02	0.794	1.28
BKGD-SO-5-0.5	0.786	0.804	0.98
BKGD-SO-5-9.5	0.966	0.869	1.11
BKGD-SO-6-0.5	0.747	0.76	0.98
BKGD-SO-6-12	0.943	0.668	1.41
BKGD-SO-7-0.5	0.777	0.467	1.66
BKGD-SO-7-6	0.748	0.645	1.16
BKGD-SO-8-0.5	0.518	0.822	0.63
BKGD-SO-8-6	0.634	0.615	1.03
BKGD-SO-9-0.5	0.883	0.88	1.00
BKGD-SO-9-20	0.781	0.581	1.34
BKGD-SO-10-0.5	0.394	0.367	1.07
BKGD-SO-11-0.5	0.767	1.25	0.61
BKGD-SO-12-0.5	0.827	1.36	0.61
BKGD-SO-13-0.5	0.921	0.981	0.94
BKGD-SO-14-0.5	0.831	0.671	1.24
BKGD-SO-15-0.5	0.648	1.04	0.62
BKGD-SO-16-0.5	0.679	0.877	0.77
BKGD-SO-17-0.5	0.691	0.515	1.34
BKGD-SO-3-0.5	0.867	1.3	0.67
BKGD-SO-4-0.5	0.831	0.81	1.03
BKGD-SO-5-0.5	0.786	0.804	0.98
BKGD-SO-6-0.5	0.747	0.76	0.98
BKGD-SO-7-0.5	0.777	0.467	1.66
BKGD-SO-8-0.5	0.518	0.822	0.63
BKGD-SO-9-0.5	0.883	0.88	1.00
			Mean Ratio =1.04

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Table 8-7. Relative Abundance of Radium-226 and Uranium-238 Detected in Building 401 Core Samples at the Niagara Falls Storage Site

Building 401 Core Sample ID	Radium-226 (pCi/g)	Uranium-238 (pCi/g)	Ratio
RC-CORE01-3730	0.461	0.558	0.83
RC-CORE02-3732	0.373	0.503	0.74
RC-CORE03-3734	0.392	0.694	0.56
RC-CORE04-3736	0.468	1.3	0.36
RC-CORE05-3738	0.482	0.668	0.72
RC-CORE06-3740	0.381	0.756	0.50
RC-CORE07-3742	0.681	1.2	0.57
RC-CORE08-3744	0.663	1.08	0.61
RC-CORE09-3746	0.586	0.677	0.87
RC-CORE10-3748	0.529	0.903	0.59
			Mean Ratio = 0.64

Table 8-8. Relative Abundance of Radium-226 and Uranium-238 Detected in Building 401 Underlying Soil Samples at the Niagara Falls Storage Site

Building 401 Underlying Soil Sample ID	Radium-226 (pCi/g)	Uranium-238 (pCi/g)	Ratio
SB-CORE01-0.5-3731	0.763	1.3	0.59
SB-CORE02-0.5-3733	0.375	0.481	0.78
SB-CORE03-1.5-3735	0.616	0.502	1.23
SB-CORE04-0.5-3737	0.781	1.15	0.68
SB-CORE05-0.5-3739	0.6	0.546	1.10
SB-CORE06-0.5-3741	0.916	2.08	0.44
SB-CORE07-0.5-3743	0.626	0.976	0.64
SB-CORE08-0.5-3745	0.652	0.558	1.17
SB-CORE09-0.5-3747	0.687	0.521	1.32
SB-CORE10-0.5-3749	0.726	1.12	0.65
			Mean Ratio = 0.86

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Table 8-9. Relative Abundance of Radium-226 and Uranium-238 Detected in Niagara Falls Storage Site Railroad Ballast Samples

Railroad Ballast Sample ID	Radium-226 (pCi/g)	Uranium-238 (pCi/g)	Ratio
RB01	5.13	5.96	0.86
RB02	4.67	4.01	1.16
RB03	2.59	3.74	0.69
RB04	0.389	1.35	0.29
RB05	5.13	2.64	1.94
			Mean Ratio = 0.99

Table 8-10. Relative Abundance of Radium-226 and Uranium-238 Detected in Niagara Falls Storage Site Road Core Samples

Road Core Sample ID	Radium-226 (pCi/g)	Uranium-238 (pCi/g)	Ratio
RC01-964	7.31	2.88	2.54
RC02-965	6.34	5.48	1.16
RC03-966	10.5	2.75	3.82
RC04-968	3.2	2.78	1.15
RC05-969	4.47	0.415	10.77
RC06-970	2.92	3.02	0.97
RC07-971	2.85	2.77	1.03
RC08-972	11.7	13.6	0.86
RC09-973	5.42	2.76	1.96
RC10-974	3.37	3.33	1.01
RC11-976	0.429	0.731	0.59
RC12-977	3.96	4.52	0.88
RC13-978	4.67	3.28	1.42
RC14-979	5.66	3.76	1.51
RC15-2445	3.27	3.82	0.86
RC16-2447	10.5	4.76	2.21
RC17-2448	32	1.73	18.50
RC18-2449	129	8.94	14.43
RC19-2450	21.4	0.815	26.26
			Mean Ratio = 4.84

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9.0 SUPPLEMENTAL ENVIRONMENTAL SURVEILLANCE PROGRAM DATA FOR GROUNDWATER, AND SURFACE WATER AND SEDIMENTS IN ON-SITE DRAINAGES

This section presents a description of the NFSS ESP and enhancements to the ESP made in 2008 and 2009 as well as radiological results for groundwater from the supplemental ESP sampling conducted in the fall of 2008, including results for cesium, plutonium, strontium, tritium, and technetium. Analytical results for surface water and sediment from the Spring/Fall 2008 and Spring/Fall 2009 ESP sampling will also be incorporated into the RIR database for surface water and sediment in order to re-assess SRCs for these media. Post-RI results for surface water and sediments will be discussed in terms of what these results suggest about the transport of radionuclides through on-site ditches and assessment of the nature and extent of radiological contamination at the NFSS.

9.1 DESCRIPTION OF THE ENVIRONMENTAL SURVEILLANCE PROGRAM

The ESP is conducted by the Corps to quantify and evaluate chemical, radiological and water quality data collected from the NFSS to ensure that human health and the environment are protected. Results of the ESP are published annually as Environmental Surveillance Technical Memoranda. The ESP was initiated by DOE in 1981 to demonstrate the continued containment of radioactive wastes and residues buried within the IWCS and to ensure that on-site contamination does not pose a threat to human health or the environment. The program includes sampling of air, water, surface water and sediments for radiological and chemical parameters with the purpose of ensuring that the NFSS does not pose a threat to human health or the environment. The Corps has continued to follow the DOE program guidelines with some revisions over the years. Modifications to the ESP made in 2008 and 2009 were based on findings of the 2007 RIR (December 2007).

Environmental media monitored at the NFSS by the ESP include surface water, groundwater, and drainage ditch sediment for radiological and chemical parameters. Radon is measured in air, both at the surface of the IWCS and at the IWCS fence line. Gamma radiation is monitored at the IWCS fence line. Prior to the ESP enhancements made in 2008 and 2009, sampling activities included:

- Annual placement of 183 radon flux canisters on the IWCS protective cap to measure the release of Radon-222.
- Radon and external gamma radiation monitors located around the IWCS and the perimeter of the site, exchanged and analyzed twice per year.
- Surface water and sediment samples collected annually and tested for radium, thorium, and uranium.
- Groundwater wells sampled annually and tested for radium, thorium, and uranium, as well as metals and water quality parameters.
- Water level measurements recorded quarterly from 91 wells to determine the groundwater flow directions in the UWBZ and LWBZ.

In December 2007, the Corps Buffalo District completed an RIR that defined the nature and extent of contaminants on the NFSS and assessed their potential long-term risks to a variety of hypothetical

receptors. Based upon 2007 RIR findings, and public input, the Corps enhanced the ESP to further ensure the protection of human health and the environment.

9.2 ESP ENHANCEMENTS FOR 2008 AND 2009

Enhancements for the ESP from the 2007 RIR findings and public comments include:

- The addition of ten groundwater-monitoring well locations for water quality and radiological and/or chemical parameters;
- One time analysis of three of the ten additional groundwater-monitoring well locations for a supplemental list of radiological parameters;
- The addition of a fall round of groundwater, surface water and sediment sampling increasing the ESP sampling frequency from once to twice a year; and
- The addition of five surface water and sediment locations (three of which are located in the WDD) for an expanded list of radiological and chemical parameters.

Over the years the number of wells monitored for water levels on the NFSS has increased from 66 in 1997 to 101 in 2010. During the fall 2008 sampling event a subset of three of the ten newly added groundwater monitoring well locations were analyzed for an expanded set of radionuclides. The results of this expanded radiological analysis of groundwater are discussed below.

9.2.1 Supplemental Radiological Analysis for Groundwater

Enhancements to the ESP initiated in 2008 included the addition of ten groundwater monitoring well locations for water quality parameters and isotopic uranium. During the fall 2008 and 2009 ESP sampling, groundwater samples from three of the ten additional ESP wells (201A, BH49A and OW11B) were also analyzed for a supplemental set of radionuclides including: cesium-137, plutonium-238, plutonium-239/240, strontium-90, technetium-99 and tritium. Subsequent sampling of these wells in the spring and fall of 2009 did not include technetium-99 or tritium. The wells selected for supplemental radiological analysis had cesium-137 concentrations above background levels observed during the RI. The location of these wells is shown on Figure 9-1. Analytical results for the supplemental radiological analysis of groundwater for Fall 2008 and Spring 2009 are presented in Table 9-1 and 9-2, respectively. Although uranium is not considered one of the supplemental radionuclides, results for uranium in groundwater at these three wells are included on Tables 9-1 and 9-2 for informational purposes. The supplemental radiological analysis for groundwater showed all non-detect results; however, uranium was detected at BH49A and OW11B. Analytical results for other radionuclides monitored by the ESP sampling are presented and discussed in the annual Environmental Surveillance Technical Memoranda. Analytical results for surface water and sediments from ESP sampling conducted in 2008, 2009 and 2010 and are included in Appendix 4-A.

9.2.2 Supplemental Investigation for Surface Water and Sediment

To characterize potential impacts to surface water and sediment from historic site operation the NFSS RI included sampling in man-made ditches and low-lying areas that collect and retain standing water during wet portions of the year. The majority of these samples were collected from ditches and low-lying areas that drain portions of the NFSS formerly used to handle, store, treat, transport or dispose of chemical

and/or radiological materials and waste. The majority of surface water sampling locations coincided with sediment sampling locations.

To define the nature and extent of chemical and radiological contamination associated with surface water and sediment at the NFSS, SRCs were identified. SRCs were defined to be chemicals or radionuclides that were present in a given medium and EU at concentrations greater than the corresponding background concentrations. SRCs are then subjected to additional screening steps, including a comparison to conservative risk-based concentrations known as Preliminary Remediation Goals (PRGs), to determine which constituents warrant quantitative risk evaluation. These constituents are referred to as COPCs or ROPCs. The BRA identifies COCs and ROCs which are constituents that exceed target cancer risk levels of 10^{-4} or a non-cancer risk threshold of a Hazard Index greater than one. Radionuclides that present a total dose greater than 25 mrem/yr were also identified as ROCs. The BRA for the NFSS identified COPCs and ROPCs, but no COCs or ROCs in sediment or surface water in on-site surface water bodies.

Since the RI was completed, consistently decreasing concentrations of uranium in the WDD surface water have been observed. To characterize current surface water and sediment conditions at the NFSS supplemental data from the ESP was incorporated into the RI data set and SRCs and COPCs/ROPCs were screened out using the same technique as was used for the 2007 RIR. Supplemental ESP data incorporated into the RI data base include information from five new surface water and sediment sampling locations that were added to the five existing ESP surface water and sediment sampling locations during the fall of 2008. The location of new and existing surface water sediment locations are presented in Figure 9-1. Surface water/sediment sample locations added in 2008 include three locations in the WDD (WDD1, WDD2 and WWD3), and two locations along the southern (SWSD023) and eastern (SWSD024) borders of the NFSS selected to assess potential run-on to the site from Modern Landfill. The supplemental surface water/sediment ESP data include four rounds of sampling completed at the five new locations. Surface water samples were not filtered to remove suspended solids so surface water results are total phase, as opposed to dissolved phase results.

Surface water and sediment samples were analyzed for radiological analytes (radium-226, radium-228, thorium-228 [added in 2008], thorium-230, thorium-232, uranium-234, uranium-235, and uranium-238), metals, VOCs, PAHs, PCBs, and pesticides. Metals and the organics (VOCs, PAHs and PCBs) are new to the ESP program for 2008. Supplemental surface water and sediment ESP data includes analytical results from ESP sampling conducted in 2008, 2009 and 2010. These data are presented in Appendix 4-A.

9.2.3 Surface Water SRC with Supplemental ESP Data

Table 9-3 presents a side-by-side comparison of the surface water SRCs identified by the RI with those identified using the same screening technique conducted using the RI database supplemented with the 2008 and 2009 ESP data described above. Four new surface water SRCs (acetone, 4-methyl-2-pentanone, radium-228 and tetrachloroethene) are identified using the RI data set supplemented with ESP data; however, none of these compounds exceeds the PRGs, so no new ROPC/COPCs are identified. Locations where new surface water SRCs were detected using the expanded data set are summarized in Table 9-4 and are presented graphically on Figure 9-2a and 9-2b. Figure 9-2a identifies total phase SRCs in site-wide surface water based on the RI data set. Figure 9-2b presented the same information based on the RI data set merged with supplemental ESP data collected in 2008 and 2009. ESP sampling results from 2010 (radiological results only) were qualitatively compared to results presented in Table 9-3. Individual sample results from the 2010 ESP data were compared to SRCs developed using RI and 2008-2009 ESP data. This comparison was conducted to assess if there was a need to identify any additional radiological SRCs. Using this approach, no changes to the surface water SRCs were necessary.

Within the supplemental ESP data set from 2008, 2009 and 2010, four constituents are identified as surface water SRCs that were not identified by the RI. However, all four constituents (acetone, 4-methyl-2-pentanone, radium-228 and tetrachloroethene) were detected at concentrations lower than their respective risk-based PRGs, so they do not qualify as COPCs or ROPCs. Acetone is now identified as an SRC, however the detected concentrations of acetone exceeded the background level at just one location (SWSD009), and this location is viewed as a background location since it is located at the site boundary where surface water flows onto NFSS from off-site. A total of three of the seven locations where surface water SRCs were identified for the supplemental ESP data set are boundary locations where surface water flows onto NFSS from off-site.

9.2.4 Sediment SRCs with Supplemental ESP Data

Table 9-5 presents a side-by-side comparison of the sediment SRCs identified by the RI with those identified using the same screening technique conducted using the RI data base supplemented with the ESP data described above. Locations where new sediment COPC/ROPCs were detected are summarized in Table 9-6 and are presented graphically on Figures 9-3a and 9-3b. Figure 9-3a identifies SRCs in site-wide sediment based on the RI data set. Figure 9-3b presented the same information based on the RI data set merged with supplemental ESP data collected in 2008 and 2009.

ESP sampling results from 2010 were qualitatively compared to results presented in Table 9-5. Using the RI database supplemented with ESP data, 33 constituents are identified as sediment SRCs that were not identified by the RI. However, 14 of these constituents do not exceed risk-based PRGs so they do not qualify as COPCs or ROPCs, and eight of the remaining constituents exceed background levels at a single location. It is important to note that for the remaining 11 SRCs, more than 40 percent of the above background level detections occurred at boundary locations. Sample locations SWSD009, SWSD021, SWSD023 (added in 2008) and SWSD024 (added in 2008) are located at the upstream NFSS fence line where surface water flows on to the NFSS from adjacent properties. During 2010 ESP sampling, 5.97 pCi/g of thorium-232 was detected at location SWSD009, which exceeds the maximum level detected in previous sampling (1.834 pCi/g). Since this is a boundary location where surface water flows onto the NFSS, additional investigation of this area may be conducted during the BOP OU FS. While the new sediment SRCs include metals (aluminum, antimony, cobalt, lithium and vanadium), one VOC (tetrachloroethene), four polychlorinated biphenyls (Aroclor-1242, Aroclor-1248, Aroclor-1254 and Aroclor-1260) and two radionuclides (thorium-232 and uranium-235) the most prevalent chemical fraction for the new SRCs is PAHs. Seven PAHs were identified as new SRCs including benzo(a)anthracene, benzo(a)pyrene, benzo(b)fluoranthene, benzo(k)fluoranthene, chrysene, dibenzo(a,h)anthracene, and indeno(1,2,3-cd)pyrene. These PAHs exceed background levels at 7 sampling locations; however, 2 of these are boundary locations which may have been impacted by run-on to the site.

9.2.5 Radiological Impacts to the WDD

There is no current direct evidence that SRCs are migrating west from the NFSS onto the National Grid property or from one environmental medium to another. However, the presence of radiological SRCs in EU 9 environmental media is likely the result of historical NFSS operations.

Additional surface water and sediment sampling locations (WDD1, WDD2, and WDD3) were added to the ESP program in 2008 to further assess potential impacts to the WDD from the NFSS. Additional samples along the western boundary of the NFSS were also added to address uncertainty associated with the uranium groundwater plume west of the IWCS.

Although there appears to be some correlation between the levels of total uranium in surface water and groundwater west of the IWCS, several lines of evidence were examined that suggest otherwise, including the pattern of uranium distribution in surface water and groundwater and the possibility of other potential uranium sources. Based on sampling conducted in EUs 9 and 10, it appears that contaminated surface soil and erosion from the R-10 pile on the NFSS could have been a potential historical source of constituents detected in sediment and surface water in the WDD (Figure 5-22).

During the RI the concentration of total uranium in WDD surface water was variable along the ditch with no obvious concentration gradient. This suggests that the uranium could have come from multiple sources rather than a single source with gradually decreasing concentrations moving away from a groundwater seep or some other discreet source. The outer extent of the groundwater contamination along the west side of the IWCS has been well characterized and delineated using densely spaced sampling points (both permanent and temporary). The concentrations of dissolved total uranium and total uranium (as well as isotopic uranium) detected in wells and temporary well points between the IWCS and the WDD correspond to background levels. These background-level uranium concentrations strongly suggest that the source of uranium contamination in the WDD is not groundwater seepage.

Since the RI was completed, consistently decreasing concentrations of uranium in the WDD surface water have been observed. Recent ESP sampling results for total uranium in the WDD surface water and sediment are an order of magnitude, or more, below RI values. Figure 4-13 compares the concentration of total uranium in WDD surface water during the RI with more recent samples collected during 2008 and 2009 by the ESP. Figure 4-13 presents a comparison of surface water sampling results for total uranium at three WDD sampling locations during the RI with newer ESP results collected at these same locations in 2008, 2009 and 2010. Using the three collocated locations in the WDD, ESP 2008, 2009 and 2010 surface water sampling results indicate that total uranium concentrations in the WDD are currently at levels below the background UTL at all three sampling locations along the ditch. The observed decrease in total uranium in the WDD surface water between the time of RI sampling and the ESP sampling conducted during 2008, 2009 and 2010 suggests that the WDD is not greatly impacted by groundwater contaminant transport. Concentrations of total uranium observed in the WDD surface water and sediment during the RI are likely more indicative of material entering the WDD due to historical soil erosion and turbid overland flow. The radioactive R-10 storage pile had been left uncovered and unprotected in this area for a number of years. Wind erosion and surface water runoff from the R-10 pile likely contributed to contaminant migration to the west.

Additionally, simulations were performed using the site groundwater flow model (USACE 2007c) to predict flow and mass discharge into drainage ditches located on the NFSS property. Of the four drainage ditches analyzed, the lowest diluted concentrations of U-238 are predicted to occur in the WDD. The WDD primarily receives U-238 from the IWCS-based sources (i.e., discharge of groundwater in the vicinity of the IWCS to the WDD), which only impact a portion of its length. Results of this evaluation also indicate that the predicted diluted concentrations in the WDD do not exceed the screening level for U-238 in surface water within 1,000 years. This is consistent with conclusions presented above, which state that consistently decreasing concentrations of uranium in the WDD surface water have been observed since completion of the RI, and ESP results indicate that total uranium concentrations in the WDD are currently at levels below the background level. So, although predictive modeling results may indicate a uranium contribution to the WDD from groundwater, this predicted contribution appears to be minimal and the levels of uranium in WDD surface water and sediment observed during the early phases of the RI are still likely more indicative of material entering the WDD due to historical soil erosion and turbid overland flow. The *Evaluation of Groundwater and Surface Water in the West Drainage Ditch and Central Drainage Ditch* (USACE 2007c) is later presented in Section 12.9 and Appendix 12-I of this document.

9.3 SUMMARY

Enhancements to the ESP initiated in 2008 included the addition of ten groundwater monitoring well locations for water quality parameters and isotopic uranium. Analytical results for the supplemental radiological analysis of groundwater for 2008-2009 showed all non-detect results. Analytical results for other radionuclides monitored by the ESP sampling are presented and discussed in the Annual 2008 Environmental Surveillance Technical Memoranda (USACE 2009).

To characterize current conditions in surface water and sediment, enhancements to the ESP initiated in 2008 also included the addition of five new surface water and sediment locations (bring the total number of locations up to 10) analyzed for an expanded list of radiological and chemical parameters twice a year (increased from once a year). Analytical results for surface water and sediment from the enhanced ESP sampling were merged with the RI data set and screened for SRCs using the same screening technique as was used for the RI.

Within the supplemental ESP dataset, four constituents are identified as surface water SRCs that were not called out by the RI. However, all four constituents were detected at concentrations lower than their respective risk-based PRGs, so they do not qualify as COPCs or ROPCs. Three of the seven locations where surface water SRCs were identified for the supplemental ESP data set are boundary locations where surface water flows onto NFSS from off-site.

Within the supplemental 2008, 2009 and 2010 ESP dataset, 33 constituents are identified as sediment SRCs that were not called out by the RI. However, 14 of these constituents do not exceed risk-based PRGs so they do not qualify as ROPCs/COPCs, and eight of the remaining constituents exceed background levels at a single location. Because new COPCs and ROPCs were identified in sediments, these constituents should be subjected to further risk evaluation to confirm whether or not they are COCs (rather than simply COPCs and ROPCs) during the BOP FS. This risk evaluation should utilize the same methodology as that used for the NFSS BRA (USACE 2007b). If confirmed, these new ditch COCs should be compared to the list of soil COCs for determination of whether or not additional COCs need to be considered when developing soil cleanup goals for the BOP. It is important to note that for the remaining 11 SRCs identified in sediment using the supplemental 2008, 2009 and 2010 ESP dataset, more than 40 percent of the above background level detections occurred at boundary locations. Sample locations SWSD009, SWSD021, SWSD023 (added in 2008) and SWSD024 (added in 2008) are located at the upstream NFSS fence line where surface water flows on to the NFSS from adjacent properties. During 2010 environmental surveillance sampling, 5.97 pCi/g of thorium-232 was detected at SWSD009, which exceeds the maximum level detected in previous sampling (1.834 pCi/g). Since this is a boundary location where surface water flows onto the NFSS, additional investigation of this area may be conducted during the BOP OU FS. While the new sediment SRCs include a variety of constituents, the most prevalent chemical class for the new SRCs is PAHs. Seven PAHs were identified as new SRCs. These PAHs exceed background levels at seven sampling locations; however two of these are boundary locations that may have been impacted by runoff onto the NFSS from adjacent roadways or landfill properties.

Supplemental ESP results for surface water and sediment sampling collected along the WDD (WDD1, WDD2 and WDD3) were used to assess potential impacts to the WDD from the NFSS including uncertainty associated with the uranium groundwater plume west of the IWCS. By comparing RI data to more recent ESP data a marked decrease in total uranium in the WDD was observed. ESP results indicate that total uranium concentrations in the WDD are currently at levels below the background UTL at all three sampling locations along the ditch. The observed decrease in total uranium in the WDD surface water between the time of RI sampling and the ESP sampling conducted during 2008, 2009 and 2010

suggests that the WDD is not greatly impacted by groundwater contaminant transport. Concentrations of total uranium observed in the WDD surface water and sediment during the RI are likely more indicative of material entering the WDD due to historical soil erosion and turbid overland flow.

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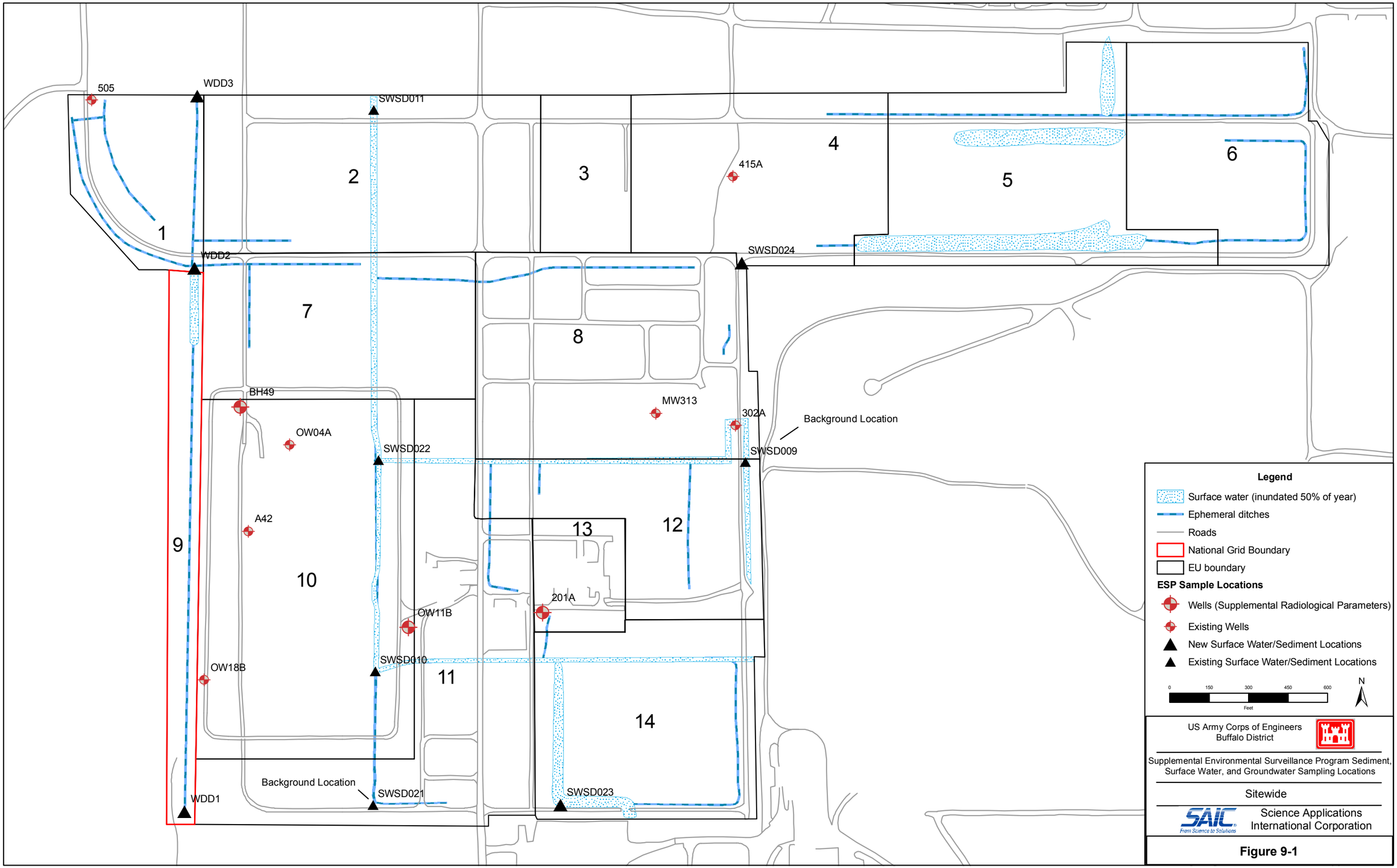
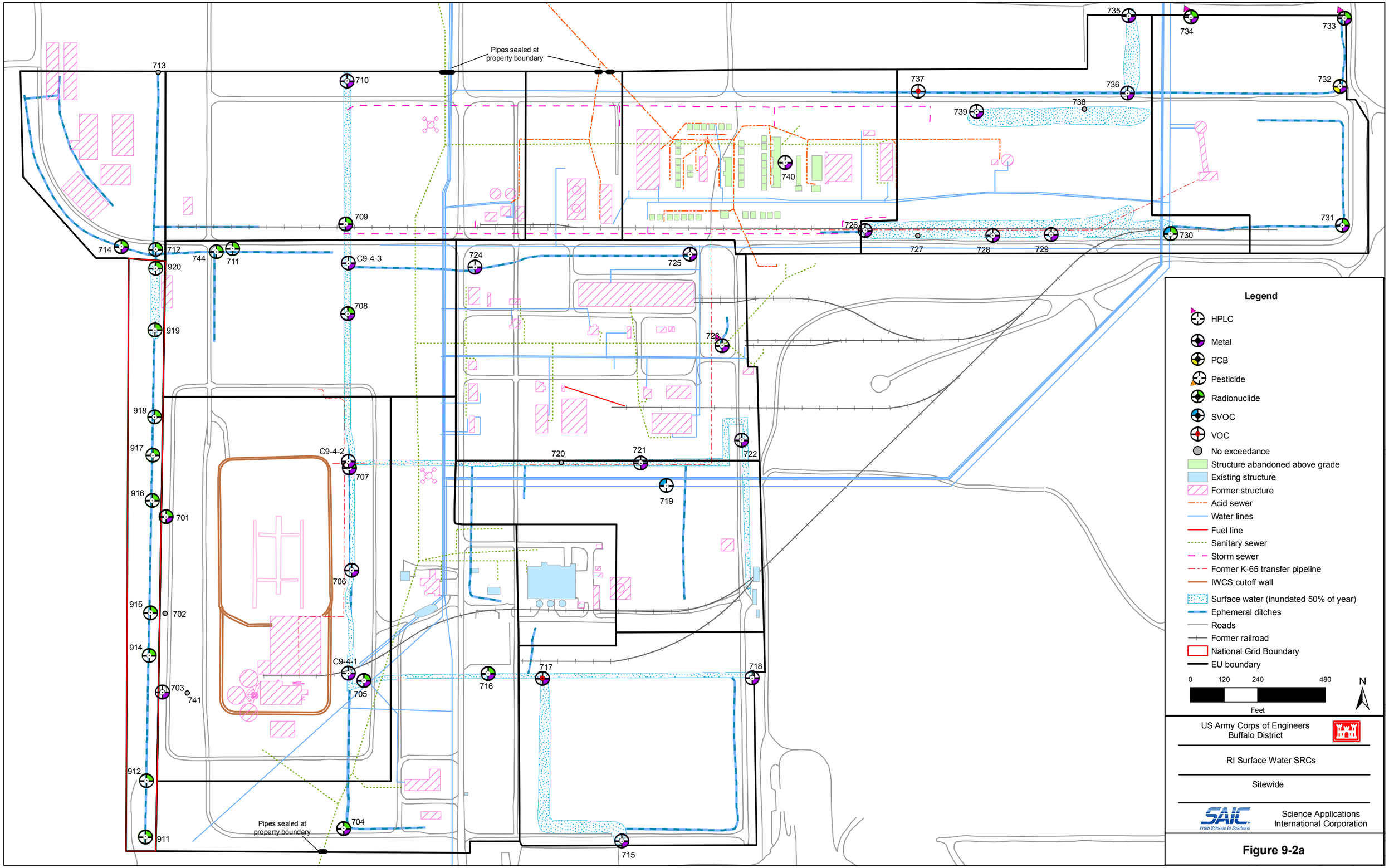
SECTION 9

FIGURES


505
WDD3
SWSD011
415A
SWSD024
WDD2
BH49
MW313
302A
Background Location
OW04A
SWSD022
SWSD009
A42
OW11B
201A
OW18B
SWSD010
Background Location
WDD1
SWSD021
SWSD023
1
2
3
4
5
6
7
8
9
10
11
12
13
14
Legend
Surface water (inundated 50% of year)
Ephemeral ditches
Roads
National Grid Boundary
EU boundary
ESP Sample Locations
Wells (Supplemental Radiological Parameters)
Existing Wells
New Surface Water/Sediment Locations
Existing Surface Water/Sediment Locations
0
150
300
450
600
Feet
N
US Army Corps of Engineers
Buffalo District
Supplemental Environmental Surveillance Program Sediment, Surface Water, and Groundwater Sampling Locations
Sitewide
SAIC
From Science to Solutions
Science Applications International Corporation
Figure 9-1


Pipes sealed at property boundary
713
710
709
714
712
744
711
920
C9-4-3
708
919
724
725
726
727
728
729
730
731
732
733
734
735
736
737
738
739
740
918
917
916
915
914
912
911
C9-4-2
707
701
706
702
703
741
C9-4-1
705
704
Pipes sealed at property boundary
720
721
722
719
716
717
718
715
Legend
HPLC
Metal
PCB
Pesticide
Radionuclide
SVOC
VOC
No exceedance
Structure abandoned above grade
Existing structure
Former structure
Acid sewer
Water lines
Fuel line
Sanitary sewer
Storm sewer
Former K-65 transfer pipeline
IWCS cutoff wall
Surface water (inundated 50% of year)
Ephemeral ditches
Roads
Former railroad
National Grid Boundary
EU boundary
0
120
240
480
Feet
N
US Army Corps of Engineers
Buffalo District
RI Surface Water SRCs
Sitewide
Science Applications International Corporation
Figure 9-2a

Pipes sealed at property boundary

WDD3

SWSD011

WDD2

SWSD024

SWSD022

SWSD009

SWSD010

SWSD021

SWSD023

Pipes sealed at property boundary

WDD1

Legend

- HPLC
- Metal
- PCB
- Pesticide
- Radionuclide
- SVOC
- VOC
- No exceedance
- Structure abandoned above grade
- Existing structure
- Former structure
- Acid sewer
- Water lines
- Fuel line
- Sanitary sewer
- Storm sewer
- Former K-65 transfer pipeline
- IWCS cutoff wall
- Surface water (inundated 50% of year)
- Ephemeral ditches
- Roads
- Former railroad
- National Grid Boundary
- EU boundary

0 120 240 480

Feet

N

US Army Corps of Engineers
Buffalo District

ESP 2008/2009 Surface Water SRCs

Sitewide

SAIC From Science to Solutions

Science Applications International Corporation

Figure 9-2b

Pipes sealed at property boundary

710 CD4

OTFL2

709

C9-4-3

920

919

708

CD3

CD2

C9-4-2

707

706

C9-4-1

705

CD5

720

721

722

716

717

718

715

726

SEDC03

727

728

729

SEDC04

730

735

736

739

SEDC01

738

SEDC02

Pipes sealed at property boundary

Legend

- HPLC
- Metal
- PCB
- Pesticide
- Radionuclide
- SVOC
- VOC
- No exceedance
- Structure abandoned above grade
- Existing structure
- Former structure
- Acid sewer
- Water lines
- Fuel line
- Sanitary sewer
- Storm sewer
- Former K-65 transfer pipeline
- IWCS cutoff wall
- Surface water (inundated 50% of year)
- Ephemeral ditches
- Roads
- Former railroad
- National Grid Boundary
- EU boundary

0 120 240 480
Feet

N

US Army Corps of Engineers
Buffalo District

RI Sediment SRCs

Sitewide

SAIC From Science to Solutions
Science Applications International Corporation

Figure 9-3a

Pipes sealed at property boundary

WDD3

SWSD011

WDD2

SWSD024

SWSD022

SWSD009

SWSD010

SWSD023

SWSD021

WDD1

Pipes sealed at property boundary

Legend

- HPLC
- Metal
- PCB
- Pesticide
- Radionuclide
- SVOC
- VOC
- No exceedance
- Structure abandoned above grade
- Existing structure
- Former structure
- Acid sewer
- Water lines
- Fuel line
- Sanitary sewer
- Storm sewer
- Former K-65 transfer pipeline
- IWCS cutoff wall
- Surface water (inundated 50% of year)
- Ephemeral ditches
- Roads
- Former railroad
- National Grid Boundary
- EU boundary

0 120 240 480

Feet

N

During spring 2010 environmental surveillance sampling, 5.97 pCi/g of thorium-232 was detected at SWSD009, which exceeds the maximum level detected in previous sampling (previous maximum detected concentration was 1.83 pCi/g). Therefore, thorium-232 was included at location SWSD009.

US Army Corps of Engineers
Buffalo District

ESP 2008/2009 Sediment SRCs

Sitewide

SAIC From Science to Solutions

Science Applications International Corporation

Figure 9-3b

SECTION 9

TABLES

Table 9-1. NFSS Fall 2008 Environmental Surveillance Program Findings for Radiological Constituents in Groundwater

NFSS Well ID	CAS Number	Analyte	Result	Unit	Qualifier
201A	13981-16-3	Plutonium-238	-0.014	pCi/L	U
201A	OER-100-70	Plutonium-239/240	-0.014	pCi/L	U
201A	14133-76-7	Technetium-99	8.570	pCi/L	U
201A	10045-97-3	Cesium-137	0.106	pCi/L	U
201A	10098-97-2	Strontium-90	0.053	pCi/L	U
201A	10028-17-8	Tritium	-43.900	pCi/L	U
BH49A	13981-16-3	Plutonium-238	-0.067	pCi/L	U
BH49A	OER-100-70	Plutonium-239/240	-0.040	pCi/L	U
BH49A	14133-76-7	Technetium-99	3.040	pCi/L	U
BH49A	10045-97-3	Cesium-137	1.430	pCi/L	U
BH49A	10098-97-2	Strontium-90	0.025	pCi/L	U
BH49A	10028-17-8	Tritium	59.800	pCi/L	U
BH49A	13966-29-5	Uranium-233/234	10.900	pCi/L	
BH49A	13982-70-2	Uranium-235/236	0.562	pCi/L	
BH49A	7440-61-1	Uranium-238	9.860	pCi/L	
OW11B	13981-16-3	Plutonium-238	-0.013	pCi/L	U
OW11B	OER-100-70	Plutonium-239/240	0.000	pCi/L	U
OW11B	14133-76-7	Technetium-99	-6.720	pCi/L	U
OW11B	10045-97-3	Cesium-137	0.075	pCi/L	U
OW11B	10098-97-2	Strontium-90	-0.008	pCi/L	U
OW11B	10028-17-8	Tritium	164.000	pCi/L	U
OW11B	13966-29-5	Uranium-233/234	87.600	pCi/L	
OW11B	13982-70-2	Uranium-235/236	4.270	pCi/L	
OW11B	7440-61-1	Uranium-238	84.100	pCi/L	

U - Compound not detected.

