2015 Annual Monitoring Report
Group 1 Sites (PICA-079)

Picatinny Arsenal, New Jersey

Prepared for

Prepared by

EA Engineering, Science, and Technology, Inc., PBC
Contract No. W91ZLK-13-D-0004-0009

March 2016

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Prepared for

U.S. Army

Prepared by

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March 2016
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TABLE OF CONTENTS

LIST OF FIGURES

LIST OF TABLES

LIST OF ACRONYMS AND ABBREVIATIONS

µg/L	Microgram(s) per liter
amsl	Above mean sea level
ARCADIS	ARCADIS U.S., Inc.
bgs	Below ground surface
COC	Contaminant of concern
DNT	Dinitrotoluene
EA	EA Engineering, Science, and Technology, Inc., PBC
ft	Feet
LTM	Long-term management
LUC	Land use control
mg/kg	Milligram(s) per kilogram
mg/L	Milligrams per liter
MNA	Monitored natural attenuation
mV	Millivolt
NJDEP	New Jersey Department of Environmental Protection
NM	Not measured
PICA	Picatinny Arsenal
RAWP	Remedial Action Work Plan
RDX	Cyclotrimethylenetrinitramine
ROD	Record of Decision
SCL	Site Cleanup Level
SD	Sediment
Sovereign	Sovereign Consulting Inc.
S.U.	Standard unit
SW	Surface water
TIC	Top of inside casing
TNT	Trinitrotoluene
U.S. Army	United States Army
USEPA	United States Environmental Protection Agency

1. INTRODUCTION

EA Engineering, Science, and Technology, Inc., PBC (EA) has been contracted by the United States Army (U.S. Army) Environmental Command to perform Installation Restoration Program activities at Picatinny Arsenal (PICA), located in Morris County, New Jersey (**Figure 1**). This work is being conducted under a Performance Based Contract that encompasses 84 sites. The full scope of services for this contract is defined in the Contract W91ZLK-13-D-0004 Task Order 0009. Field activities associated with this contract are being conducted by EA's subcontractor Sovereign Consulting Inc. (Sovereign).

1.1 SITE BACKGROUND

The Group 1 Sites (PICA-079) are located in Area I in the central portion of PICA, west of Picatinny Lake in Rockaway Township, Morris County, New Jersey (**Figure 2**). Group 1 consists of the followings four sites: Site 40, Site 93, Site 156, and Site 157. Each of these four sites contain buildings that have been used in the manufacturing, testing, and cleaning up of explosives. These sites are described below:

- Site 40 contains Buildings 809 and 810 that were used for a large caliber projectile washout facility and as a melt-pour facility. Explosives-contaminated wastewater was generated as part of those operations.

- Site 93 includes Building 800 and 807 which were used for sampling of propellants, loading submissiles (cluster bombs) into warheads, and as a cleaning, inspection, and receiving facility for explosives.

- Site 156 includes Buildings 813, 816, and 816B used as large caliber projectile loading plants and as an inert storage facility.

- Site 157 consists of two separate areas, a northern and southern area. The southern area of Site 157 is located northeast of Site 93 and includes Buildings 823 and 824 that were used as large caliber projectile loading plants. In addition Building 823 was also used to treat operational wastewaters. The northern area of Site 157 includes Building 820 which was also used as a large caliber projectile loading plant. The projectile loading plants consisted of packing and shipping facilities for the completed rounds loading production line, and a melt-load facilities for the loading of melted 2,4,6-trinitrotoluene (TNT) and cyclotrimethylenetrinitramine (RDX) explosives into shells.

The Record of Decision (ROD) (U.S. Army 2010) for the Group 1 Sites (PICA-079) was developed jointly with the U.S. Army and the United States Environmental Protection Agency (USEPA) Region 2, with input from the community, and was approved and signed by the U.S. Army and the USEPA on 29 July and 16 September 2010, respectively. The New Jersey Department of Environmental Protection (NJDEP) also concurred with the selected response.

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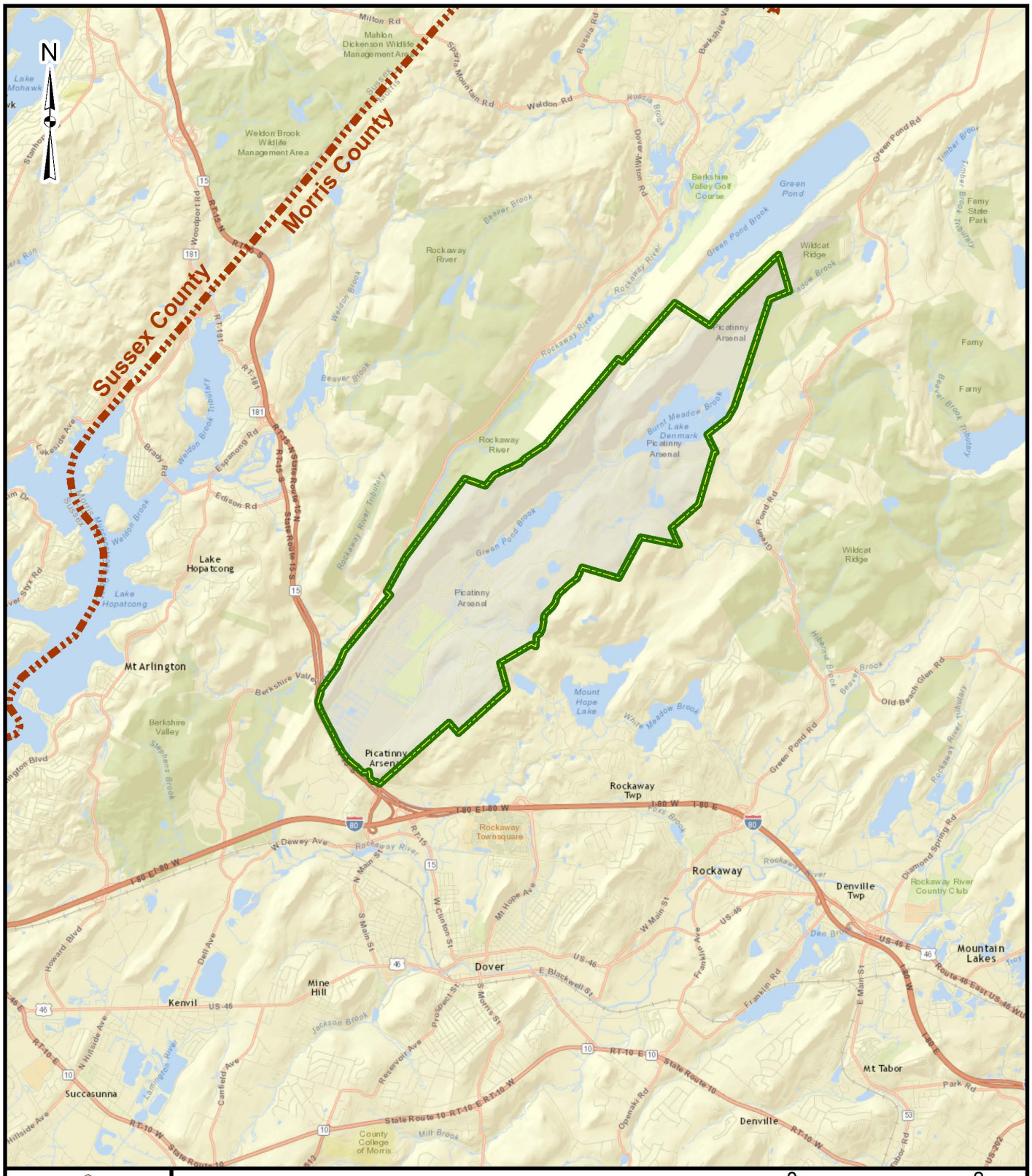