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Table 9-2. NFSS Spring 2009 Environmental Surveillance Program Findings for Radiological Constituents in Groundwater

NFSS Well ID	CAS Number	Analyte	Result	Unit	Qualifier
201A	10045-97-3	Cesium-137	1.406	pCi/L	U
201A	13981-16-3	Plutonium-238	0.015	pCi/L	U
201A	15117-48-3	Plutonium-239	0.026	pCi/L	U
201A	14158-27-1	Strontium-89	-0.885	pCi/L	U
201A	10098-97-2	Strontium-90	1.839	pCi/L	U
201A		Total Strontium	1.243	pCi/L	U
BH49A	10045-97-3	Cesium-137	-0.593	pCi/L	U
BH49A	13981-16-3	Plutonium-238	-0.018	pCi/L	U
BH49A	15117-48-3	Plutonium-239	-0.009	pCi/L	U
BH49A	14158-27-1	Strontium-89	0.553	pCi/L	U
BH49A	10098-97-2	Strontium-90	1.036	pCi/L	U
BH49A		Total Strontium	1.408	pCi/L	U
BH49A	13966-29-5	Uranium-234	7.665	pCi/L	
BH49A	13982-70-2	Uranium-235	0.605	pCi/L	
BH49A	7440-61-1	Uranium-238	6.586	pCi/L	
BH49A	7440-61-1TU	Total Uranium	14.856	pCi/L	
OW11B	10045-97-3	Cesium-137	-0.162	pCi/L	U
OW11B	13981-16-3	Plutonium-238	0.012	pCi/L	U
OW11B	15117-48-3	Plutonium-239	0.027	pCi/L	U
OW11B	14158-27-1	Strontium-89	-0.678	pCi/L	U
OW11B	10098-97-2	Strontium-90	1.465	pCi/L	U
OW11B		Total Strontium	1.009	pCi/L	U
OW11B	13966-29-5	Uranium-234	137.900	pCi/L	
OW11B	13982-70-2	Uranium-235	12.400	pCi/L	
OW11B	7440-61-1	Uranium-238	123.700	pCi/L	
OW11B	7440-61-1TU	Total Uranium	274.000	pCi/L	

U - Compound not detected.

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Table 9-3. Surface Water SRCs and COPCs/ROPCs Identified for the RI Data Set and the RI Data Set with Supplemental 2008 and 2009 ESP Data

Original RI Data Set					RI Data Set with ESP 2008/2009 Data[a]						
Parameter	Unit	Background	Background Exceedance	RI SRC	Minimum Detect	Maximum Detect	Background Exceedance	SRC	PRG	PRG Exceedence	ROPC/ COPC
1,3,5-Trinitrobenzene	µg/L	0.0249	1/22	No:0	0.34	0.34	1/22	No:0	--	--	No
2,6-Dinitrotoluene	µg/L	0.0501	1/35	No:0	0.34	0.34	1/35	No:0	--	--	No
2-Amino-4,6-dinitrotoluene	µg/L	0.0779	2/23	Yes	0.16	0.28	2/23	Yes	--	Yes	Yes
Aluminum	µg/L	5030	13/35	Yes	38	21000	13/73	Yes	--	Yes	Yes
Antimony	µg/L	2.33	10/34	Yes	0.45	12.2	18/72	Yes	8.4	No:2	No
Arsenic	µg/L	6.33	2/35	Yes	0.85	8.3	2/73	Yes	0.6	No:2	No
Barium	µg/L	117	4/35	Yes	21.7	358	4/73	Yes	4211.5	No:2	No
Beryllium	µg/L	0.253	12/34	Yes	0.12	2.4	13/72	Yes	42.1	No:2	No
Boron	µg/L	244	6/39	Yes	20.4	1150	30/72	Yes	4211.5	No:2	No
Cadmium	µg/L		10/35	Yes	0.16	5.1	20/73	Yes	10.5	No:2	No
Calcium	µg/L	141000	3/35	No:1	18900	204000	24/73	No:2		No:1	No
Chromium	µg/L	7.52	14/35	Yes	0.62	267	19/73	Yes	31586.5	No:2	No
Cobalt	µg/L	1.08	15/34	Yes	0.3	14.2	31/72	Yes		Yes	Yes
Copper	µg/L	15	14/35	Yes	2.6	132	24/73	Yes	842.3	No:2	No
Iron	µg/L	4740	14/35	No:1	230	29300	14/73	No:2	--	No:2	No
Lead	µg/L	11.1	8/36	Yes	0.07	151	8/74	Yes	--	Yes	Yes
Lithium	µg/L	13.2	15/38	Yes	0.79	155	33/71	Yes	--	Yes	Yes
Magnesium	µg/L	30200	6/35	No:1	5090	95000	39/73	No:2	--	No:2	No
Manganese	µg/L	951	1/35	Yes	10.4	1230	2/73	Yes	2948.1	No:2	No
Mercury	µg/L		13/36	Yes	0.05	0.94	13/72	Yes	6.3	No:2	No
Nickel	µg/L	7.74	15/36	Yes	3.1	33.5	35/74	Yes	421.2	No:2	No
Potassium	µg/L	9540	2/35	No:1	1300	130000	22/73	No:2	--	No:2	No
Selenium	µg/L	4.24	1/35	Yes	0.34	12	9/73	Yes	105.3	No:2	No
Silver	µg/L	0.03	11/35	Yes	0.078	0.84	15/73	Yes	105.3	No:2	No
Sodium	µg/L	179000	0/35	No:1	1150	170000	0/73	No:0	--	--	No
Thallium	µg/L	0.026	2/35	Yes	0.37	2.6	5/73	Yes	1.7	Yes	Yes
Total Uranium	µg/L	12.5	9/50	Yes	0.475	48.3	9/50	Yes	63.2	No:2	No
Vanadium	µg/L	8.52	14/35	Yes	0.26	38.4	15/73	Yes	105.3	No:2	No
Zinc	µg/L	70.5	12/36	Yes	4.1	1460	22/74	Yes	6317.3	No:2	No
Acenaphthylene	µg/L				0.203	0.203	1/70	No:0	--	--	No
Anthracene	µg/L		1/32	No:0	0.14	0.14	1/70	No:0	--	--	No
Benzo(a)anthracene	µg/L	0.108	1/32	No:0	0.0372	0.54	1/70	No:0	--	--	No
Benzo(a)pyrene	µg/L				0.0394	0.0394	1/70	No:0	--	--	No
Benzo(b)fluoranthene	µg/L				0.0759	0.0759	1/70	No:0	--	--	No
Benzo(g,h,i)perylene	µg/L				0.0172	0.0172	1/70	No:0	--	--	No
Chrysene	µg/L	0.151	1/32	No:0	0.0321	0.51	1/70	No:0	--	--	No
Fluoranthene	µg/L				0.149	0.149	0/70	No:0	--	--	No
Pyrene	µg/L	0.302	1/32	No:0	0.0228	0.59	1/70	No:0	--	--	No
Aroclor-1260	µg/L		1/26	No:0	0.086	0.086	1/64	No:0	--	--	No
delta-BHC	µg/L				0.0063	0.0063	1/64	No:0	--	--	No
Endosulfan I	µg/L				0.0771	0.0949	2/65	No:0	--	--	No
Radium-226	pCi/L	0.487	16/50	Yes	0.231	3.66	25/88	Yes	1370.2	No:2	No
Radium-228	pCi/L				0.203	1.76	3/50	Yes[b]	508.6	No:2	No
Thorium-228	pCi/L	0.41	1/50	Yes	0.0823	17.7	1/86	Yes	1763.0	No:2	No
Thorium-230	pCi/L	0.606	1/50	Yes	0.0694	24	3/86	Yes	5812.1	No:2	No
Thorium-232	pCi/L		11/50	Yes	0.0726	12.5	11/86	Yes	5200.0	No:2	No
Uranium-234	pCi/L	5.78	9/50	Yes	0.288	17.7	11/88	Yes	7480.9	No:2	No
Uranium-235	pCi/L	0.529	5/50	Yes	0.103	0.964	10/88	Yes	7366.3	No:2	No
Uranium-238	pCi/L	4.81	10/50	Yes	0.2158	16.5	13/88	Yes	6072.3	No:2	No
o-Cresol	µg/L		1/32	No:0	1.7	1.7	1/32	No:0	--	--	No
2-Butanone	µg/L				1.46	1.46	0/42	No:0	--	--	No
4-Methyl-2-pentanone	µg/L		1/24	No:0	3.56	16.6	4/42	Yes[b]	80.9	No:2	No
Acetone	µg/L				0.05	33.2	1/62	Yes[b]	4442.6	No:2	No
Benzene	µg/L		1/25	No:0	0.669	2.5	2/63	No:0	--	--	No
Chlorobenzene	µg/L				0.41	0.41	1/62	No:0	--	--	No
cis-1,2-Dichloroethene	µg/L				0.47	3.95	3/63	No:0	--	--	No
Tetrachloroethene	µg/L	0.554	0/24	No:0	0.25	7.91	3/62	Yes[b]	0.009	No:2	No
Toluene	µg/L				0.262	0.262	1/62	No:0	--	--	No
Trichloroethene	µg/L				1.73	3.63	2/62	No:0	--	--	No
Xylenes (total)	µg/L		1/24	No:0	0.14	0.14	1/62	No:0	--	--	No

"--" Compound was not brought forward.

No - Does not meet screening or exceed screening criteria.

No:0 - Not identified as a SRC or COPC/ROPC due to low (<5%) frequency of detection.

No:1 - Not identified as a SRC or COPC because compound is an essential human nutrient.

No:2 - Not identified as COPC/ROPC because it does not exceed the PRG.

* PRGs are listed in mg/L or pCi/L.

COPC - chemical of potential concern

ESP - Environmental Suveillance Program

PRG - Preliminary Remedial Goal

ROPC - radionuclide of potential concern

SRC -site related compound

[a] RI data set supplemented with ESP data from 2008 and 2009 sampling. Results for ESP sampling from 2008, 2009 and 2010 provided in Appendix 4-A.

[b] Acetone, 4-methyl-2-pentanone, radium-228 and tetrachloroethene were identified as new SRCs with the supplemented data set. Note that for surface water none of the new SRCs exceed PRGs so they are not identified as ROPC/COPCs.

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Table 9-4. New Surface Water SRC Summary for the RI Data Set with Supplemental 2008 and 2009 ESP Data[a]

Parameter	Background Screening Value	Surface Water Samples That Exceed Background Screening Value	Concentration
4-Methyl-2-pentanone (µg/L)	--	SWSD010	3.56
		SWSD009	6.4
		SWSD011	3.7
Acetone (µg/L)	--	SWSD009	33.2
Radium-228 (pCi/L)	--	SWSD023	1.73
		SWSD024	1.76
		WDD3	1.75
Tetrachloroethene (µg/L)	0.554	SWSD010	7.91
		SWSD022	2.08
		SWSD011	0.7

-- No background value available

[a] New SRCs identified with supplemented data set. Note that for surface water none of the new SRCs exceed PRGs so they are not identified as ROPC/COPCs. Results for ESP sampling from 2008, 2009 and 2010 provided in Appendix 4-A.

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Table 9-5. Sediment SRCs and COPCs/ROPCs Identified for the RI Data Set and the RI Data Set with Supplemental ESP Data

Original RI Data Set					RI Data Set with ESP 2008/2009 Data						
Parameter	Unit	Background	Background Exceedance	RI SRC	Minimum Detect	Maximum Detect	Background Exceedance	SRC	PRG*	PRG Exceedence	ROPC/ COPC
Aluminum	mg/kg	30400	0/21	No:1	5960	57000	1/61	Yes	--	Yes	--
Antimony	mg/kg				0.15	5.5	1/61	Yes	1.067	Yes	--
Arsenic	mg/kg	7.14	1/21	Yes	1.8	12	7/61	Yes	0.216	Yes	--
Barium	mg/kg	246	2/21	Yes	54.5	340	3/61	Yes	763.323	No	--
Beryllium	mg/kg	1.44	0/21	No:1	0.27	2	1/62	Yes	13.764	No	No
Boron	mg/kg	31.4	3/24	Yes	2.2	66	10/58	Yes	12.142	Yes	--
Cadmium	mg/kg	1.89	1/21	Yes	0.13	2.1	1/61	Yes	0.711	Yes	--
Calcium	mg/kg	59400	0/21	No, No:2	2420	83000	6/61	No, No:2	--	--	--
Chromium	mg/kg	472	0/21	No:1	11	120	0/61	No:1	--	--	--
Cobalt	mg/kg	21.3	0/21	No:1	3.8	27	1/61	Yes	--	Yes	--
Copper	mg/kg	184	0/21	No:1	18	124	0/61	No:1	--	--	--
Iron	mg/kg	37800	2/21	No:2	8310	67000	6/61	No:2	--	--	--
Lead	mg/kg	121	1/21	Yes	6.3	144	2/61	Yes	400.000	No	--
Lithium	mg/kg	47	0/24	No:1	9.5	130	6/60	Yes	--	Yes	--
Magnesium	mg/kg	27300	0/21	No, No:2	2450	32000	1/61	No, No:2	--	--	--
Manganese	mg/kg	814	5/21	Yes	144	3000	19/61	Yes	254.613	Yes	--
Mercury	mg/kg	0.47	3/21	Yes	0.014	0.95	3/61	Yes	0.084	Yes	--
Nickel	mg/kg	51.9	1/21	Yes	10.2	74.6	2/61	Yes	29.289	Yes	--
Potassium	mg/kg	5070	0/21	No:2	641	12000	12/61	No:2	--	--	--
Selenium	mg/kg	1.87	3/21	Yes	0.35	2.6	5/61	Yes	8.827	No	--
Silver	mg/kg	0.742	0/21	No:1	0.02	1.5	8/61	Yes	2.572	No	No
Sodium	mg/kg	679	0/21	No, No:2	56.7	950	4/61	No:2	--	--	--
Thallium	mg/kg	0.356	2/21	Yes	0.02	0.53	2/62	Yes	0.194	Yes	--
Total Uranium	µg/g	6.47	1/32	Yes	1.4	7.73	1/32	Yes	16.436	No	--
Vanadium	mg/kg	60.6	0/21	No:1	13.2	83	1/61	Yes	30.217	Yes	--
Zinc	mg/kg	405	1/21	Yes	39.4	930	10/61	Yes	28.842	Yes	--
Acenaphthene	µg/kg				110	1300	7/59	Yes	33.436	No	No
Anthracene	µg/kg				2.8	257	18/59	Yes	289.137	No	No
Benzo(a)anthracene	µg/kg				18.2	1610	5/59	Yes	0.121	Yes	--
Benzo(a)pyrene	µg/kg				15.1	2820	5/59	Yes	0.010	Yes	--
Benzo(b)fluoranthene	µg/kg				19	2820	1/59	Yes	0.092	Yes	--
Benzo(g,h,i)perylene	µg/kg				12.7	1300	16/59	Yes	5.406	No	No
Benzo(k)fluoranthene	µg/kg				33	1320	2/59	Yes	0.931	Yes	--
Chrysene	µg/kg				8.4	1500	2/59	Yes	1.218	Yes	--
Dibenzo(a,h)anthracene	µg/kg				65	195	5/59	Yes	0.005	Yes	--
Fluoranthene	µg/kg	696	0/19	No:1	20	2300	10/59	Yes	63.202	No	No
Fluorene	µg/kg				23	210	6/59	Yes	28.031	No	No
Indeno(1,2,3-cd)pyrene	µg/kg				55	1380	8/59	Yes	0.026	Yes	--
Phenanthrene	µg/kg				12.4	570	13/59	Yes	20.850	No	No
Pyrene	µg/kg	1000	0/19	No:1	19.3	1380	2/59	Yes	45.129	No	No
Aroclor-1242	µg/kg				4	101	1/54	Yes	0.023	Yes	--
Aroclor-1248	µg/kg				29.1	42.1	4/54	Yes	--	Yes	--
Aroclor-1254	µg/kg	58.3	0/14	No:1	2.8	61.8	1/54	Yes	0.021	Yes	--
Aroclor-1260	µg/kg				12.2	38.3	3/54	Yes	0.012	Yes	--
Cesium-137	pCi/g	0.389	2/30	Yes	0.0357	0.49	2/30	Yes	0.022	Yes	--
Potassium-40	pCi/g		5/5	Yes	16.4	22.5	5/5	Yes	0.013	Yes	--
Radium-226	pCi/g	2.43	0/32	No:1	0.3738	2.05	0/72	No:1		--	--
Radium-228	pCi/g	1.14	1/10	Yes	0.498	2.42	18/50	Yes	0.007	Yes	--
Thorium-228	pCi/g	1.31	2/32	Yes	0.556	2.249	22/72	Yes	0.068	Yes	--
Thorium-230	pCi/g	5.58	0/32	No:1	0.519	1.89	0/72	No:1	--	--	--
Thorium-232	pCi/g	1.23	0/32	No:1	0.624	1.834	12/72	Yes	0.002	Yes	--
Total Uranium	pCi/g				1.4	7.73	1/40	Yes	16.436	No	No
Uranium-234	pCi/g	3.57	0/32	No:1	0.595	3.402	0/72	No:1	--	--	--
Uranium-235	pCi/g	0.309	0/32	No:1	0.0217	0.3154	1/72	Yes	0.080	Yes	--
Uranium-238	pCi/g	3.08	0/32	No:1	0.674	3.08	0/72	No:1	--	--	--
2-Butanone	µg/kg	49.3	0/20	No:1	4.35	52.5	1/40	Yes	676.463	No	No
Acetone	µg/kg	206	0/20	No:1	1.6	150	0/60	No:1	--	--	--
cis-1,2-Dichloroethene	µg/kg				1.61	11.9	4/60	Yes	4.028	No	No
Methylene chloride	µg/kg		3/20	Yes	6.8	16.1	3/40	Yes	0.717	No	--
Tetrachloroethene	µg/kg				7.3	28.9	3/60	Yes	0.022	Yes	--
Toluene	µg/kg	8.89	0/20	No:1	0.14	88	1/60	Yes	162.350	No	No
Trichloroethene	µg/kg				3.91	14.1	3/60	Yes	2.253	No	No
Xylenes (total)	µg/kg				0.641	0.641	1/60	No:0	--	--	--

No - Does not exceed background or Preliminary Remedial Goal (PRG).

No:0 - Not identified as a SRC or COPC/ROPC due to low (<5%) frequency of detection.

No:1 - Not identified as a SRC or ROPC due to the isotope's short half-life

No:2 - Not identified as a SRC or COPC because compound is an essential human nutrient.

*PRGs are listed in mg/kg or pCi/g

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Table 9-6. Summary of New Sediment COPC/ROPCs for the RI Data Set with Supplemental ESP Data[a]

Parameter	Background Screening Value	Sediment Samples That Exceed Background Screening Value	Concentration
Aluminum (mg/kg)	30400	WDD1	57000
Antimony (mg/kg)	--	SWSD022	5.5
Aroclor-1242 (µg/kg)	--	SWSD024	101
Aroclor-1248 (µg/kg)	--	SWSD010	42.1
		SWSD009	29.6
		SWSD023	33.6
		SWSD024	29.1
Aroclor-1254 (µg/kg)	58.3	SWSD023	61.8
Aroclor-1260 (µg/kg)	--	SWSD010	28.5
		SWSD022	30.1
		SWSD023	38.3
Benzo(a)anthracene (µg/kg)	--	SWSD010	430
		SWSD009	463
		SWSD009	490
		SWSD023	530
		WDD3	1610
Benzo(a)pyrene (µg/kg)	--	SWSD010	670
		SWSD010	710
		SWSD022	710
		SWSD023	1400
		WDD3	2820
Benzo(b)fluoranthene (µg/kg)	--	WDD3	2820
Benzo(k)fluoranthene	--	SWSD023	430
		WDD3	1320
Chrysene (µg/kg)	--	SWSD023	510
		WDD3	1500
Cobalt (mg/kg)	21.3	WDD1	27
Dibenzo(a,h)anthracene (µg/kg)	--	WDD2	78
		SWSD009	66
		SWSD023	65
		SWSD023	130
		WDD3	195
Indeno(1,2,3-cd)pyrene (µg/kg)	--	SWSD010	270
		SWSD010	430
		SWSD022	320
		SWSD022	470
		SWSD023	430
		SWSD023	530
		SWSD011	310
		WDD3	1380
Lithium (mg/kg)	47	WDD1	130
		SWSD021	56
		SWSD011	54
		SWSD024	47.3
		SWSD024	53
		WDD3	49.6
Tetrachloroethene (µg/kg)	--	SWSD023	28.9
		SWSD024	16.1
		WDD3	7.3

Table 9-6. Summary of New Sediment COPC/ROPCs for the RI Data Set with Supplemental ESP Data[a]

Parameter	Background Screening Value	Sediment Samples That Exceed Background Screening Value	Concentration
Thorium-232 (pCi/g)	1.23	WDD1	1.353
		WDD1	1.36
		WDD1	1.557
		WDD2	1.813
		SWSD022	1.27
		SWSD021	1.25
		SWSD021	1.29
		SWSD021	1.803
		SWSD011	1.45
		SWSD024	1.239
		SWSD024	1.834
		WDD3	1.383
		SWSD009	5.97[b]
Uranium-235 (pCi/g)	0.309	SWSD022	0.3154
Vanadium (mg/kg)	60.6	WDD1	83

-- No background value available

[a] ROPC/COPCs that were not identified by the RI do come forward using the RI data base supplemented with analytical results from the 2008, 2009 and 2010 Environmental Surveillance Program sampling. Note that for sediment 33 new SRCs were identified, however 14 do not exceed Preliminary Remedial Goals so they are not identified as ROPC/COPCs. Results for ESP sampling from 2008, 2009 and 2010 are provided in Appendix 4-A.

[b] During 2010 environmental surveillance sampling, 5.97 pCi/g of thorium-232 was detected at SWSD009, which exceeds the maximum level detected in previous sampling (previous maximum detected concentration was 1.83 pCi/g).

10.0 RADIOLOGICAL INVESTIGATION OF UNDERGROUND UTILITY LINES ON THE FORMER LAKE ONTARIO ORDNANCE WORKS PROPERTY

This section presents radiological results from waste water and pipeline sediment collected as split samples during the LOOW UURI and a determination as to whether radionuclides detected in waste water and pipeline sediments might be considered SRCs and ROPCs.

10.1 INTRODUCTION

The LOOW UURI was conducted during the fall of 2005 through January 2007 to investigate chemical contamination present in sediment, waste water and soil associated with underground utilities that were put in place to support the formerly used defense sites within the footprint of the LOOW, and which did not appear to have been impacted heavily by non-U.S. DoD site users (USACE 2007d). Sediment and waste water were sampled within pipelines, and soil was sampled beneath pipelines and at pipeline discharge points, which included a discharge line from the former LOOW WWTP to the Niagara River referred to as the 30-inch line (USACE 2009f).

To explore the possibility for radiological contaminant migration off the NFSS via pipelines, some of the LOOW UURI samples were split to allow for radiological analysis. Radiological results from these split samples were not included in the 2007 RIR or BRA. Radiological results from waste water and pipeline sediment collected as split samples during the LOOW UURI were screened against applicable background criteria to determine if they might be considered SRCs.

10.1.1 Purpose and Objective

During the NFSS RI, samples were collected within and around underground utility lines, which had been installed to support the LOOW's TNT manufacturing effort. This investigation indicated that radiological contamination exists within pipeline sediment and waste water in the sanitary sewer and acid waste pipelines on the NFSS. Since radiological-contaminated sediment exists within pipelines on the NFSS property, and the pipelines could act as a preferential pathway for contaminants to move off-site (i.e., north toward the former LOOW WWTP), pipelines on the northern boundary of the NFSS were grouted in 2006 to prevent future migration off-site.

To investigate the possibility that radiological contaminants have migrated to the north of the NFSS via pipelines, split soil, sediment, and waste water samples collected during the LOOW UURI were analyzed for radiological constituents. During the LOOW UURI, soil samples were collected within or adjacent to pipelines, and sediment and waste water samples were collected within pipelines running off the NFSS property onto the LOOW. A review of radiological results from split samples collected during the former LOOW UURI is presented as part of this RIR Addendum. This evaluation also includes screening of results using applicable background criteria to identify possible SRCs and ROCs.

10.2 NFSS RI GENERAL CONCLUSIONS FOR PIPELINE MEDIA

A variety of pipelines are present at the NFSS; however, based on process knowledge, the most heavily contaminated lines are the acid waste and sanitary lines (USACE 2007a). These lines carried operational waste water, making it likely that they would be the most heavily contaminated. Fire suppression, drinking, process and cooling water pipelines were pressurized and carried clean water. These lines were left intact and are believed to be clean. Flow in the acid waste and sanitary lines was based on gravity, so

the lines slope and get deeper as they approach the WWTP north of the NFSS. The NFSS RI sampling focused on the acid waste and sanitary lines because these lines are believed to be the subsurface utilities with the greatest potential for impact. Also, the distribution of manholes along these lines provided adequate spacing and sampling distribution along the lines.

During the RI, compounds were compared to background levels as part of the SRC identification process. Radiological SRCs identified for pipeline media that exceed residential PRGs were designated as ROPCs. ROPCs that exceed target risk levels (1×10^{-4} increased excess cancer risk and 25 mrem/year) were labeled as ROCs. The RI identified radiological SRCs in pipeline waste water and sediment in several EUs. However, no ROPCs or ROCs were identified in pipeline waste water. Radiological ROPCs identified in pipeline soil and sediment include:

- Cesium-137;
- Potassium-40;
- Radium-226 and radium-228;
- Strontium-90;
- Thorium-228, thorium-230 and thorium-232; and
- Uranium-234, uranium-235 and uranium-238.

During the BRA, reasonable maximum exposure (RME) risks for a construction worker associated with pipeline soil and sediment ROPCs were estimated to be below target risk levels. Therefore, no ROCs were identified for pipeline soil, sediment or waste water at the NFSS.

10.3 SUPPLEMENTAL PIPELINE SAMPLING

Between August and October of 2006, the Corps conducted sampling at the former LOOW to confirm the presence or absence of radiological contamination in soil, sediment, and waste water within or adjacent to underground lines extending off the NFSS. At the NFSS, underground lines range from 2 to 17 ft bgs with the deepest lines being acid waste and sanitary sewer lines as they approach the LOOW WWTP, as well as some of the lines traversing between structures at the WWTP. These locations were targeted for radiological analysis because these lines are most likely to contain radiological contamination. Radiological sampling included sealed pipelines that extend off the NFSS to the north and a 30-inch outfall line that extends from the former LOOW WWTP to the Niagara River.

A total of 60 split samples (27 soil samples, 15 sediment samples, 17 waste water samples, and 1 surface water sample) were collected from within or adjacent to underground utility lines on the former LOOW site. These samples were analyzed for radiological constituents, including, but not limited to, isotopic uranium, isotopic thorium, radium-226, and radium-228 (USACE 2007d). The location of radiological split samples collected during the UURI for soil, sediment and waste water are shown on Figures 10-1, 10-2 and 10-3, respectively. This sampling included the 30-inch outfall line that runs from the former LOOW WWTP across several properties to an outfall on the Niagara River. A total of 12 additional soil samples were collected for waste disposal and quality assurance purposes. In addition to the pipeline media samples, co-located surface water, sediment, surface soil and subsurface soil samples were collected where the 30-inch outfall line traverses the Southwest Drainage Ditch on the Lewiston-Porter Central School District property. Sediment samples were also collected from sumps within the former LOOW WWTP, including the chlorination tank and Imhoff tank.

10.4 RADIOLOGICAL SRCS ASSOCIATED WITH OFFSITE PIPELINES

The results from radiological analysis of pipeline soil, sediment and waste water were compared to background levels to determine whether radiological SRCs are present in these media. Soil, sediment and waste water samples were compared to the NFSS background levels for subsurface soil, surface soil, and groundwater, respectively. Radionuclides were compared to background levels as part of the SRC identification process. SRCs that exceed preliminary remedial goals were identified as ROPCs. Consistent with the RI, if no background UTL was established for an analyte within a medium, all detected values were identified as an occurrence of an SRC. This comparison for pipeline soil, sediment and waste water is presented in Table 10-1.

The disintegration of radioactive nuclei over time, or the rate of decay, is described as the half-life. The half-life of a radionuclide is the time needed for half of the nuclei present to decay. After ten half-lives, the activity of a given source drops to approximately a thousandth of its original value and the environmental hazard posed by radiation is considerably less. As a general rule, residual radioactivity after ten half-lives is considered to be minimal (WSDEC 2002). The radiological analysis for pipeline media included results for several relatively short-lived radionuclides and is listed below.

Radionuclide	Half-Life (BNL 2000)
Actinium-228	6.15 hours
Bismuth-214	19.9 minutes
Lead-212	10.64 hours
Lead-214	26.8 minutes
Protactinium-234m	1.17 minutes
Thallium-208	3.05 minutes
Thorium-234	24.1 days

These short-lived radionuclides are not considered SRCs because the doses associated with these short-lived radionuclides are accounted for with the longer-lived radionuclides. That is, the dose conversion factor for uranium-238 includes the contribution of protactinium-234m, protectinium-234, and thorium-234.

The short-lived radionuclides listed above were not part of the analytical suite used for the NFSS RI. Two different laboratories were used for the UURI and the NFSS RI. The laboratory used for the UURI reported these short-lived radionuclides, but the laboratory used for the NFSS RI did not report them.

10.4.1 Pipeline Soil SRCs

Soil sample locations with and without SRCs are presented in Figure 10-1. Soil samples for radiological analysis were collected at 27 locations, adjacent to or beneath pipelines. Both surface and subsurface soil samples were collected where the 30-inch line traverses the Southwest Drainage Ditch. Uranium-234, uranium-235 and uranium-238 were identified as SRCs at two of the 27 soil sampling locations. These two locations include the 30-inch line just west of the former LOOW WWTP (Location No. 2 on Figure 10-1) and the 30-inch line where it traverses the Southwest Drainage Ditch (Location No. 6 on Figure 10-1). Uranium-235 was identified as a radiological SRC in a soil sample collected along a sanitary line south of "M" Street. However, given that uranium-235 occurs naturally at an activity level of 4.44% of that for uranium-238 or 4.43% of that for U-234, this uranium-235 result may be a matter of variation due to analytical counting statistics and may not represent a true value. An SRC summary for pipeline soil is presented in Table 10-2.

10.4.2 Pipeline Sediment SRCs

Sediment sample locations with and without SRCs are presented in Figure 10-2. Sediment samples for radiological analysis were collected at 14 locations within pipelines, from sumps at the former LOOW WWTP, and at one location where the 30-inch line traverses the Southwest Drainage Ditch. Radiological SRCs and ROPCs were identified at 13 locations and include:

- Cesium-137;
- Lead-210;
- Radium-226;
- Radium-228;
- Thorium-230;
- Uranium-234;
- Uranium-235; and
- Uranium-238.

Some of the highest concentrations of radiological SRCs detected in sediment were collected from sumps at the former LOOW WWTP. Lead-210 was the only SRC identified for sediment collected where the 30-inch line traverses the Southwest Drainage Ditch (Location No. 1 on Figure 10-2). Lead-210 was identified as an SRC because no background level or PRG is available for this isotope. Although lead-210 in sediment collected where the 30-inch line traverses the Southwest Drainage Ditch (0.61 pCi/g) has conservatively been identified as an SRC, lead-210 can be assumed to be in secular equilibrium with radium-226 in unimpacted soil. If the radium-226 background screening criteria (2.43 pCi/g) were used for comparative purposes, the lead-210 detection (0.61 pCi/g) would not have been identified as an SRC because it is less than background. An SRC summary for pipeline sediment is presented in Table 10-3.

10.4.3 Pipeline Waste Water/Surface Water SRCs

Waste water sample locations with and without SRCs are presented in Figure 10-3. Pipeline waste water samples for radiological analysis were collected at 17 pipeline or WWTP locations. One surface water sample was also collected from the Southwest Drainage Ditch where it traverses the 30-inch line. Radiological SRCs were identified in pipeline waste water at five locations on CWM property. These waste water samples were collected from the sanitary line that leaves the NFSS north of EU 2 and from the acid waste lines that leave the NFSS north of EU 3. Radiological SRCs identified in waste water include uranium-234, uranium-235 and uranium-238. An SRC summary for pipeline waste water is presented in Table 10-4.

10.5 OFFSITE TRANSPORT OF RADIOLOGICAL CONTAMINATION VIA PIPELINES

Transport of radiological contaminants from the NFSS via pipelines is limited by the fact that few lines cross the NFSS boundary. Lines extending off the NFSS include four sanitary lines (one on the north side, one on the south side, and two on the east side) and two acid waste lines on the north side. Since the LOOW sanitary waste water system relied on gravity flow, sanitary pipelines located on the south and east sides of the NFSS were sloped to flow onto NFSS property toward the WWTP located along the northwest boundary of the NFSS. Therefore, these lines are not likely to be pathways for off-site contaminant flow.

Acid waste and sanitary sewer lines on CWM property just north of “M” Street were sealed in 1978 in response to consent orders issued by NYSDEC (Rhodes 2009). The sanitary sewer and acid waste lines extending north from the NFSS to CWM were sealed by the Corps in 2006 (Rhodes 2009). Since these

lines were sealed around the same time that samples were collected for radiological analysis, the impact of this action may not be evident in the radiological sample results reported here.

Another important observation for off-site contaminant transport via pipelines is that no porous bedding material (e.g., sand or gravel) was observed around pipelines leaving the NFSS. Porous bedding material would enhance the likelihood that pipelines would act as preferential pathways for contaminant migration. During pipeline construction, pipeline trenches were most often backfilled with native material (USACE 2009f). In some cases, pipelines were encased in concrete bedding material. The sanitary sewer line extending north from the NFSS is described as a 30 inch diameter pipe encased in concrete and located 10 to 12 ft bgs. The acid waste line extending north from the NFSS is described as a 36 inch diameter pipe encased in concrete and located 9 to 10 ft bgs. Since water levels in the upper-water-bearing zone fluctuate seasonally between 2 and 10 ft bgs, and the depths of the acid waste and sanitary sewer lines leaving the NFSS range from approximately 9 to 12 ft bgs, there is a potential for the line to be exposed to groundwater more than just seasonally. Thus, the threat of contaminant transport via pipelines/bedding material is legitimate. However, since both of these lines are encased in concrete, this threat is greatly reduced.

10.6 SUMMARY

Radiological SRCs were identified in three out of 27 soil sample locations. The SRCs identified include uranium-234, uranium-235, and uranium-238. At two soil sample locations with radiological SRCs, the same radionuclides were identified as SRCs in sediments. Given the age and generally poor repair of the underground utility system at the LOOW, media mixing could be occurring that would account for this observation.

A total of eight radiological SRCs were identified in sediments with SRCs identified at 13 of the 15 sediment sample locations. Some of the highest concentrations of radiological SRCs detected in sediment were collected from sumps within the former LOOW WWTP. Although operation of the LOOW WWTP ceased in the mid-1970s, residual radiological contamination appears to be present in pipeline and sump sediments.

Radiological SRCs were identified in five out of 18 waste water sample locations and the SRCs identified (uranium-234, uranium-235 and uranium-238) were the same as those identified in pipeline soil. Since these lines were sealed around the same time that samples were collected for radiological analysis, the impact of sealing pipelines may not be evident in the radiological sample results reported here. During the UURI, it was noted that trends in constituent concentration were not discernable in many of the pipelines. This appears to occur for the acid waste and sanitary lines leaving the NFSS and can be attributed to the fact that several lines, including the former LOOW acid waste, sanitary sewer, and water lines, were previously sealed to prevent open conveyance for contaminant migration. Since only low concentrations of the radiological SRCs were detected in waste water samples, and the pipelines were subsequently sealed, the detected SRCs pose little risk.