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GROUP 1 SITES (PICA-079)
PICATINNY ARSENAL

Figure 1
Picatinny Arsenal
General Location

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2015 ANNUAL REPORT
GROUP 1 SITES (PICA-079)
PICATINNY ARSENAL

Figure 2
Group 1 (PICA-079)
Location Map

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As stated in the ROD, the selected response action for the site included the following:

- Excavation and offsite disposal of explosive-impacted soils
- Implementation of LUCs
- Monitored natural attenuation (MNA) of explosives in groundwater at the site.

LUCs for soil and groundwater were implemented to control current and future activities that could result in unacceptable risk to human health, as detailed in the Final Remedial Action Work Plan (RAWP) (ARCADIS 2010) and the 2014 Annual Land Use Certification Report (ARCADIS 2014a).

In accordance with the ROD, soils impacted with explosives at concentrations exceeding Site Cleanup Levels (SCLs) were excavated and disposed of at a permitted landfill. Excavation and offsite disposal of 600 cubic yards of impacted soil was conducted in September 2010. Further discussion of the 2010 soil remedial action is included within the Final Interim Remedial Action Report (ARCADIS 2011). Following completion of removal activities, long-term monitoring of groundwater, surface water, and sediment was initiated. This report only discusses the groundwater, surface water, and sediment sampling conducted to address the commingled groundwater plume located beneath Sites 40 and the southern 157 site. Land use controls (LUCs) are in place to control impacted media within Site 156 and are discussed in the 2014 Annual Land Use Certification Report (ARCADIS U.S., Inc. [ARCADIS] 2014a).

1.2 SCOPE OF WORK

The MNA program, which began in September of 2010, was designed to: (1) evaluate long-term effectiveness of MNA, (2) verify that exposure to contaminants and their breakdown products do not pose additional risks, and (3) assess when it is necessary to implement any contingency actions.

The monitoring program at PICA-079 consists of groundwater, surface water, and sediment sampling. The program sampling is implemented according to the following schedule:

- Quarterly for the first 2 years
- Semi-annually for the next 3 years
- Annually for the remainder of the remedy, with adjustment (greater or lesser) in frequency to be considered during each 5-year review.

Two years of consecutive, site-wide (e.g., Sites 40, 93, and 157), quarterly sampling was concluded following the 2012 second quarter. In accordance with NJDEP's request, sampling will continue on a quarterly basis at 40MW-1, 40MW-2, 40MW-3, 40MW-5, 40MW-6,

79SW/SD-1, and 79SW/SD-2 through the second quarter of 2016[1]. Site-wide sampling will continue on a semi-annual basis for the next 3 years (i.e., through the first half of 2016). This Annual Monitoring Report discusses the long-term monitoring activities conducted during 2015 to evaluate MNA of explosives in groundwater at the Group 1 Sites (PICA-079). Furthermore, this report presents data collected during the site-wide semi-annual event, as well as data collected during quarterly events for the year 2015. Lastly, the results of MNA long-term monitoring for explosives in groundwater, surface water, and sediment are discussed and interpreted in this report. A summary of the monitoring program is presented in **Table 1**.

[1] Following submission of the 2011 Annual Report, NJDEP requested quarterly sampling through the third quarter of 2015. Due to a gap in contractors, quarterly sampling was not conducted during the 1st and 2nd quarters of 2015. Therefore, quarterly sampling will be extended through the first half of 2016.

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Table 1 Monitored Natural Attenuation Program Summary