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SECTION 10

FIGURES

SRC - Site Related Constituent
WWTP - Waste Water Treatment Plant

Legend

- Roads
- EU Boundary
- Utility Lines
- Outfall 30 Inch Line
- Acid
- Buildings NY
- Sanitary

UURI Soils

- Locations with SRCs
- Locations without SRCs

0 200 400 600 Feet

N

US Army Corps of Engineers
Buffalo District

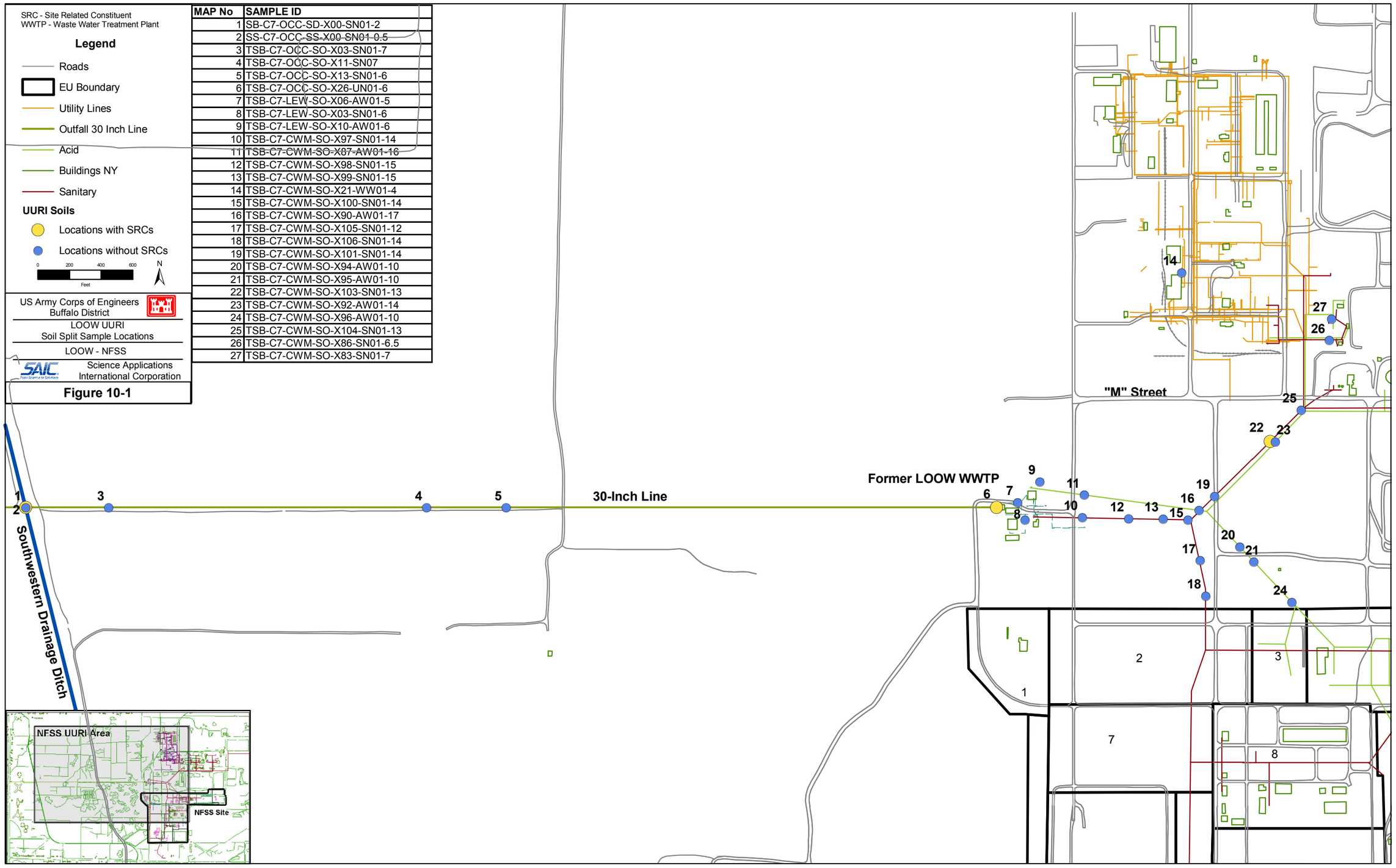
LOOW UURI
Soil Split Sample Locations

LOOW - NFSS

Science Applications
International Corporation

Figure 10-1

MAP No	SAMPLE ID
1	SB-C7-OCC-SD-X00-SN01-2
2	SS-C7-OCC-SS-X00-SN01-0.5
3	TSB-C7-OCC-SO-X03-SN01-7
4	TSB-C7-OCC-SO-X11-SN07
5	TSB-C7-OCC-SO-X13-SN01-6
6	TSB-C7-OCC-SO-X26-UN01-6
7	TSB-C7-LEW-SO-X06-AW01-5
8	TSB-C7-LEW-SO-X03-SN01-6
9	TSB-C7-LEW-SO-X10-AW01-6
10	TSB-C7-CWM-SO-X97-SN01-14
11	TSB-C7-CWM-SO-X87-AW01-16
12	TSB-C7-CWM-SO-X98-SN01-15
13	TSB-C7-CWM-SO-X99-SN01-15
14	TSB-C7-CWM-SO-X21-WW01-4
15	TSB-C7-CWM-SO-X100-SN01-14
16	TSB-C7-CWM-SO-X90-AW01-17
17	TSB-C7-CWM-SO-X105-SN01-12
18	TSB-C7-CWM-SO-X106-SN01-14
19	TSB-C7-CWM-SO-X101-SN01-14
20	TSB-C7-CWM-SO-X94-AW01-10
21	TSB-C7-CWM-SO-X95-AW01-10
22	TSB-C7-CWM-SO-X103-SN01-13
23	TSB-C7-CWM-SO-X92-AW01-14
24	TSB-C7-CWM-SO-X96-AW01-10
25	TSB-C7-CWM-SO-X104-SN01-13
26	TSB-C7-CWM-SO-X86-SN01-6.5
27	TSB-C7-CWM-SO-X83-SN01-7



SRC - Site Related Constituent
WWTP - Waste Water Treatment Plant

Legend

- Roads
- EU Boundary
- Utility Lines
- Outfall 30-Inch Line
- Acid
- Buildings NY
- Sanitary

UURI Sediment

- Locations with SRCs
- Locations without SRCs

0 200 400 600 Feet

N

US Army Corps of Engineers
Buffalo District

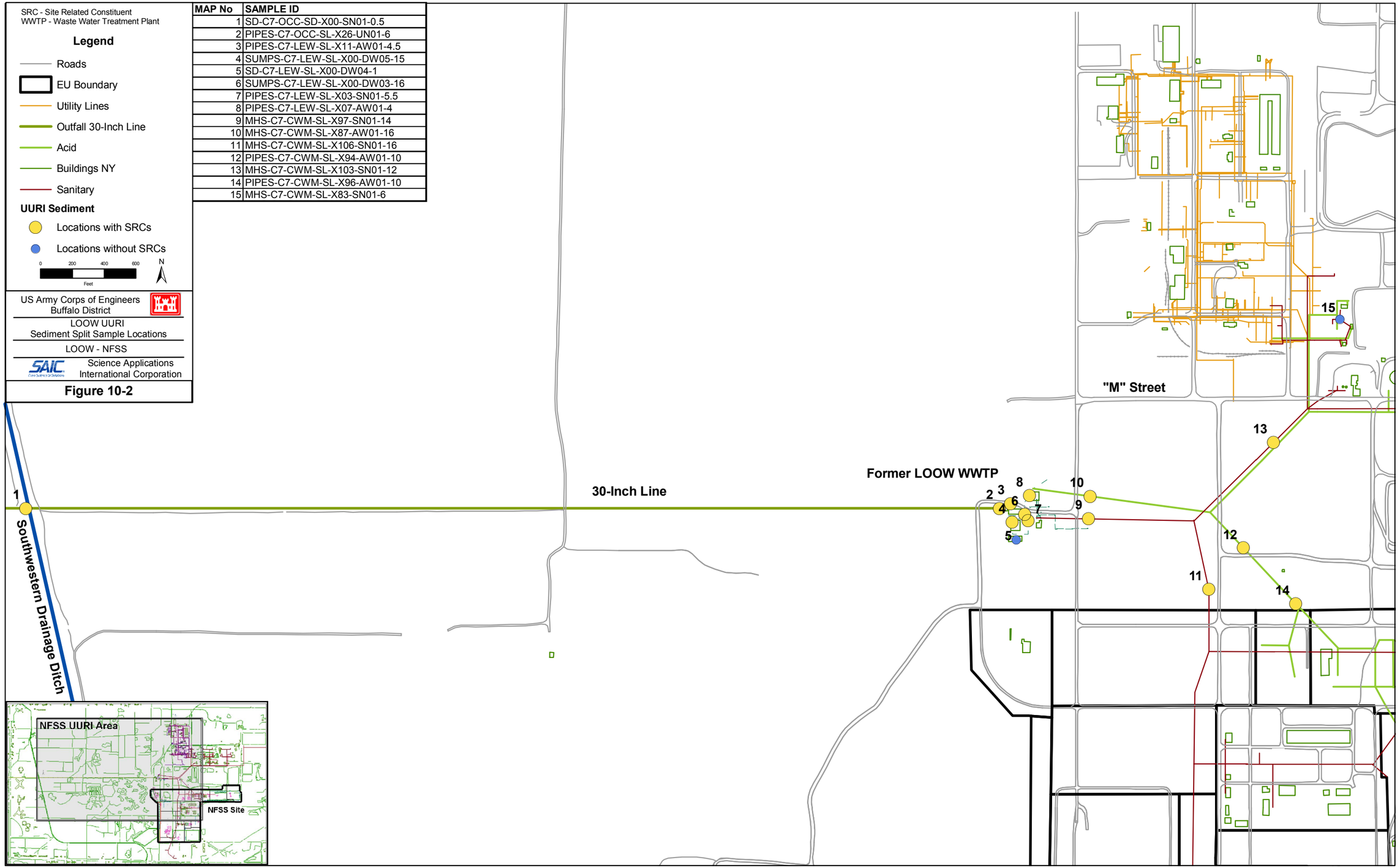
LOOW UURI
Sediment Split Sample Locations

LOOW - NFSS

SAIC Science Applications International Corporation

Figure 10-2

MAP No	SAMPLE ID
1	SD-C7-OCC-SD-X00-SN01-0.5
2	PIPES-C7-OCC-SL-X26-UN01-6
3	PIPES-C7-LEW-SL-X11-AW01-4.5
4	SUMPS-C7-LEW-SL-X00-DW05-15
5	SD-C7-LEW-SL-X00-DW04-1
6	SUMPS-C7-LEW-SL-X00-DW03-16
7	PIPES-C7-LEW-SL-X03-SN01-5.5
8	PIPES-C7-LEW-SL-X07-AW01-4
9	MHS-C7-CWM-SL-X97-SN01-14
10	MHS-C7-CWM-SL-X87-AW01-16
11	MHS-C7-CWM-SL-X106-SN01-16
12	PIPES-C7-CWM-SL-X94-AW01-10
13	MHS-C7-CWM-SL-X103-SN01-12
14	PIPES-C7-CWM-SL-X96-AW01-10
15	MHS-C7-CWM-SL-X83-SN01-6



SRC - Site Related Constituent
WWTP - Waste Water Treatment Plant

Legend

- Roads
- EU boundary
- Utility Lines
- Outfall 30-Inch Line
- Acid
- Buildings NY
- Sanitary

UURI Waste Water

- Locations with SRCs
- Locations without SRCs

0 200 400 600 Feet

N

US Army Corps of Engineers
Buffalo District

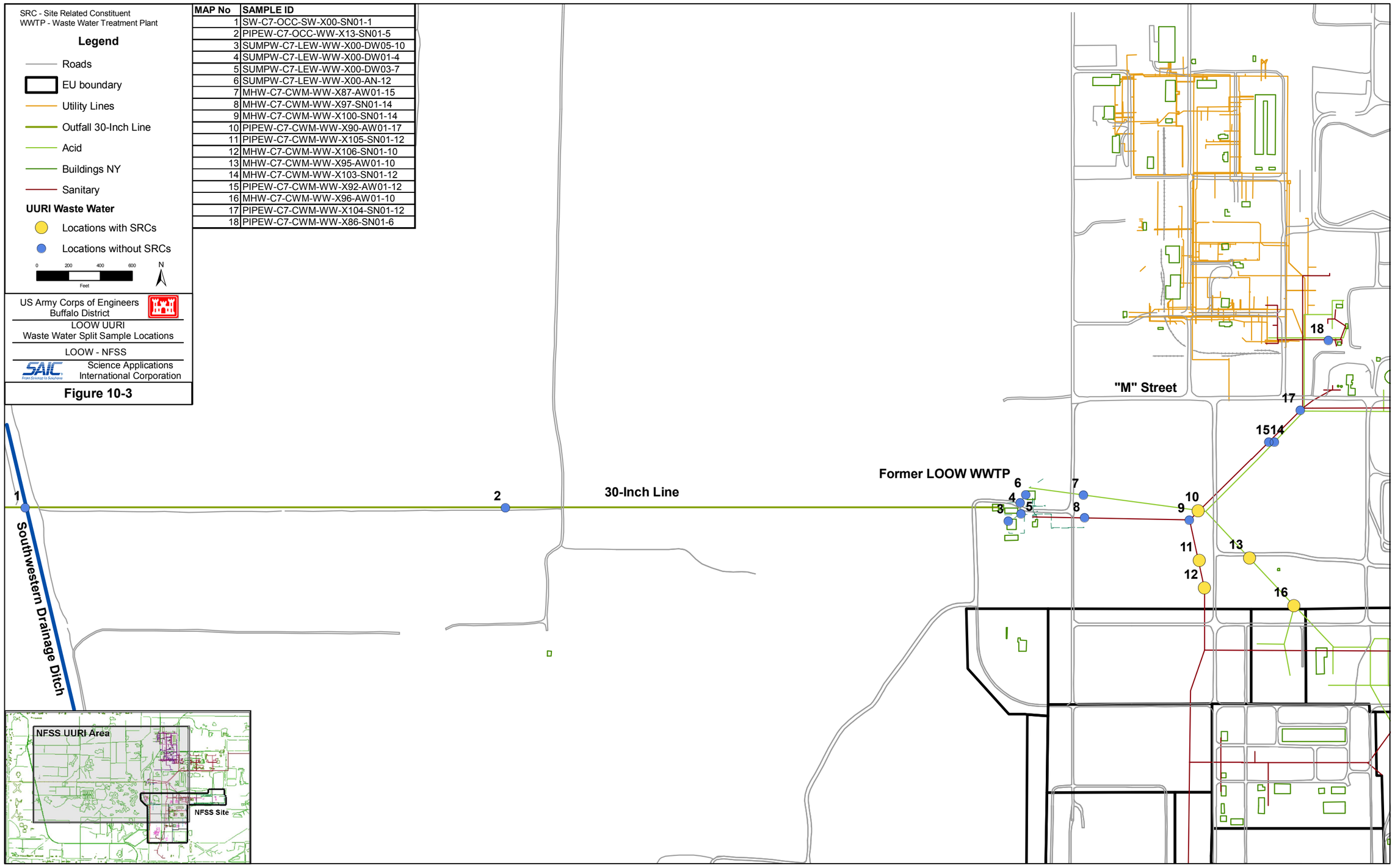
LOOW UURI
Waste Water Split Sample Locations

LOOW - NFSS

Science Applications
International Corporation

Figure 10-3

MAP No	SAMPLE ID
1	SW-C7-OCC-SW-X00-SN01-1
2	PIPEW-C7-OCC-WW-X13-SN01-5
3	SUMPW-C7-LEW-WW-X00-DW05-10
4	SUMPW-C7-LEW-WW-X00-DW01-4
5	SUMPW-C7-LEW-WW-X00-DW03-7
6	SUMPW-C7-LEW-WW-X00-AN-12
7	MHW-C7-CWM-WW-X87-AW01-15
8	MHW-C7-CWM-WW-X97-SN01-14
9	MHW-C7-CWM-WW-X100-SN01-14
10	PIPEW-C7-CWM-WW-X90-AW01-17
11	PIPEW-C7-CWM-WW-X105-SN01-12
12	MHW-C7-CWM-WW-X106-SN01-10
13	MHW-C7-CWM-WW-X95-AW01-10
14	MHW-C7-CWM-WW-X103-SN01-12
15	PIPEW-C7-CWM-WW-X92-AW01-12
16	MHW-C7-CWM-WW-X96-AW01-10
17	PIPEW-C7-CWM-WW-X104-SN01-12
18	PIPEW-C7-CWM-WW-X86-SN01-6



SECTION 10

TABLES

Table 10-1. Site-Related Constituents (SRCs) and Radionuclides of Potential Concern (ROPCs) in Off-site Pipeline Soil, Sediment and Waste Water North of the Niagara Falls Storage Site

Parameter	Unit	Detects	Minimum Detect	Min Qual	Maximum Detect	Max Qual	Background	Background Exceedance	SRC	PRG	PRG Exceedence	ROPC
Pipeline Soil												
Actinium 228	pCi/g	21/21	0.48		1.16		No UTL	21/21	No:1	--	--	--
Bismuth 212	pCi/g	6/6	0.43		1.1		No UTL	6/6	No:1	--	--	--
Bismuth 214	pCi/g	20/20	0.39		3.94		No UTL	20/20	No:1	--	--	--
Cesium 137	pCi/g	1/1	0.172		0.172		0.343	0/1	No	--	--	--
Lead 212	pCi/g	27/27	0.368		1.17		No UTL	27/27	No:1	--	--	--
Lead 214	pCi/g	28/28	0.496		3.86		No UTL	28/28	No:1	--	--	--
Potassium 40	pCi/g	27/27	9.8		26.6		32.900	0/27	No	--	--	--
Radium 226	pCi/g	27/27	0.39	J	3.94		1.200	1/27	No:0	--	--	--
Radium 228	pCi/g	26/27	0.48	J	1.2		1.260	0/27	No	--	--	--
Thallium 208	pCi/g	26/26	0.121		0.45		No UTL	26/26	No:1	--	--	--
Thorium 228	pCi/g	27/27	0.45	J	1.08		1.640	0/27	No	--	--	--
Thorium 230	pCi/g	27/27	0.45	J	1.18		1.390	0/27	No	--	--	--
Thorium 232	pCi/g	27/27	0.4	J	1.11		1.240	0/27	No	--	--	--
Thorium 234	pCi/g	2/3	1.86		3.19		No UTL	2/3	No:1	--	--	--
Uranium 234	pCi/g	27/27	0.362	J	2.94		1.660	12/27	Yes	0.545	22/27	Yes
Uranium 235	pCi/g	21/27	0.02	J	0.161	J	0.085	2/27	Yes	0.080	3/27	Yes
Uranium 238	pCi/g	27/27	0.363	J	2.65		1.340	1/27	Yes	0.304	27/27	Yes
Pipeline Sediment												
Actinium 228	pCi/g	11/11	0.327		1.73		No UTL	11/11	No:1	--	--	--
Bismuth 214	pCi/g	14/14	0.33		3.85		No UTL	14/14	No:1	--	--	--
Cesium 137	pCi/g	8/8	0.107		1.2		0.34	3/8	Yes	0.0224	8/8	Yes
Lead 210	pCi/g	9/9	0.61		8.1		No UTL	9/9	Yes	No PRG	9/9	Yes
Lead 212	pCi/g	15/15	0.372		1.86		No UTL	15/15	No:1	--	--	--
Lead 214	pCi/g	15/15	0.345		5		No UTL	15/15	No:1	--	--	--
Potassium 40	pCi/g	15/15	7.8		28.7		31.1	0/15	No	--	--	--
Protactinium 234M	pCi/g	2/2	14.9		38		No UTL	2/2	No:1	--	--	--
Radium 226	pCi/g	15/15	0.33	J	5		0.92	8/15	Yes	0.0031	15/15	Yes
Radium 228	pCi/g	14/15	0.327	J	2.49		1.26	2/15	Yes	0.0073	15/15	Yes
Thallium 208	pCi/g	15/15	0.15		0.5		No UTL	15/15	No:1	--	--	--
Thorium 228	pCi/g	15/15	0.196	J	1.61		1.64	0/15	No	--	--	--
Thorium 230	pCi/g	15/15	0.246	J	2.69		1.6	4/15	Yes	0.0068	15/15	Yes
Thorium 232	pCi/g	15/15	0.192	J	1.24		1.24	1/15	No	--	--	--

Table 10-1. Site-Related Constituents (SRCs) and Radionuclides of Potential Concern (ROPCs) in Off-site Pipeline Soil, Sediment and Waste Water North of the Niagara Falls Storage Site

Parameter	Unit	Detects	Minimum Detect	Min Qual	Maximum Detect	Max Qual	Background	Background Exceedance	SRC	PRG	PRG Exceedence	ROPC
Thorium 234	pCi/g	11/11	0.78		30.2		No UTL	11/11	No:1	--	--	--
Uranium 234	pCi/g	15/15	0.52		30		1.68	11/15	Yes	0.5447	14/15	Yes
Uranium 235	pCi/g	17/17	0.026	J	1.56		0.08	14/17	Yes	0.0798	14/17	Yes
Uranium 238	pCi/g	15/15	0.44	J	29.4		1.36	11/15	Yes	0.3043	15/15	Yes
Pipeline Waste Water												
Radium 226	pCi/L	8/18	0.21	J	0.49	J	1.76	0/18	No	--	--	--
Radium 228	pCi/L	1/18	1.1		1.1		1.67	0/18	No	--	--	--
Thorium 228	pCi/L	5/18	0.166	J	0.29	J	0.25	1/18	No:0	--	--	--
Thorium 230	pCi/L	5/18	0.29	J	0.51	J	0.88	0/18	No	--	--	--
Thorium 232	pCi/L	5/18	0.126	J	0.24	J	0.23	1/18	No:0	--	--	--
Uranium 234	pCi/L	16/18	0.125	J	17.3		8.73	4/18	Yes	0.6722	12/18	Yes
Uranium 235	pCi/L	10/18	0.075	J	0.87		0.72	2/18	Yes	0.6619	2/18	Yes
Uranium 238	pCi/L	18/18	0.101	J	17	J	5.79	5/18	Yes	0.5456	13/18	Yes

No - Does not exceed background or Preliminary Remedial Goal (PRG).

No:0 - Not identified as a SRC or ROPC due to <5% frequency of detection.

No:1 - Not identified as a SRC or ROPC due to the isotope's short half-life

Table 10-2. SRC Summary for Pipeline Soil
Niagara Falls Storage Site

Parameter	Background Screening Value	Soil Samples That Exceed Background Screening Value	Map Number	Sample Location	Concentration (pCi/g)
Uranium-234	1.66	SS-C7-OCC-SS-X00-SN01-0.5	2	Southwest Drainage Ditch	2.42
		TSB-C7-OCC-SO-X26-UN01-6	6	30-inch Outfall (OCC-X26)	2.94
Uranium-235	0.085	SS-C7-OCC-SS-X00-SN01-0.5	2	Southwest Drainage Ditch	0.135
		TSB-C7-CWM-SO-X103-SN01-13	22	Area South of "M" Street (CWM-X103)	0.091
		TSB-C7-OCC-SO-X26-UN01-6	6	30-inch Outfall (OCC-X26)	0.161
Uranium-238	1.34	SS-C7-OCC-SS-X00-SN01-0.5	2	Southwest Drainage Ditch	2.56
		TSB-C7-OCC-SO-X26-UN01-6	6	30-inch Outfall (OCC-X26)	2.65

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Table 10-3. SRC Summary for Pipeline Sediment
Niagara Falls Storage Site

Parameter	Background Screening Value	Sediment Samples That Exceed Background Screening Value	Map Number	Sample Location	Concentration (pCi/g)
Cesium-137	0.34	PIPES-C7-LEW-SL-X07-AW01-4	9	Former LOOW WWTP (LEW-X07)	0.57
		SUMPS-C7-LEW-SL-X00-DW05-15	4	Former LOOW WW TP (Imhoff Tank)	1.2
		MHS-C7-CWM-SL-X87-AW01-16	10	Area South of "M" Street (CWM-X87)	0.343
Lead-210 *	No bkgd.	SD-C7-OCC-SD-X00-SN01-0.5	1	Southwest Drainage Ditch	0.61
		PIPES-C7-LEW-SL-X03-SN01-5.5	7	Former LOOW WWTP (LEW-X03)	3.7
		SUMPS-C7-LEW-SL-X00-DW03-16	6	Former LOOW WWTP (Chlorination Tank)	2.22
		SUMPS-C7-LEW-SL-X00-DW05-15	4	Former LOOW WWTP (Imhoff Tank)	4.8
		MHS-C7-CWM-SL-X97-SN01-14	9	Area South of "M" Street (CWM-X97)	2.5
		PIPES-C7-CWM-SL-X94-AW01-10	12	Area South of "M" Street (CWM-X94)	2.13
		MHS-C7-CWM-SL-X103-SN01-12	13	Area South of "M" Street (CWM-X103)	8.1
		MHS-C7-CWM-SL-X106-SN01-16	11	Area South of "M" Street (CWM-X106)	3.29
		MHS-C7-CWM-SL-X87-AW01-16	10	Area South of "M" Street (CWM-X87)	2.19
Radium-226	0.92	PIPES-C7-LEW-SL-X03-SN01-5.5	7	Former LOOW WWTP (LEW-X03)	1.33
		PIPES-C7-LEW-SL-X07-AW01-4	9	Former LOOW WWTP (LEW-X07)	5
		PIPES-C7-LEW-SL-X11-AW01-4.5	3	Former LOOW WWTP (LEW-X11)	1.51
		SUMPS-C7-LEW-SL-X00-DW03-16	6	Former LOOW WWTP (Chlorination Tank)	1.67
		SUMPS-C7-LEW-SL-X00-DW05-15	4	Former LOOW WWTP (Imhoff Tank)	1.8
		MHS-C7-CWM-SL-X97-SN01-14	9	Area South of "M" Street (CWM-X97)	1.12
		PIPES-C7-CWM-SL-X94-AW01-10	12	Area South of "M" Street (CWM-X94)	1.09
		MHS-C7-CWM-SL-X106-SN01-16	11	Area South of "M" Street (CWM-X106)	0.99
Radium-228	1.26	PIPES-C7-LEW-SL-X07-AW01-4	9	Former LOOW WWTP (LEW-X07)	2.49
		PIPES-C7-LEW-SL-X11-AW01-4.5	3	Former LOOW WWTP (LEW-X11)	1.73
Thorium-230	1.6	PIPES-C7-LEW-SL-X07-AW01-4	9	Former LOOW WWTP (LEW-X07)	1.82
		PIPES-C7-LEW-SL-X11-AW01-4.5	3	Former LOOW WWTP (LEW-X11)	1.61
		SUMPS-C7-LEW-SL-X00-DW03-16	6	Former LOOW WWTP (Chlorination Tank)	2.38
		SUMPS-C7-LEW-SL-X00-DW05-15	4	Former LOOW WWTP (Imhoff Tank)	2.69
Uranium-234	1.68	PIPES-C7-OCC-SL-X26-UN01-6	2	30-inch Outfall (OCC-X26)	4.65
		PIPES-C7-LEW-SL-X07-AW01-4	9	Former LOOW WWTP (LEW-X07)	2.13
		PIPES-C7-LEW-SL-X11-AW01-4.5	3	Former LOOW WWTP (LEW-X11)	5.74
		SUMPS-C7-LEW-SL-X00-DW03-16	6	Former LOOW WWTP (Chlorination Tank)	13
		SUMPS-C7-LEW-SL-X00-DW05-15	4	Former LOOW WWTP (Imhoff Tank)	30

Table 10-3. SRC Summary for Pipeline Sediment
Niagara Falls Storage Site

Parameter	Background Screening Value	Sediment Samples That Exceed Background Screening Value	Map Number	Sample Location	Concentration (pCi/g)
Uranium-234 (cont.)	1.68	MHS-C7-CWM-SL-X97-SN01-14	9	Area South of "M" Street (CWM-X97)	9.6
		PIPES-C7-CWM-SL-X94-AW01-10	12	Area South of "M" Street (CWM-X94)	6.62
		PIPES-C7-CWM-SL-X96-AW01-10	14	Area South of "M" Street (CWM-X96)	5.02
		MHS-C7-CWM-SL-X103-SN01-12	13	Area South of "M" Street (CWM-X103)	3.43
		MHS-C7-CWM-SL-X106-SN01-16	11	Area South of "M" Street (CWM-X106)	12.9
		MHS-C7-CWM-SL-X87-AW01-16	10	Area South of "M" Street (CWM-X87)	3.36
Uranium-235	0.08	PIPES-C7-OCC-SL-X26-UN01-6	2	30-inch Outfall (OCC-X26)	0.258
		PIPES-C7-LEW-SL-X03-SN01-5.5	7	Former LOOW WWTP (LEW-X03)	0.108
		PIPES-C7-LEW-SL-X07-AW01-4	8	Former LOOW WWTP (LEW-X07)	0.114
		PIPES-C7-LEW-SL-X11-AW01-4.5	3	Former LOOW WWTP(LEW-X11)	0.289
		SUMPS-C7-LEW-SL-X00-DW03-16	6	Former LOOW WWTP (Chlorination Tank)	0.63
		SUMPS-C7-LEW-SL-X00-DW05-15	4	Former LOOW WWTP (Imhoff Tank)	1.56
		MHS-C7-CWM-SL-X97-SN01-14	9	Area South of "M" Street (CWM-X97)	0.38
		PIPES-C7-CWM-SL-X94-AW01-10	12	Area South of "M" Street (CWM-X94)	0.44
		PIPES-C7-CWM-SL-X96-AW01-10	14	Area South of "M" Street (CWM-X96)	0.225
		MHS-C7-CWM-SL-X103-SN01-12	13	Area South of "M" Street (CWM-X103)	0.121
		MHS-C7-CWM-SL-X106-SN01-16		Area South of "M" Street (CWM-X106)	0.73
		MHS-C7-CWM-SL-X106-SN01-16		Area South of "M" Street (CWM-X106)	0.65
		MHS-C7-CWM-SL-X87-AW01-16	10	Area South of "M" Street (CWM-X87)	0.135
Uranium-238	1.36	PIPES-C7-OCC-SL-X26-UN01-6	2	30-inch Outfall (OCC-X26)	4.5
		PIPES-C7-LEW-SL-X07-AW01-4	8	Former LOOW WWTP (LEW-X07)	2.14
		PIPES-C7-LEW-SL-X11-AW01-4.5	3	Former LOOW WWTP (LEW-X11)	4.98
		SUMPS-C7-LEW-SL-X00-DW03-16	6	Former LOOW WWTP (Chlorination Tank)	13
		SUMPS-C7-LEW-SL-X00-DW05-15	4	Former LOOW WWTP (Imhoff Tank)	29.4
		MHS-C7-CWM-SL-X97-SN01-14	9	Area South of "M" Street (CWM-X97)	8.9
		PIPES-C7-CWM-SL-X94-AW01-10	12	Area South of "M" Street (CWM-X94)	6.87
		PIPES-C7-CWM-SL-X96-AW01-10	14	Area South of "M" Street (CWM-X96)	4.92
		MHS-C7-CWM-SL-X103-SN01-12	13	Area South of "M" Street (CWM-X103)	2.78
		MHS-C7-CWM-SL-X106-SN01-16	11	Area South of "M" Street (CWM-X106)	11.4
		MHS-C7-CWM-SL-X87-AW01-16	10	Area South of "M" Street (CWM-X87)	3.25

WWTP – Waste Water treatment Plant

Lead-210 was the only SRC identified for sediment collected where the 30-inch line traverses the Southwest Drainage Ditch (Location No. 1 on Figure 10-2). Lead-210 was identified as an SRC because no background level or PRG is available for this isotope. Although lead-210 in sediment collected where the 30-inch line traverses the Southwest Drainage Ditch (0.61 pCi/g) has conservatively been identified as an SRC, lead-210 can be assumed to be in secular equilibrium with radium-226 in unimpacted soil. If the radium-226 background screening criteria (2.43 pCi/g) were used for comparative purposes, the 0.61 pCi/g detection of lead-210 would not be used to identify lead-210 as an SRC.

Table 10-4. SRC Summary for Pipeline Waste Water
Niagara Falls Storage Site

Parameter	Background Screening Value	Waste Water Samples That Exceed Background Screening Value	Map Number	Sample Location	Concentration (pCi/L)
Uranium-234	8.73	MHW-C7-CWM-WW-X106-SN01-10	12	Area South of "M" Street (CWM-X106)	9.9
		MHW-C7-CWM-WW-X95-AW01-10	13	Area South of "M" Street (CWM-X95)	17.3
		PIPEW-C7-CWM-WW-X105-SN01-12	11	Area South of "M" Street (CWM-X105)	12.5
		PIPEW-C7-CWM-WW-X90-AW01-17	10	Area South of "M" Street (CWM-X90)	13.2
Uranium-235	0.72	MHW-C7-CWM-WW-X95-AW01-10	13	Area South of "M" Street (CWM-X95)	0.87
		PIPEW-C7-CWM-WW-X90-AW01-17	10	Area South of "M" Street (CWM-X90)	0.77
Uranium-238	5.79	MHW-C7-CWM-WW-X106-SN01-10	12	Area South of "M" Street (CWM-X106)	9
		MHW-C7-CWM-WW-X95-AW01-10	13	Area South of "M" Street (CWM-X95)	17
		MHW-C7-CWM-WW-X96-AW01-10	16	Area South of "M" Street (CWM-X96)	7.6
		PIPEW-C7-CWM-WW-X105-SN01-12	11	Area South of "M" Street (CWM-X105)	11
		PIPEW-C7-CWM-WW-X90-AW01-17	10	Area South of "M" Street (CWM-X90)	12.3

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11.0 RE-EVALUATION OF PLUTONIUM-239/240 IN SOIL

The nature and extent of plutonium in NFSS soils was re-evaluated as part of this RIR Addendum using results from the first three phases of the RI and from RIR Addendum sampling activities. Details of this review are discussed in this section.

11.1 INTRODUCTION

A review of plutonium-239/240 analytical results collected from NFSS soil during the RI and RIR Addendum field activities was conducted to re-evaluate conclusions regarding the nature and extent of plutonium contamination in site soils. As part of this review, plutonium data collected during the first three phases of the RI from 1999 through 2003 have been summarized, including plutonium results for 17 surface soil locations that were inadvertently omitted from the 2007 RIR. Also included in the data summary are plutonium results for soil collected during the RIR Addendum field investigations conducted in 2009. RIR Addendum soil investigation activities included the sampling and analysis of soil collected from additional boring locations, as well as the sampling and analysis of soil IDW generated during the initial phases of the RI. A graphic representation of the plutonium-239/240 sample locations and a discussion regarding how the updated results affect previous conclusions concerning the nature and extent of plutonium contamination at the site are also presented.

The predominant radionuclides expected at the NFSS include radionuclides from the decay series for naturally-occurring uranium, thorium and actinium. Since plutonium is not part of these decay series, the NFSS RI database included limited analysis for isotopic plutonium with sampling focused around areas where KAPL waste was historically stored. Since there was a lot of americium data (via gamma spec analysis) collected across the site, this was used as an indicator of plutonium. After the 2007 RIR was released, it was discovered that plutonium-239/240 results from 17 surface soil samples re-analyzed by the laboratory had inadvertently been omitted from the RIR database. Comments received on the NFSS RI suggest that, even with this missing data, sample coverage for plutonium was sparse. Therefore, additional soil sampling and analysis for plutonium-239/240 was conducted during the RIR Addendum field investigations. During the 2009 RIR Addendum field activities, soil samples were collected from 20 of 23 locations where TWPs were installed. One surface and one subsurface soil sample was collected from 20 TWP locations and analyzed for radiological parameters, including plutonium-239/240 by alpha spectroscopy. Samples were also collected from 50 drums of IDW stored in Building 401. The drums contained soil cuttings from discrete soil boring locations investigated during previous phases of RI field activities. This IDW was analyzed for radiological parameters, including plutonium-239/240.

11.2 TRANSURANICS AT THE NFSS

Although the predominant ROPCs at NFSS include naturally-occurring uranium, thorium and actinium decay series, fission products and plutonium associated with past waste storage activities are also present at low concentrations in isolated areas. Plutonium is not naturally-occurring and is considered to be a transuranic (atomic number of 92 or greater) and a nuclear fuel activation product. The analytical methods used to collect radiological data during the RI are presented in 2007 RIR Tables 2-2 and 2-3. The spectral peaks for plutonium-239 and plutonium-240 are very close and make separate delineation difficult. Therefore, plutonium results are reported together as plutonium-239/240. The QC procedures employed during the RI are documented in Appendix F of the 2007 RIR. Although the RI database included limited sampling for plutonium-239/240, the database contains extensive results for americium-241, which is part of the gamma spectroscopy analysis and a transuranic typically considered to be a nuclear fuel activation product. The results for americium-241 may be indicative of other transuranics

associated with the nuclear industry, including plutonium. Out of a total of 768 americium-241 results in the RI database, only 9 were listed as detected (~1%). The small number of americium-241 detections (9 of 768) is not unexpected because approximately 5% false positives (detected activity when there is actually no activity due to statistical variations) are expected.

The laboratory identification of radionuclides, at low concentrations, typical of environmental media, can easily be mistaken, due to incomplete chemical separation, and coincident or overlapping spectral peaks, resulting in false positive results. A known example of incomplete chemical separation and breakthrough of natural radionuclides and/or daughters of laboratory tracers generating false positives in soils includes natural thorium-228 causing false positives of ameicium-241 and plutonium-238 (Kubilius, et al, 2004). It is also noteworthy that all but 1 of the americium-241 hits were well below 1 pCi/g and also below Nuclear Regulatory Commission's (NRC's) screening level for decommissioning (at 25 mrem/year free release dose limit) of 2.1 pCi/g.

Thus, review of available data indicates that americium-241 is not a COC at the NFSS, and, it is unlikely that other transuranics, such as plutonium-239/240, are present at significant concentrations or are widespread in NFSS soils/sediment.

The most likely source for any plutonium contamination at the NFSS, beyond that associated with fallout from atmospheric testing of nuclear warheads, is waste material from the KAPL. From 1952 to 1954, wastes generated at the KAPL were shipped to the NFSS. Records indicate that contaminated materials from the KAPL may have contained some residual plutonium and fission product radioactivity. The KAPL materials were originally stored near a railroad spur north of the NFSS. Later, the wastes were moved to Buildings 443, 444, 445, 446, 447 and 448 in the Baker-Smith area. Some of the waste was also stored in Building 401; however, the exact storage locations within Building 401 are not known. The KAPL materials were transferred to the Oak Ridge Burial grounds in Oak Ridge, Tennessee, during the late 1950s and most of the storage buildings at the NFSS were later destroyed (EA 1998).

11.3 RI SAMPLING FOR PLUTONIUM-239/240

For the RI, radiological sampling locations were selected to investigate elevated cesium or gamma-walkover survey results, or to investigate locations where records indicate that KAPL materials had been stored. Samples were collected where above background concentrations of radionuclides, including plutonium-239/240, were expected to be found. During the RI, 24 soil samples and four sediment samples were collected from areas with elevated cesium or gamma walkover survey results and analyzed for plutonium-239/240. The location of these samples is shown on Figure 11-1 and a summary of the plutonium-239/240 analytical results that were presented in the RI are repeated in Table 11-1.

There were only two very low detections of plutonium-239/240 in soil out of the 24 samples analyzed during the RI. These detections occurred in EU 8 and EU 11 at concentrations of 0.322 and 0.129 pCi/g, respectively. Based on an examination of the spectral display, analytical results for the EU 8 sample included partial interference from the analyte tracer, but is still believed to include some plutonium-239/240. Further discussion of this uncertainty is provided in the following section. The EU 11 sample was an asphalt sample collected in the vicinity of Trench 812 which exhibited radiological activities above background levels. There were no detections of plutonium-239/240 in the four sediment samples.

To investigate whether previous storage activities of the KAPL waste within Building 401 had resulted in building contamination, samples from the building were analyzed for plutonium-239/240. During Phase 3 of the NFSS RI field investigations, ten core samples were collected from the concrete floor slab inside Building 401. Soil immediately underlying the location of the core samples was also collected along with 11 samples of drain sediment. The Building 401 core, sub-slab soil and drain sediment samples were

collected near former laboratory and loading areas and locations of floor staining where radiological or chemical contamination was most likely to be present. The Building 401 sample locations are shown on Figure 11-2 and a summary of the analytical results for plutonium-239/240 are presented in Table 11-2.

Although the precise location within Building 401 where KAPL materials were stored is not known, the Building 401 core samples and the underlying soils were collected from locations where contamination was most likely to be present based on the building's operational history or physical signs of potential impacts. There were two detections of plutonium-239/240 associated with Building 401. These samples include one building core sample that reportedly contained 5.72 pCi/g plutonium-239/240, and one sub-slab soil sample with 0.536 pCi/g plutonium-239/240. Both of these samples included tracer interference. The floor core (RC-CORE03-3734) included significant interference and is not believed to represent a real plutonium-239/240 detection. The sub-slab soil sample (SB-CORE01-0.5-3731) included partial tracer interference, but is still believed to include some plutonium-239/240. The RI identified plutonium-239/240 as a site-related compound in subsurface soil in EUs 8, 11 and 13, but due to analytical uncertainties and the fairly low concentrations of plutonium-239/240 detected, it was not identified as an ROC in any medium or EU.

11.3.1 Uncertainty

A QA review of the RI plutonium data identified two plutonium-239/240 results (RC-CORE03-3734 and SS827-406), with significant interference from the tracer peak that do not appear to have any counts attributable to plutonium-239/240. One of these samples, a floor core collected in Building 401 (RC-CORE03-3734), represents the highest detection of plutonium-239/240 on site. The other sample (SS827-406) is a surface soil sample collected in EU11. Two other samples (SB-CORE01-0.5-3731 and SB3D001-5.0-3632) appear to have some minor tracer interference, but also have some counts likely due to plutonium-239/240. One of these samples (SB-CORE01-0.5-3731) is a sub-slab soil core collected within Building 401. The other (SD3D001-5.0-3632) is a subsurface soil sample collected in EU8. The spectral display was not sufficient to determine the exact amount of interference for these sample analyses.

11.4 SUPPLEMENTAL RI PLUTONIUM DATA

After completion of the Phase I and Phase II RI sampling activities, results from the indicator compound, americium-241, and the limited direct sampling for plutonium 239/240 showed no indication that fission products were present at elevated levels in site media. Despite this result, the Corps selected 17 RI surface soil samples for re-analysis for plutonium-239/240. A total of 11 of these samples were located in the Baker-Smith Area (EU 1) and two were near Building 401 (EU 13) because these are areas where KAPL materials were reportedly stored. Other sample locations were in the northeast corner of the NFSS (EU 6), in the Shops Area (EU 8), and by the front gate (EU 11). These locations exhibited elevated ratios of total alpha activity to activity of the individual radioisotopes identified by the spectroscopic analysis.

Given the relative high abundance of alpha emissions associated with plutonium-239/240 decay, a large variance in gross alpha results as compared to the isotopic alpha data evaluation could indicate the presence of alpha-emitting radionuclides, including plutonium. This ratio was used to qualitatively select the additional sample locations for plutonium-239/240 re-analysis.

Analytical results for these re-analyzed samples were received from the laboratory later than most other RI results and were inadvertently omitted from the RI database. Out of the 17 surface soil samples re-analyzed for plutonium-239/240, there were three low-level detections. These detections occurred in EU 8, EU 11 and EU 1 at concentrations of 0.212, 0.088, and 0.156 pCi/g, respectively. The location of these

17 surface soil samples is shown on Figure 11-1 and a summary of the plutonium-239/240 results for these samples are presented in Table 11-3.

The plutonium-239/240 detected in surface soils in EU 1 may be attributed to the KAPL wastes that were stored in this area. The other plutonium detections in EU 8 and EU 11 are generally located near on-site roads and may be attributable to materials transport and handling; however, no specific documentation for this could be found. Analytical results for the EU 11 surface soil sample (SS827-406) included significant tracer interference and is not believed to represent a positive plutonium-239/240 result. The EU 8 surface soil sample (SS314-404) included partial tracer interference, but is still believed to include some plutonium-239/240. The spectral display for SS314-404 was not sufficient to determine the exact amount of interference.

11.5 IDW DRUMMED SOIL SAMPLES

During the RIR Addendum field investigations, the Corps decided to collect additional plutonium data from previous RI-related waste materials. Samples were collected from 50 drums of IDW stored in Building 401. The drums contained soil cuttings from discrete soil boring locations investigated during the RI. The drums were identified by their soil boring number, so the associated sample locations were readily identifiable. This IDW was analyzed for radiological parameters, including plutonium-239/240.

The location of these 50 samples is shown on Figure 11-1 and plutonium-239/240 results for these samples are presented in Table 11-4. Plutonium-239/240 activities were below detection limits for all 50 samples.

11.6 RIR ADDENDUM SOIL SAMPLES

During field investigations conducted in 2009 for completion of the RIR Addendum, additional soil samples were collected from 20 out of 23 locations where TWPs were installed. One surface and one subsurface soil sample was collected at each of the 20 TWP locations and analyzed for radiological parameters including plutonium-239/240.

The 20 RIR Addendum sample locations are shown on Figure 11-1 and plutonium-239/240 results for surface and subsurface soil at each of these locations are presented in Table 11-5. Plutonium-239/240 activities were below detection limits for all 40 samples.

11.7 SUMMARY

The NFSS RI database included analytical results for plutonium-239/240 from 59 samples of on-site environmental media, which included four low-level detections. The highest concentration of plutonium-239/240 was measured in a floor core collected in Building 401; however, this sample included significant interference from the tracer peak and is not believed to have any counts attributable to plutonium-239/240. Two other RI samples with plutonium detections included partial tracer interference, but are still believed to include some plutonium-239/240. This RI data set was augmented with plutonium results for 17 surface soil samples re-analyzed for plutonium-239/240 and inadvertently omitted from the RI database. Data for the 17 missing samples included three low-level detections for plutonium-239/240. Of the three low-level plutonium-239/240 detections included in this data set, one contained significant tracer interference and is not believed to be a positive plutonium-239/240 result and one contained partial tracer interference, but is still believed to include some plutonium-239/240. The remaining sample was collected in EU1 where KAPL materials had been stored. During RIR Addendum field investigations an additional 40 soil samples were collected and analyzed for plutonium-239/240. Plutonium-239/240 was not detected in any of the RIR Addendum field investigation samples.

Although the RI database included limited sampling for plutonium-239/240, the database contains results for americium-241, which may be indicative of other transuranics associated with the nuclear industry, including plutonium. Out of a total of 768 americium-241 results, only 9 were listed as detected (~1%). The small number of americium-241 detections (9 of 768), and the low concentrations detected, indicates that americium-241 is not a COC at the NFSS, and also suggests that other transuranics, such as plutonium-239/240, are unlikely to be present at significant concentrations or to be widespread in NFSS soils/sediment.

To summarize, a total of 166 samples of various environmental media were analyzed for plutonium-239/240. These samples include those associated with the NFSS RI and RI Addendum, as discussed above, as well as the additional 50 samples associated with the IDW collected during the RI field activities. Of these samples, seven were reported as detections for plutonium-239/240. However, two contained significant tracer interference and are not believed to be positive plutonium-239/240 results. Two other samples contained partial tracer interference, but are still believed to include some plutonium-239/240. Based on the low number and concentration of detections, as well as the analytical uncertainties of these findings, plutonium-239/240 is not believed to be a significant contaminant at the site, but its possible presence at various locations of the NFSS will continue to be considered during preparation of the FS.

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SECTION 11

FIGURES

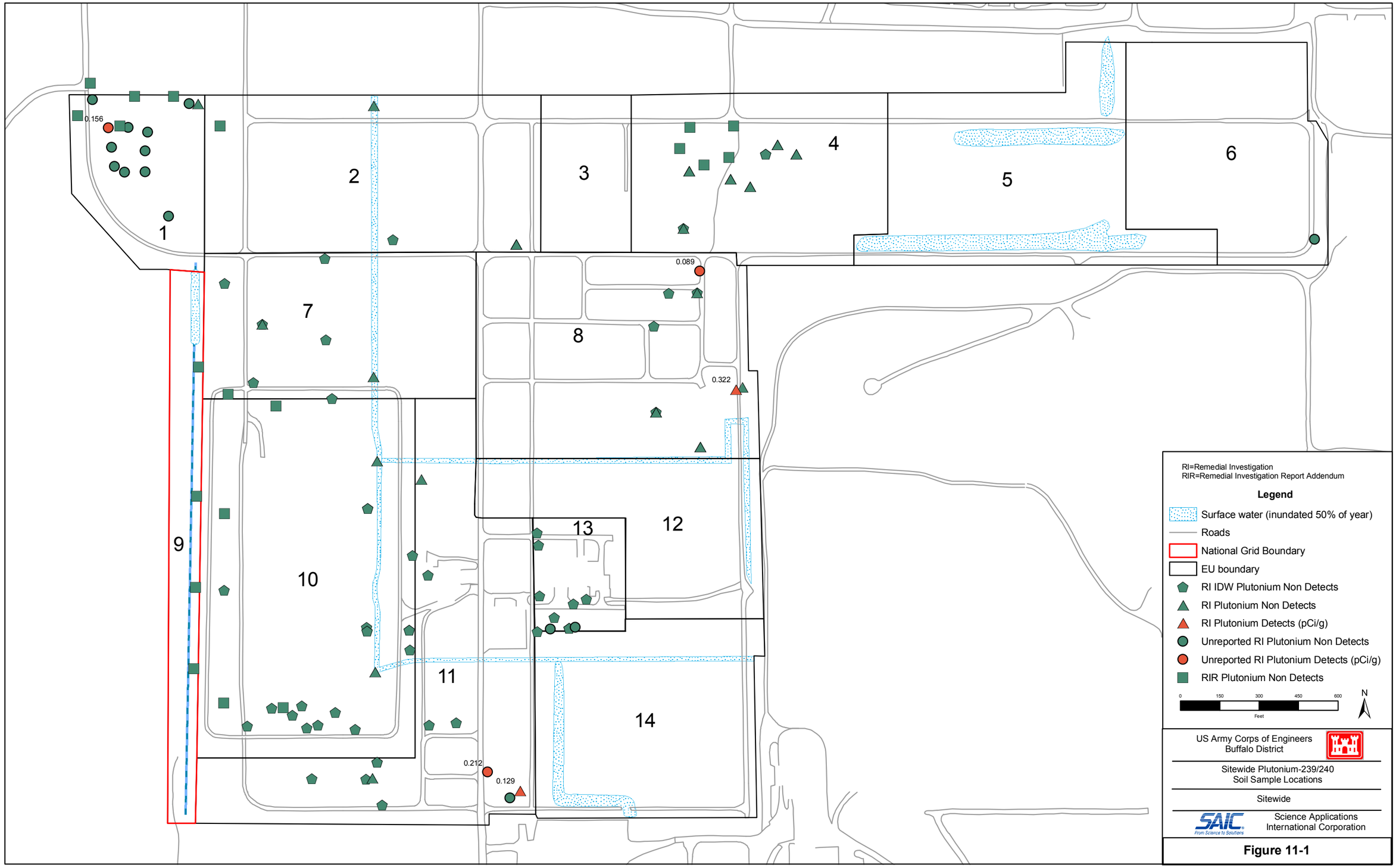
0.156
1
2
3
4
5
6
7
0.089
8
0.322
9
10
11
12
13
14
0.212
0.129
RI=Remedial Investigation
RIR=Remedial Investigation Report Addendum
Legend
Surface water (inundated 50% of year)
Roads
National Grid Boundary
EU boundary
RI IDW Plutonium Non Detects
RI Plutonium Non Detects
RI Plutonium Detects (pCi/g)
Unreported RI Plutonium Non Detects
Unreported RI Plutonium Detects (pCi/g)
RIR Plutonium Non Detects
0
150
300
450
600
Feet
N
US Army Corps of Engineers
Buffalo District
Sitewide Plutonium-239/240
Soil Sample Locations
Sitewide
SAIC
From Science to Solutions
Science Applications
International Corporation

Figure 11-1

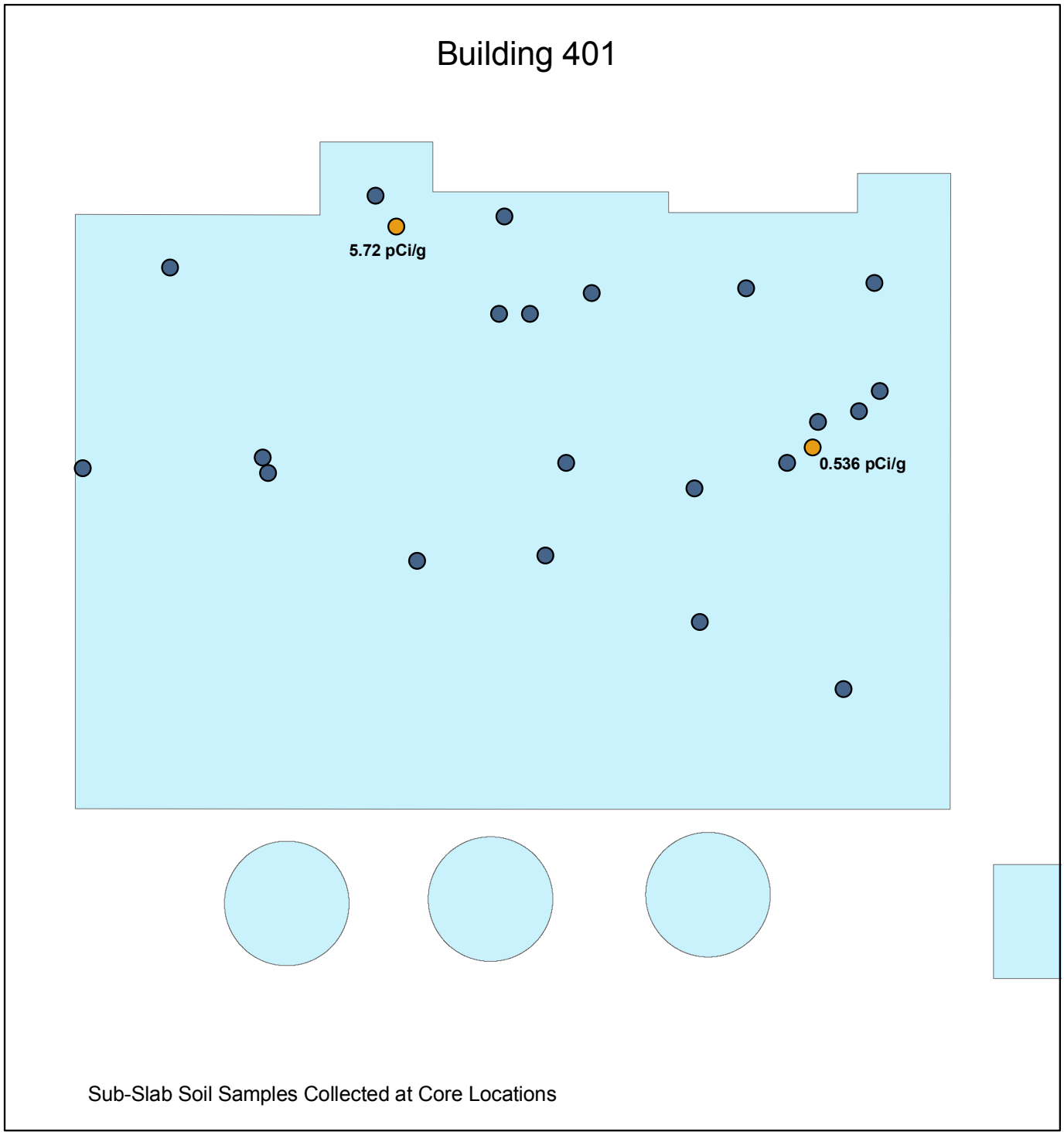

Figure 11-2. Building 401 Plutonium-239/240 Sample Locations

SECTION 11

TABLES

Table 11-1. Summary of Soil and Sediment Samples Analyzed for Plutonium-239/240* during the Niagara Falls Storage Site Remedial Investigation Conducted from 1999 through 2003

Sample ID	Exposure Unit	Environmental Media	Plutonium-239/240 Result	Unit	Qualifier
SD-WD1-3406-0.5	EU1	Surface soil	-0.035	pCi/g	U
SD-CD1-3401-0.67	EU11	Subsurface soil	0.0194	pCi/g	U
SB-EU111-3325-1.5	EU11	Subsurface soil	0.00723	pCi/g	U
TS812-2928-062	EU11	Surface soil	0.129	pCi/g	
SB-DRUM01-3370-1.0	EU2	Subsurface soil	-0.0657	pCi/g	U
SS-DRUM01-3369	EU2	Surface soil	0.0546	pCi/g	U
SB414-5.0-3631	EU4	Subsurface soil	0	pCi/g	U
SS-DRUM02-3372	EU4	Surface soil	0.149	pCi/g	U
SB-DRUM04-3379-1.0	EU4	Subsurface soil	-0.032	pCi/g	U
SS-DRUM04-3378	EU4	Surface soil	0.00107	pCi/g	U
SB-DRUM05-3382-1.0	EU4	Subsurface soil	0.0164	pCi/g	U
SS-DRUM05-3381	EU4	Surface soil	0.0641	pCi/g	UJ
SB-DRUM06-3396-1.0	EU4	Subsurface soil	0.0144	pCi/g	U
SS-DRUM06-3395	EU4	Surface soil	0.0616	pCi/g	U
SB-DRUM07-3399-1.0	EU4	Subsurface soil	-0.0128	pCi/g	U
SS-DRUM07-3398	EU4	Surface soil	-0.0361	pCi/g	U
SB8D016-3.5-3634	EU7	Subsurface soil	-0.0793	pCi/g	U
SB3D001-5.0-3632**	EU8	Subsurface soil	0.322	pCi/g	
SB3D002-5.0-3633	EU8	Subsurface soil	-0.0469	pCi/g	U
SB3D006-5.0-3630	EU8	Subsurface soil	0.0354	pCi/g	U
SB-MW313-11.0-3591	EU8	Subsurface soil	-0.029	pCi/g	U
SS-MW313-3590	EU8	Surface soil	0.0225	pCi/g	U
SB-MW314-15.0-3594	EU8	Subsurface soil	0.0108	pCi/g	U
SS-MW314-3593	EU8	Surface soil	-0.0373	pCi/g	U
SD-CD2-3402-1.0	EU10	Sediment	0.0173	pCi/g	U
SD-CD5-3405-0.67	EU10	Sediment	-0.0251	pCi/g	U
SD-CD4-3404-1.0	EU2	Sediment	0.0325	pCi/g	U
SD-CD3-3403-1.25	EU7	Sediment	-0.00695	pCi/g	U

* All plutonium-239/240 results are based on alpha spectroscopy analysis.
** Possible partial interference from tracer: some real counts.
U = Compound was analyzed for but not detected
J = Value is estimated

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Table 11-2. Summary of Building 401 Floor Core Samples, Sub-slab Soil Samples and Drain Sediment Samples Analyzed for Plutonium-239/240* during the Niagara Falls Storage Site Remedial Investigation Conducted from 1999 through 2003

Sample ID	Environmental Media	Plutonium-239/240 Result	Unit	Qualifier
RC-CORE01-3730	Bldg 401 Floor Core	-0.0366	pCi/g	U
RC-CORE02-3732	Bldg 401 Floor Core	-0.0726	pCi/g	U
RC-CORE03-3734**	Bldg 401 Floor Core	5.72	pCi/g	
RC-CORE04-3736	Bldg 401 Floor Core	0.0367	pCi/g	U
RC-CORE05-3738	Bldg 401 Floor Core	0.0114	pCi/g	U
RC-CORE06-3740	Bldg 401 Floor Core	0	pCi/g	U
RC-CORE07-3742	Bldg 401 Floor Core	0.0131	pCi/g	U
RC-CORE08-3744	Bldg 401 Floor Core	-0.0194	pCi/g	U
RC-CORE09-3746	Bldg 401 Floor Core	0	pCi/g	U
RC-CORE10-3748	Bldg 401 Floor Core	0.0405	pCi/g	U
SB-CORE01-0.5-3731***	Soil below Bldg 401	0.536	pCi/g	
SB-CORE02-0.5-3733	Soil below Bldg 401	-0.0172	pCi/g	U
SB-CORE03-1.5-3735	Soil below Bldg 401	-0.182	pCi/g	U
SB-CORE04-0.5-3737	Soil below Bldg 401	0.0746	pCi/g	U
SB-CORE05-0.5-3739	Soil below Bldg 401	-0.0426	pCi/g	U
SB-CORE06-0.5-3741	Soil below Bldg 401	0.0557	pCi/g	U
SB-CORE07-0.5-3743	Soil below Bldg 401	-0.0736	pCi/g	U
SB-CORE08-0.5-3745	Soil below Bldg 401	-0.0417	pCi/g	U
SB-CORE09-0.5-3747	Soil below Bldg 401	-0.103	pCi/g	U
SB-CORE10-0.5-3749	Soil below Bldg 401	0.0638	pCi/g	U
DRAIN01-S-3701	Bldg 401 Drain Sediment	0.0195	pCi/g	U
DRAIN03-S-3705	Bldg 401 Drain Sediment	0.155	pCi/g	U
DRAIN04-S-3707	Bldg 401 Drain Sediment	-0.0638	pCi/g	U
DRAIN06-S-3711	Bldg 401 Drain Sediment	-0.0302	pCi/g	U
DRAIN07-S-3712	Bldg 401 Drain Sediment	-0.0115	pCi/g	U
DRAIN08-S-3713	Bldg 401 Drain Sediment	0.106	pCi/g	U
DRAIN09-S-3714	Bldg 401 Drain Sediment	-0.0133	pCi/g	U
DRAIN10-S-3715	Bldg 401 Drain Sediment	0.603	pCi/g	U
DRAIN11-S-3716	Bldg 401 Drain Sediment	-0.0329	pCi/g	U
DRAIN12-S-3717	Bldg 401 Drain Sediment	-0.0187	pCi/g	U
DRAIN14-S-3719	Bldg 401 Drain Sediment	-0.0329	pCi/g	U

* All plutonium-239/240 results are based on alpha spectroscopy analysis.
** Significant tracer interference; not a real plutonium-239/240 detection.
*** Possible partial interference from tracer: some real plutonium-239/240 counts.

U = Compound was analyzed for but not detected

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Table 11-3. Summary of Surface Soil Samples Re-Analyzed for Plutonium-239/240* during the Niagara Falls Storage Site Remedial Investigation but Omitted from the Database

Sample ID	Exposure Unit	Plutonium-239/240 Result	Unit	Qualifier
SS830-1036	EU11	-0.0161	pCi/g	U
SS829-409	EU6	0.0274	pCi/g	U
SS827-406**	EU11	0.212	pCi/g	
SS314-404	EU8	0.0888	pCi/g	
SS2B006-539	EU13	-0.0143	pCi/g	U
SS2B004-536	EU13	0	pCi/g	U
SS5A008-644	EU1	0.0437	pCi/g	U
SS5A007-643	EU1	0.0704	pCi/g	U
SS5A006-642	EU1	0.0477	pCi/g	U
SS5A005-641	EU1	0.0497	pCi/g	U
SS5A004-640	EU1	-0.0101	pCi/g	U
SS5A003-639	EU1	-0.0156	pCi/g	U
SS5A002-638	EU1	-0.0083	pCi/g	U
SS5A001-637	EU1	0.156	pCi/g	
SS506-696	EU1	0.0239	pCi/g	U
SS505-694	EU1	-0.00655	pCi/g	U
SS504-692	EU1	0.0603	pCi/g	U

* All plutonium-239/240 results are based on alpha spectroscopy analysis.
** Significant tracer interference; not a real plutonium-239/240 detection.
U = Compound was analyzed for but not detected

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Table 11-4. Summary of Investigation Derived Waste Soil Samples Analyzed for Plutonium-239/240* during Investigation Activities for the Niagara Falls Storage Site Remedial Investigation Report Addendum

Sample ID	Exposure Unit	Plutonium-239/240 Result	Unit	Qualifier
SB3C014-5.0-3638	EU8	0.00	pCi/g	U
SB-TWP845-13.0-3546	EU11	0.00	pCi/g	U
SB-TWP854-13.0-3573	EU10	0.0492	pCi/g	U
SB-TWP832-12.5-3507	EU10	-0.0316	pCi/g	U
SB-TWP859-18.0-3588	EU10	-0.0112	pCi/g	U
SB-TWP835-15.0-3516	EU7	-0.0265	pCi/g	U
SB8D016-3.5-3634	EU7	0.00	pCi/g	U
SB-TWP836-15.0-3519	EU7	0.00	pCi/g	U
SB-TWP837-19.0-3522	EU7	0.0791	pCi/g	U
SB-MW862-11.5-3603	EU10	-0.0115	pCi/g	U
SB-MW863-32.0-3606	EU10	0.00	pCi/g	U
SB3D006-5.0-3630	EU8	0.00	pCi/g	U
SB-MW313-11.0-3591	EU8	0.00	pCi/g	U
SB-MW423-15.0-3612	EU4	-0.0347	pCi/g	U
SB-MH07/08-11.0-3652	EU11	0.00	pCi/g	U
SB-MW863-32.0-3606	EU10	-0.0117	pCi/g	U
SB-MW861-34.5-3596	EU10	0.00	pCi/g	U
SB-MW228-11.0-3615	EU13	-0.0116	pCi/g	U
SB-MW228-11.0-3615	EU13	0.00	pCi/g	U
SB-TWP853-16.5-3570	EU10	0.0493	pCi/g	U
SB-TWP838-14.0-3525	EU7	0.0589	pCi/g	U
SB-TWP831-15.0-3504	EU10	0.00	pCi/g	U
SB-TWP852-15.0-3567	EU10	-0.106	pCi/g	U
SB-MW228-11.0-3615	EU13	-0.0114	pCi/g	U
SB-BH224-10.0-3666	EU13	-0.0236	pCi/g	U
SB-BH225-10.0-3667	EU13	0.00	pCi/g	U
SB-BH223-3.0-3665	EU14	0.00	pCi/g	U
SB3C015-5.0-3639	EU8	0.00	pCi/g	U
SB-MH06-8.5-3650	EU10	0.00	pCi/g	U
SB-TWP857-11.0-3582	EU10	-0.0357	pCi/g	U
SB-TWP833-10.0-3510	EU10	-0.0111	pCi/g	U
SB-TWP858-16.0-3585	EU10	-0.0226	pCi/g	U
SB-BH226-12.0-3668	EU13	0.00	pCi/g	U
SB-OTFL11-13.0-3658	EU2	0.00	pCi/g	U
SB-BH222-6.0-3664	EU13	0.00	pCi/g	U
SB-TWP856-11.0-3579	EU10	-0.037	pCi/g	U
SB-MH08-11.0-3653	EU11	0.0351	pCi/g	U
SB-TWP847-10.0-3552	EU11	0.00	pCi/g	U
SB-TWP857-11.0-3582	EU10	-0.0122	pCi/g	U
SB-TWP849-11.0-3558	EU11	-0.0115	pCi/g	U
SB-BH220-20.0-3662	EU13	-3.61E-09	pCi/g	U
SB-BH221-15.0-3663	EU13	0.0218	pCi/g	U
SB8E003-5.0-3649	EU7	0.0131	pCi/g	U
SB-MW861-34.5-3596	EU10	0.0766	pCi/g	U
SB-TWP846-16.0-3549	EU11	0.0138	pCi/g	U
SB-TWP844-11.0-3543	EU10	-0.0116	pCi/g	U
SB-MW423-15.0-3612	EU4	-0.0863	pCi/g	U
SB414-5.0-3631	EU4	0.0844	pCi/g	U
SB-MH07/08-11.0-3652	EU11	-0.0148	pCi/g	U
SB-TWP848-11.0-3555	EU11	-0.0532	pCi/g	U

* All plutonium-239/240 results are based on alpha spectroscopy analysis.
U = Compound not detected

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Table 11-5. Summary of Surface and Subsurface Soil Samples Collected and Analyzed for Plutonium-239/240* during Investigation Activities for the Niagara Falls Storage Site Remedial Investigation Report Addendum

Sample ID	Exposure Unit	Environmental Media	Plutonium-239/240 Result	Unit	Qualifier
921SB14.0-16.0-0002	EU1	Subsurface soil	0.0146	pCi/g	U
921SS0.0-0.5-0001	EU1	Surface soil	-0.0277	pCi/g	U
922SB12.0-14.0-0006	EU1	Subsurface soil	-0.0366	pCi/g	U
922SS0.0-0.5-0005	EU1	Surface soil	0.0957	pCi/g	U
923SS0.0-0.5-0009	EU1	Surface soil	-0.0926	pCi/g	U
923SB16.0-18.0-0010	EU1	Surface soil	-0.0417	pCi/g	U
924SB12.0-14.0-0014	EU1	Subsurface soil	-0.0365	pCi/g	U
924SS0.0-0.5-0013	EU1	Surface soil	-0.112	pCi/g	U
925SB10.0-12.0-0018	EU1	Subsurface soil	-0.0432	pCi/g	U
925SS0.0-0.5-0017	EU1	Surface soil	0.0225	pCi/g	U
926SB8.0-10.0-0022	EU2	Subsurface soil	0.00	pCi/g	U
926SS0.0-0.5-0021	EU2	Surface soil	-0.0298	pCi/g	U
927SB10.0-12.0-0026	EU4	Subsurface soil	0.0319	pCi/g	U
927SS0.0-2.5-0025	EU4	Surface soil	-0.0857	pCi/g	U
928SB12.0-14.0-0030	EU4	Subsurface soil	-0.0131	pCi/g	U
928SS0.0-0.5-0029	EU4	Surface soil	0.0966	pCi/g	U
929SB8.0-10.0-0034	EU4	Subsurface soil	0.180	pCi/g	U
929SS0.0-0.5-0033	EU4	Surface soil	0.0152	pCi/g	U
930SB15.0-17.0-0038	EU4	Subsurface soil	-0.0293	pCi/g	U
930SS0.0-0.5-0037	EU4	Surface soil	-0.109	pCi/g	U
931SB8.0-10.0-0042	EU4	Subsurface soil	-0.0394	pCi/g	U
931SS0.0-0.5-0041	EU4	Surface soil	-0.0139	pCi/g	U
935SB10.0-12.0-0058	EU9	Subsurface soil	0.0153	pCi/g	U
935SS0.0-0.5-0057	EU9	Surface soil	-0.0797	pCi/g	U
936SB12.0-14.0-0062	EU10	Subsurface soil	0.0672	pCi/g	U
936SS0.0-0.5-0061	EU10	Surface soil	0.0495	pCi/g	U
937SB12.0-14.0-0074	EU10	Subsurface soil	-0.0755	pCi/g	U
937SS0.0-0.5-0073	EU10	Surface soil	-0.155	pCi/g	U
938SB14.0-15.0-0070	EU9	Subsurface soil	-0.0541	pCi/g	U
938SS0.0-0.5-0069	EU9	Surface soil	-0.172	pCi/g	U
939SB2.0-4.0-0066	EU10	Subsurface soil	-0.0529	pCi/g	U
939SS0.0-0.5-0065	EU10	Surface soil	-0.0531	pCi/g	U
940SB8.0-10.0-0078	EU9	Subsurface soil	-0.0294	pCi/g	U
940SS0.0-0.5-0077	EU9	Surface soil	-0.077	pCi/g	U
941SB10.0-12.0-0082	EU9	Subsurface soil	-0.131	pCi/g	U
941SS0.0-0.5-0081	EU9	Surface soil	-0.059	pCi/g	U
942SB4.0-6.0-0086	EU10	Subsurface soil	-0.116	pCi/g	U
942SS0.0-0.5-0085	EU10	Surface soil	-0.048	pCi/g	U
943SB8.0-10.0-0090	EU10	Subsurface soil	-0.105	pCi/g	U
943SS0.0-0.5-0089	EU10	Surface soil	0.0182	pCi/g	U

* All plutonium-239/240 results are based on alpha spectroscopy analysis.
U = Compound not detected

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12.0 PRESENTATION OF SUPPLEMENTAL DOCUMENTATION

Several comments received on the 2007 RIR concerned the public availability of specific documentation that was either referenced in the 2007 RIR or that contained information pertinent to conclusions presented in the 2007 RIR. Supplemental documentation requested by 2007 RIR reviewers is presented in this RIR Addendum to ensure that the public has the opportunity to review documentation forming the basis of 2007 RIR conclusions. This supplemental information is in the form of published reports, papers, fact sheets, correspondence, and field notes. Additional documentation identified through the 2007 RIR review process and included in this addendum is listed below. The documents are further discussed in the following subsections.

- KAPL Waste Research (from correspondence and various sources of information);
- LOOW Completion Report, Youngstown, New York (USACE 1943);
- NFSS Historical Photographic Analysis (U.S. Army Geospatial Center 2009);
- Utilizing Isotopic Uranium Ratios in Groundwater Evaluations at NFSS (Rhodes et al. 2006);
- Underground Utility Lines Remedial Investigation at the Former LOOW Fact Sheet (USACE 2007d);
- NFSS Topographic Survey (Gourdie-Fraser 2009);
- RIR Phase III Soil Boring Logs and Well Construction Details;
- Water Level Information used in the Groundwater Flow Model;
- Evaluation of Groundwater and Surface Water Interaction in the WDD and the Central Drainage Ditch; and
- Preparation and Review of Cross-Sections to Evaluate the Presence of Sand Lenses in the Vicinity of the IWCS.

12.1 KAPL WASTE RESEARCH

During review of the 2007 RIR, additional sources containing information on KAPL waste were identified. USACE requested and received additional KAPL documentation from NIOSH. This information is included as single source files in Appendix 12-A under the subfolder National Institute for Occupational Safety and Health (NIOSH) KAPL Information (see the Appendix CD accompanying this RIR Addendum). Several other information sources have been compiled into a single readable file and are included in Appendix 12-A as file *Appendix 12-A KAPL Information.pdf*. Each information source within this file is listed below with a brief explanation of its contents.

- *KAPL Historical Assessment:* This document chronologically summarizes the handling, shipment and storage of KAPL waste from 1952 to 1971. The types and quantities of KAPL waste either stored or shipped to NFSS and ORNL are discussed.

- *December 20, 1957 letter from the U.S. Atomic Energy Commission (Mr. Herman Roth) to the Union Carbide Nuclear Company (Dr. J.A. Swartout, ORNL) regarding burial of KAPL waste:* This letter discusses the tentative plans to send 1,000 drums of KAPL related waste from NFSS to ORNL for burial. The nature of the waste and the condition of the drums are included in the waste description.

- *December 26, 1957 letter from Mr. Herman Roth to Mr. V.V. Hendrix regarding handling of KAPL waste:* This letter discusses the handling, shipment and planned disposal of the KAPL waste. The letter proposes the burning of combustibles by Hooker Chemical Company to reduce the total volume of the waste prior to shipment to ORNL for burial. The involvement of Hooker Chemical Company in the handling and shipping process is also discussed.

- *Waste Disposal Progress Report: September, October, November 1951; prepared by members of KAPL staff, General Electric Company, KAPL, Schenectady, New York. (Part of Study of Radioactive Waste Storage Areas at* Energy Research and Development Administration *(ERDA)-Niagara Falls Site, National Lead Company of Ohio, April 1977:* This resource includes a progress report for waste disposal operations at KAPL and a discussion regarding ultimate disposal of KAPL waste at a remote site. The LOOW is identified as a possible disposal site for all but highly radioactive combustible wastes.

- *August 10, 2005 letter from DOE (Mr. J. Hughes Robillard) to New York State Department of Health (Mr. Stephen Gavitt) regarding KAPL radioactive waste information related to the Lake Ontario Ordnance Works; contains several attachments:* This letter, with attachments, provides information specific to the number and types of KAPL waste sent to LOOW from 1952 to 1954. Additionally, information is included on the subsequent shipment of KAPL waste from LOOW to Oak Ridge in 1958. A list of attachments to this letter is provided below. The letter with attachments is provided in Appendix 12-A. A summary sheet for each attachment is included in the appendix of materials.