				Calendar Year	2010		2011		2011		2012		2013		2013		2014		2014		2014		2015				2015	
				Operation Year	1st Year				2nd year				3rd Year				4th year				5th Year						6th Year	
					Jul-Sep	Oct-Dec	Jan-Mar	Apr-Jun	Jul-Sep	Oct-Dec	Jan-Mar	Apr-Jun	Jul-Sep	Oct-Dec	Jan-Mar	Apr-Jun	Jul-Sep	Oct-Dec	Jan-Mar	Apr-Jun	Jul-Sep	Oct-Dec	Jan-Mar	Apr-Jun	Jul-Sep	Oct-Dec			
Category	**Media**	**Schedule**	**Sample Locations**	**COCs**	**3rd**	**4th**	**1st**	**2nd**	**3rd**	**4th**	**1st**	**2nd**	**3rd**	**4th**	**1st**	**2nd**	**3rd**	**4th**	**1st**	**2nd**	**3rd**	**4th[4]**	**1st[4]**	**2nd[4]**	**3rd**	**4th**			
Groundwater Monitoring	Groundwater	Yr: 1-2 quarterly Yr 3-5: semi-annually Yr 6+: annually	40MW-1, 40MW-2, 40MW-3 40MW-5, 40MW-6, 93MW-2 157MW-1, 157MW-2 157MW-3, 157MW-4	2,4,6-Trinitrotoluene 2-amino-4,6-Dinitrotoluene 4-amino-2,6-Dinitrotoluene Amino-Dinitrotoluene RDX	Completed	Completed	Completed	Completed	Completed	Completed	Completed	Completed	Site 40 Added[3]	Completed	Site 40 Added[3]	Completed	Site 40 Added[3]	Completed	Site 40 Added[3]	Completed	Completed				Completed	Site 40 Added[3]			
Surface Water and Sediment Sampling	Surface Water	Yr: 1-2 quarterly Yr 3-5: semi-annually Yr 6+: annually	79SW/SD-1 79SW/SD-2[2]	2,4,6-Trinitrotoluene 2-amino-4,6-Dinitrotoluene 4-amino-2,6-Dinitrotoluene Amino-Dinitrotoluene RDX	Completed	Completed	Completed	Completed	Completed	Completed	Completed	Completed	Added[2]	Completed	Added[2]	Completed	Added[2]	Completed	Added[2]	Completed	Added[2]				Completed	Added[2]			

				Calendar Year	2016				2017				2018				2019				2020	
				Operation Year	6th Year		7th Year				8th Year		9th Year				10th Year					
					Jan-Mar	Apr-Jun	Jul-Sep	Oct-Dec	Jan-Mar	Apr-Jun	Jul-Sep	Oct-Dec	Jan-Mar	Apr-Jun	Jul-Sep	Oct-Dec	Jan-Mar	Apr-Jun	Jul-Sep	Oct-Dec	Jan-Mar	Apr-Jun
Category	**Media**	**Schedule**	**Sample Locations**	**COCs**	**1st**	**2nd**	**3rd**	**4th**	**1st**	**2nd**	**3rd**	**4th**	**1st**	**2nd**	**3rd**	**4th**	**1st**	**2nd**	**3rd**	**4th**	**1st**	**2nd**
Groundwater Monitoring	Groundwater	Yr: 1-2 quarterly Yr 3-5: semi-annually Yr 6+: annually	40MW-1, 40MW-2, 40MW-3 40MW-5, 40MW-6, 93MW-2 157MW-1, 157MW-2 157MW-3, 157MW-4 157MW-6S[1]	2,4,6-Trinitrotoluene 2-amino-4,6-Dinitrotoluene 4-amino-2,6-Dinitrotoluene Amino-Dinitrotoluene RDX	Planned	Site 40 Added[3]		Planned			Planned				Planned				Planned			
Surface Water and Sediment Sampling	Surface Water	Yr: 1-2 quarterly Yr 3-5: semi-annually Yr 6+: annually	79SW/SD-1 79SW/SD-2[2]	2,4,6-Trinitrotoluene 2-amino-4,6-Dinitrotoluene 4-amino-2,6-Dinitrotoluene Amino-Dinitrotoluene RDX	Planned	Added[2]	Added[2]	Planned			Planned				Planned				Planned			

NOTES:

[1]157MW=6S sampled only for 1Q2012 and 2Q2012 to establish a trend
[2]79SW/SD2 added per NJDEP request in response to 2011 Annual Report. In addition, quarterly
[3]Quarterly sampling extended at Site 40 to Sept 2015 based upon NJDEP request to monitor plume
[4]No sampling conducted due to gap in contractors.
COC = Contaminant of concern
RDX = Cyclotrimethylenetrinitramine
NJDEP = New Jersey Department of Environmental Protection

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2. SAMPLING ACTIVITIES AND ANALYSES

This section summarizes the technical rational for MNA of explosives within groundwater and also presents a summary of the monitoring program.

The scope of the response action for groundwater set forth in the Group 1 Sites (PICA-079) ROD was a combination of MNA and LUCs. No active treatment was to be implemented to remove contaminants from groundwater at the sites. Rather, monitoring of groundwater and surface water for contaminants of concern (COCs) and field parameters would verify that contaminants are continuing to be attenuated under existing conditions.

The MNA program, which began in September 2010, was designed to:

- Evaluate long-term effectiveness of MNA
- Verify that exposure to contaminants and their breakdown products do not pose additional risks
- Assess whether it is necessary to implement any contingency actions.

Section 2.1 summarizes the MNA of explosives, and Section 2.2 summarizes the activities conducted during 2015 to assess the status of the MNA program.

2.1 MONITORED NATURAL ATTENUATION OF EXPLOSIVES IN GROUNDWATER

Natural attenuation includes a variety of processes, such as dispersion, volatilization, immobilization, and biological transformation that occur in groundwater reducing COC concentrations. These natural processes can be an effective, non-intrusive, and a safe means for attenuating constituents at locations with no direct human contact or other immediate receptor concerns (ARCADIS 2009).

The 2005 Feasibility Study evaluated the fate and transport of TNT and RDX to assess the potential reduction of these compounds through biological processes, physical processes, and chemical reactions. Overall, this evaluation yielded a qualitative confirmation that groundwater conditions are favorable for the natural degradation of TNT and RDX (Shaw 2005).

2.2 2015 SAMPLING ACTIVITIES AND ANALYSES

A semi-annual site-wide monitoring event was conducted in September of 2015. Typically, the semi-annual sampling is conducted during the second and fourth quarters of each year. However, the first semi-annual sampling event was conducted in September 2015 following award of a new contract. The next semi-annual event will occur in 1st quarter of 2016. The NJDEP requested that quarterly groundwater sampling be extended through September 2015 for monitoring locations within Site 40; groundwater monitoring continued on a quarterly basis at groundwater monitoring wells located in Site 40 (40MW-1, 40MW-2, 40MW-3, 40MW-5, 40

MW-6) and at surface water/sediment location 79SW/SD-1 in 2014. This will be extended through the first half of 2016 to account for missed quarters during the gap in contractors. Furthermore, an additional surface water/sediment location (79SW/SD-2) was added downgradient of 157MW-3 in the second quarter of 2012 per NJDEP request. Monitoring at 79SW/SD-2 will also be conducted on a quarterly basis through the first half of 2016.