  Attachments

  1. October 13, 1954 letter from AEC Schenectady Operations Office (Batza) to KAPL (Perleberg), subject “KAPL Radioactive Waste Presently Stored at LOSA”

  2. October 26, 1954 letter from KAPL (Perleberg) to USAEC Schenectady Operations Office (Anderson), subject “KAPL Radioactive Waste as LOSA”

  3. December 2, 1954 internal letter from KAPL (Manieri to Collins), subject “Estimated Curies Activity Shipped from LOSA from KAPL”

  4. January 29, 1958 letter from KAPL (Manieri) to ORNL (Witkowski), subject “Radioactive Waste Shipment from Model City, New York”

  5. February 14, 1958 letter from Hooker Electrochemical company (Seager) to KAPL (Manieri), subject “Radioactive Waste Shipment from Model city, New York”

  6. June 26, 1958 letter from Hooker Electrochemical Company (Seager) to ORNL (Witkowski), subject “Radioactive Waste Shipment form Model City, New York”

7. August 18, 1961 letter from KAPL (Manieri) to Virginia Military Institute (Morgan), subject "Data on KAPL's Radioactive Waste Disposal"

8. Paper on LOOW Waste from KAPL files, date unknown

- *July 2009 Special Exposure Cohort (SEC) Petition Evaluation Report:* This evaluation report was completed by the NIOSH and addresses a class of employees proposed for addition to the SEC. The proposed class definition includes all employees of DOE, its predecessor agencies, and their contractors and subcontractors who worked at LOOW in Niagara Falls, New York, from January 1, 1944 through December 31, 1953 and who meet a requirement for a specified number of work hours. The report evaluates the feasibility for completing dose reconstructions for employees at LOOW during this time. The shipment of KAPL waste to LOOW, and its temporary storage at the site, is discussed as part of this evaluation.

12.2 LOOW COMPLETION REPORT

On April 1, 1943, the Corps submitted the document, *Completion Report, Lake Ontario Ordnance Works, Youngstown, New York,* which covers construction of the LOOW from January 1, 1942 to March 15, 1943. This completion report is presented in two volumes. The first volume includes information and data specific to the construction of the plant. The second volume primarily contains summary information on contract details. These two volumes are included in Appendix 12-B of this RIR Addendum. Key information presented in the LOOW Completion Report is listed below.

- Site location details and maps;
- Land survey information;
- Details on acquired land and buildings;
- Details on surrounding land use;
- Completed site layout with descriptions of constructed building areas;
- Historic photographs of completed site features;
- Soil conditions including test hole data;
- Groundwater and surface water conditions;
- Utility installation and use;
- Details of road construction;
- List of engineering maps and drawings; and
- Contract details (funding, progress reports, labor wages, worker housing survey, etc.).

12.3 NFSS HISTORICAL PHOTOGRAPHIC ANALYSIS

A site historical photographic analysis of the NFSS was prepared for the Corps Buffalo District by the U.S. Army Geospatial Center in 2009. The historical photographic analysis of the NFSS expands the area of research from the LOOW, New York, which was the subject of a similar study completed in September 2002 by the U.S. Army Topographic Engineering Center, the predecessor agency to the U.S. Army Geospatial Center. The latest document, titled *Niagara Falls Storage Site Historical Photographic Analysis, Lewiston Township, New York,* has been included as Appendix 12-C of this RIR Addendum. An accompanying Geographic Information System (GIS) is not reproduced for this RIR Addendum.

12.3.1 Methodology

The latest study focused on two areas of interest, the Lewiston-Porter Central School property in Lewiston, NY and the NFSS. Three separate areas of the NFSS were selected for detailed aerial

photographic review. These areas included the vicinity of the present day IWCS; the Acidification Area in portions of EUs 3, 4, and 8; and the Panhandle Area in EUs 5 and 6. Figure 12-1 shows the areas of interest included in the historical photographic analysis. Refer to Figure 1-4 for locations of buildings discussed in this section.

The 2009 photographic analysis report presents the results of a GIS-based historical photographic analysis of the two main areas of interest, the Lewiston-Porter Central School property and the NFSS. The analysis identified potential areas of concern related to activities around the site since its development. Areas of potential concern, such as scars, disturbed ground, trenches, ditches, etc., were identified and mapped by reviewing historical aerial photographs.

The analysis in the report is primarily based on interpretation of black and white and color aerial photography over the project area for the period 1938 to 2005. Geodetic control was applied to the 1938, 1942, 1944, 1951, 1956, 1958, 1978, 1985, 1990, and 1995 aerial photography using 2005 New York State GIS data. Both single-optical and stereoscopic viewing, at various magnifications, was performed on historical aerial photographs. Visible signatures, such as size, scale, shape, shadow, tone, texture, and pattern, allowed features to be recognized on the aerial photographs (U.S. Army Geospatial Center 2009). Imagery from 1938 to 2005 was used to identify drainage patterns and major utility lines (i.e., railroad, pipes, electricity). Major findings of this analysis are briefly summarized below for the two areas of interest.

12.3.2 Findings for the Lewiston-Porter Central School Property

The Town of Lewiston acquired this property in 1948 for the purpose of constructing the Lewiston-Porter School District. Key photographic findings for this area are listed below.

- Mounded material observed in 1942 photographs is not seen in pre-development photographs from 1938.
- Construction of the school building and activity along the nearby drainage ditch can be seen in 1951 photographs. Mounded material is evident on either side of the ditch.
- Activity around the Southwest Drainage Ditch and south of the area of interest is evident in photographs from 1944 to 1995.
- School sport activities can be seen in photographs from 1958 to 2005.

12.3.3 Findings for the Niagara Falls Storage Site

Three separate areas of the NFSS were selected for detailed aerial photographic review. These areas included the vicinity of the present day IWCS, the acidification area in portions of EUs 3, 4, and 8 and the panhandle area in EUs 5 and 6. Key photographic findings for these areas are listed below.

12.3.3.1 IWCS Area

This area formerly housed the LOOW Freshwater Treatment Plant, which included circular clarifiers and several water storage reservoirs. Water from this facility was used for fire protection, steam generation, process water for TNT production and process cooling. In 1944, the Freshwater Treatment Plant shut down prior to the start of storage of radioactive wastes and residues at the site. In the 1980s, the IWCS

was built over these facilities (EA 1999; BNI 1994). The 2009 historical photographic analysis indicated the following with respect to this area:

- Buildings 403, 409, 410, and 411, formerly present in the current area of the IWCS, first appear in 1944 photographs. They are not seen in 1938 or 1942 photographs.

- Buildings 412, 413, 414, and 415 (former storage tanks) are seen in photographs from 1944 to 1978. They do not appear in 1985 photographs.

- Two ramps to Building 411 are visible in 1951 photographs, whereas only one ramp was seen in 1944 photographs.

- Building 411 still appears in 1985 photographs, but not in 1990 photographs taken following construction of the IWCS.

12.3.3.2 Acidification Area in Portions of EUs 3, 4, and 8

The Acidification Area is located in the north central portion of the site, north of O Street and east of Campbell Street. An area called the "T.N.T. Mix Storage" was contained within the Acidification Area (Reconstruction Finance Corporation circa 1945). Nitric acid is known to have been stored in this area, as was fuel oil. Anhydrous ammonia may also have been stored in this area (Industrial Research Corporation 1948). Remnants of several above ground tank cradles are still evident at this location (USACE 2007a). The 2009 historical photographic analysis indicated the following:

- Structures are evident in this area in 1944 photographs, but do not appear in pre-development photographs of 1938. Remains of structures can be observed in the 2005 photograph.

- Storage tanks are observed in 1944 photographs between N and O Streets. The tanks are not seen in photographs from 1951 or later.

- In 1985 photographs, mounded material is present in a stockpile area reportedly used for uncontaminated rubble.

- Building430 is observed to be half its original size in a 1990 photograph. This building remains unchanged in photographs from 1944 to 1985; however, the eastern portion of the building appears to be dismantled and cleared in the 1990 photograph.

12.3.3.3 Panhandle Area in EUs 5 and 6

The Panhandle Area is located in the northeastern portion of the site. Building 434, a water tower during the operation of the LOOW and later a storage facility for the K-65 residues, was located in this area. A thaw house (Building 434a), located near Building 434, was used to store P-54 and P-56 residues that originated from the processing of L-30 and L-50 ore at the Linde refinery. Ammonia storage facilities were also present in this area. The 2009 historical photographic analysis indicated the following with respect to this area:

- Several features are evident in the 1944 photograph of this area, including a storage silo (Building 434), a storage tank located west of Building 434, a railroad, a fence line and drainage ditch. No structures appear in the panhandle area in pre-development photographs of 1938.

- Building 434 is seen in photographs from 1944 to 1985, but is not seen in the 1990 photograph.

- A building, reported to be a thaw house (Building 434a), is seen adjacent to the storage silo (Building 434) in photographs from 1951 through 1978. It is not seen in 1985 photographs.

12.3.4 Summary

Pre-development photographs from 1938 show minimal human activity in the areas of the Lewiston-Porter Central School property and the NFSS property. Activity around the drainage ditch near the school property is evident in photographs as early as 1944, and construction of the school building can be seen in 1951 photographs. Development of structures across the NFSS property is evident in 1944 photographs. At this time, the Corps' MED was granted use of a portion of the LOOW for the storage of radioactive residues generated through the processing of uranium ore (BNI 1990). Photographs from 1978 and later show that fewer building structures were present at the site than during previous years. This observance coincides with site investigations and remedial actions that occurred at the site during the 1970s and 1980s, and culminated with construction of the IWCS from 1982 to 1986.

During 2010, the Corps plans to investigate the mounded materials not adjacent to a ditch, the trenches, and the pits located on the undeveloped portion of the Lewiston-Porter Schools property, and the Southwest Drainage Ditch as identified within the 1944 aerial photographs. The Corps will investigate the potential for chemical contamination as a result of historic Department of Defense use under the Defense Environmental Restoration Program - Formerly Used Defense Site (DERP-FUDS) authority and the potential for radiological contamination in the Southwest Drainage Ditch as a result of historic MED and AEC use under the FUSRAP authority.

12.4 UTILIZING ISOTOPIC URANIUM RATIOS IN GROUNDWATER EVALUATION AT NFSS

In the paper titled, *Utilizing Isotopic Uranium Ratios in Groundwater Evaluations at NFSS* (Rhodes et al. 2006), the Corps and Argonne National Laboratory present the results of an evaluation of U-234 to U-238 ratios in groundwater at the NFSS to help distinguish natural groundwater from zones impacted by past site releases. The premise of this study lies in the fact that in natural groundwater, the ratio of U-234 to U-238 exceeds 1 due to the alpha particle recoil effect, in which U-234 is preferentially mobilized to groundwater from adjacent rock or soil. Because this process is very slow, it can be hundreds to thousands of years before a measureable impact is seen in the isotopic ratio. Thus, the ratio of U-234 to U-238 will be higher in natural groundwater than in contaminated groundwater. Using site and regional groundwater data, Rhodes et al. (2006) identified a site specific isotopic ratio of 1.2 to use as a signature to help distinguish natural groundwater from contaminated groundwater at the NFSS. This site specific ratio is intended to be used as a weight of evidence, in conjunction with other site information, to make decisions regarding contaminated groundwater at the NFSS. This research paper has been included in this RIR Addendum as Appendix 12-D.

12.5 RADIOLOGICAL INVESTIGATION OF UNDERGROUND UTILITY LINES – OCTOBER 2007 FACT SHEET

In October 2007, the Corps released a fact sheet presenting results of a radiological investigation of underground utility lines on the former LOOW property (USACE 2007d). The objective of the investigation was to confirm the presence or absence of radiological contamination in wastewater and sludge within, and soil below and adjacent to, underground utility lines. Between August and October 2006, the Corps collected a total of 60 samples for radiological analysis from within or adjacent to underground utility lines on the former LOOW site. The fact sheet summarizes details of this sampling

effort and presents the analytical data verification report for laboratory results. The fact sheet is included as Appendix 12-E of this RIR Addendum.

12.6 TOPOGRAPHIC SURVEY OF THE IWCS

Ground surface elevation data for the IWCS was collected during four separate topographic survey events over the past eighteen years. Topographic survey information obtained in 1991, 1996, and 1999 was presented and discussed in the 2007 RIR. The most recent topographic survey of the IWCS was conducted in June 2009.

The 2009 survey report, *Survey, Niagara Falls Storage Site, Lewiston, New York*, was submitted by Gourdie-Fraser. Horizontal control for this survey was based on the NAD83 and vertical control was based on the NGVD29. Survey coordinates were transformed to match the local site coordinate system, and elevation data was reported in U.S. Survey feet. This survey report (Gourdie-Fraser 2009) has been included as Appendix 12-F of this RIR Addendum. Surface elevation data from the 2009 topographic survey and from surveys completed in 1991, 1996 and 1999 have been summarized and compared to identify changes in surface elevation across the IWCS that could indicate settlement of the cap material. Interpretation of the topographic survey results is presented with the analysis of the integrity of the IWCS that is discussed in Section 5 of this RIR Addendum.

12.7 RI PHASE III SOIL BORING LOGS

Phase 3 fieldwork for the NFSS RI was started in May 2001 and continued on an intermittent basis until October 2003. As part of the Phase 3 investigation, surface and subsurface soil samples were collected at multiple site locations to support findings of the gamma walkover survey. Additional monitoring wells were also installed during Phase 3 to further investigate and characterize the groundwater at the NFSS. Boring logs associated with soil sampling and monitoring well installation during Phase 3 field activities are presented in this RIR Addendum as Appendix 12-G.

12.8 WATER LEVEL INFORMATION USED IN THE GROUNDWATER FLOW MODEL

Water level measurement data collected at the NFSS and used in the groundwater flow and contaminant transport modeling effort performed for the Corps by HGL have been included in this RIR Addendum for information purposes. These data include water level measurements collected from NFSS wells in May, September, and October 2000. This data is presented in Appendix 12-H of this RIR Addendum.

12.9 EVALUATION OF GROUNDWATER AND SURFACE WATER IN THE WEST DRAINAGE DITCH AND THE CENTRAL DRAINAGE DITCH

Simulations were performed using the site groundwater flow model (USACE 2007c) to predict flow and mass discharge into drainage ditches located on the NFSS property. Results are presented for the U-238 baseline case for the Central, Western, South 16, and South 31 drainage ditches. Key findings of this study include:

- The highest average flow rate was predicted for the Central Drainage Ditch at 3.9e-5 cfs (95 L/day).
- The lowest flow rate was predicted for the South 16 Drainage Ditch at 8.6e-6 cfs (21 L/day).
- The diluted concentration of U-238 along each ditch length, within the NFSS property boundary, increases with time from t=0 to 1,000 years.

- Of the four drainage ditches analyzed, the lowest diluted concentrations are predicted to occur in the Western Drainage Ditch. The Western Drainage Ditch primarily receives U-238 from the IWCS-based sources which only impact a portion of its length.

- Of the four drainage ditches analyzed, the highest diluted concentrations are predicted to occur in the South 16 Drainage Ditch.

- U-238 screening level exceedances are predicted to occur in the South 16 and South 31 drainage ditches after t=350 years. Screening level exceedances are not predicted to occur in the Central or Western Drainage Ditches.

Additional explanation of these results, as presented in an e-mail from Don DeMarco (HGL) to Michelle Rhodes (USACE Buffalo District) (Rhodes 2009), and the supporting tables are provided in Appendix 12-I of this RIR Addendum.

12.10 PREPARATION AND REVIEW OF CROSS-SECTIONS TO EVALUATE THE PRESENCE OF SAND LENSES IN THE VICINITY OF THE IWCS

The geostatistical analysis of sand lens connectivity at the NFSS, presented in USACE 2007c, indicated an average sand lens thickness of 5 ft. and length of 15 ft. A subsequent analysis, included in Appendix 12-J of this RIR Addendum, considered the RI Phase III borehole data, boreholes installed during investigations conducted for the RIR Addendum, and IWCS construction cut-off wall elevation profiles. As part of the follow-on analysis, seven cross-sections were prepared to illustrate subsurface profiles adjacent to the IWCS and elsewhere on the NFSS.

Results of the additional sand lens evaluation verified the conclusions of the initial geostatistical analysis; that is, the sand lenses are isolated and discontinuous, with an average sand lens thickness of approximately 5 ft. and length of 15 ft. across the NFSS.

Consistent with historical data, the RIR Addendum borehole data confirmed evidence of higher sand lens occurrence near EU 4 (see cross-section G-G' in Appendix 12-J) in the vicinity of the chlorinated solvent plume. Due to the greater occurrence of sand lenses in the vicinity of EU 4, the cross-sections suggest the bulk permeability of the subsurface in this area may be locally higher than that in the subsurface near the northwest corner of the NFSS. Also consistent with historical data, the cut-off wall elevation profiles indicate a higher level of occurrence of sand lenses in localized areas adjacent to the IWCS than elsewhere on the site. The permeability in these areas may also be locally higher than in areas with fewer sand lenses, such as in the northwest corner of the NFSS. The purpose of the existing cutoff wall and dike system surrounding the IWCS, however, was to hydraulically separate sand lenses in regions outside of the IWCS from waste contained within the IWCS. The cutoff wall and dike system consists of compacted clay constructed around the IWCS perimeter to act as an engineered barrier to migration of contaminants from the containment area. The cutoff wall has a minimum width of 12 ft., extends through the entire Brown Clay Till Unit, and is keyed into the Glaciolacustrine Clay Unit a minimum of 1.5 ft.

Data collected for the RIR Addendum and review of the cut-off wall elevation profiles do not alter the conclusions of the initial geostatistical evaluation. RIR Addendum borehole data indicate that sand lenses are not widespread contiguous features, but are disconnected. In cases, where the distance between boreholes is large, e.g., 100 ft., sand lens connectivity cannot be substantiated based on the available data. To address this uncertainty, it is recommended that monitoring results from wells with sand lenses be subject to a higher degree of scrutiny to discern or identify concentration trends that may imply hydraulic connectivity via sand lenses. Moreover, the groundwater model will be updated to account for the potential for localized increased permeability due to sand lenses and the resultant potential for

contaminant migration. A value of hydraulic conductivity representative of a sandy material will be assigned to the model wherever a sand lens has been observed. Previously the hydraulic conductivity field was based on available site-specific measured values of hydraulic conductivity. The updates to the hydraulic conductivity field will give priority to the presence of sand lenses and are a conservative means of representing areas of potentially increased permeability.

For full details of the cross-section evaluation, refer to information provided in Appendix 12-J.

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SECTION 12

FIGURE

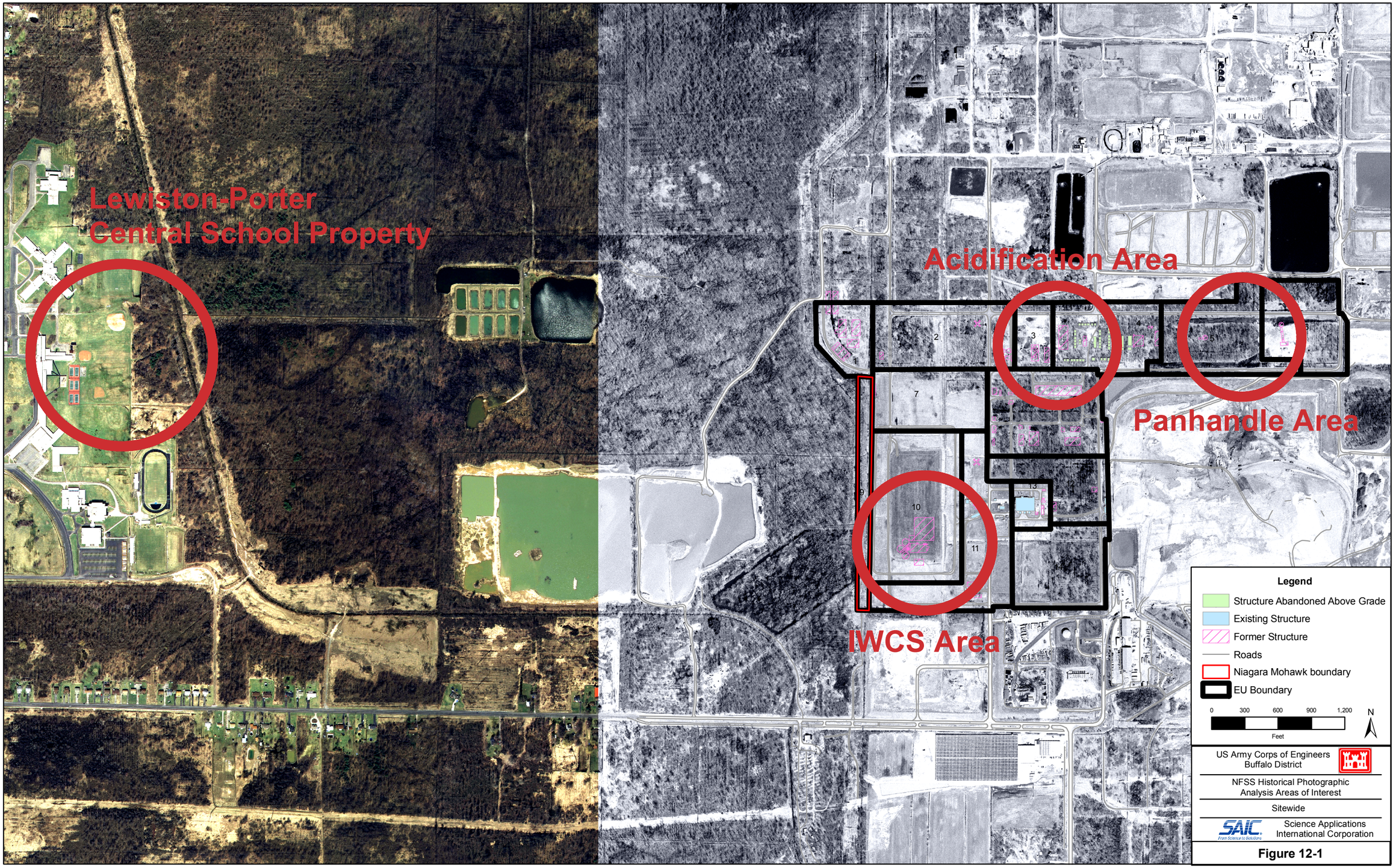
Lewiston-Porter
Central School Property
Acidification Area
Panhandle Area
IWCS Area
Legend
Structure Abandoned Above Grade
Existing Structure
Former Structure
Roads
Niagara Mohawk boundary
EU Boundary
0
300
600
900
1,200
Feet
N
US Army Corps of Engineers
Buffalo District
NFSS Historical Photographic
Analysis Areas of Interest
Sitewide
SAIC
From Science to Solutions
Science Applications
International Corporation

Figure 12-1

13.0 TABLE AND TEXT REVISIONS TO THE REMEDIAL INVESTIGATION REPORT AND THE BASELINE RISK ASSESSMENT

Topics discussed in this section include items from the 2007 RIR (USACE 2007a) that have been revised to address public comments or to accurately portray pertinent information for the RI. Items that have been revised and are presented below include:

- *Tables in Appendix K of the 2007 RIR showing downhole gamma logging results:* The revision corrects a formula error for the X and Y axes used to display the data.

- *The discussion of the SRC determination process presented in Section 4 of the 2007 RIR:* The text has been revised so the SRC determination process accurately corresponds to the process depicted in 2007 RIR Figure 4-1.

- *Tables 2.1 (Background Data Summary for NFSS with Upper Tolerance Limits) and 2.2 (Toxicity Criteria and Chemical-Specific Parameters for Chemical SRCs) of the Baseline Risk Assessment:* Table 2.1 has been revised to correct the UTL for arsenic in surface soil. Table 2.2 of the BRA has been revised to include reference columns for the toxicity information.

These revisions are discussed in greater detail in the following sections.

13.1 REVISION OF DOWNHOLE GAMMA LOGGING RESULTS

During Phase 1 of the RI, a downhole gamma survey was performed on each investigative soil boring. These downhole surveys were performed to evaluate the vertical distribution of gamma-emitting radionuclides and to confirm the results of the gamma survey performed on the corresponding soil core. Downhole logging was performed using a 1 cm by 1 cm (3/8 inch by 3/8 inch) NaI gamma detector with a portable logging device. The 1 cm by 1 cm detector was equipped with a collimator to ensure that the photons detected originated from the nearest boring wall. Testing was performed through the PVC casing that was placed along one side of the boring. The NaI 1 cm by 1 cm detector was attached to a cable and initially lowered to the bottom of the casing. The instrument was then withdrawn to the surface and the boring was continuously logged. The real time data generated during the downhole logging was found to be consistent with the continuous core gamma logging performed during the installation of each borehole. Information from both gamma scans was used to determine where samples were collected along the soil core (i.e., the zone with elevated gamma readings). The results of the downhole logging were originally presented in Appendix K of the 2007 RIR for informational purposes only. The graphs in Appendix K of the 2007 RIR (USACE 2007a) showing downhole gamma logging results have been revised to correct a formula error for the X and Y axes used to display the data. The revised graphs are presented in this RIR Addendum as Appendix 13-A.

13.2 REVISION OF METHODOLOGY FOR DETERMINATION OF SRCS

The process for determination of SRCs was presented in Section 4 of the 2007 RIR (USACE 2007a). The discussion in Section 4 of the 2007 RIR (USACE 2007a) was revised so the SRC determination process accurately corresponded to the process depicted in 2007 RIR Figure 4-1. 2007 RIR Figure 4-1 was revised as part of this revision and is included as Figure 13-1 with the text revision presented in Section 13.2.1.

Additionally, an EPA comment on the RIR stated "the deletion of radionuclides based on the frequency of detection (<5%) should be removed from the RI." The Corps' response to this comment is provided in Section 13.2.2.

13.2.1 Determination of SRCs (Revision of 2007 RIR Section 4.4.2)

The methodology for the determination of SRCs is consistent with the methodology presented in the BRA. SRCs are defined to be chemicals or radionuclides that are present in a given medium and EU at concentrations statistically greater than the corresponding background concentrations.

The process for the determination of SRCs uses a series of statistical comparisons and weight-of-evidence factors. Because of problems inherent in applying a single statistical tool to data sets that have different characteristics, multiple types of evidence are considered to determine whether a parameter is site-related or naturally occurring. Chemicals and radionuclides retained after this screen are considered SRCs. The evaluation process is depicted in Figure 13-1 (Revised 2007 RIR Figure 4-1) and briefly described below.

SRCs were determined for soil (0 to 10 ft bgs), surface soil (0 to 0.5 ft bgs), sediments, surface water, groundwater, pipeline/utility sediments, and pipeline/utility water. For each medium, analytical results for samples collected from both the NFSS and the background locations were compiled into data sets. For the purpose of this report, "data set" is defined to be all of the analytical results for a given parameter from samples of a given medium, collected within a given EU. This approach allows the determination of SRCs for each EU that reflects the actual conditions and past historical uses.

For the RI, background samples were collected for groundwater, surface soil (0 to 0.5 ft bgs), soil (to depths of approximately 20 ft bgs), sediment, and surface water and compiled into background data sets. Suitable locations for the collection of background pipeline/utility sediment and water samples were not identified. For these matrices, the background sediment and surface water data sets were used to determine SRCs.

The data sets were evaluated using several different statistical tests in accordance with the process outlined in Figure 13-1 (Revised 2007 RIR Figure 4-1). First, a determination was made as to whether the parameter was detected within a given EU. If there were no detections of the parameter in the EU, the parameter was not considered to be an SRC. Next, site sample results for each parameter were compared to the corresponding background screening values. A background screening value was defined to be the lesser of the 95% background UTL or the maximum value in the background data set. Parameters were designated as Preliminary Site-Related Constituents (pSRCs) if their site data sets contained at least one value that was greater than the background screening value. This step did not definitively determine if a particular parameter was an SRC or not. It was possible for a parameter that was not a pSRC to be deemed an SRC. However, the statistical requirements in this case were more rigorous than those required of parameters that were pSRCs.

If the parameter was detected in the EU and the parameter is present in the background samples, a statistical analysis of variance (ANOVA) between the site data and the background data was performed. Parameters identified as SRCs through ANOVA testing were designated as ANOVA SRCs (aSRC). A comparison of the distributions for the site data and the background data was performed for parameters that have sufficient data from site sampling ($n \geq 8$), and that have detectable background concentrations. ANOVA testing is used to determine whether the means of two populations are significantly different. If both data sets are normally distributed (or log-normally distributed) then a standard ANOVA is performed. If the two data sets have dissimilar distributions or are non-parametric, a non-parametric ANOVA is performed using the Wilcoxon Rank Sum statistical method. Determination of data

distributions in conjunction with the use of the ANOVA and Wilcoxon Rank Sum methods allows for a more statistically rigorous comparison of the site and background data.

The final determination of an SRC involves a logical evaluation process, as shown in Figure 13-1 (Revised 2007 RIR Figure 4-1). Several weight of evidence factors are used in the final SRC determination process. One of these factors includes the calculation of a "weight-of-evidence" ratio. The weight-of-evidence ratio is used when statistical evaluations yield differing outcomes or to support the statistical evaluation when only one evaluation could be performed on the data set. The weight-of-evidence ratio is only calculated if the parameter is identified as a pSRC and the parameter was not identified as an aSRC. A weight of evidence ratio greater than 1.1 indicates that the absolute value of the difference between the site data and the background level is greater than 10% of the background level. If this is the case, the parameter is considered to be site related. The weight-of-evidence ratio is determined by the following equation:

$$\text{Weight-of-Evidence} = \frac{\left|\text{maximum detected concentration - background level}\right|}{\text{background level}}$$

Additionally, parameters that were not detected in at least five percent of the samples in each EU/medium were dropped from further evaluation and were not considered to be SRCs. For parameters that were identified as aSRCs, but not pSRCs, a comparison of the site data mean and the background data mean was used as a weight of evidence factor. A site data mean greater than the background data mean indicates the parameter is site related. Parameters identified as essential nutrients were not considered to be SRCs.

The evaluation process discussed above and shown in Figure 13-1 (Revised 2007 RIR Figure 4-1) was used in the BRA to identify SRCs for each medium in each physical EU (1-14). SRCs were also identified on a site-wide basis for the following media:

- Surface water in interconnected drainage ways (EU 15);
- Pipeline sediment and water (EU 16);
- Groundwater (EU 17); and
- Deep soils (for use in Seasonal Soil Compartment [SESOIL] modeling and discussion of nature and extent in various EUs).

In the 2007 RIR, the EU-specific SRCs for soil, surface water, sediment, and groundwater (as determined in the preliminary steps of the BRA) were used for discussion of nature and extent of contamination within each EU. Risk from exposure to groundwater was to be evaluated in the BRA on a site-wide basis only. However, prior to combining EU-specific data to create a site-wide groundwater data set, preliminary screening of SRCs in each physical EU was performed to ensure that no areas exhibiting localized contamination were inadvertently dismissed. During this screening process, localized VOC contamination in groundwater was identified in EUs 4 and 13. To fully address this localized VOC contamination, the BRA evaluated groundwater on an EU-specific basis for EUs 4 and 13, as well as for EU 17 (sitewide). Although EU-specific groundwater SRCs were developed for each physical EU, only groundwater in EUs 4 and 13 were evaluated on an EU-specific basis in the BRA. As mentioned above, this RIR used the EU-specific groundwater SRCs developed in the BRA for discussion of nature and extent of contamination.

13.2.2 Response to EPA Comment Concerning the Screening Methodology for Radionuclides

An EPA comment on the RIR stated "the deletion of radionuclides based on the frequency of detection (<5%) should be removed from the RI." The Corps responded to this comment to clarify their position concerning the screening methodology for radionuclides with respect to the frequency of detection. The Corps' response to this comment, provided for information here, was as follows:

The screening process described in the RIR and used for the Baseline Risk Assessment was developed using the guidance contained in the Risk Assessment Guidance for Superfund (RAGS) developed by EPA (EPA/540/1-89/002, dated December 1989). As discussed in Section 4.4.2 of the RIR and illustrated in Figure 4-1, frequency of detection is only one component associated with determining whether a detected constituent should be considered a Site Related Constituent (SRC). When possible, a weight-of evidence test was also used.

Also, as stated in Section 3.1.1 of the Baseline Risk Assessment; "Results for parent radionuclides are sometimes reported in addition to results for short-lived decay products. To eliminate this duplication and/or mislabeling, the parent radionuclide result is always used and equilibrium conditions are assumed." This takes into account the daughter radionuclides that may or may not have been detected, thus providing a more accurate assessment than simply relying on actual analytical results for radionuclides known to be associated with a parent radionuclide. For the radionuclides alone, the Corps does not see any benefit nor rationale for revising the screening methodology used in the RIR and Baseline Risk Assessment, which was based on the RAGS guidance.

Please note that only two detected radionuclides were not identified as radionuclides of concern (ROCs): americium-241 and cobalt-60 (RIR, Sections 5.9.4.1 and 5.9.4.2). Americium-241 was detected in 9 out of 768 samples with minimum and maximum detected values of 0.0301 pCi/g and 0.636 pCi/g, respectively. Cobalt-60 was detected in 1 out of 768 samples with an estimated value of 0.0058 pCi/g. Also, any cobalt-60 that would have been brought to the site over fifty (50) years ago would have decayed significantly since it only has a half-life of 5.27 years. This is supported by the sampling results for cobalt-60.

13.3 REVISION OF BACKGROUND DATA SUMMARY AND TOXICITY

A summary of the background data for each investigative media and associated UTLs calculated for the NFSS was presented in Table 2.1 (Background Data Summary for NFSS with UTLs) of the BRA. The set of background values, represented by either the UTL or maximum detected concentration of each analyte for each sample medium, was used in comparisons to background concentrations for SRC and COPC determinations. Toxicity criteria and chemical specific parameters for chemical SRCs were presented in Table 2.2 (Toxicity Criteria and Chemical-Specific Parameters for Chemical SRCs) of the BRA.

The revision to Table 2.1 of the BRA is shown in Table 13-1 of this RIR Addendum. BRA Table 2.1 has been revised to correct the UTL (background concentration) for arsenic in surface soil. The revised background concentration for arsenic reflects the removal of statistical outlier results as explained in the 2007 RIR (USACE 2007a). The correct background concentration for arsenic in surface soil was used for 2007 RIR evaluations. Table 13-1 (Revised BRA Table 2.1) is consistent with information presented in the 2007 RIR and does not affect conclusions of the 2007 RIR or BRA. Footnotes have also been included in Table 13-1.

The revision of Table 2.2 of the BRA is presented in this RIR Addendum as Table 13-2. BRA Table 2.2 has been revised to indicate references for toxicity information. References to toxicity values are explained in the footnotes of Table 13-2.

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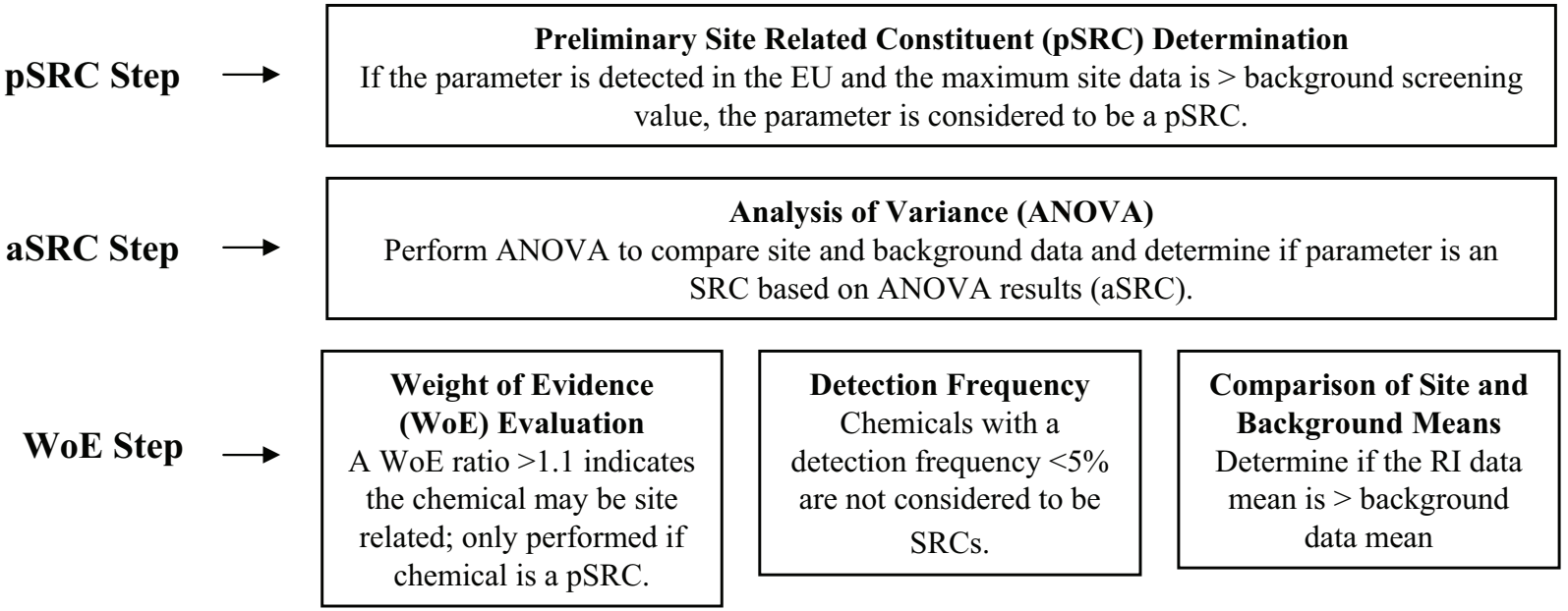
SECTION 13

FIGURE



Evaluation Cases for Determination of Final SRC

pSRC	aSRC	WoE	Final SRC? *
Yes	Yes	NA	Yes
Yes	No	>1.1	Yes
Yes	NA	>1.1	Yes
No	Yes	RI Mean>Bkg Mean	Yes
Yes	No	<1.1	No
No	No	NA	No
No	Yes	RI Mean<Bkg Mean	No
No	NA	<5% detects	No

* **Essential Nutrient** – Any chemical identified as an essential nutrient is not considered to be an SRC.