Samples were collected on the dates listed in the following table:

Media	3rd Quarter Site-Wide (Semi-Annual Event)	4th Quarter Quarterly Event (Site 40 Only)
Groundwater	11 September 2015	2 November 2015
Surface Water	11 September 2015	2 November 2015
Sediment	11 September 2015	2 November 2015

The monitoring program summary is provided in **Table 1**. A site location map is included as **Figure 2**. **Figure 3** provides the groundwater monitoring well network and surface water/sediment sampling locations.

2.3 2015 SITE-WIDE QUARTERLY AND SEMI-ANNUAL SAMPLING ACTIVITIES

Quarterly monitoring events were conducted at Site 40 during the 3rd and 4th quarters of 2015 and consisted of groundwater elevation measurements, groundwater monitoring, and surface water/sediment monitoring in accordance with the monitoring program established RAWP (ARCADIS 2010). Quarterly groundwater sampling was conducted at Site 40 monitoring wells 40MW-1, 40MW-2, 40MW-3, 40MW-5, 40MW-6; and sediment and surface water sampling was conducted from two locations within Picatinny Lake, at locations 79SW/SD-1 and 79SW/SD-2.

Semi-annual groundwater monitoring was conducted at 93 and 157 and consisted of sampling 5 monitoring wells (157MW-1, 157MW-2, 157MW-3, 157MW-4, and 93MW-2) during the 3rd quarter. Field forms from the quarterly and semi-annual monitoring events are provided in **Appendix A**.

Prior to collection of groundwater samples during both quarterly and semi-annual events, depth to groundwater measurements were collected. Depth to groundwater measurements and corresponding groundwater elevations for the monitoring wells in the monitoring program are provided in **Table 2**. Groundwater samples were collected using HydraSleeves™ and analyzed for the following four COCs via USEPA Method 8330:

- 2-amino-4,6-dinitrotoluene (DNT)
- 4-amino-2,6-DNT
- RDX
- TNT.

Field parameters including pH, temperature, dissolved oxygen, and oxidation reduction potential, were also measured via a down-well probe following retrieval of each HydraSleeve™. Groundwater analytical results and field parameters are provided in **Table 3**.

To evaluate the potential for surface water and/or sediment impairment due to impacted groundwater discharging to Picatinny Lake, two surface water (SW) and sediment (SD) monitoring locations (79SW/SD-1 and 79SW/SD-2) were sampled and are depicted on **Figure 3**. Sample location 79SW/SD-2 was added to the long-term management (LTM) program in the second quarter of 2012 pursuant to the NJDEP's request. Grab samples were collected and analyzed for the same COCs as detailed above. Surface water and sediment will be monitored for the duration of the groundwater response action; however, SCLs were not established for these media. Rather, surface water data will be screened against the New Jersey Surface Water Quality Standards (NJDEP 2011) (**Table 4**). The sediment will be compared against the surface soil SCL to evaluate sediment data.

2.4 DATA VALIDATION AND USABILITY

All data collected were third party validated in accordance with the USEPA National Functional Guideline for Organic Data Review, dated August 2014. The validation criteria for long-term monitoring data include a review of the laboratory report narrative for noted deficiencies and the potential impact to data usability. Therefore, a review of chain-of-custodies, sample preservation, sample receipt logs, and a review of quality control parameters were performed for all data packages. No major deficiencies were identified for COCs during the data validation. The 3rd Quarter aqueous blank and MS/MSD of the sample from 157MW-1 displayed low recovery for PETN. PETN is not a COC and no positive results were detected in the native sample from 157MW-1. A copy of the Data Validation Report is included with Appendix B.

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2015 ANNUAL REPORT
GROUP 1 SITES (PICA-079)
PICATINNY ARSENAL

Figure 3
Group 1 (PICA-079)
Sample Locations

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Table 2 Depth to Groundwater

Well ID	Screened Interval (ft bgs)	Total Depth (ft amsl)	Land Elevation (ft amsl)	TIC Elevation (ft amsl)	12/6/2007		1/30/2008		12/21/2010		3/1/2011		6/6/2011		8/17/2011		12/20/2011		3/22/2012	
					Water Level Depth (ft bgs)	Water Level Elevation (ft amsl)	Water Level Depth (ft bgs)	Water Level Elevation (ft amsl)	Water Level Depth (ft bgs)	Water Level Elevation (ft amsl)	Water Level Depth (ft bgs)	Water Level Elevation (ft amsl)	Water Level Depth (ft bgs)	Water Level Elevation (ft amsl)	Water Level Depth (ft bgs)	Water Level Elevation (ft amsl)	Water Level Depth (ft bgs)	Water Level Elevation (ft amsl)	Water Level Depth (ft bgs)	Water Level Elevation (ft amsl)
40MW-1	24-34	688.88	722.7	722.44	9.85	712.59	9.91	712.53	11.71	710.73	11.2	711.24	12.1	710.34	10.31	712.13	12.45	709.99	9.87	712.57
40MW-2	24.8-34.8	688.7	722.35	723.02	10.45	712.57	10.5	712.52	12.4	710.62	11.95	711.07	12.71	710.31	11.11	711.91	13.18	709.84	10.42	712.60
40MW-3	26.5-36.5	681.29	714.29	717.28	4.41	712.87	4.75	712.53	6.58	710.7	6.11	711.17	6.94	710.34	5.23	712.05	7.38	709.9	4.70	712.58
40MW-5	24.5-34.5	682.78	716.83	718.82	6.23	712.59	6.3	712.52	8.04	710.78	7.38	711.44	8.58	710.24	6.55	712.27	8.85	709.97	6.28	712.54
40MW-6	24-34	690.75	724.75	724.42	11.65	712.77	11.69	712.73	12.53	711.89	13.05	711.37	12.87	711.55	12.21	712.21	14.27	710.15	11.64	712.78
93MW-2	27-37	682.52	719.52	722.81	NM	NM	NM	NM	7.75	715.06	11.16	711.65	12.36	710.45	10.65	712.16	12.43	710.38	10.30	712.51
157MW-6S	14-19	699.69	718.96	718.69	NM	NM	NM	NM	NM	NM	NM	NM	NM	NM	NM	NM	8.91	709.78	6.67	712.02
157MW-1	24.1-34.1	685	718.61	720.96	8.43	712.53	NM	NM	10.35	710.61	9.88	711.08	10.66	710.3	9.15	711.81	11.07	709.89	8.42	712.54
157MW-2	25.8-35.8	684.66	716.99	719.9	7.3	712.6	NM	NM	9.12	710.78	8.63	711.27	9.58	710.32	8.01	711.89	9.81	710.09	7.35	712.55
157MW-3	36.6-36.6	684.62	717.86	720.57	8	712.57	NM	NM	9.87	710.7	9.41	711.16	10.25	710.32	8.76	711.81	10.51	710.06	8.02	712.55
157MW-4	24-34	683.3	717.29	719.63	6.77	712.86	NM	NM	8.58	711.05	8.11	711.52	8.95	710.68	7.56	712.07	9.16	710.47	6.83	712.80