Figure 13-1. SRC Determination Process

SECTION 13

TABLES

Table 13-1. Background Data Summary for NFSS

Analyte (units)	Results >Detection Limit	Minimum Detect	Maximum Detect	Site-specific Background Criteria
Groundwater				
Metals				
Aluminum (µg/L)	23/ 28	3.94	979	979
Antimony (µg/L)	13/ 28	0.099	2.34	2.34
Arsenic (µg/L)	23/ 28	3.3	30.6	30.6
Barium (µg/L)	28/ 28	5.69	46.8	46.8
Boron (µg/L)	28/ 28	67.9	3820	3820
Cadmium (µg/L)	26/ 28	0.9	2.51	2.51
Calcium (µg/L)	28/ 28	50400	620000	620000
Chromium (µg/L)	14/ 28	1.03	3.19	3.19
Cobalt (µg/L)	6/ 28	0.468	2.8	2.8
Copper (µg/L)	18/ 28	1.66	204	204
Iron (µg/L)	26/ 27	28.1	8810	8810
Lead (µg/L)	24/ 28	0.017	5.99	5.99
Lithium (µg/L)	27/ 28	3.5	1130	1130
Magnesium (µg/L)	28/ 28	25900	580000	580000
Manganese (µg/L)	28/ 28	2.97	722	722
Mercury (µg/L)	2/ 28	0.15	0.17	0.17
Nickel (µg/L)	4/ 28	0.831	6.48	6.48
Potassium (µg/L)	28/ 28	712	63600	62100
Selenium (µg/L)	23/ 28	1.79	4.24	4.24
Silver (µg/L)	9/ 28	0.006	0.018	0.018
Sodium (µg/L)	28/ 28	17700	1200000	1200000
Thallium (µg/L)	16/ 28	0.014	1.72	1.72
Vanadium (µg/L)	9/ 28	0.323	2.8	2.8
Zinc (µg/L)	20/ 28	0.35	131	131
PAHs				
Benzo(k)fluoranthene (µg/L)	1/ 24	0.0334	0.0334	0.0334
Pesticides				
4,4'-DDE (µg/L)	7/ 24	0.00447	0.0146	0.0146
4,4'-DDT (µg/L)	9/ 24	0.0134	0.0413	0.0413
Radionuclides				
Alpha (pCi/L) *	6/ 24	5.91	59.2	15
Americium-241 (pCi/L) **	1/ 24	12.2	12.2	12.2
Beta (pCi/L) *	23/ 24	11.3	2340	50
Radium-226 (pCi/L)	20/ 24	0.308	1.76	1.76
Radium-228 (pCi/L)	11/ 24	0.569	1.67	1.67
Thorium-228 (pCi/L)	1/ 24	0.25	0.25	0.25
Thorium-230 (pCi/L)	23/ 24	0.285	0.877	0.877
Thorium-232 (pCi/L)	9/ 24	0.0456	0.229	0.229
Total Uranium (µg/L)	24/ 24	0.295	15.6	15.6
Uranium-234 (pCi/L)	23/ 24	0.21	8.73	8.73
Uranium-235 (pCi/L)	5/ 24	0.188	0.715	0.715
Uranium-238 (pCi/L)	19/ 24	0.116	5.79	5.79
Volatile Organics				
1,1,1-Trichloroethane (µg/L)	1/ 24	0.435	0.435	0.435
2-Butanone (µg/L)	1/ 24	4.49	4.49	4.49
Acetone (µg/L)	4/ 24	3.96	30.5	30.5

Table 13-1. Background Data Summary for NFSS

Analyte (units)	Results >Detection Limit	Minimum Detect	Maximum Detect	Site-specific Background Criteria
Benzene (µg/L)	1/ 24	0.366	0.366	0.366
Chlorobenzene (µg/L)	1/ 24	0.387	0.387	0.387
Ethylbenzene (µg/L)	1/ 24	0.297	0.297	0.297
Toluene (µg/L)	2/ 24	0.438	4.45	4.45
trans-1,3-Dichloropropene (µg/L)	1/ 24	0.495	0.495	0.495
Vinyl chloride (µg/L)	1/ 24	1.48	1.48	1.48
Xylenes (total) (µg/L)	1/ 24	0.958	0.958	0.958
Soil				
Moisture, Percent (%)	4/ 4	14.6	17.2	
Percent Solids (%)	8/ 8	76.9	84.3	84.3
Total Organic Carbon (mg/Kg)	30/ 30	2250	47300	47300
Metals				
Aluminum (mg/Kg)	34/ 34	4380	19100	19100
Antimony (mg/Kg)	13/ 34	0.26	0.94	0.94
Arsenic (mg/Kg)	33/ 33	1.7	11.4	8.73
Barium (mg/Kg)	34/ 34	45.2	279	263
Beryllium (mg/Kg)	34/ 34	0.12	1	1
Boron (mg/Kg)	29/ 34	1.4	10.1	10.1
Cadmium (mg/Kg)	13/ 34	0.04	0.53	0.53
Calcium (mg/Kg)	34/ 34	994	58900	58900
Chromium (mg/Kg)	34/ 34	5.3	25.8	25.8
Cobalt (mg/Kg)	34/ 34	2.2	57.4	36.7
Copper (mg/Kg)	34/ 34	4.1	49.3	49.3
Iron (mg/Kg)	34/ 34	6240	36400	36400
Lead (mg/Kg)	33/ 33	2.8	55.2	37.6
Lithium (mg/Kg)	34/ 34	4.6	36.8	36.8
Magnesium (mg/Kg)	34/ 34	931	14800	14800
Manganese (mg/Kg)	34/ 34	70	6650	6650
Mercury (mg/Kg)	13/ 34	0.013	0.27	0.27
Nickel (mg/Kg)	34/ 34	5.8	38	38
Potassium (mg/Kg)	34/ 34	138	3200	2860
Selenium (mg/Kg)	8/ 33	0.21	0.37	0.37
Silver (mg/Kg)	2/ 34	0.27	0.27	0.27
Sodium (mg/Kg)	34/ 34	51.7	331	331
Vanadium (mg/Kg)	34/ 34	9.9	35.2	35.2
Zinc (mg/Kg)	34/ 34	23.1	266	266
PAHs				
Acenaphthene (µg/kg)	1/ 34	79	79	79
Anthracene (µg/kg)	1/ 34	8	8	8
Benzo(a)anthracene (µg/kg)	4/ 34	3.7	284	284
Benzo(a)pyrene (µg/kg)	3/ 34	3.5	313	313
Benzo(b)fluoranthene (µg/kg)	8/ 34	1.6	396	396
Benzo(g,h,i)perylene (µg/kg)	2/ 34	4.1	16	16
Benzo(k)fluoranthene (µg/kg)	5/ 34	0.53	322	322
Chrysene (µg/kg)	4/ 19	1.6	378	378
Dibenzo(a,h)anthracene (µg/kg)	1/ 34	2.7	2.7	2.7
Fluoranthene (µg/kg)	6/ 34	1.3	889	889
Fluorene (µg/kg)	1/ 34	2.9	2.9	2.9

Table 13-1. Background Data Summary for NFSS

Analyte (units)	Results >Detection Limit	Minimum Detect	Maximum Detect	Site-specific Background Criteria
Indeno(1,2,3-cd)pyrene (µg/kg)	1/ 34	8.8	8.8	8.8
Phenanthrene (µg/kg)	6/ 34	3.5	538	538
Pyrene (µg/kg)	7/ 34	1.5	716	716
Pesticides				
4,4'-DDE (µg/kg)	1/ 4	1.4	1.4	
4,4'-DDT (µg/kg)	1/ 4	0.65	0.65	
Heptachlor epoxide (µg/kg)	1/ 4	0.37	0.37	
Radionuclides				
Alpha (pCi/g)	8/ 8	9.69	15.1	15.1
Beta (pCi/g)	8/ 8	21.4	28.9	28.9
Cesium-137 (pCi/g)	14/ 30	0.0321	0.343	0.343
Potassium-40 (pCi/g)	22/ 22	10	32.9	32.9
Radium-226 (pCi/g)	30/ 30	0.394	1.3	1.2
Radium-228 (pCi/g)	30/ 30	0.365	1.26	1.26
Thorium-228 (pCi/g)	30/ 30	0.595	1.64	1.64
Thorium-230 (pCi/g)	30/ 30	0.444	1.62	1.39
Thorium-232 (pCi/g)	30/ 30	0.368	1.24	1.24
Total Uranium (µg/g)	30/ 30	1.22	3.94	3.58
Uranium-234 (pCi/g)	30/ 30	0.281	1.68	1.66
Uranium-235 (pCi/g)	1/ 30	0.0847	0.0847	0.0847
Uranium-238 (pCi/g)	30/ 30	0.367	1.36	1.34
Semi-Volatile Organics				
bis(2-Ethylhexyl)phthalate (µg/kg)	4/ 19	260	5130	5130
Pentachlorophenol (µg/kg)	1/ 19	110	110	110
Sediment				
Explosives				
HMX (µg/kg)	1/ 10	99.6	99.6	99.6
Metals				
Aluminum (mg/Kg)	10/ 10	9710	30400	30400
Antimony (mg/Kg)	6/ 10	0.518	5.03	5.03
Arsenic (mg/Kg)	10/ 10	1.42	7.14	7.14
Barium (mg/Kg)	10/ 10	78.8	246	246
Beryllium (mg/Kg)	10/ 10	0.412	1.44	1.44
Boron (mg/Kg)	10/ 10	7.26	31.4	31.4
Cadmium (mg/Kg)	10/ 10	0.137	1.89	1.89
Calcium (mg/Kg)	10/ 10	3960	59400	59400
Chromium (mg/Kg)	10/ 10	14.2	472	472
Cobalt (mg/Kg)	10/ 10	4.55	21.3	21.3
Copper (mg/Kg)	10/ 10	16.6	184	184
Iron (mg/Kg)	10/ 10	12200	37800	37800
Lead (mg/Kg)	10/ 10	9.42	121	121
Lithium (mg/Kg)	10/ 10	14.4	47	47
Magnesium (mg/Kg)	10/ 10	2730	27300	27300
Manganese (mg/Kg)	10/ 10	165	814	814
Mercury (mg/Kg)	10/ 10	0.013	0.47	0.47
Nickel (mg/Kg)	10/ 10	12	51.9	51.9
Potassium (mg/Kg)	10/ 10	1510	5070	5070
Selenium (mg/Kg)	10/ 10	0.586	1.87	1.87

Table 13-1. Background Data Summary for NFSS

Analyte (units)	Results >Detection Limit	Minimum Detect	Maximum Detect	Site-specific Background Criteria
Silver (mg/Kg)	10/ 10	0.049	0.742	0.742
Sodium (mg/Kg)	10/ 10	56.4	679	679
Thallium (mg/Kg)	10/ 10	0.118	0.356	0.356
Vanadium (mg/Kg)	10/ 10	19	60.6	60.6
Zinc (mg/Kg)	10/ 10	64.4	405	405
PAHs				
Acenaphthylene (µg/kg)	1/ 10	134	134	134
Benzo(a)anthracene (µg/kg)	6/ 10	2.3	399	399
Benzo(a)pyrene (µg/kg)	3/ 10	148	618	618
Benzo(b)fluoranthene (µg/kg)	6/ 10	27.9	1090	1090
Benzo(g,h,i)perylene (µg/kg)	2/ 10	68.4	179	179
Benzo(k)fluoranthene (µg/kg)	3/ 10	250	381	381
Chrysene (µg/kg)	4/ 10	57.3	470	470
Fluoranthene (µg/kg)	5/ 10	42.6	696	696
Indeno(1,2,3-cd)pyrene (µg/kg)	2/ 10	140	265	265
Phenanthrene (µg/kg)	3/ 10	99.1	169	169
Pyrene (µg/kg)	5/ 10	7.64	1000	1000
PCBs				
Aroclor-1242 (µg/kg)	3/ 10	9.61	66.3	66.3
Aroclor-1254 (µg/kg)	6/ 10	3.59	58.3	58.3
Aroclor-1260 (µg/kg)	6/ 10	1.8	21.7	21.7
Pesticides				
4,4'-DDE (µg/kg)	4/ 10	0.511	1.38	1.38
4,4'-DDT (µg/kg)	3/ 10	1.12	2.26	2.26
Dieldrin (µg/kg)	2/ 10	0.344	0.638	0.638
Radionuclides				
Alpha (pCi/g)	10/ 10	10.7	22.4	22.4
Beta (pCi/g)	10/ 10	20.7	38.6	38.6
Cesium-137 (pCi/g)	7/ 10	0.0333	0.389	0.389
Radium-226 (pCi/g)	10/ 10	0.713	2.43	2.43
Radium-228 (pCi/g)	10/ 10	0.8	1.14	1.14
Thorium-228 (pCi/g)	10/ 10	0.704	1.31	1.31
Thorium-230 (pCi/g)	6/ 10	0.956	5.58	5.58
Thorium-232 (pCi/g)	10/ 10	0.637	1.23	1.23
Total Uranium (µg/g)	10/ 10	1.7	6.47	6.47
Uranium-234 (pCi/g)	10/ 10	0.835	3.57	3.57
Uranium-235 (pCi/g)	2/ 10	0.19	0.309	0.309
Uranium-238 (pCi/g)	10/ 10	0.487	3.08	3.08
Semi-Volatile Organics				
bis(2-Ethylhexyl)phthalate (µg/kg)	5/ 10	99.5	31300	31300
Volatile Organics				
1,1-Dichloroethene (µg/kg)	6/ 10	0.921	3.46	3.46
2-Butanone (µg/kg)	1/ 10	49.3	49.3	49.3
Acetone (µg/kg)	5/ 10	23.5	206	206
Toluene (µg/kg)	3/ 10	0.923	8.89	8.89
Surface Soil				
Moisture, Percent (%)	1/ 1	14.6	14.6	
Percent Solids (%)	4/ 4	76.9	82.5	

Table 13-1. Background Data Summary for NFSS

Analyte (units)	Results >Detection Limit	Minimum Detect	Maximum Detect	Site-specific Background Criteria
Total Organic Carbon (mg/Kg)	15/ 15	8150	47300	47300
Metals				
Aluminum (mg/Kg)	16/ 16	4380	18400	18400
Antimony (mg/Kg)	6/ 16	0.26	0.94	0.94
Arsenic (mg/Kg)	15/ 15	2.3	11.4	11.3
Barium (mg/Kg)	16/ 16	45.2	279	279
Beryllium (mg/Kg)	16/ 16	0.18	1	1
Boron (mg/Kg)	12/ 16	1.7	10.1	10.1
Cadmium (mg/Kg)	8/ 16	0.04	0.53	0.53
Calcium (mg/Kg)	16/ 16	994	45200	45200
Chromium (mg/Kg)	16/ 16	5.3	24.3	24.3
Cobalt (mg/Kg)	16/ 16	2.2	57.4	57.4
Copper (mg/Kg)	16/ 16	4.4	34.7	34.7
Iron (mg/Kg)	16/ 16	6240	36400	36400
Lead (mg/Kg)	15/ 15	4.7	55.2	55.2
Lithium (mg/Kg)	16/ 16	4.6	27.9	27.9
Magnesium (mg/Kg)	16/ 16	931	10200	10200
Manganese (mg/Kg)	16/ 16	70	6650	5630
Mercury (mg/Kg)	9/ 16	0.029	0.27	0.27
Nickel (mg/Kg)	16/ 16	5.8	37.5	37.5
Potassium (mg/Kg)	16/ 16	138	1820	1820
Selenium (mg/Kg)	7/ 15	0.21	0.37	0.37
Silver (mg/Kg)	2/ 16	0.27	0.27	0.27
Sodium (mg/Kg)	16/ 16	51.7	286	286
Vanadium (mg/Kg)	16/ 16	9.9	34	34
Zinc (mg/Kg)	16/ 16	23.1	78	78
PAHs				
Benzo(a)anthracene (µg/kg)	2/ 16	208	284	284
Benzo(a)pyrene (µg/kg)	1/ 16	313	313	313
Benzo(b)fluoranthene (µg/kg)	3/ 16	2.5	396	396
Benzo(k)fluoranthene (µg/kg)	3/ 16	0.74	322	322
Chrysene (µg/kg)	2/ 16	303	378	378
Fluoranthene (µg/kg)	3/ 16	2.3	889	889
Phenanthrene (µg/kg)	1/ 16	538	538	538
Pyrene (µg/kg)	3/ 16	1.5	716	716
Radionuclides				
Alpha (pCi/g)	4/ 4	10.4	13.9	
Beta (pCi/g)	4/ 4	21.4	27.5	
Cesium-137 (pCi/g)	13/ 15	0.0321	0.343	0.343
Potassium-40 (pCi/g)	11/ 11	10	31.1	31.1
Radium-226 (pCi/g)	15/ 15	0.394	0.921	0.921
Radium-228 (pCi/g)	15/ 15	0.365	1.26	1.26
Thorium-228 (pCi/g)	15/ 15	0.595	1.64	1.64
Thorium-230 (pCi/g)	15/ 15	0.444	1.62	1.6
Thorium-232 (pCi/g)	15/ 15	0.473	1.24	1.24
Total Uranium (µg/g)	15/ 15	1.22	3.94	3.94
Uranium-234 (pCi/g)	15/ 15	0.281	1.68	1.68
Uranium-235 (pCi/g)	1/ 15	0.0847	0.0847	0.0847

Table 13-1. Background Data Summary for NFSS

Analyte (units)	Results >Detection Limit	Minimum Detect	Maximum Detect	Site-specific Background Criteria
Uranium-238 (pCi/g)	15/ 15	0.367	1.36	1.36
Semi-Volatile Organics				
bis(2-Ethylhexyl)phthalate (µg/kg)	3/ 16	320	5130	5130
Surface Water				
Explosives				
1,3,5-Trinitrobenzene (µg/L)	1/ 10	0.0249	0.0249	0.0249
2,4,6-Trinitrotoluene (µg/L)	1/ 10	0.0779	0.0779	0.0779
2,4-Dinitrotoluene (µg/L)	1/ 10	0.0349	0.0349	0.0349
2,6-Dinitrotoluene (µg/L)	1/ 10	0.0501	0.0501	0.0501
2-Amino-4,6-dinitrotoluene (µg/L)	1/ 10	0.0779	0.0779	0.0779
2-Nitrotoluene (µg/L)	1/ 10	0.064	0.064	0.064
3-Nitrotoluene (µg/L)	1/ 10	0.064	0.064	0.064
4-Amino-2,6-dinitrotoluene (µg/L)	1/ 10	0.0409	0.0409	0.0409
4-Nitrotoluene (µg/L)	1/ 10	0.064	0.064	0.064
HMX (µg/L)	1/ 10	0.0779	0.0779	0.0779
m-Dinitrobenzene (µg/L)	1/ 9	0.033	0.033	0.033
Nitrobenzene (µg/L)	1/ 10	0.0131	0.0131	0.0131
RDX (µg/L)	1/ 10	0.053	0.053	0.053
Tetryl (µg/L)	1/ 10	0.032	0.032	0.032
Metals				
Aluminum (µg/L)	10/ 10	23.6	5030	5030
Antimony (µg/L)	7/ 10	0.075	2.33	2.33
Arsenic (µg/L)	9/ 10	2.58	6.33	6.33
Barium (µg/L)	10/ 10	24.4	117	117
Beryllium (µg/L)	2/ 10	0.224	0.253	0.253
Boron (µg/L)	10/ 10	26.7	244	244
Calcium (µg/L)	10/ 10	37200	141000	141000
Chromium (µg/L)	6/ 10	1.57	7.52	7.52
Cobalt (µg/L)	1/ 10	1.08	1.08	1.08
Copper (µg/L)	9/ 10	2.3	15	15
Iron (µg/L)	10/ 10	114	4740	4740
Lead (µg/L)	10/ 10	0.14	11.1	11.1
Lithium (µg/L)	10/ 10	0.94	13.2	13.2
Magnesium (µg/L)	10/ 10	9730	30200	30200
Manganese (µg/L)	10/ 10	24.3	951	951
Nickel (µg/L)	5/ 10	1.4	7.74	7.74
Potassium (µg/L)	10/ 10	1850	9540	9540
Selenium (µg/L)	5/ 10	0.344	4.24	4.24
Silver (µg/L)	7/ 10	0.006	0.03	0.03
Sodium (µg/L)	10/ 10	3300	179000	179000
Thallium (µg/L)	3/ 10	0.008	0.026	0.026
Vanadium (µg/L)	8/ 10	0.246	8.52	8.52
Zinc (µg/L)	9/ 10	1.36	70.5	70.5
PAHs				
Benzo(a)anthracene (µg/L)	2/ 10	0.0974	0.108	0.108
Chrysene (µg/L)	2/ 10	0.142	0.151	0.151
Fluoranthene (µg/L)	2/ 10	0.415	0.522	0.522
Phenanthrene (µg/L)	1/ 10	0.223	0.223	0.223

Table 13-1. Background Data Summary for NFSS

Analyte (units)	Results >Detection Limit	Minimum Detect	Maximum Detect	Site-specific Background Criteria
Pyrene (µg/L)	2/ 10	0.23	0.302	0.302
Pesticides				
4,4'-DDE (µg/L)	3/ 10	0.00922	0.0461	0.0461
4,4'-DDT (µg/L)	3/ 10	0.0121	0.0318	0.0318
Radionuclides				
Alpha (pCi/L)	6/ 8	2.74	12.2	12.2
Beta (pCi/L)	7/ 8	2.33	12.3	12.3
Radium-226 (pCi/L)	2/ 10	0.449	0.487	0.487
Radium-228 (pCi/L)	6/ 10	0.538	1.43	1.43
Thorium-230 (pCi/L)	6/ 10	0.293	0.606	0.606
Total Uranium (µg/L)	8/ 8	0.444	12.5	12.5
Uranium-234 (pCi/L)	8/ 8	0.252	5.78	5.78
Uranium-235 (pCi/L)	2/ 8	0.301	0.529	0.529
Uranium-238 (pCi/L)	7/ 8	0.56	4.81	4.81
Volatile Organics				
1,2-Dichloropropane (µg/L)	1/ 10	1.72	1.72	1.72
2-Butanone (µg/L)	1/ 10	15.8	15.8	15.8
Acetone (µg/L)	4/ 10	4.2	16.4	16.4
Bromodichloromethane (µg/L)	1/ 10	3.25	3.25	3.25
Chloroform (µg/L)	1/ 10	5.3	5.3	5.3
Dibromochloromethane (µg/L)	1/ 10	1.59	1.59	1.59
Tetrachloroethene (µg/L)	1/ 10	0.554	0.554	0.554

* MCLs used for background screening criteria for both total and dissolved gross alpha and gross beta.

** Since Am-241 was not detected in onsite groundwater, the detection of Am-241 in background had no impact on the RI/BRA.

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Table 13-2. Toxicity Criteria and Chemical-Specific Parameters for Chemical SRCs

Constituent	CASRN	TOXICITY VALUES: Noncancer Reference Doses RfDs - (mg/kg/day) Oral RfDo	Ref.	Dermal RfDa	Ref.	Inhalation RfDi[a]	Ref.	Cancer Slope Factors CSFs - (kg-day/mg) Oral CSFo	Ref.	Dermal CSFa	Ref.	Inhalation CSFi[a]	Ref.	EPA Cancer Class	Non-Food Factors: Gastrointestinal Absorption Factor[e] (ABS_{GI})	Dermal Absorption Factor[f] (ABS_d)	Volatilization Factor VF (m^3/kg)
PCBs/Pesticides																	
4CMX	None	NA		NA		NA		NA		NA		NA		NA	1.00	NA	NA
Aroclor-1242	53469-21-9	2.0E-05	iris, b	2.0E-05	iris, b	2.00E-05	iris, b	2.0E+00	iris, b	2.0E+00	iris, b	2.00E+00	iris, b	B2	1.00	0.14 f, g	NA
Aroclor-1254	27323-18-8	2.0E-05	iris, b	2.0E-05	iris, b	2.00E-05	iris, b	2.0E+00	iris, b	2.0E+00	iris, b	2.00E+00	iris, b	B2	0.80	0.14 f, g	NA
Aroclor-1260	11096-82-5	2.0E-05	iris, b	2.0E-05	iris, b	2.00E-05	iris, b	2.0E+00	iris, b	2.0E+00	iris, b	2.00E+00	iris, b	B2	0.80	0.14 f, g	NA
4,4'-DDD	72-54-8	NA		NA		NA		2.4E-01	iris	2.4E-01	iris	NA		B2	0.70	0.03 f, g	NA
4,4'-DDE	72-55-9	NA		NA		NA		3.4E-01	iris	3.4E-01	iris	NA		B2	0.70	0.03 f, g	NA
4,4'-DDT	50-29-3	5.0E-04	iris	5.0E-04	iris	5.00E-04	iris	3.4E-01	iris	3.4E-01	iris	3.40E-01	iris	B2	0.70	0.03 f, g	NA
Aldrin	309-00-2	3.0E-05	iris	3.0E-05	iris	2.85E-05	iris	1.7E+01	iris	1.7E+01	iris	1.70E+01	iris	B2	1.00	NA	NA
alpha-BHC	319-84-6	NA		NA		NA		6.3E+00	iris	6.3E+00	iris	6.30E+00	iris	B2	1.00	NA	NA
alpha-Chlordane (technical)	5103-71-9	5.0E-04	iris	5.0E-04	iris	2.00E-04	iris	3.5E-01	iris	3.5E-01	iris	3.50E-01	iris	B2	0.80	0.04 f, g	NA
beta-BHC	319-85-7	NA		NA		NA		1.8E+00	iris	1.8E+00	iris	1.86E+00	iris	C	1.00	NA	NA
beta-Chlordane (technical)	5103-74-2	5.0E-04	iris	5.0E-04	iris	2.00E-04	iris	3.5E-01	iris	3.5E-01	iris	3.50E-01	iris	B2	0.80	0.04 f, g	NA
delta-BHC	319-86-8	NA		NA		NA		NA		NA		NA		D	1.00	NA	NA
Dieldrin	60-57-1	5.0E-05	iris	5.0E-05	iris	NA		1.6E+01	iris	1.6E+01	iris	1.60E+01	iris	B2	1.00	NA	NA
Endosulfan I	959-98-8	6.0E-03	iris	6.0E-03	iris	NA		NA		NA		NA		NA	1.00	NA	NA
Endosulfan II	332-13-65-9	6.0E-03	iris	6.0E-03	iris	NA		NA		NA		NA		NA	1.00	NA	NA
Endosulfan sulfate	1031-07-8	6.0E-03	iris	6.0E-03	iris	NA		NA		NA		NA		NA	1.00	NA	NA
Endrin	72-20-8	3.0E-04	iris	3.0E-04	iris	NA		NA		NA		NA		D	1.00	NA	NA
Endrin aldehyde	7421-93-4	3.0E-04	iris	3.0E-04	iris	NA		NA		NA		NA		D	1.00	NA	NA
Endrin ketone	53494-70-5	3.0E-04	iris	3.0E-04	iris	NA		NA		NA		NA		D	1.00	NA	NA
gamma-BHC (Lindane)	58-89-9	3.0E-04	iris	3.0E-04	iris	NA		1.3E+00	heast	1.3E+00	heast	NA		B2	1.00	0.04 f, g	NA
gamma-Chlordane (technical)	12789-03-6	5.0E-04	iris	5.0E-04	iris	2.00E-04	iris	3.5E-01	iris	3.5E-01	iris	3.50E-01	iris	B2	0.80	0.04 f, g	NA
Heptachlor	76-44-8	5.0E-04	iris	5.0E-04	iris	NA		4.5E+00	iris	4.5E+00	iris	4.60E+00	iris	B2	1.00	NA	NA
Heptachlor epoxide	1024-57-3	1.3E-05	iris	1.3E-05	iris	NA		9.1E+00	iris	9.1E+00	iris	9.10E+00	iris	B2	1.00	NA	NA
Isophorone	78-59-1	2.0E-01	iris	2.0E-01	iris	NA		9.5E-04	iris	9.5E-04	iris	9.50E-04	iris	C	1.00	NA	NA
Methoxychlor	72-43-5	5.0E-03	iris	5.0E-03	iris	NA		NA		NA		NA		D	1.00	NA	NA
Toxaphene	8001-35-2	NA		NA		NA		1.1E+00	iris	1.1E+00	iris	1.12E+00	iris	B2	1.00	NA	NA
SVOCs																	
1,2-Dichloropropane	78-87-5	NA		NA		1.14E-03	iris	6.8E-02	heast	6.8E-02	heast	6.80E-02	heast	B2	1.00	0.10 f	NA
1,2-Dinitrobenzene	528-29-0	1.00E-04	pprtv	NA		NA		NA		NA		NA		NA	1.00	0.10	
1,3,5-Trinitrobenzene	99-35-4	3.0E-02	iris	3.0E-02	iris	NA		NA		NA		NA		NA	1.00	0.10 f	NA
1,4-Dichlorobenzene	106-46-7	NA		NA		2.29E-01	iris	2.4E-02	heast	2.4E-02	heast	NA		C	1.00	0.10 f	NA
2,4,6-Tribromophenol	118-79-6	NA		NA		NA		NA		NA		NA		NA	1.00	0.10 f	NA
2,4-Dinitrotoluene	121-14-2	2.0E-03	iris	2.0E-03	iris	NA		6.8E-01	iris, c	6.8E-01	iris, b	NA		B2	1.00	0.102 f	NA
2,6-Dinitrotoluene	606-20-2	1.0E-03	heast	1.0E-03	heast	NA		6.8E-01	iris, c	6.8E-01	iris, b	NA		B2	1.00	0.099 f	NA
2-Amino-4,6-dinitrotoluene	35572-78-2	2.0E-04	ncea	2.0E-04	ncea	NA		NA		NA		NA		NA	1.00	0.10 f	NA
2-Chlorophenol	95-57-8	5.0E-03	iris	5.0E-03	iris	NA		NA		NA		NA		NA	1.00	0.10 f	NA
2-Fluorobiphenyl	321-60-8	NA		NA		NA		NA		NA		NA		NA	1.00	0.10 f	NA
2-Methylnaphthalene	91-57-6	4.0E-03	iris	4.0E-03	iris	NA		NA		NA		NA		NA	1.00	0.13 f	NA
2-Nitrotoluene	88-72-2	1.0E-02	heast	1.0E-02	heast	NA		NA		NA		NA		NA	1.00	0.10 f	NA
Acenaphthene	83-32-9	6.0E-02	iris	6.0E-02	iris	6.00E-02	iris	NA		NA		NA		NA	0.58	0.20 f, g	NA
Acenaphthylene	208-96-8	6.0E-02	ncea, rpf	6.0E-02	ncea, rpf	6.00E-02	ncea, rpf	NA		NA		NA		NA	0.58	0.15 g	NA
Anthracene	120-12-7	3.0E-01	iris	3.0E-01	iris	2.86E-01	iris	NA		NA		NA		D	0.58	0.29 f, g	NA
Benz(a)anthracene	56-55-3	NA		NA		NA		7.3E-01	ncea, rpf	7.3E-01	ncea, rpf	3.08E-01	ncea, rpf	B2	0.58	0.18 g	NA
Benzo(a)pyrene	50-32-8	NA		NA		NA		7.3E+00	iris	7.3E+00	iris	3.08E+00	ncea, rpf	B2	0.58	0.18 g	NA
Benzo(b)fluoranthene	205-99-2	NA		NA		NA		7.3E-01	ncea, rpf	7.3E-01	ncea, rpf	3.08E-01	ncea, rpf	B2	0.58	0.18 g	NA
Benzo(g,h,i)perylene	191-24-2	3.0E-02	ncea, rpf	3.0E-02	ncea, rpf	NA		NA		NA		NA		D	0.58	0.18 g	NA

Table 13-2. Toxicity Criteria and Chemical-Specific Parameters for Chemical SRCs

		TOXICITY VALUES													Non-Food Factors		
		Noncancer Reference Doses RfDs - (mg/kg/day)						Cancer Slope Factors CSFs - (kg-day/mg)						EPA	Gastrointestinal Absorption	Dermal Absorption	Volatilization Factor
Constituent	CASRN	Oral RfDo	Ref.	Dermal RfDa	Ref.	Inhalation RfDi[a]	Ref.	Oral CSFo	Ref.	Dermal CSFa	Ref.	Inhalation CSFi[a]	Ref.	Cancer Class	Factor[e] (ABS_{GI})	Factor[f] (ABS_d)	VF (m^3/kg)
Benzo(k)fluoranthene	207-08-9	NA		NA		NA		7.3E-02	ncea, rpf	7.3E-02	ncea, rpf	3.08E-02	ncea, rpf	B2	0.58	0.15 g	NA
Benzoic Acid	65-85-0	4.0E+00	iris	4.0E+00	iris	NA		NA		NA		NA		D	1.00	0.10 f	NA
bis(2-Chloroethyl)ether	111-91-1	1.1E+00	iris	1.1E+00	iris	1.16E+00	iris	NA		NA		NA			1.00	0.10	
bis(2-Ethylhexyl)phthalate	117-81-7	2.0E-02	iris	2.0E-02	iris	NA		1.4E-02	iris	1.4E-02	iris	NA		B2	1.00	0.10 f	NA
Butylbenzylphthalate	85-68-7	2.0E-01	iris	2.0E-01	iris	NA		NA		NA		NA		C	1.00	0.10 f	NA
Carbazole	86-74-8	NA		NA		NA		2.0E-02	heast	2.0E-02	heast	NA		B2	1.00	0.10 f	NA
Chrysene	218-01-9	NA		NA		NA		7.3E-02	ncea, rpf	7.3E-02	ncea, rpf	3.08E-03	ncea, rpf	B2	0.58	0.15 g	NA
Dibenz(a,h)anthracene	53-70-3	NA		NA		NA		7.3E+00	ncea, rpf	7.3E+00	ncea, rpf	3.08E+00	ncea, rpf	B2	0.58	0.18 g	NA
Dibenzofuran	132-64-9	2.00E-03	ncea	2.00E-03	ncea	NA		NA		NA		NA		NA	0.51	0.10 f	NA
Diethylphthalate	84-66-2	8.0E-01	iris	8.0E-01	iris	NA		NA		NA		NA		D	1.00	0.10 f	NA
Dimethylphthalate	131-11-3	1.0E+01	heast	NA		NA		NA		NA		NA			1.00	0.10	
Di-n-butylphthalate	84-74-2	1.0E-01	iris	1.0E-01	iris	NA		NA		NA		NA		D	1.00	0.10 f	NA
Di-n-octyphthalate	117-84-0	4.0E-02	pprtv	NA		NA		NA		NA		NA			1.00	0.10 f	
Fluoranthene	206-44-0	4.0E-02	iris	4.0E-02	iris	NA		NA		NA		NA		D	0.58	0.20 g	NA
Fluorene	86-73-7	4.0E-02	iris	4.0E-02	iris	NA		NA		NA		NA		D	0.58	0.20 g	NA
Indeno(1,2,3-c,d)pyrene	193-39-5	NA		NA		NA		7.3E-01	ncea, rpf	7.3E-01	ncea, rpf	3.08E-01	ncea, rpf	B2	0.58	0.20 g	NA
2-methylphenol (o-cresol)	95-48-7	5.0E-02	iris	5.0E-02	iris	NA		NA		NA		NA		C	1.00	0.10 f	NA
3-methylphenol (m-cresol)	108-39-4	5.0E-02	iris	5.0E-02	iris	NA		NA		NA		NA		C	1.00	0.10 f	NA
4-methylphenol (p-cresol)	106-44-5	NA		NA		NA		NA		NA		NA		C	1.00	0.10 f	NA
Naphthalene	91-20-3	2.0E-02	iris	2.0E-02	iris	8.60E-04	iris	NA		NA		NA		C	0.58	0.10 g	NA
Pentachlorophenol	87-86-5	3.0E-02	iris	3.0E-02	iris	NA		1.2E-01	iris	1.2E-01	iris	NA		B2	0.76	0.25 f, g	NA
Phenanthrene	85-01-8	2.0E-02	iris	2.0E-02	iris	8.60E-04	iris	NA		NA		NA		D	0.58	0.18 g	NA
Phenol	108-95-2	3.0E-01	iris	3.0E-01	iris	NA		NA		NA		NA		D	1.00	0.10 f	NA
Pyrene	129-00-0	3.0E-02	iris	3.0E-02	iris	NA		NA		NA		NA		D	0.58	0.18 g	NA
TNT, (2,4,6-Trinitrotoluene)	118-96-7	5.0E-04	iris	5.0E-04	iris	NA		3.0E-02	iris	3.0E-02	iris	NA		C	1.00	0.32 f	NA
RDX (Cyclonite)	121-82-4	3.0E-03	iris	3.0E-03	iris	NA		1.1E-01	iris	1.1E-01	iris	NA		C	1.00	0.015 f	NA
VOCs																	
1,1,1-Trichloroethane	71-55-6	2.8E-01	ncea	2.8E-01	ncea	6.30E-01	ncea	NA		NA		NA		D	1.00	NA	2.20E+03 f
1,1,2-Trichloroethane	79-00-5	4.0E-03	iris	4.0E-03	iris	4.00E-03	iris	5.7E-02	iris	5.7E-02	iris	5.60E-02	iris	C	1.00	NA	6.50E+03 f
1,1-Dichloroethene	75-35-4	5.0E-02	iris	5.0E-02	iris	5.71E-02	iris	NA		NA		NA		C	1.00	NA	1.40E+03 f
1,2-Dichloroethane	107-06-2	2.00E-02	ncea	2.00E-02	ncea	1.40E-03	heast	9.1E-02	iris	9.1E-02	iris	9.10E-02	iris	B2	1.00	NA	3.90E+03 g
2-Butanone (Methyl Ethyl Ketone)	78-93-3	6.0E-01	iris	6.0E-01	iris	1.43E+00	iris	NA		NA		NA		D	1.00	NA	1.90E+04 f
2-Hexanone	591-78-6	NA		NA		NA		NA		NA		NA		NA	1.00	NA	NA
4-Methyl-2-pentanone (Methyl Isobutyl Ketone)	108-10-1	8.0E-02	heast	8.0E-02	heast	8.60E-01	iris	NA		NA		NA		NA	1.00	NA	2.50E+04 f
Acetone	67-64-1	9.0E-01	iris	9.0E-01	iris	NA		NA		NA		NA		D	1.00	NA	1.30E+04 f
Benzene	71-43-2	4.0E-03	iris	4.0E-03	iris	8.60E-03	iris	5.5E-02	iris	5.5E-02	iris	2.70E-02	iris	A	1.00	0.08 g	2.70E+03 f
Carbon Disulfide	75-15-0	1.0E-01	iris	1.0E-01	iris	2.00E-01	iris	NA		NA		NA		NA	1.00	NA	1.20E+03 f
Carbon tetrachloride	56-23-5	7.0E-04	iris	7.0E-04	iris	NA		1.3E-01	iris	1.3E-01	iris	5.25E-02	iris	B2	1.00	NA	2.10E+03 f
Chlorobenzene	108-90-7	2.0E-02	iris	2.0E-02	iris	1.70E-02	ncea	NA		NA		NA		D	1.00	NA	6.30E+03 f
Chloroform	67-66-3	1.0E-02	iris	1.0E-02	iris	1.43E-02	ncea	NA		NA		8.05E-03	iris	B2	1.00	NA	2.70E+03 f
Chloromethane (Methyl chloride)	74-87-3	NA		2.6E-02	iris	2.60E-02	iris	1.3E-02	heast	1.3E-02	heast	6.30E-03	heast	D	1.00	NA	1.20E+03 f
cis-1,2-Dichloroethene	156-59-2	1.0E-02	pprtv	1.0E-02	pprtv	NA		NA		NA		NA		D	1.00	NA	2.90E+03 f
Dibromochloromethane	124-48-1	2.0E-02	iris	2.0E-02	iris	NA		8.4E-02	iris	8.4E-02	iris	NA		C	1.00	NA	1.60E+04 f
Ethylbenzene	100-41-4	1.0E-01	iris	1.0E-01	iris	2.90E-02	iris	NA		NA		NA		D	1.00	0.20 g	5.40E+03 f
Methylene Chloride	75-09-2	6.0E-02	iris	6.0E-02	iris	8.60E-01		7.5E-03	iris	7.5E-03	iris	1.65E-03	iris	B2	1.00	NA	2.50E+03 f
Styrene	100-42-5	2.0E-01	iris	2.0E-01	iris	2.90E-01	iris	NA		NA		NA		NA	1.00	NA	1.30E+04 f
Tetrachloroethene	127-18-4	1.0E-02	iris	1.0E-02	iris	1.00E-02	Cal/EPA	5.4E-01	Cal/EPA	5.4E-01	Cal/EPA	2.10E-02	Cal/EPA	NA	1.00	NA	2.60E+03 f
Toluene	108-88-3	8.0E-02	iris	8.0E-02	iris	1.43E+00	iris	NA		NA		NA		D	1.00	0.12 g	4.00E+03 f