Well ID	Screened Interval (ft bgs)	Total Depth (ft amsl)	Land Elevation (ft amsl)	TIC Elevation (ft amsl)	6/26/2012		9/10/2012		12/17/2012		3/19/2013		5/9/2013		1/28/2014		4/14/2014		7/7/2014	
					Water Level Depth (ft bgs)	Water Level Elevation (ft amsl)	Water Level Depth (ft bgs)	Water Level Elevation (ft amsl)	Water Level Depth (ft bgs)	Water Level Elevation (ft amsl)	Water Level Depth (ft bgs)	Water Level Elevation (ft amsl)	Water Level Depth (ft bgs)	Water Level Elevation (ft amsl)	Water Level Depth (ft bgs)	Water Level Elevation (ft amsl)	Water Level Depth (ft bgs)	Water Level Elevation (ft amsl)	Water Level Depth (ft bgs)	Water Level Elevation (ft amsl)
40MW-1	24-34	688.88	722.7	722.44	9.88	712.56	12.82	709.62	9.45	712.99	9.45	712.99	9.55	712.89	10.39	712.05	9.93	712.51	10.98	711.46
40MW-2	24.8-34.8	688.7	722.35	723.02	10.45	712.57	13.40	709.62	10.27	712.75	10.13	712.89	10.18	712.84	10.02	713.00	15.69	707.33	11.56	711.46
40MW-3	26.5-36.5	681.29	714.29	717.28	4.70	712.58	7.67	709.61	4.50	712.78	4.36	712.92	4.43	712.85	5.31	711.97	4.91	712.37	5.81	711.47
40MW-5	24.5-34.5	682.78	716.83	718.82	6.30	712.52	9.27	709.55	6.06	712.76	5.82	713.00	5.99	712.83	6.82	712.00	6.29	712.53	7.36	711.46
40MW-6	24-34	690.75	724.75	724.42	11.65	712.77	10.35	714.07	11.44	712.98	11.25	713.17	11.36	713.06	12.22	712.20	11.71	712.71	12.73	711.69
93MW-2	27-37	682.52	719.52	722.81	10.22	712.59	10.22	712.59	10.05	712.76	NM	NM	9.99	712.82	NM	NM	10.05	712.76	NM	NM
157MW-6S	14-19	699.69	718.96	718.69	6.63	712.06	NM	NM	NM	NM	NM	NM	NM	NM	NM	NM	NM	NM	NM	NM
157MW-1	24.1-34.1	685	718.61	720.96	8.43	712.53	8.43	712.53	8.23	712.73	NM	NM	8.14	712.82	NM	NM	8.52	712.44	NM	NM
157MW-2	25.8-35.8	684.66	716.99	719.9	7.35	712.55	7.35	712.55	7.14	712.76	NM	NM	7.06	712.84	NM	NM	7.45	712.45	NM	NM
157MW-3	36.6-36.6	684.62	717.86	720.57	8.04	712.53	8.04	712.53	7.82	712.75	NM	NM	7.74	712.83	NM	NM	8.06	712.51	NM	NM
157MW-4	24-34	683.3	717.29	719.63	6.82	712.81	6.82	712.81	6.60	713.03	NM	NM	6.51	713.12	NM	NM	6.75	712.88	NM	NM

Well ID	Screened Interval (ft bgs)	Total Depth (ft amsl)	Land Elevation (ft amsl)	TIC Elevation (ft amsl)	8/26/2014		9/9/2015	
					Water Level Depth (ft bgs)	Water Level Elevation (ft amsl)	Water Level Depth (ft bgs)	Water Level Elevation (ft amsl)
40MW-1	24-34	688.88	722.7	722.44	12.53	709.91	11.55	710.89
40MW-2	24.8-34.8	688.7	722.35	723.02	13.17	709.27	12.21	710.23
40MW-3	26.5-36.5	681.29	714.29	717.28	7.43	715.59	6.45	716.57
40MW-5	24.5-34.5	682.78	716.83	718.82	8.98	708.30	8.03	709.25
40MW-6	24-34	690.75	724.75	724.42	14.34	704.48	13.36	705.46
93MW-2	27-37	682.52	719.52	722.81	12.96	711.46	11.98	712.44
157MW-1	24.1-34.1	685	718.61	720.96	11.14	707.55	10.10	708.59
157MW-2	25.8-35.8	684.66	716.99	719.9	10.06	710.90	9.08	711.88
157MW-3	36.6-36.6	684.62	717.86	720.57	10.73	709.17	9.75	710.15
157MW-4	24-34	683.3	717.29	719.63	9.52	711.05	8.53	712.04

NOTES:
ft bgs = feet below ground surface
ft amsl = feet above mean sea level
NM = Not Measured
TIC = top of inside casing

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Table 3 Summary of Groundwater Results