Table 13-2. Toxicity Criteria and Chemical-Specific Parameters for Chemical SRCs

		TOXICITY VALUES													Non-Food Factors		
		Noncancer Reference Doses RfDs - (mg/kg/day)						Cancer Slope Factors CSFs - (kg-day/mg)						EPA	Gastrointestinal Absorption	Dermal Absorption	Volatilization Factor
Constituent	CASRN	Oral RfDo	Ref.	Dermal RfDa	Ref.	Inhalation RfDi[a]	Ref.	Oral CSFo	Ref.	Dermal CSFa	Ref.	Inhalation CSFi[a]	Ref.	Cancer Class	Factor[e] (ABS_{GI})	Factor[f] (ABS_d)	VF (m^3/kg)
trans-1,2-Dichloroethene	156-60-5	2.0E-02	iris	2.0E-02	iris	NA		NA		NA		NA		NA	1.00	NA	2.30E+03 f
Trichloroethene	79-01-6	NA		NA		1.70E-01	Cal/EPA	1.3E-02	Cal/EPA	1.3E-02	Cal/EPA	7.00E-03	Cal/EPA	NA	1.00	NA	3.30E+03 f
Vinyl chloride	75-01-4	3.0E-03	iris	3.0E-03	iris	2.90E-02	iris	1.5E+00	iris	1.5E+00	iris	3.08E-02	iris	A	1.00	NA	1.00E+03 f
Xylenes (total)	1310-20-7	2.0E-01	iris	2.0E-01	iris	2.90E-02	iris	NA		NA		NA		D	1.00	0.12 g	6.10E+03 f
Metals/Inorganics																	
Aluminum	7429-90-5	1.0E+00	pprtv	1.0E+00	pprtv	1.40E-03	pprtv	NA		NA		NA		NA	1.000	NA	NA
Antimony	7440-36-0	4.0E-04	iris	6.0E-05	iris	NA		NA		NA		NA		NA	0.150	NA	NA
Arsenic	7440-38-2	3.0E-04	iris	3.0E-04	iris	NA		1.5E+00	iris	1.5E+00	iris	1.51E+01	iris	A	0.950	0.030 f, g	NA
Barium	7440-39-3	2.0E-01	iris	1.4E-02	iris	1.43E-04	heast	NA		NA		NA		D	0.070	NA	NA
Beryllium	7440-41-7	2.0E-03	iris	1.4E-05	iris	5.71E-06	iris	NA		NA		8.40E+00	iris	B1	0.007	NA	NA
Boron	7440-42-8	2.0E-01	iris	2.0E-01	iris	5.70E-03	heast	NA		NA		NA		NA	1.000	NA	NA
Cadmium	7440-43-9	1.0E-03[food]/5.0E-04[water]	iris, d	2.5E-05	iris	NA		NA		NA		6.30E+00	iris	B1	0.025	0.001 f, g	NA
Calcium	7440-70-2	NA		NA		NA		NA		NA		NA		NA	1.000	NA	NA
Chromium (III)(insoluble salts)	7440-47-3	1.5E+00	iris	2.0E-02	iris	NA		NA		NA		NA		D	0.013	NA	NA
Chromium (VI)	18540-29-9	3.0E-03	iris	7.5E-05	iris	2.86E-05	iris	NA		NA		4.20E+01	iris	A	0.025	NA	NA
Cobalt	7440-48-4	2.0E-02	pprtv	2.0E-02	pprtv	5.70E-06	pprtv	NA		NA		9.80E+00	pprtv	NA	1.000	NA	NA
Copper	7440-50-8	4.0E-02	heast	4.0E-02	heast	NA		NA		NA		NA		D	1.000	NA	NA
Cyanide (CN-)	57-12-5	2.0E-02	iris	2.0E-02	iris	NA		NA		NA		NA		D	0.510	NA	NA
Iron	7439-89-6	NA		NA		NA		NA		NA		NA		NA	1.000	NA	NA
Lead	7439-92-1	NA		NA		NA		NA		NA		NA		B2	1.000	0.300 g	NA
Lithium	7439-93-2	NA		NA		NA		NA		NA		NA		NA	1.000	NA	NA
Magnesium	7439-95-4	NA		NA		NA		NA		NA		NA		NA	1.000	NA	NA
Manganese	7439-96-5	1.4E-01	iris	5.6E-03	iris	1.40E-05	iris	NA		NA		NA		D	0.040	NA	NA
Mercury	7439-97-6	3.0E-04	iris	2.1E-05	iris	NA		NA		NA		NA		C	0.070	NA	NA
Nickel	7440-02-0	2.0E-02	iris	8.0E-04	iris	NA		NA		NA		NA		NA	0.040	NA	NA
Potassium	7440-09-7	NA		NA		NA		NA		NA		NA		NA	1.000	NA	NA
Selenium	7782-49-2	5.0E-03	iris	2.6E-03	iris	NA		NA		NA		NA		D	0.510	NA	NA
Silver	7440-22-4	5.0E-03	iris	2.0E-04	iris	NA		NA		NA		NA		D	0.040	NA	NA
Sodium	7440-23-5	NA		NA		NA		NA		NA		NA		NA	1.000	NA	NA
Thallium (carbonate)	7440-28-0	8.0E-05	iris	8.0E-05	iris	NA		NA		NA		NA		D	1.000	NA	NA
Uranium (soluble salts)	7440-61-1	3.0E-03	iris	3.0E-03	iris	NA		NA		NA		NA		NA	1.000	NA	NA
Vanadium	7440-62-2	5.0E-03	iris	1.3E-04	iris	NA		NA		NA		NA		NA	0.026	NA	NA
Zinc	7440-66-6	3.0E-01	iris	3.0E-01	iris	NA		NA		NA		NA		D	0.510	NA	NA

Table 13-2. Toxicity Criteria and Chemical-Specific Parameters for Chemical SRCs

				Food Pathway Factors[j]					Dermal Exposure to Water Factors[k]				
Constituent	CASRN	logKow	Ref	Uptake Factor Plants (BCFr)	Uptake Factor Beef (Babeef)	Uptake Factor Milk (Bamilk)	Uptake Factor Chicken (Bachicken)	Uptake Factor Deer (Badeer)	Fraction Absorbed FA (unitless)	Permeability Constant Kp (cm/hr)	Partitioning Constant B (unitless)	Steady-State Time t* (hour)	Lag Time t (hour)
PCBs/Pesticides													
4CMX	None	NA		NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Aroclor-1242	53469-21-9	6.50E+00	h	6.78E-03	7.94E-02	2.51E-02	3.73E-02	1.59E-02	6.00E-01	7.50E-01	4.90E+00	2.03E+01	4.63E+00
Aroclor-1254	27323-18-8	6.50E+00	h	6.78E-03	7.94E-02	2.51E-02	3.73E-02	1.59E-02	6.00E-01	7.50E-01	4.90E+00	2.03E+01	4.63E+00
Aroclor-1260	11096-82-5	6.80E+00	h	4.55E-03	1.58E-01	5.01E-02	7.45E-02	3.17E-02	6.00E-01	7.50E-01	4.90E+00	2.03E+01	4.63E+00
4,4'-DDD	72-54-8	6.12E+00	h	1.12E-02	3.32E-02	1.05E-02	1.56E-02	6.63E-03	8.00E-01	1.80E-01	1.20E+00	2.60E+01	6.65E+00
4,4'-DDE	72-55-9	6.26E+00	h	9.39E-03	4.52E-02	1.43E-02	2.13E-02	9.04E-03	8.00E-01	1.60E-01	1.10E+00	2.51E+01	6.48E+00
4,4'-DDT	50-29-3	6.07E+00	h	1.20E-02	2.94E-02	9.29E-03	1.38E-02	5.88E-03	7.00E-01	2.70E-01	1.90E+00	4.25E+01	1.05E+01
Aldrin	309-00-2	6.18E+00	h	1.04E-02	3.79E-02	1.20E-02	1.78E-02	7.59E-03	1.00E+00	1.40E-03	0.00E+00	2.85E+01	1.19E+01
alpha-BHC	319-84-6	3.80E+00	h	2.47E-01	1.58E-04	5.00E-05	7.44E-05	3.16E-05	1.00E+00	1.20E-02	7.87E-02	1.07E+01	4.47E+00
alpha-Chlordane (technical)	5103-71-9	3.32E+00	h	4.67E-01	5.25E-05	1.66E-05	2.47E-05	1.05E-05	7.00E-01	3.40E-02	3.00E-01	5.11E+01	2.13E+01
beta-BHC	319-85-7	3.83E+00	h	2.36E-01	1.71E-04	5.41E-05	8.04E-05	3.42E-05	1.00E+00	1.26E-02	8.28E-02	1.07E+01	4.47E+00
beta-Chlordane (technical)	5103-74-2	5.54E+00	h	2.43E-02	8.71E-03	2.75E-03	4.09E-03	1.74E-03	7.00E-01	3.40E-02	3.00E-01	5.11E+01	2.13E+01
delta-BHC	319-86-8	4.14E+00	h	1.57E-01	3.47E-04	1.10E-04	1.63E-04	6.93E-05	1.00E+00	2.01E-02	1.32E-01	1.07E+01	4.47E+00
Dieldrin	60-57-1	5.27E+00	h	3.49E-02	4.67E-03	1.48E-03	2.20E-03	9.34E-04	8.00E-01	1.20E-02	1.00E-01	3.51E+01	1.46E+01
Endosulfan I	959-98-8	3.83E+00	h	2.37E-01	1.70E-04	5.37E-05	7.98E-05	3.40E-05	1.00E+00	2.81E-03	2.18E-02	4.79E+01	2.00E+01
Endosulfan II	332-13-65-9	3.83E+00	h	2.37E-01	1.70E-04	5.37E-05	7.98E-05	3.40E-05	1.00E+00	2.81E-03	2.18E-02	4.79E+01	2.00E+01
Endosulfan sulfate	1031-07-8	3.66E+00	h	2.97E-01	1.15E-04	3.63E-05	5.40E-05	2.30E-05	1.00E+00	1.77E-03	1.40E-02	5.89E+01	2.45E+01
Endrin	72-20-8	4.89E+00	h	5.76E-02	1.96E-03	6.19E-04	9.20E-04	3.91E-04	1.00E+00	1.97E-02	1.48E-01	6.06E+01	1.43E+01
Endrin aldehyde	7421-93-4	3.14E+00	h	5.93E-01	3.47E-05	1.10E-05	1.63E-05	6.93E-06	1.00E+00	1.38E-03	1.03E-02	3.42E+01	1.43E+01
Endrin ketone	53494-70-5	NA		NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
gamma-BHC (Lindane)	58-89-9	3.72E+00	h	2.74E-01	1.32E-04	4.17E-05	6.20E-05	2.64E-05	1.00E+00	1.06E-02	6.97E-02	1.07E+01	4.47E+00
gamma-Chlordane (technical)	12789-03-6	5.54E+00	h	2.43E-02	8.71E-03	2.75E-03	4.09E-03	1.74E-03	7.00E-01	3.80E-02	3.00E-01	5.09E+01	2.12E+01
Heptachlor	76-44-8	5.02E+00	h	4.88E-02	2.61E-03	8.26E-04	1.23E-03	5.22E-04	8.00E-01	8.60E-03	1.00E-01	3.19E+01	1.33E+01
Heptachlor epoxide	1024-57-3	4.93E+00	h	5.48E-02	2.14E-03	6.76E-04	1.00E-03	4.28E-04	8.00E-01	8.60E-03	1.00E-01	3.19E+01	1.33E+01
Isophorone	78-59-1	1.70E+00	h	4.03E+00	1.26E-06	3.98E-07	5.92E-07	2.52E-07	1.00E+00	3.40E-03	0.00E+00	1.52E+00	6.30E-01
Methoxychlor	72-43-5	5.67E+00	h	2.05E-02	1.17E-02	3.69E-03	5.49E-03	2.34E-03	1.00E+00	1.01E-01	7.23E-01	9.54E+01	9.05E+00
Toxaphene	8001-35-2	6.79E+00	h	4.58E-03	1.57E-01	4.95E-02	7.36E-02	3.13E-02	1.00E+00	1.16E-02	1.00E-01	5.38E+01	2.24E+01
SVOCs													
1,2-Dichloropropane	78-87-5	2.25E+00	g	1.94E+00	4.46E-06	1.41E-06	2.10E-06	8.92E-07	1.00E+00	7.80E-03	0.00E+00	1.10E+00	4.60E-01
1,2-Dinitrobenzene	528-29-0												
1,3,5-Trinitrobenzene	99-35-4	1.18E+00	h	8.06E+00	3.79E-07	1.20E-07	1.78E-07	7.59E-08	1.00E+00	6.09E-04	3.42E-03	3.93E+00	1.64E+00
1,4-Dichlorobenzene	106-46-7	3.41E+00	h	4.13E-01	6.48E-05	2.05E-05	3.05E-05	1.30E-05	1.00E+00	4.20E-02	2.00E-01	1.71E+00	7.10E-01
2,4,6-Tribromophenol	118-79-6	4.13E+00		1.59E-01	3.39E-04	1.07E-04	1.59E-04	6.78E-05	1.00E+00	1.18E-02	8.28E-02	1.79E+01	7.48E+00
2,4-Dinitrotoluene	121-14-2	2.00E+00	h	2.72E+00	2.49E-06	7.86E-07	1.17E-06	4.97E-07	1.00E+00	3.10E-03	1.61E-02	2.69E+00	1.12E+00
2,6-Dinitrotoluene	606-20-2	1.89E+00	h	3.14E+00	1.93E-06	6.12E-07	9.09E-07	3.87E-07	1.00E+00	2.10E-03	1.09E-02	2.69E+00	1.12E+00
2-Amino-4,6-dinitrotoluene	35572-78-2	NA		NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
2-Chlorophenol	95-57-8	2.16E+00	h	2.18E+00	3.64E-06	1.15E-06	1.71E-06	7.28E-07	1.00E+00	1.20E-02	1.00E-01	1.34E+00	5.60E-01
2-Fluorobiphenyl	321-60-8	NA		NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
2-Methylnaphthalene	91-57-6	3.86E+00	h	2.27E-01	1.82E-04	5.75E-05	8.55E-05	3.64E-05	1.00E+00	8.94E-02	4.10E-01	1.58E+00	6.57E-01
2-Nitrotoluene	88-72-2	2.30E+00	h	1.81E+00	5.01E-06	1.58E-06	2.36E-06	1.00E-06	1.00E+00	8.91E-03	4.01E-02	1.48E+00	6.15E-01

Table 13-2. Toxicity Criteria and Chemical-Specific Parameters for Chemical SRCs

				Food Pathway Factors[j]					Dermal Exposure to Water Factors[k]				
Constituent	CASRN	logKow	Ref	Uptake Factor Plants (BCFr)	Uptake Factor Beef (Babeef)	Uptake Factor Milk (Bamilk)	Uptake Factor Chicken (Bachicken)	Uptake Factor Deer (Badeer)	Fraction Absorbed FA (unitless)	Permeability Constant Kp (cm/hr)	Partitioning Constant B (unitless)	Steady-State Time t* (hour)	Lag Time t (hour)
Acenaphthene	83-32-9	3.96E+00	h	1.98E-01	2.32E-04	7.32E-05	1.09E-04	4.63E-05	1.00E+00	8.98E-02	4.29E-01	1.84E+00	7.67E-01
Acenaphthylene	208-96-8	4.07E+00	h	1.72E-01	2.95E-04	9.33E-05	1.39E-04	5.90E-05	1.00E+00	1.08E-01	5.13E-01	1.79E+00	7.47E-01
Anthracene	120-12-7	4.47E+00	h	1.01E-01	7.41E-04	2.34E-04	3.48E-04	1.48E-04	1.00E+00	1.42E-01	7.29E-01	1.11E+01	1.05E+00
Benz(a)anthracene	56-55-3	5.68E+00	h	2.02E-02	1.20E-02	3.79E-03	5.63E-03	2.40E-03	1.00E+00	4.70E-01	2.80E+00	8.53E+00	2.03E+00
Benzo(a)pyrene	50-32-8	6.13E+00	h	1.11E-02	3.39E-02	1.07E-02	1.59E-02	6.78E-03	1.00E+00	7.00E-01	4.30E+00	1.17E+01	2.69E+00
Benzo(b)fluoranthene	205-99-2	6.20E+00	h	1.01E-02	3.99E-02	1.26E-02	1.88E-02	7.99E-03	1.00E+00	7.00E-01	4.30E+00	1.20E+01	2.77E+00
Benzo(g,h,i)perylene	191-24-2	7.10E+00	h	3.05E-03	3.16E-01	1.00E-01	1.49E-01	6.32E-02	1.00E+00	2.18E+00	1.39E+01	-2.29E+05	3.70E+00
Benzo(k)fluoranthene	207-08-9	6.19E+00	h	1.02E-02	3.92E-02	1.24E-02	1.84E-02	7.84E-03	1.00E+00	7.49E-01	4.58E+00	-6.33E+02	2.72E+00
Benzoic Acid	65-85-0	1.86E+00	h	3.26E+00	1.82E-06	5.75E-07	8.55E-07	3.64E-07	1.00E+00	5.70E-03	2.42E-02	1.24E+00	5.10E-01
bis(2-Chloroethyl)ether	111-91-1												
bis(2-Ethylhexyl)phthalate	117-81-7	5.20E+00	h	3.80E-02	4.02E-03	1.27E-03	1.89E-03	8.04E-04	8.00E-01	2.50E-02	2.00E-01	3.99E+01	1.66E+01
Butylbenzylphthalate	85-68-7	4.41E+00	h	1.09E-01	6.51E-04	2.06E-04	3.06E-04	1.30E-04	1.00E+00	2.31E-02	1.57E-01	1.41E+01	5.89E+00
Carbazole	86-74-8	3.72E+00	h	2.74E-01	1.32E-04	4.17E-05	6.20E-05	2.64E-05	1.00E+00	5.23E-02	2.60E-01	2.18E+00	9.07E-01
Chrysene	218-01-9	5.74E+00	h	1.87E-02	1.38E-02	4.35E-03	6.47E-03	2.75E-03	1.00E+00	4.70E-01	2.80E+00	8.53E+00	2.03E+00
Dibenz(a,h)anthracene	53-70-3	6.55E+00	h	6.36E-03	8.87E-02	2.80E-02	4.17E-02	1.77E-02	1.00E+00	9.18E-01	5.89E+00	-3.93E+03	3.80E+00
Dibenzofuran	132-64-9	4.33E+00	h	1.22E-01	5.37E-04	1.70E-04	2.52E-04	1.07E-04	1.00E+00	1.31E-01	6.51E-01	8.82E+00	9.18E-01
Diethylphthalate	84-66-2	4.44E+00	h	1.06E-01	6.86E-04	2.17E-04	3.22E-04	1.37E-04	1.00E+00	3.90E-03	2.24E-02	4.50E+00	1.87E+00
Dimethylphthalate	131-11-3												
Di-n-butylphthalate	84-74-2	4.72E+00	h	7.24E-02	1.32E-03	4.17E-04	6.20E-04	2.64E-04	9.00E-01	2.40E-02	2.00E-01	9.27E+00	3.86E+00
Di-n-octyphthalate	117-84-0												
Fluoranthene	206-44-0	5.08E+00	h	4.47E-02	3.04E-03	9.61E-04	1.43E-03	6.08E-04	1.00E+00	2.20E-01	1.20E+00	5.68E+00	1.45E+00
Fluorene	86-73-7	4.17E+00	h	1.51E-01	3.69E-04	1.17E-04	1.74E-04	7.38E-05	1.00E+00	1.05E-01	5.19E-01	2.15E+00	8.95E-01
Indeno(1,2,3-c,d)pyrene	193-39-5	6.91E+00	h	3.90E-03	2.06E-01	6.53E-02	9.70E-02	4.13E-02	6.00E-01	1.00E+00	6.70E+00	1.68E+01	3.78E+00
2-methylphenol (o-cresol)	95-48-7	1.95E+00	h	2.93E+00	2.19E-06	6.92E-07	1.03E-06	4.38E-07	1.00E+00	7.80E-03	0.00E+00	1.03E+00	4.30E-01
3-methylphenol (m-cresol)	108-39-4	1.96E+00	h	2.93E+00	2.19E-06	6.92E-07	1.03E-06	4.38E-07	1.00E+00	7.80E-03	0.00E+00	1.03E+00	4.30E-01
4-methylphenol (p-cresol)	106-44-5	1.95E+00	h	2.93E+00	2.19E-06	6.92E-07	1.03E-06	4.38E-07	1.00E+00	7.80E-03	0.00E+00	1.03E+00	4.30E-01
Naphthalene	91-20-3	3.37E+00	h	4.35E-01	5.93E-05	1.87E-05	2.79E-05	1.19E-05	1.00E+00	4.70E-02	2.00E-01	1.34E+00	5.60E-01
Pentachlorophenol	87-86-5	5.08E+00	h	4.49E-02	3.01E-03	9.53E-04	1.42E-03	6.03E-04	9.00E-01	3.90E-01	2.50E+00	1.38E+01	3.33E+00
Phenanthrene	85-01-8	4.55E+00	h	9.08E-02	8.92E-04	2.82E-04	4.19E-04	1.78E-04	1.00E+00	1.40E-01	7.00E-01	4.11E+00	1.06E+00
Phenol	108-95-2	1.48E+00	h	5.42E+00	7.54E-07	2.38E-07	3.54E-07	1.51E-07	1.00E+00	4.30E-03	1.60E-02	8.60E-01	3.60E-01
Pyrene	129-00-0	5.00E+00	h	4.99E-02	2.51E-03	7.94E-04	1.18E-03	5.02E-04	1.00E+00	2.33E-01	1.27E+00	2.65E+01	1.43E+00
TNT, (2,4,6-Trinitrotoluene)	118-96-7	1.60E+00	h	4.60E+00	1.00E-06	3.16E-07	4.70E-07	2.00E-07	1.00E+00	9.64E-04	5.59E-03	4.71E+00	1.96E+00
RDX (Cyclonite)	121-82-4	8.70E-01	h	1.22E+01	1.86E-07	5.89E-08	8.75E-08	3.72E-08	1.00E+00	3.39E-04	1.94E-03	4.42E+00	1.84E+00
VOCs													
1,1,1-Trichloroethane	71-55-6	6.12E+00	h	1.12E-02	3.32E-02	1.05E-02	1.56E-02	6.63E-03	1.00E+00	1.30E-02	1.00E-01	1.43E+00	6.00E-01
1,1,2-Trichloroethane	79-00-5	2.01E+00	h	2.66E+00	2.58E-06	8.17E-07	1.21E-06	5.17E-07	1.00E+00	6.40E-03	0.00E+00	1.43E+00	6.00E-01
1,1-Dichloroethene	75-35-4	6.26E+00	h	9.39E-03	4.52E-02	1.43E-02	2.13E-02	9.04E-03	1.00E+00	1.20E-02	4.54E-02	8.90E-01	3.70E-01
1,2-Dichloroethane	107-06-2	6.07E+00	h	1.20E-02	2.94E-02	9.29E-03	1.38E-02	5.88E-03	1.00E+00	4.20E-03	1.61E-02	9.20E-01	3.80E-01
2-Butanone (Methyl Ethyl Ketone)	78-93-3	6.18E+00	h	1.04E-02	3.79E-02	1.20E-02	1.78E-02	7.59E-03	1.00E+00	9.60E-04	3.14E-03	6.50E-01	2.70E-01
2-Hexanone	591-78-6	3.80E+00	h	2.47E-01	1.58E-04	5.00E-05	7.44E-05	3.16E-05	1.00E+00	3.55E-03	1.37E-02	9.17E-01	3.82E-01
(Methyl Isobutyl Ketone)	108-10-1	3.32E+00	h	4.67E-01	5.25E-05	1.66E-05	2.47E-05	1.05E-05	1.00E+00	2.66E-03	1.02E-02	9.17E-01	3.82E-01

Table 13-2. Toxicity Criteria and Chemical-Specific Parameters for Chemical SRCs

				Food Pathway Factors[j]					Dermal Exposure to Water Factors[k]				
Constituent	CASRN	logKow	Ref	Uptake Factor Plants (BCFr)	Uptake Factor Beef (Babeef)	Uptake Factor Milk (Bamilk)	Uptake Factor Chicken (Bachicken)	Uptake Factor Deer (Badeer)	Fraction Absorbed FA (unitless)	Permeability Constant Kp (cm/hr)	Partitioning Constant B (unitless)	Steady-State Time t* (hour)	Lag Time t (hour)
Acetone	67-64-1	3.83E+00	h	2.36E-01	1.71E-04	5.41E-05	8.04E-05	3.42E-05	1.00E+00	5.35E-04	1.57E-03	5.33E-01	2.22E-01
Benzene	71-43-2	5.54E+00	h	2.43E-02	8.71E-03	2.75E-03	4.09E-03	1.74E-03	1.00E+00	1.50E-02	1.00E-01	7.00E-01	2.90E-01
Carbon Disulfide	75-15-0	4.14E+00	h	1.57E-01	3.47E-04	1.10E-04	1.63E-04	6.93E-05	1.00E+00	1.70E-02	1.00E-01	7.20E-01	3.00E-01
Carbon tetrachloride	56-23-5	2.44E+00	h	1.50E+00	6.95E-06	2.20E-06	3.27E-06	1.39E-06	1.00E+00	1.61E-02	7.67E-02	1.86E+00	7.80E-01
Chlorobenzene	108-90-7	2.64E+00	h	1.16E+00	1.09E-05	3.45E-06	5.12E-06	2.18E-06	1.00E+00	2.78E-02	1.00E-01	1.09E+00	4.60E-01
Chloroform	67-66-3	5.27E+00	h	3.49E-02	4.67E-03	1.48E-03	2.20E-03	9.34E-04	1.00E+00	6.80E-03	2.86E-02	1.19E+00	5.00E-01
Chloromethane (Methyl chloride)	74-87-3	3.83E+00	h	2.37E-01	1.70E-04	5.37E-05	7.98E-05	3.40E-05	1.00E+00	3.30E-03	9.02E-03	4.90E-01	2.00E-01
cis-1,2-Dichloroethene	156-59-2	3.66E+00	h	2.97E-01	1.15E-04	3.63E-05	5.40E-05	2.30E-05	1.00E+00	7.70E-03	2.92E-02	8.90E-01	3.70E-01
Dibromochloromethane	124-48-1	1.70E+00	h	4.03E+00	1.26E-06	3.98E-07	5.92E-07	2.52E-07	1.00E+00	1.43E-03	7.94E-03	4.08E-02	1.70E-02
Ethylbenzene	100-41-4	4.89E+00	h	5.76E-02	1.96E-03	6.19E-04	9.20E-04	3.91E-04	1.00E+00	4.90E-02	2.00E-01	1.01E+00	4.20E-01
Methylene Chloride	75-09-2	3.14E+00	h	5.93E-01	3.47E-05	1.10E-05	1.63E-05	6.93E-06	1.00E+00	3.50E-03	1.24E-02	7.60E-01	3.20E-01
Styrene	100-42-5	2.95E+00	h	NA	NA	NA	NA	NA	1.00E+00	3.70E-02	1.00E-01	9.80E-01	4.10E-01
Tetrachloroethene	127-18-4	3.72E+00	h	2.74E-01	1.32E-04	4.17E-05	6.20E-05	2.64E-05	1.00E+00	3.30E-02	2.00E-01	2.18E+00	9.10E-01
Toluene	108-88-3	5.54E+00	h	2.43E-02	8.71E-03	2.75E-03	4.09E-03	1.74E-03	1.00E+00	3.10E-02	1.00E-01	8.40E-01	3.50E-01
trans-1,2-Dichloroethene	156-60-5	5.02E+00	h	4.88E-02	2.61E-03	8.26E-04	1.23E-03	5.22E-04	1.00E+00	7.70E-03	2.92E-02	8.90E-01	3.70E-01
Trichloroethene	79-01-6	4.93E+00	h	5.48E-02	2.14E-03	6.76E-04	1.00E-03	4.28E-04	1.00E+00	1.20E-02	1.00E-01	1.39E+00	5.80E-01
Vinyl chloride	75-01-4	1.70E+00	h	4.03E+00	1.26E-06	3.98E-07	5.92E-07	2.52E-07	1.00E+00	5.60E-03	0.00E+00	5.70E-01	2.40E-01
Xylenes (total)	1310-20-7	1.60E+00	h	4.60E+00	1.00E-06	3.16E-07	4.70E-07	2.00E-07	1.00E+00	5.30E-02	2.00E-01	1.01E+00	4.20E-01
Metals/Inorganics													
Aluminum	7429-90-5	NA		6.50E-04	1.50E-03	2.00E-04	7.05E-04	3.00E-04	NA	1.00E-03	NA	NA	NA
Antimony	7440-36-0	NA		3.00E-02	1.00E-03	1.00E-04	4.70E-04	2.00E-04	NA	1.00E-03	NA	NA	NA
Arsenic	7440-38-2	NA		6.00E-03	2.00E-03	6.00E-05	9.40E-04	4.00E-04	NA	1.00E-03	NA	NA	NA
Barium	7440-39-3	NA		1.50E-02	1.50E-04	3.50E-04	7.05E-05	3.00E-05	NA	1.00E-03	NA	NA	NA
Beryllium	7440-41-7	NA		1.50E-03	1.00E-03	9.00E-07	4.70E-04	2.00E-04	NA	1.00E-03	NA	NA	NA
Boron	7440-42-8	NA		2.00E+00	8.00E-04	1.50E-03	3.76E-04	1.60E-04	NA	1.00E-03	NA	NA	NA
Cadmium	7440-43-9	NA		1.50E-01	5.50E-04	1.00E-03	2.59E-04	1.10E-04	NA	1.00E-03	NA	NA	NA
Calcium	7440-70-2	NA		3.50E-01	7.00E-04	1.00E-02	3.29E-04	1.40E-04	NA	1.00E-03	NA	NA	NA
Chromium (III)(insoluble salts)	7440-47-3	NA		4.50E-03	5.50E-03	1.50E-03	2.59E-03	1.10E-03	NA	1.00E-03	NA	NA	NA
Chromium (VI)	18540-29-9	NA		4.50E-03	5.50E-03	1.50E-03	2.59E-03	1.10E-03	NA	2.00E-03	NA	NA	NA
Cobalt	7440-48-4	NA		7.00E-03	2.00E-02	2.00E-03	9.40E-03	4.00E-03	NA	4.00E-04	NA	NA	NA
Copper	7440-50-8	NA		2.50E-01	1.00E-02	1.50E-03	4.70E-03	2.00E-03	NA	1.00E-03	NA	NA	NA
Cyanide (CN-)	57-12-5	NA		8.70E+00	3.10E-07	9.90E-08	1.46E-07	6.20E-08	NA	1.00E-03	NA	NA	NA
Iron	7439-89-6	NA		1.00E-03	2.00E-02	2.50E-04	9.40E-03	4.00E-03	NA	1.00E-03	NA	NA	NA
Lead	7439-92-1	NA		9.00E-03	3.00E-04	2.50E-04	1.41E-04	6.00E-05	NA	1.00E-04	NA	NA	NA
Lithium	7439-93-2	NA		4.00E-03	1.00E-02	2.00E-02	4.70E-03	2.00E-03	NA	1.00E-03	NA	NA	NA
Magnesium	7439-95-4	NA		5.50E-01	5.00E-03	4.00E-03	2.35E-03	1.00E-03	NA	1.00E-03	NA	NA	NA
Manganese	7439-96-5	NA		5.00E-02	4.00E-04	3.50E-04	1.88E-04	8.00E-05	NA	1.00E-03	NA	NA	NA
Mercury	7439-97-6	NA	i	2.00E-01	2.50E-01	4.50E-04	1.18E-01	5.00E-02	NA	1.00E-03	NA	NA	NA
Nickel	7440-02-0	NA		6.00E-02	6.00E-03	1.00E-03	2.82E-03	1.20E-03	NA	2.00E-04	NA	NA	NA
Potassium	7440-09-7	NA		5.50E-01	2.00E-02	7.00E-03	9.40E-03	4.00E-03	NA	2.00E-03	NA	NA	NA
Selenium	7782-49-2	NA		2.50E-02	1.50E-02	4.00E-03	7.05E-03	3.00E-03	NA	1.00E-03	NA	NA	NA

Table 13-2. Toxicity Criteria and Chemical-Specific Parameters for Chemical SRCs

				Food Pathway Factors[j]					Dermal Exposure to Water Factors[k]				
Constituent	CASRN	logKow	Ref	Uptake Factor Plants (BCFr)	Uptake Factor Beef (Babeef)	Uptake Factor Milk (Bamilk)	Uptake Factor Chicken (Bachicken)	Uptake Factor Deer (Badeer)	Fraction Absorbed FA (unitless)	Permeability Constant Kp (cm/hr)	Partitioning Constant B (unitless)	Steady-State Time t* (hour)	Lag Time t (hour)
Silver	7440-22-4	NA		1.00E-01	3.00E-03	2.00E-02	1.41E-03	6.00E-04	NA	6.00E-04	NA	NA	NA
Sodium	7440-23-5	NA		5.50E-02	5.50E-02	3.50E-02	2.59E-02	1.10E-02	NA	1.00E-03	NA	NA	NA
Thallium (carbonate)	7440-28-0	NA		4.00E-04	4.00E-02	2.00E-03	1.88E-02	8.00E-03	NA	1.00E-03	NA	NA	NA
Uranium (soluble salts)	7440-61-1	NA		4.00E-03	2.00E-04	6.00E-04	9.40E-05	4.00E-05	NA	1.00E-03	NA	NA	NA
Vanadium	7440-62-2	NA		3.00E-03	2.50E-03	2.00E-05	1.18E-03	5.00E-04	NA	1.00E-03	NA	NA	NA
Zinc	7440-66-6	NA		9.00E-01	1.00E-01	1.00E-02	4.70E-02	2.00E-02	NA	6.00E-04	NA	NA	NA

NA = not available
RfDo = oral reference dose
RFDa = adjusted reference dose (dermal)
RfDi = inhalation reference dose
CSFo = cancer slope factor
CSFa = adjusted cancer slope factor (dermal)
CSFi = inhalation cancer slope factor

iris = Integrated Risk Information System (IRIS). U.S. Environmental Protection Agency.
Cal/EPA = toxicological reference values from DHS 1990, Cal/EPA 1994, Cal/EPA 1999, Cal/EPA 2002.
heast = Health Effects and Environmental Affects Summary Table (HEAST). U.S. Environmental Protection Agency.
ncea = National Center for Environmental Assessment
ncea,rpf = National Center for Environmental Assessment, relative potency factor
pprtv = provisional peer reviewed toxicity values, Region 9PRG Table

a = Inhalation values given as Reference Concentrations for systemic toxicants or Air Unit Risks for carcinogens were converted to an RfD_i or CSF_i as follows:
For non-carcinogens: Inhalation RfD (mg/kg/day) = RfC mg/m^3 x $(70\ kg)^{-1}$ x 20 m^3/day
For carcinogens: Inhalation CSF $(mg/kg/day)^{-1}$ = Unit Risk $(\mu g/m^3)^{-1}$ x 70 kg x $(20\ m^3/day)^{-1}$ x 1000 µg/mg

b = The cancer potency of PCB mixtures is determined using a three tiered approach, 2.00e+00 per (mg/kg)/day, is the upper-bound slope factor for the high risk and persistence tier Aroclors.

c = The carcinogenicity assessment for dintrotoluene mixtures includes both 2,4-dinitrotoluene and 2,6-dinitrotoluene.

d = "Since the fraction of ingested Cd that is absorbed appears to vary with the source (e.g., food vs. drinking water), this difference is accounted for using different RfDs based on the medium of exposure.

e = Gastrointestinal absorption (ABS_{GI})cited from Risk Assessment Guidance for Superfund: Human Health Evaluation Manual (Part E, Supplemental Guidance for Dermal Risk Assessment). U.S. Environmental Protection Agency, EPA/540/R/99/005, 2004. Values from Exhibit 4-1, pages 4-5 to 4-8. When a range is presented, low end value of range was used. When range overlaps 0.5 and table recomends no adjustment, a GI value of 0.51 is reported. If no value is available, ABS_{GI} assumed to be 100%.

f = Dermal absorption factor (ABS_d) cite from Risk Assessment Guidance for Superfund: Human Health Evaluation Manual (Part E, Supplemental Guidance for Dermal Risk Assessment). U.S. Environmental Protection Agency, EPA/540/R/99/005, 2004.Values from Exhibit 3-4, page 3-16 and supplemental values from http://www.epa.gov/oswer/riskassessment/ragse/.

g = USEPA Region 9 PRG Intercalc Tables:Physical Chemical Data. Updated October 2004. http://www.epa.gov/region9/waste/sfund/prg/index.html

h = Values taken from U.S. EPA Office of Pollution, Prevention and Toxics, Estimates Programs Interface, http://www.epa.gov/oppt/exposure/docs/episuitedl.htm.

i = Syracuse Research Corporation (SRC). 2005. PHYSPROP Database. SRC. Syracuse, NY. Accessed July 2005. (http://www.syrres.com/esc/physdemo.htm).

j = Food Factors cited from the following sources:
Baes et al. 1984. *A Review and Analysis of Parameters for Assessing Transport of Environmentally Releases Radionuclides through Agriculture* . Oak Ridge National Laboratory, Oak Risge, TN ORNL-5786
DOE 1998a. *Empirical Model for the Uptake of Inorganic Chemicals from Soil by Plants* . BJC/OR-133.
EPA 1996b. *Soil Screening Guidance: User's Guide* . OSWER #9355.4-12. 1994.
EPA 1999a - Screening Level Ecological Risk Assessment Protocol for Hazardous Waste Cumbustion Facilities (Peer Review Draft). EPA 530-D-99-001A. USEPA, OSWER.
Travis & Arms 1988. Bioconcentration of organics in beef, milk, and vegetation. *Environ. Sci. Technol* 22:271-274.
Washington State Department of Ecology (WSDE) 2002. Terrestrial Ecological Evaluation Process - Exclusions. Toxics Cleanup Program, Table 746-5. WSDE, Olympia, WA.

k = RAGS E Risk Assessment Guidance for Superfund: Human Health Evaluation Manual (Part E, Supplemental Guidance for Dermal Risk Assessment) (RAGS E). U.S. Environmental Protection Agency, Appendix B. EPA/540/R/99/005, 2004.