	Location ID		40MW-1		40MW-2		40MW-3		40MW-5		40MW-6		93MW-2	157MW-1	157MW-2	157MW-3	157MW-4
	Sample Date		9/11/2015	11/2/2015	9/11/2015	11/2/2015	9/11/2015	11/2/2015	9/11/2015	11/2/2015	9/11/2015	11/2/2015	9/11/2015	9/11/2015	9/11/2015	9/11/2015	9/11/2015
Groundwater Results	**Unit**	**Groundwater SCL**															
COCs																	
2,4,6-Trinitrotoluene	µg/L	2	**8.6 J-**	**7.3**	**104**	**111**	< 0.20 U	0.62 J	< 0.20 U	< 0.2 U	**2.4**	**5.9**	< 0.20 U	< 0.22 U	< 0.20 U	**73.9**	< 0.20 U
2-amino-4,6-Dinitrotoluene	µg/L	73	4.5 J	4.2	3.1 J+	4.3	2.8 J+	0.93 J	< 0.20 U	< 0.2 U	3.4 J+	5.5	< 0.20 U	< 0.22 U	< 0.20 U	10.3	< 0.20 U
4-amino-2,6-Dinitrotoluene	µg/L	73	12.3 J-	11.5	34.6	41.8	4.9	2.8	< 1.0 U	< 1 U	5.9	16.2	< 1.0 U	1.6 J	1.3 J	20.5	< 1.0 U
RDX	µg/L	2	**24.8 J-**	**24.7**	**42.2**	**40.7**	**2.3**	1.2	1.3	**2.1**	**12.7**	**20.9**	0.45 J	**4.2**	**2.8**	**27.2**	< 0.20 U
Water Quality Parameters																	
Oxidation Reduction Potential	mV	---	236	0.2	219	19	244	45	241	92	233	18	266	186	241	136	98
pH	S.U.	---	6.71	8.06	7.14	8.11	6.84	7.95	6.8	7.26	6.59	7.9	6.9	6.71	6.08	7.1	6.89
Dissolved Oxygen	mg/L	---	1.39	5.71	2.14	7.44	1.36	4.71	1.36	7.78	1.07	5.51	2.58	2.12	3.06	1.71	2.17

NOTES:
1. Values exceeding the applicable screening criterion are boldfaced and shaded.
µg/L = micrograms per liter
COC = contaminent of concern
RDX = Cyclotrimethylenetrinitramine
SCL = Site Cleanup Level
U = Indicates that the analyte was analyzed but not detected.
J = Indicates an estimated result. Result is less than laboratory reporting limits.
mg/L = milligram per liter
mV = millivolt
S.U. = standard unit
- = Value biased low
+ = Value biased high

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Table 4 Summary of Surface Water and Sediment Results

Surface Water	Location ID		79SW-1		79SW-2	
	Sample Date		9/11/2015	11/2/2015	9/11/2015	11/2/2015
	Unit	Surface Water SCL				
COCs						
2,4,6-Trinitrotoluene	µg/L	2.2	< 0.20 U	< 0.20 U	< 0.20 U	< 0.20 U
2-amino-4,6-Dinitrotoluene	µg/L	73	< 0.20 U	< 0.20 U	< 0.20 U	< 0.20 U
4-amino-2,6-Dinitrotoluene	µg/L	73	< 1.0 U	< 1.0 U	< 1.0 U	< 1.0 U
RDX	µg/L	2	< 0.20 U	< 0.20 U	< 0.20 U	< 0.20 U

Sediment	Location ID		79SD-1		79SD-2	
	Sample Date		9/11/2015	11/2/2015	9/11/2015	11/2/2015
	Unit	Sediment SCL				
COCs						
2,4,6-Trinitrotoluene	mg/kg	95	< 0.088 U	< 0.088 U	< 0.086 U	0.343 J
2-amino-4,6-Dinitrotoluene	mg/kg	2000	< 0.180 U	< 0.180 U	< 0.170 U	< 0.160 U
4-amino-2,6-Dinitrotoluene	mg/kg	1900	< 0.440 U	< 0.440 U	< 0.430 U	< 0.410 U
RDX	mg/kg	26	< 0.088 U	< 0.088 U	< 0.086 U	2.01

NOTES:

1. Values exceeding the applicable screening criterion are boldfaced and shaded.
µg/L = micrograms per liter
COC = constituent of concern
mg/kg = milligram per kilogram
RDX = Cyclotrimethylenetrinitramine
SCL = Site Cleanup Level
U = Indicates that the analyte was analyzed but not detected.
J = Indicates an estimated result. Result is less than laboratory reporting limits.

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3. 2015 SEMI-ANNUAL MONITORING RESULTS

This section presents the results of the monitoring conducted in 2015. Groundwater and surface water/sediment analytical results are provided in **Tables 3 and 4**, respectively.

Field forms are included in Appendix A. Laboratory and data validation reports are provided in Appendix B. Appendix C presents graphs of concentration trends that include the historical data.

3.1 GROUNDWATER ELEVATION MEASUREMENTS

Typical groundwater elevations measured since 2010 indicate an easterly flow direction towards Picatinny Lake (**Figure 4**). Depth to groundwater measurements and corresponding groundwater elevations for the monitoring wells in the monitoring program are provided in **Table 2**.

3.2 GROUNDWATER MONITORING

Table 3 presents the 2015 analytical results for groundwater. A summary of COC analytical results is provided on **Figure 5**. A summary of the COC results for samples collected in 2015 is discussed below:

- 2-amino-4,6-DNT and 4-amino-2,6-DNT were not detected at concentrations exceeding the SCL (73 micrograms per liter [µg/L] for both) .

- RDX was detected above the SCL (2 µg/L) in all monitoring locations except the upgradient monitoring well 93MW-2 and monitoring well 157MW-4. The highest concentration detected was 42.2 µg/L at 40MW-2 during September 2015.

- TNT exceeded the SCL (2 µg/L) at four locations: 40MW-1, 40MW-2, 40MW-6, and 157MW-3. The highest concentration of TNT occurred at location 40MW-2 with a reported concentration of 111 µg/L during November 2015.