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14.0 CONCLUSIONS

Discussions presented in this RIR Addendum were targeted to address specific data gaps and 2007 RIR reviewer comments. In general, the scope of the RIR Addendum focused on additional site characterization, assessment of the integrity of the IWCS, and presentation of supplemental information and data needed to move forward into the FS process. Key findings presented in this RIR Addendum are summarized below.

14.1 RIR ADDENDUM DATA COLLECTION AND ANALYSIS

The RIR Addendum fieldwork was conducted from mid-November 2009 to the end of January 2010. A total of 23 TWPs were installed and sampled for soil and groundwater to further delineate impacts to the soil and groundwater along the western and northern boundaries of the NFSS. Ten of the 23 TWPs were converted to permanent monitoring wells in the UWBZ in the Brown Clay Unit, which underlies the IWCS. The field and analytical data collected during the RIR Addendum has been incorporated into the evaluations presented in this addendum and will also be used for future FS related tasks.

14.2 NATURE AND EXTENT OF GROUNDWATER

RIR Addendum groundwater sampling activities focused on addressing groundwater contamination in three main areas of the NFSS:

- The Baker-Smith Area in EUs 1 and 2;
- The Acidification Area in EU 4; and
- IWCS and Vicinity in EUs 7, 9, 10 and 11.

14.2.1 Baker-Smith Area in EUs 1 and 2

During previous phases of the RI, a plume with elevated concentrations of dissolved total uranium was found near the former Baker-Smith Area. RI data identified the potential for the presence of this plume off-site on the north side of EU 1.

Re-evaluation of the dissolved total uranium plume in EUs 1 and 2 incorporating the results of the RIR Addendum fieldwork indicates that the north-south width of the plume is more constrained than originally presented in the 2007 RIR. The southwestern edge of the uranium plume is bounded near the northwestern site boundary by groundwater samples collected at TWP924 and TWP925; uranium concentrations below background criteria were observed at these two locations (Figures 4-1 and 4-5). Measured dissolved total uranium concentrations within the plume range from 25.2 µg/L to 47.2 µg/L. RIR Addendum sampling results confirm that dissolved uranium in groundwater is currently present to the north of EU 1 at concentrations greater than the MCL (30 µg/L). Groundwater modeling results indicate that groundwater contamination is not migrating (laterally) and that the groundwater plumes at the NFSS are horizontally static, essentially maintaining an equilibrium condition of adsorption with slow advective flow following removal of most ground surface source terms (USACE 2011). A review of site operational information and environmental investigative data indicate that groundwater contamination in this area is the result of historic site operations and past waste storage practices used in the Baker-Smith Area.

14.2.2 Acidification Area in EU 4

Plumes with elevated concentrations of dissolved total uranium, boron, and chlorinated solvents (e.g., PCE and degradation products) were found in the Acidification Area during previous phases of the RI. Data from the RI indicated the possible contribution of VOCs to groundwater from DNAPL at this location.

Two small UWBZ groundwater areas exhibiting concentrations of dissolved total uranium greater than the background criteria (16.7 µg/L) and MCL (30 µg/L) are present in the central and north-central portions of EU 4 (Figure 4-5). The maximum concentration of dissolved total uranium in these two areas is 36.69 µg/L and is located north of the storm sewer line near the western portion of the northern plume. The northwestern portion of this plume in the downgradient groundwater flow direction is not bounded by any sample results. Two groundwater samples collected immediately north-northeast of this plume indicate that dissolved total uranium concentrations are less than the MCL in this area. Groundwater modeling results indicate that groundwater contamination is not migrating (laterally) and that the groundwater plumes at the NFSS are horizontally static, essentially maintaining an equilibrium condition of adsorption with slow advective flow following removal of most ground surface source terms by DOE (USACE 2011). Additionally, off-site exposure to this plume is unlikely because the groundwater is not used as a source of drinking water and CWM Chemical Services is located downgradient of this plume where public access is restricted. Available site operational information and environmental investigative data indicate that groundwater contamination in this area is the result of historic site operations and past waste storage practices.

The boron plume identified within the UWBZ in the central portion of EU 4 was further evaluated for the RIR Addendum (Figure 4-7). The maximum concentration of dissolved boron in this plume is 29,200 µg/L, a concentration observed during RIR Addendum sampling. This dissolved boron plume is bounded to the north by several sample locations that exhibit dissolved boron concentrations below the background level of 4,750 µg/L, indicating that this plume is not currently migrating off-site. Furthermore, groundwater flow and transport modeling indicates that the existing boron plume in EU 4 will exhibit little dispersion over the next 10,000 years and is not expected to exceed screening levels at the property boundary (USACE 2011).

During previous phases of the RI, a southeast to northwest trending volatile organic contaminant plume was identified in EU 4 within the UWBZ. This plume contains PCE and its degradation products, TCE, cis-1,2-DCE, trans-1,2-DCE, and vinyl chloride. The source of the organic plume in EU 4 appears to be near wells MW415, MW415A, MW930 and TWP933 (Figures 4-1 and 4-8 through 4-12). Visible DNAPL was observed during the RIR Addendum sampling at locations MW930 and TWP933. The downgradient extent of the organic plume appears to be within 150 feet of the northern property boundary. This VOC groundwater plume is currently bounded on-site to the north and west by wells showing either dry conditions (TWP929) or no detections of VOCs (MW934, 411 and 411A) (USACE 2007a). According to the latest groundwater modeling results only minor dispersion of this VOC plume is predicted over time, and despite the increased presence of sand lenses within EU 4, the plume is not predicted to extend off-site (USACE 2011). Furthermore, the maximum on-site concentrations of PCE, TCE, cis-1,2-DCE, and vinyl chloride in the Brown Clay Till are all expected to biodegrade to concentrations below their respective screening level values within 300 years.

The Corps currently monitors the VOC plume through the ESP by collecting semi-annual groundwater samples for VOC analysis from bounding wells MW934 and 411A. It is important to note that groundwater is not used as a source of drinking water and CWM Chemical Services property is located downgradient of this plume where public access is restricted. The BOP FS will address the remedial

alternatives for PCE and its degradation products present in EU 4 soil. Furthermore, the Corps will conduct additional field activities to address data gaps in support of the BOP FS, as warranted.

Potential inhalation pathway risks associated with elevated VOC concentrations in EU 4 groundwater were estimated by modeling volatilization to ambient air and by using soil gas sampling results to consider the potential for soil gas to impact a potential building as a result of vapor intrusion. Groundwater and soil gas sampling results indicate that the presence of VOCs in groundwater has the potential to impact human health in an industrial setting, in either the presence or absence of a future building. Since this potential health impact is via the inhalation pathway, it could occur even if the site groundwater is not used as a drinking water source. Exposure to VOCs in groundwater through inhalation is currently a risk only to on-site personnel, not to off-site receptors. The Corps is mitigating this risk by limiting access to this area of the NFSS until a long-term remedy is in place. Unacceptable risk for potential future receptors will be considered in the development of remedial action objectives for EU 4 during the FS.

As stated above, the screening methods used to evaluate risk due to the inhalation of VOCs indicate that the presence of VOCs in groundwater at EU 4 has the potential to impact human health in an industrial setting or as the result of vapor intrusion into a building. While this does represent an upward revision to the vapor exposure assessment presented in the HHRA, the conclusions do not change. The HHRA identified VOCs in groundwater at EU 4 and EU 13 as COCs, and concluded that these groundwater COCs pose very high cancer risk (e.g., in excess of 1×10^{-2}). However, it was concluded that the VOCs driving risk are localized to EU 4 and EU 13 with the qualitative groundwater model showing limited potential for future off-site migration. The RIR Addendum investigation of VOC contamination in EU 4 groundwater was conducted to bound the VOC contamination identified during the RI. The conclusions based on this information are not substantially different from those presented in the HHRA.

14.2.3 IWCS and Vicinity in EUs 7, 9, 10 and 11

During previous phases of the RI, plumes of dissolved uranium were found around the north and west sides of the IWCS and in the area south-southeast of the IWCS. RI data identified the potential for the presence of this plume off-site on the west side of the IWCS.

RIR Addendum wells north and northwest of the IWCS contained concentrations of dissolved total uranium greater than the background criteria; this suggests the dissolved total uranium groundwater plumes identified in the 2007 RIR north of the IWCS and along the western boundary of EU 7 are connected. RIR Addendum sampling indicates that concentrations of dissolved total uranium in EU 9 groundwater are above the background level (16.7 µg/L) west of EU 7. Results of RIR Addendum sampling also indicate that concentrations of dissolved total uranium in groundwater are present above the background level in EU 9 west of the northern portion of the IWCS. Concentrations of dissolved total uranium at these two locations, both just east of the WDD in EU 9, are roughly two times greater than the background level. The location west of EU 7 is included in the plume north of the IWCS, while the location west of the IWCS remains unconnected to the plume on the west side of the IWCS. This observation suggests that the plume on the west side of the IWCS has not migrated to the boundary of EU 10 and is, in fact, bounded to the west by multiple sampling points below the background level.

RIR Addendum groundwater sampling results from EU 10 confirm the presence of dissolved total uranium in groundwater south of the IWCS at concentrations greater than the background level. Additionally, RIR Addendum sampling results confirm that dissolved total uranium concentrations are not present above the background level off-site.

Surface water samples collected from the WDD during the RI (1999-2001) contained total uranium at levels above the NFSS background level for surface water (12.4 µg/L). Surface water sample results collected from the WDD in 2008-2010 indicate that total uranium concentrations in the WDD are currently at levels below the background level of 12.4 µg/L. The observed decrease in total uranium distribution in the WDD surface water between the time of RI sampling and sampling conducted during 2008-2010 suggests that the WDD is not greatly impacted by groundwater contaminant transport. Concentrations of total uranium observed in the WDD surface water and sediment during the RI is likely more indicative of material entering the WDD due to historical soil erosion and turbid overland flow.

Available site operational information and environmental investigative data indicate that groundwater contamination surrounding the IWCS is the result of historic site operations and past waste storage practices. Most of the soil contamination that contributed to current groundwater contamination was removed during the remedial efforts performed by the DOE in the 1980s.

14.3 ASSESSMENT OF THE INTEGRITY OF THE IWCS

Additional assessments of the IWCS integrity since the RIR was completed in 2007 included an examination of topographic survey information to assess potential settlement of the IWCS cap, an overview of the IWCS cap maintenance procedures and ESP monitoring techniques, a review of aerial photos and assessment of groundwater plumes in the vicinity of the IWCS, and a review of information regarding the potential for building pipelines within the IWCS to provide a pathway for release from the IWCS to the environment.

14.3.1 Topographic Survey

Topographic survey data from four survey events conducted between 1991 and 2009 indicate that the average change in elevation across the surface of the IWCS between 1991 and 2009 is approximately +/- 0.1 ft. Very minor settling is evident in the central portion of the IWCS cap where the former R-10 pile was located and where waste drums and miscellaneous debris were added to the IWCS in 1991. The average negative change in surface elevation for this area of the IWCS between 1991 and 2009 was negative 0.14 ft, with a range of negative 0.05 to negative 0.25 feet.

14.3.2 IWCS Cap Maintenance Procedures and ESP Monitoring Techniques

Inspection and maintenance procedures conducted to ensure the integrity of the cap include: monthly walkovers and visual inspections of the cap; and maintaining of the cap vegetative cover. Additionally, the ESP monitoring of radon and gamma radiation is a direct indicator of cap performance and integrity. The most direct measurement of cap performance is radon flux monitoring which is measured directly on top of the cap. Radon flux monitoring is the primary indicator of ongoing releases from the IWCS through the cap. External gamma radiation measurement taken at the site perimeter provides information regarding the magnitude of any releases, should they occur. Conclusions of ESP monitoring techniques are briefly described below.

Radon-222 Flux Monitoring
As in previous years, radon flux monitoring conducted in 2008 indicates that results are well below the 20.0 $pCi/m^2/s$ standard specified in 40 CFR Part 61, Subpart Q, are comparable to background levels and demonstrate the effectiveness of the IWCS cap in reducing the potential for radon-222 migration and exposure.

External Gamma Radiation Monitoring
External gamma radiation monitoring results along the perimeter of the IWCS for years 1998 through 2008 have typically been at or near background levels and are well below the DOE guideline of 100 mrem/year for all pathways, excluding radon.

Radon Gas Monitoring
Consistent with results from previous years, all radon-222 results from the 2008 ESP were well below the DOE off-site limit of 3.0 pCi/L above background. Without subtracting background levels the results for year 2008 ranged from non-detect (less than 0.2 pCi/L) to 0.2 pCi/L (USACE 2009e).

14.3.3 Review of Aerial Photos and Assessment of Groundwater Plumes in the Vicinity of the IWCS

Historical site operations documented by a 1956 aerial photo of the IWCS area were compared to current levels of dissolved total uranium in groundwater in this same area. One of the key features in the 1956 aerial photo is the radioactive R-10 storage pile which was left uncovered and unprotected in this area for a number of years. The uranium groundwater plumes west of the IWCS correspond to the location of the former radioactive R-10 storage pile that is now enclosed with the IWCS. The uranium groundwater plumes south of the IWCS are believed to be associated with former Building 409 and nearby residue storage activities. The 1956 aerial photo shows material piles located south of the IWCS that correspond to elevated concentrations of dissolved total uranium observed in area groundwater.

Groundwater plumes may appear to be emanating from the IWCS, however, aerial photos showing historic site operations, the RI data, and longer-term ESP data trends do not support this conclusion. Groundwater plumes in the vicinity of the IWCS were established prior to IWCS construction, and were truncated by construction of the IWCS cut-off wall. Long-term trends in the ESP groundwater data show steady-state to declining contaminant concentration levels suggesting that the IWCS is performing as designed. An exception to this observation is well OW11B, which exhibits an increasing trend in uranium concentrations. However, this well is near a former pipeline east of the IWCS and is no longer considered to be part of the groundwater plume. During the BOP FS, the Corps will conduct additional field activities to address BOP data gaps, such as the integrity of the underground utility lines south and east of the IWCS. Additionally, the Corps will continue to maintain and monitor the site and evaluate, in the IWCS FS, long-term remedies to ensure future protectiveness of human health and the environment.

14.3.4 Assessment of Potential for Pipelines to Provide a Pathway for Releases from the IWCS to the Environment

During the public information session held in September 2008, following release of the 2007 RIR, concern was expressed that pipelines within the IWCS that connected former freshwater treatment plant buildings might allow for contaminant migration to groundwater. The possibility of contaminant transport via pipeline bedding material exists, but due to the absence or discontinuous nature of bedding material in the majority of the underground utility lines investigated at the former LOOW, this threat is reduced. Although the possibility that the pipelines are acting as preferential pathways for contaminant migration cannot be entirely ruled out, potential for these pipelines to act as preferential pathways for contaminant flow is very low for the following reasons:

- As-built drawings reviewed during the RI for former LOOW freshwater treatment plant buildings do not indicate the use of any bedding material for pipelines. As-built drawings for former LOOW freshwater treatment plant buildings also show that the building foundations and the connecting pipelines are located in the brown clay layer, which, due to the clay's low permeability, reduces the potential for contaminant migration surrounding the pipelines.

Furthermore, approximately 18 ft of low-permeability gray clay, which underlies the brown clay layer, inhibits potential vertical groundwater flow and contaminant transport from the pipelines.

- Results of the UURI indicated that the 42-inch diameter water supply line that traverses from the LOOW fresh water treatment plant (located on the NFSS) was not underlain by bedding material.

- Pipelines connecting the former LOOW freshwater treatment plant buildings were removed or filled and the ends plugged, further reducing the possibility of contaminant transport from the pipelines within the IWCS (USDOE 1986).

14.4 RE-EXAMINATION AND JUSTIFICATION OF THE NFSS GROUNDWATER BACKGROUND DATA SET

A re-examination of the NFSS groundwater background data set was performed to assess the effects of combining data from the UWBZ and the LWBZ to determine sitewide groundwater SRCs. Results of this re-examination suggest that dividing the combined background groundwater data set into separate data sets for the two water-bearing zones does not result in more descriptive background statistics or more reliable delineation of SRCs. Furthermore, this evaluation supports the continued use of a combined background data set to determine site-specific groundwater background levels and SRCs, as was done for the 2007 RIR (USACE 2007a). Key findings of this evaluation are listed below.

- Combining the UWBZ and LWBZ data into one background data set makes it more likely that an acceptable number of positive results are available to determine data distributions and perform reliable statistical computations.

- For many constituents, there is relatively little difference between the background levels developed for the combined background groundwater data set and the background levels developed for the separate UWBZ and LWBZ data sets.

- Visual interpretation of data trending graphs suggests that the combined background groundwater data set and the data sets for the UWBZ and the LWBZ represent essentially the same population.

- Because the presence of chemicals in the UWBZ are a determining factor for the identification of SRCs at the site, combining data from the UWBZ and LWBZ to evaluate background groundwater levels ensures a conservative approach to determine SRCs for both the UWBZ and LWBZ, and review potential risks from groundwater exposure at the NFSS.

Additionally, a review of mean and maximum values for radium-226, radium-228 and uranium levels in NFSS background groundwater data provides a qualitative indication that NFSS background groundwater levels for these radionuclides are comparable to typical levels observed in domestic groundwater sources. Thus, according to results of this review, NFSS background groundwater does not appear to have been impacted by previous LOOW or NFSS site operations, and is appropriate for assessing current groundwater conditions at the NFSS.

14.5 COMPARISON OF NFSS SOIL BACKGROUND LEVELS TO UNITED STATES AND NEW YORK AREA SOIL BACKGROUND LEVELS

A comparison of the NFSS soil background levels to other background levels from data collected for the United States, New York State and the Tonawanda, New York area were used to address the

appropriateness of applying NFSS soil background data to define the nature and extent of contaminants at the NFSS.

The comparison of the maximum, mean, and UTL values for parameters in the NFSS soil background data set to other background soil data set statistics indicate that, in many cases, the NFSS background levels appear to be less than background levels observed in U.S., New York State, and Tonawanda, New York area background soils. In cases where NFSS background levels appear to be greater than other soil background levels, the differences in the background values are often relatively small. These observations suggest that the NFSS soil background data is similar to U.S., New York State and Tonawanda area soil background data.

Therefore, the comparison of NFSS soil background levels to other soil background levels from data collected for the U.S., New York State and the Tonawanda, New York area supports the conclusion that the NFSS soil background data set is appropriate for evaluating the nature and extent of contaminants at the NFSS.

Additionally, literature research revealed that in undisturbed areas, the U.S. average concentrations of radium-226 and uranium-238 show a nearly 1:1 correlation (Myrick et al 1983). The close relationship between radium-226 and uranium-238 activities observed in NFSS subsurface background soil lends credence to the opinion that NFSS background soil locations are from an undisturbed area not affected by previous site operations.

14.6 CHARACTERIZATION OF REMEDIAL INVESTIGATION BUILDING CORE, RAILROAD BALLAST AND ROAD CORE SAMPLES

To further characterize radiological contamination at the NFSS, a review was conducted of Building 401 floor core and underlying soil samples, railroad ballast samples, and core samples of road pavement from across the site. The NFSS RI did not identify SRCs for these media because no suitable background data sets for building cores, railroad ballast, or road core materials are available. Although the materials used to construct the NFSS roadways and railroad bedding are not directly comparable to surface soil, to ensure that no SRCs were missed, it was decided that the road core and railroad ballast samples should be screened using the NFSS site-specific background levels for surface soil.

No new SRCs were identified for railroad ballast and road core samples during screening of existing analytical results for these media using background surface soil levels.

The ratio of various radionuclides in railroad ballast and road materials was assessed to determine whether they are at, or near, secular equilibrium, meaning that the material has not been processed to remove radium or uranium. Since the Manhattan Project involved uranium enrichment and extraction processes, materials associated with the MED/AEC operations could have higher or lower ratios of radium-226 to uranium-238, but would be significantly different from naturally occurring material.

The delineation of MED/AEC-materials at the NFSS was complicated by the presence of a phosphate slag material with elevated radiological activity that was used throughout the Niagara Falls area for bedding under asphalt and for general gravel applications (ORNL 1986). Since naturally-occurring earthen materials, like phosphate slag, contain roughly equivalent levels of uranium and radium on a picocurie per gram basis, while MED/AEC-materials are expected to have higher levels of radium, the ratio of radium-226 to uranium-238 was used to assess whether the materials found were MED-related. At the NFSS, similar concentrations of radium-226 and uranium-228, were found in Building 401 core samples, the soil underlying the Building 401 core sample and in slag materials associated with railroad ballast. Additionally, radium/uranium ratios in these data sets were similar to ratios observed in the site-specific

soil background data set. This suggests that these materials are not associated with MED/AEC activities. While many of the road core samples had comparable levels of radium-226 and uranium-238, several locations were identified with elevated ratios. The concentration of uranium-238 in these samples was significantly lower than the concentration of radium-226 on a picocurie per gram basis, suggesting that these locations may contain MED/AEC-related materials.

The analysis of railroad ballast and road core samples also revealed several locations with concentrations of radium-226 above 5 pCi/g. BOP materials with an elevated ratio of radium-226 to uranium-238, and with radium-226 concentrations greater than the ARAR-based action level will be re-examined during the FS.

14.7 SUPPLEMENTAL ENVIRONMENTAL SURVEILLANCE PROGRAM DATA FOR RADIONUCLIDES IN GROUNDWATER, AND IN SURFACE WATER AND SEDIMENTS IN ONSITE DRAINAGES

Enhancements to the ESP initiated in 2008 included the addition of ten groundwater-monitoring well locations analyzed for water quality parameters, supplemental radionuclides and isotopic uranium. Analytical results for the supplemental radiological analysis of groundwater for 2008-2009 showed all non-detect results. Analytical results for other radionuclides monitored by the ESP sampling are presented and discussed in the Annual 2008 Environmental Surveillance Technical Memoranda (USACE 2009e).

To characterize current conditions in surface water and sediment, enhancements to the ESP initiated in 2008 included the addition of five new surface water and sediment locations (bringing the total number of locations up to 10) analyzed for an expanded list of radiological and chemical parameters, twice a year, up from once a year. Analytical results for surface water and sediment from the enhanced ESP sampling were merged with the RI data set and screened for SRCs using the same screening technique as was used for the RI.

Using the RI data set supplemented with ESP data, four constituents are identified as surface water SRCs that were not previously identified in the 2007 RIR. However, all four constituents were detected at concentrations lower than their respective risk-based PRGs, so do not qualify as COPCs or ROPCs. Three of the seven locations where surface water SRCs were identified for the supplemental ESP data set are boundary locations where surface water flows on to NFSS from off-site locations.

Using the RI data set supplemented with ESP data, 33 constituents are identified as sediment SRCs that were not previously identified in the 2007 RIR. However, 14 of these constituents do not exceed risk-based PRGs so do not qualify as COPCs or ROPCs, and eight of the remaining constituents exceed background levels at a single location. Because new COPCs and ROPCs were identified in sediments, these constituents should be subjected to further risk evaluation to confirm whether or not they are COCs (rather than simply COPCs and ROPCs) during the BOP FS. This risk evaluation should utilize the same methodology as that used for the NFSS BRA (USACE 2007b). If confirmed, these new ditch COCs should be compared to the list of soil COCs for determination of whether or not additional COCs need to be considered when developing soil cleanup goals for the BOP. It is important to note that for the remaining 11 SRCs identified in sediment using the supplemental 2008, 2009 and 2010 ESP dataset, more than 40 percent of the above background level detections occurred at site boundary locations. Sample locations SWSD009, SWSD021, SWSD023 (added in 2008) and SWSD024 (added in 2008) are located at the upstream NFSS fence line where surface water flows on to the NFSS from adjacent properties. While the new sediment SRCs include a variety of constituents, the most prevalent chemical class for the new SRCs is PAHs. Seven PAHs were identified as new SRCs. These PAHs exceed background levels

at seven sampling locations, however two of these are boundary locations that may have been impacted by surface water entering the site.

Supplemental ESP data for surface water and sediment sampling collected along the WDD (WDD1, WDD2 and WDD3) were used to assess potential impacts to the WDD from the NFSS including uncertainty associated with the uranium groundwater plume west of the IWCS. By comparing RI data to more recent ESP data, a marked decrease in total uranium in the WDD was observed. ESP results indicate that total uranium concentrations in the WDD are currently at levels below the background level at all three sampling locations along the ditch. The observed decrease in total uranium in the WDD surface water between the time of RI sampling and the ESP sampling conducted during 2008, 2009 and 2010 suggests that the WDD is not greatly impacted by groundwater contaminant transport. Concentrations of total uranium observed in the WDD surface water and sediment during the RI are likely more indicative of material entering the WDD due to historical soil erosion and turbid overland flow.

14.8 RADIOLOGICAL INVESTIGATION OF UNDERGROUND UTILITY LINES ON THE FORMER LAKE ONTARIO ORDNANCE WORKS PROPERTY

The LOOW UURI was conducted during the fall of 2005 through January 2007 to investigate chemical contamination present in sediment, waste water and soil associated with underground utilities that were put in place to support the formerly used defense sites within the footprint of the LOOW, and which did not appear to have been impacted heavily by non-DoD site users (UURI Fact Sheet, USACE 2007d).

Sediment and waste water were sampled within pipelines, and soil was sampled beneath pipelines and at pipeline discharge points, which included a discharge line from the former LOOW WWTP to the Niagara River referred to as the 30-inch line (USACE 2009a). Radiological results from waste water and pipeline sediment collected as split samples during the LOOW UURI were screened against applicable background criteria to determine if they might be considered SRCs.

Radiological SRCs were identified in three out of 27 soil sample locations. The SRCs identified include uranium-234, uranium-235, and uranium-238. At two soil sample locations with radiological SRCs, the same radionuclides were identified as SRCs in sediments. Given the age and generally poor repair of the underground utility system at the LOOW, media mixing could be occurring that would account for this observation.

A total of eight radiological SRCs were identified in sediments with SRCs identified at 13 of the 15 sediment sample locations. Some of the highest concentrations of radiological SRCs detected in sediment were collected from sumps within the former LOOW WWTP. Although operation of the LOOW WWTP ceased in the mid-1970s, residual radiological contamination appears to be present in pipeline and sump sediments.

Radiological SRCs were identified in five out of 18 waste water sample locations and the SRCs identified (uranium-234, uranium-238 and uranium-238) were the same as those identified in pipeline soil. Since these lines were sealed around the same time that samples were collected for radiological analysis, the impact of sealing pipelines may not be evident in the radiological sample results reported here. During the UURI, it was noted that trends in constituent concentration were not discernable in many of the pipelines. This appears to occur for the acid waste and sanitary lines leaving the NFSS and can be attributed to the fact that several lines, including the former LOOW acid waste, sanitary sewer, and water lines, were previously sealed to prevent open conveyance for contaminant migration. Since only low concentrations of the radiological SRCs were detected in waste water samples, and the pipelines were subsequently sealed, the detected SRCs pose little risk.

14.9 RE-EVALUATION OF PLUTONIUM-239/240 IN SOIL

A review of plutonium-239/240 analytical results collected from NFSS soil during the RI and RIR Addendum field activities was conducted to re-evaluate conclusions regarding the nature and extent of plutonium contamination in site soils. As part of this review, plutonium data collected during the first three phases of the RI from 1999 through 2003 have been summarized, including plutonium results for 17 surface soil locations that were omitted from the 2007 RIR. Also included in the data summary are plutonium results for soil collected during the RIR Addendum field investigations conducted in 2009.

The NFSS RI database included analytical results for plutonium-239/240 from 59 samples of on-site environmental media, which included four low-level detections. The highest concentration of plutonium-239/240 was measured in a floor core collected in Building 401; however, this sample included significant interference from the tracer peak and is not believed to have any counts attributable to plutonium-239/240. Two other RI samples with plutonium detections included partial tracer interference, but are still believed to include some plutonium-239/240.

Each radionuclide has a unique energy spectrum measured as peaks or spectral plots during sample analysis. Nuclide identification is made by comparing measured peak energies with spectral plots stored within the analytical instrument's software library. However, the laboratory identification of radionuclides, at low concentrations, typical of environmental soils, can easily be mistaken, due to incomplete chemical separation, and coincident or overlapping spectral peaks, resulting in false positive results. Tracer peaks, from reference standards, are a laboratory quality control measurement used to test interferences found in samples.

The RI data set was augmented with plutonium results for 17 surface soil samples re-analyzed for plutonium-239/240 and inadvertently omitted from the RI database. Data for the 17 missing samples included three low-level detections for plutonium-239/240. Of the three low-level plutonium-239/240 detections included in this data set, one contained significant tracer interference and is not believed to be a positive plutonium-239/240 result and one contained partial tracer interference, but is still believed to include some plutonium-239/240. The remaining sample was collected in EU 1 where KAPL materials had been stored. During RIR Addendum field investigations an additional 40 samples were collected and analyzed for plutonium-239/240. Plutonium-239/240 was not detected in any of the RIR Addendum field investigation samples.

The predominant radionuclides expected at the NFSS include radionuclides from the decay series for naturally-occurring uranium, thorium and actinium. Since, plutonium is not part of these decay series, the NFSS RI database included limited analysis for isotopic plutonium with sampling focused around areas where KAPL waste was historically stored. Since there was a lot of americium data (via gamma spec analysis) collected across the site, this was used as an indicator of other transuranics associated with the nuclear industry, including plutonium. Out of a total of 768 americium-241 results, only 9 were listed as detected (~1%). The small number of americium-241 detections (9 of 768) indicates that americium-241 is not a COC at the NFSS, and also suggests that other transuranics, such as plutonium-239/240, are unlikely to be present at significant concentrations or to be widespread in NFSS soils/sediment.

14.10 SUPPLEMENTAL DOCUMENTATION AND REVISIONS TO THE REMEDIAL INVESTIGATION REPORT AND THE BASELINE RISK ASSESSMENT

Several comments received on the 2007 RIR concerned the public availability of specific documentation that was either referenced in the 2007 RIR or that contained information pertinent to conclusions presented in the 2007 RIR. Supplemental documentation requested by 2007 RIR reviewers is presented in this RIR Addendum to ensure that the public has the opportunity to review documentation forming the

basis of 2007 RIR conclusions. This supplemental information is in the form of published reports and papers, fact sheets, correspondence, and field notes. These items are included as appendices on a compact disc accompanying this RIR Addendum.

2007 RIR and BRA items requiring revision to address public comments or to accurately portray pertinent information for the RI have been presented in this RIR Addendum. These items include:

- *Tables in Appendix K of the 2007 RIR showing downhole gamma logging results:* The revision corrects a formula error for the X and Y axes used to display the data.
- *The discussion of the SRC determination process presented in Section 4 of the 2007 RIR:* The text has been revised so the SRC determination process accurately corresponds to the process depicted in 2007 RIR Figure 4-1.

- *Tables 2.1 (Background Data Summary for NFSS with Upper Tolerance Limits) and 2.2 (Toxicity Criteria and Chemical-Specific Parameters for Chemical SRCs) of the Baseline Risk Assessment:* Table 2.1 has been revised to correct the UTL for arsenic in surface soil. Table 2.2 of the BRA has been revised to include reference columns for the toxicity information.

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APPENDICES
(INCLUDED ON CD)

Appendix 3-A	RIR Addendum Field Photographs
Appendix 3-B	RIR Addendum Boring and Well Logs
Appendix 4-A	Environmental Surveillance Program and Supplemental Sampling Event Data Summary
Appendix 4-B	Ambient Air Calculations for VOCs in EU 4 Soil and Groundwater
Appendix 5-A	Turf Maintenance Program for the Waste Containment Structure, Niagara Falls Storage Site, Lewiston, New York
Appendix 5-B	Select Drawings from the Design Report for the Interim Waste Containment Facility at the Niagara Falls Storage Site
Appendix 5-C	Trending Analyses for Total Uranium and Radium-226 in Groundwater
Appendix 12-A	Knolls Atomic Power Laboratory (KAPL) Waste Research
Appendix 12-B	Completion Report, Lake Ontario Ordnance Works, Youngstown, New York
Appendix 12-C	Niagara Falls Storage Site Historical Photographic Analysis, Lewiston Township, New York
Appendix 12-D	Utilizing Isotopic Uranium Ratios in Groundwater Evaluations at NFSS – Research Paper by Rhodes et al. 2006
Appendix 12-E	Lake Ontario Ordnance Works Underground Utilities Remedial Investigation Fact Sheet
Appendix 12-F	2009 Survey, Niagara Falls Storage Site, Lewiston, New York
Appendix 12-G	NFSS Remedial Investigation Phase 3 Soil Boring Logs
Appendix 12-H	Water Level Measurement Data Used in the NFSS Groundwater Flow Model
Appendix 12-I	Evaluation of Groundwater and Surface Water in the West Drainage Ditch and Central Drainage Ditch
Appendix 12-J	Preparation and Review of Cross-sections to Evaluate the Presence of Sand Lenses in the Vicinity of the IWCS
Appendix 13-A	RI Downhole Gamma Logging Results