3.3 SURFACE WATER AND SEDIMENT MONITORING

Table 4 presents the 2015 analytical results for surface water and sediment. A summary of COC analytical results is provided on **Figure 4**. A summary of the COC results for samples collected in 2014 is discussed below.

3.3.1 Surface Water

No COCs were detected in surface water samples collected in 2015.

3.3.2 Sediment

SCLs have not been established for sediment; thus, the sediment data are compared to the surface soil SCLs as established in the RAWP (ARCADIS 2010). There were no SCL exceedances within sediment during the 2015 sampling event.

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Group 1 (PICA-079)

Monitoring Well

Surface Water and Sediment Sampling Location

Groundwater Contour

Inferred Groundwater Flow Direction

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Figure 4
Groundwater Elevations
September 2015

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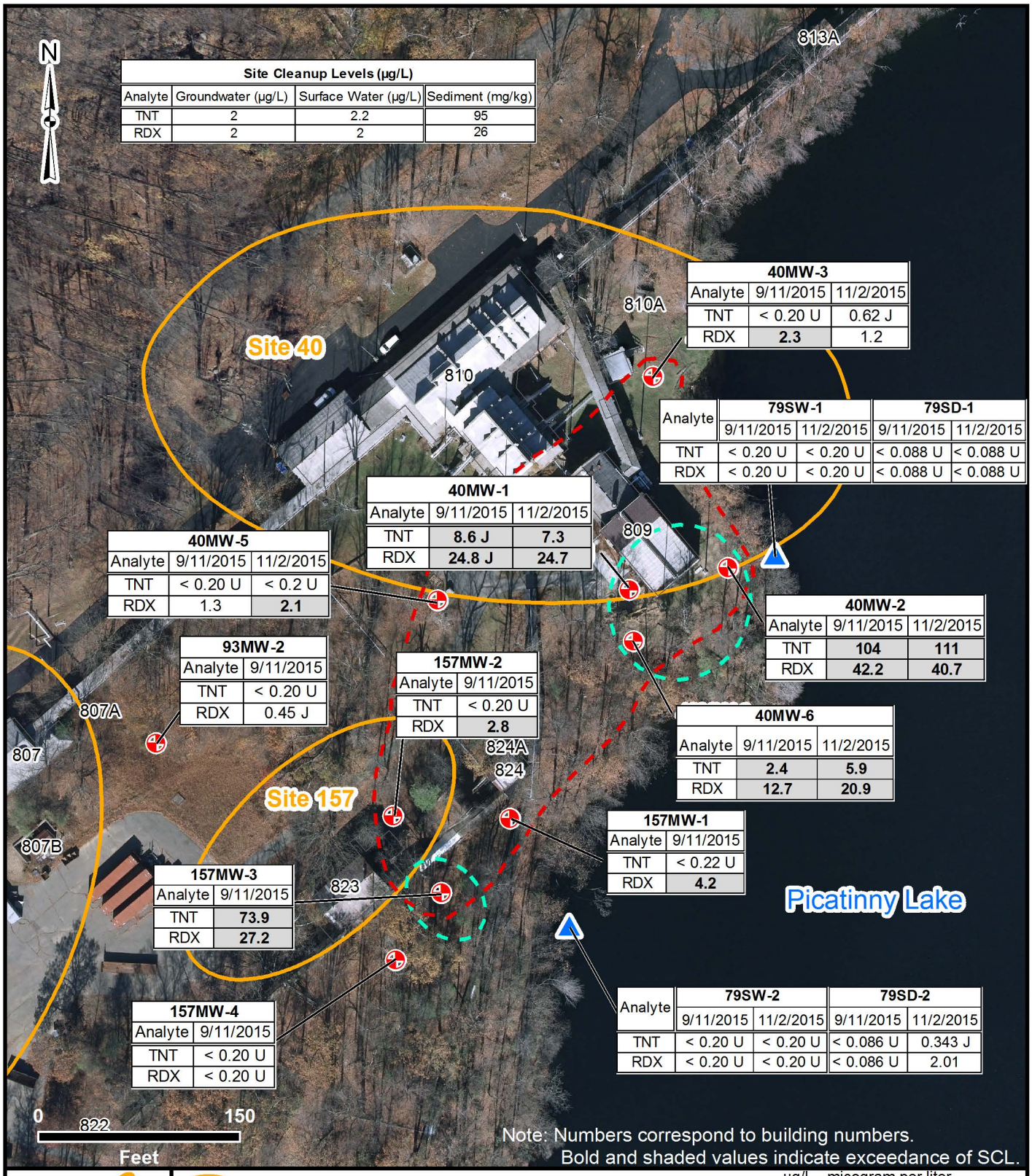

Group 1 (PICA-079)

Monitoring Well

Surface Water and Sediment Sampling Location

RDX Plume

TNT Plume

ug/L - micogram per liter
mg/kg - microgram per kilogram
J - estimated value
U - non-detect
SCL - site cleanup level
TNT - 2,4,6 Trinitrotouluene
RDX - cyclotrimethylenetrinitramine

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GROUP 1 SITES (PICA-079)
PICATINNY ARSENAL

Figure 5
Group 1 (PICA-079)
Analytical Results

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4. DATA TRENDS

Tables 3 and **4** present the groundwater and surface water/sediment analytical results for 2015. Appendix C presents graphs of concentration trends that include the historical data in addition to the long-term monitoring data.

4.1 DATA TREND EVALUATION FOR GROUNDWATER

This section summarizes the results of the trend evaluation for groundwater samples collected at the Group 1 Sites (PICA-079).

4.1.1 Site 40

There are five monitoring wells at Site 40: 40MW-1, 40MW-2, 40MW-3, 40MW-5, and 40MW-6. Monitoring well 40MW-5 is the most upgradient well; 40MW-1, 40MW-3, and 40MW-6 are generally mid-gradient or cross gradient wells; and 40MW-2 is the most downgradient of these wells, and is located nearest to Picatinny Lake.

The concentration of RDX and TNT within the upgradient and cross-gradient monitoring wells (i.e., 40MW-3, 40MW-5, and 40MW-6) are generally at low levels (i.e., typically less than 20 µg/L) or are non-detect. The concentration of RDX at 40MW-1 (24.7 µg/L in November 2015) has generally fluctuated but is more than an order of magnitude below the Site 40 historical RDX maximum of 490 µg/L, which occurred in 1999. The concentration of TNT at 40MW-1 (7.3 7 µg/L in November 2015) has declined significantly since its historical maximum of 400 µg/L during 1999. There has been an overall decline of RDX and TNT concentrations at 40MW-2 (40.7 µg/L and 111 µg/L, respectively in November 2015) since the peak concentrations were observed during January 1999 (490 µg/L) and March 2011 (523 µg/L), respectively. Although there continues to be fluctuation of RDX at 40MW-2, it is anticipated that the overall decline of RDX and TNT will continue at 40MW-2. The current remedy is still protective of human health and the environment.

4.1.2 Site 157

There are four monitoring wells at Site 157 that are included per the long-term monitoring sampling regimen: 157MW-1, 157MW-2, 157MW-3, and 157MW-4. Monitoring well 157MW-6S (not currently sampled within the long-term monitoring regimen) is upgradient of wells 157MW-1 and 157MW-3, and also has historically had the maximum concentrations at Site 157. Review of average water-level data in the immediate vicinity of these wells indicates that monitoring wells 157MW-1 and 157MW-3 are hydraulically downgradient of 157MW-6S. Therefore, the concentrations of RDX and TNT within 157MW-1 and 157MW-3 are likely attributable to 157MW-6S.

The maximum concentrations observed within 157MW-6S were 890 µg/L (TNT) and 260 µg/L (RDX) in April 2006. As noted within the 2011 Annual Monitoring Report (ARCADIS 2012a), there was a rebound of RDX and TNT concentrations observed within 157MW-6S. Furthermore, the 2012 and 2013 Annual Monitoring Reports (ARCADIS 2013, 2014b) reported

variable groundwater flow conditions, which were observed to be transient and likely the result of variation in Picatinny Lake stage during 2012 and 2013. **Table 2** presents a summary of groundwater elevations measured since 2007. Hydraulic gradients were observed to be lower than historical norms during 2012, and groundwater flow direction observed during the third quarter of 2013 suggested a westward flow. However, groundwater flow conditions observed during 2014 and 2015 site-wide sampling events suggest an eastward flow towards Picatinny Lake (**Figures 2** and **3**). Therefore, it is likely the fluctuations of RDX and TNT observed at 157MW-3 from 2011 through 2014 are the result of the concentrations within upgradient monitoring well 157MW-6S in conjunction with variable groundwater flow conditions observed at PICA-079 during 2011 to 2015.

RDX concentrations at 157MW-3 (27.2 µg/L in September 2015) fluctuate but do exhibit an overall decreasing trend since the peak concentration was observed during June 2011 (202 µg/L). TNT concentrations at 157MW-3 (73.9 µg/L in September 2015) have fluctuated since September 2010, but have been trending downward since 2013 (251 µg/L in May 2013). As depicted on the groundwater trend plot for 157MW-6S (Appendix C), it appears that the rebound is past peak, with the remnants of the rebound now flushing through downgradient wells. The current remedy is still protective of human health and the environment.

4.1.3 Site 93

There is one monitoring well included within the long-term monitoring sampling regimen for this site, 93MW-2, which is located upgradient to the explosive plumes. COCs have not been detected in 93MW-2 above SCLs since March 2012. The current remedy is still protective of human health and the environment.

4.2 SURFACE WATER AND SEDIMENT

Third and fourth quarter surface water samples were non-detect for all COCs in 2015. The only exceedance of SCLs in surface water collected during the last 10 quarterly sampling events occurred in April 2014 when RDX (SCL of 2 µg/L) at 79SW-1 was observed at a concentration of 3.99 µg/L.

Sediment sampling during 2013 exhibited SCL exceedances for TNT and RDX during the first and third quarter of 2013. However, there have been no SCL exceedances in sediment samples during 2014 and the most recent 2015 sampling events.

5. REMEDY PERFORMANCE AND FUTURE ACTIONS

Current concentrations of RDX and TNT in groundwater are generally lower when compared to historical concentrations (i.e., the data as observed during 2010-2015 compared to the late 1990s and early 2000s). Although concentrations in two monitoring wells (157MW-3 and 40MW-2) fluctuate, the concentrations in eight of the ten monitoring wells exhibit an overall declining trend for RDX and/or TNT indicating that natural attenuation continues to reduce explosives concentrations. The concentration of constituents at 157MW-3 and 40MW-2 are expected to decrease with time as the constituent concentrations in surrounding wells have been declining.

The ROD (U.S. Army 2010) states the timeframe to achieve the SCLs for TNT and RDX at Site 40 is approximately 11 years and 9 years, respectively. Similarly, the remedial timeframe to achieve SCLs at Site 157 for TNT and RDX is 8 years. However, a re-evaluation of the pore flushing model presented within the RAWP (ARCADIS 2010) using the peak concentrations for RDX and TNT observed since 2010 and current groundwater gradients indicate the remedial timeframe may be closer to 30–40 years (ARCADIS 2014c).

In accordance with the LTM program established in the RAWP (ARCADIS, 2010) and as amended within the First Quarter 2012 Monitoring Report (ARCADIS, 2012b), the following sampling activities are planned:

- ***Site 40 Groundwater***—Monitoring wells within the LTM regimen at Site 40 will be sampled quarterly through the first half of 2016.

- ***Site 157 Groundwater***—Monitoring wells will be sampled semi-annually through 1st half of 2016 then transition to annually in accordance with the original monitoring program established in the RAWP (ARCADIS 2010).

Furthermore, surface water and sediment samples will be collected on a quarterly frequency through 2016 at both 79SW/SD-1 and 79SW/SD-2 to establish concentration trends for RDX and TNT, given the 2014 detections at SD-2. The surface water and sediment sample frequency will be re-evaluated during the next 5-year review scheduled for 2016. The MNA program is presented in **Table 1** of this report.

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