Phase V Status and Remedial Monitoring Report
RTN 4-3024222
Former Bird Machine Company Site
Walpole, MA

Submitted to:

Baker Hughes Incorporated
Houston, TX

Submitted by:

AMEC Environment & Infrastructure, Inc.
Westford, Massachusetts

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LIST OF ACRONYMS

AMEC	AMEC Environment & Infrastructure, Inc.
bgs	below ground surface
BHI	Baker Hughes Inc.
BMC	Bird Machine Company
BWSC	Bureau of Waste Site Cleanup
CAM	Compendium of Analytical Methods
cfs	cubic feet per second
CMR	Code of Massachusetts Regulations
COC	Contaminants of Concern
CSA	Comprehensive Site Assessment
cVOC	chlorinated Volatile Organic Compounds
DCB	1,4-dichlorobenzene
DCE	dichloroethene
DDA	Demolition Debris Area
DO	Dissolved Oxygen
EPC	Exposure Point Concentration
EPH	Extractable Petroleum Hydrocarbons
Fe2	Ferrous Iron
FIR	Final Inspection Report (310 CMR 40.0878)
ft	feet
H&S	Health and Safety
HASP	Health and Safety Plan
HSM	Health and Safety Manager
ISCO	In Situ Chemical Oxidation
LRA3	Lead Release Area 3
LSP	Licensed Site Professional
MassDEP	Massachusetts Department of Environmental Protection
MBA	Manufacturing Building Area
MCP	Massachusetts Contingency Plan
mg/kg	milligrams per kilogram
mg/L	milligrams per liter
MMCL	Massachusetts Maximum Contaminant Level for drinking water
MNA	Monitored Natural Attenuation
mV	millivolts
NAPL	Non-aqueous phase liquid
ND	Not Detected by laboratory analysis
NSR	No Significant Risk
OHM	Oil or Hazardous Material
OMM	Operation, Maintenance, and Monitoring
ORP	Oxidation-Reduction Potential
OSHA	U.S. Occupational Safety & Health Administration
OSWER	U.S Office of Solid Waste and Emergency Response
P&T	Pump and Treat
PID	Photoionization Detector

List of ACRONYMS, continued

ppb	parts per billion (for groundwater, micrograms per liter)
PPE	Personnel Protective Equipment
RAM	Release Abatement Measure
RAP	Remedial Action Plan
RC	Reportable Concentration
RD	Reductive Dechlorination
RMR	Remedial Monitoring Report
ROS	Remedy Operation Status
RTN	Release Tracking Number
SRS	South Rail Spur
SSO	Site Safety Officer
SVOC	semivolatile organic compound
TCE	trichloroethene
USEPA	United States Environmental Protection Agency
USGS	U.S. Geological Survey
VC	vinyl chloride
VOC	volatile organic compounds
Weston	Weston Solutions, Inc.

EXECUTIVE SUMMARY

On behalf of Baker Hughes, Inc. (BHI), AMEC Environment & Infrastructure, Inc. (AMEC) completed this Phase V Status and Remedial Monitoring Report (RMR) for the former Bird Machine Company (BMC) Site located in Walpole, Massachusetts. BHI is submitting this RMR pursuant to 310 CMR 40.0890 of the Massachusetts Contingency Plan (MCP). This RMR documents the operation of a Comprehensive Remedial Action that is expected to be a Permanent Solution for the Site, and that was installed as described in the Phase IV Final Inspection Report (FIR; AMEC 2012). A Permanent Solution will achieve a condition of No Significant Risk (NSR) for current and reasonably foreseeable site uses. As documented in the Class C-2 Response Action Outcome (RAO) Statement submitted to the Massachusetts Department of Environmental Protection (MassDEP) on December 16, 2011, the Site already achieves the requirements of a Temporary Solution (AMEC 2011a).

Release Abatement Measures (RAMs) have been conducted at several locations between 2005 and 2011 to reduce the mass and concentrations of contaminants at the Site. The Phase II Comprehensive Site Assessment (CSA) reports (AMEC 2011b, AMEC 2011c) indicate that a condition of NSR exists for all areas of the Site except groundwater, where some monitoring well concentrations exceed drinking water criteria (Massachusetts Maximum Contaminant Levels or MMCLs). It is unlikely that groundwater at the Site will be used for drinking water, but the Site is within a Potential Drinking Water Source Area designated by the Town of Walpole (Walpole 2007). Considering this designation, groundwater at the Site is categorized as GW-1 under the MCP. The CSA reports found no current pathway between Site contaminants and the Town's water supply wells to the northeast, but the potential for contaminant movement from a portion of the Site warrants further monitoring. Background information including a description of RAMs and Site characteristics is summarized in Section 1 of this RMR.

Areas of groundwater contamination exceeding MMCLs have been identified for arsenic, chlorinated Volatile Organic Compounds (cVOCs), and 1,4-dichlorobenzene (DCB). A Monitored Natural Attenuation (MNA) remedy consisting of active monitoring of natural processes was selected to achieve cleanup goals, and was installed in accordance with Phase IV of the MCP. MNA is considered an Active Remedial Monitoring Program under the MCP and has been designed and constructed to provide a Permanent Solution that achieves a condition of NSR, as described in the FIR (AMEC 2012).

AMEC completed two quarterly rounds of monitoring at the site in accordance with the FIR in February/March and May/June 2013. Section 1 of this report provides background information for the site. Section 2 describes monitoring procedures, and Section 3 documents any modifications from the plans presented in the FIR. Section 4 of this RMR provides monitoring results and evaluations of MNA effectiveness, and Section 5 includes an updated Conceptual Site Model (CSM) and recommendations for future monitoring. This RMR documents that a remedial monitoring well network to support an Active Remedial Monitoring Program is being operated in accordance with the plans and specifications presented in the FIR.

1.0 SITE BACKGROUND

AMEC completed this Phase V RMR for the former BMC Site located in Walpole, Massachusetts on behalf of BHI. This document is submitted pursuant to 310 CMR 40.0892 of the MCP. This RMR documents operation and implementation of MNA, an Active Remedial Monitoring Program, which is the selected Permanent Solution for the Site. The Site location is indicated in Figure 1, and following is general information pertaining to the MCP status.

Release Tracking Number (RTN):	RTN 4-3024222
Tier Classification:	Tier IB
Site Address:	100 Neponset Street Walpole, Massachusetts 02071-1037
Person Undertaking Response Actions:	Baker Process Inc. 2929 Allen Pkwy Ste 2100 Houston TX 77019-7111 Contact: Mr. Chris Clodfelter Phone: 713-439-8329
Licensed Site Professional:	Kim M. Henry, LSP (License # 7122) AMEC Environment & Infrastructure, Inc. 2 Robbins Road Westford, Massachusetts 01886 Phone: 978-692-9090

A Tier 1B Permit Application was submitted to the MassDEP on January 10, 2008, including a revised Tier Classification and updated Phase I information combining several linked sites under the subject RTN. Tier 1B permit #W204776 for this RTN was effective on February 28, 2008, and expired on February 28, 2013. Because Remedy Operation Status (ROS) (AMEC, 2013b) was achieved and a ROS Opinion filed with the MassDEP on February 13, 2013, renewal of the permit was not required under the MCP.

This RMR is organized as follows:

- Section 1 – Site Background
- Section 2 – Operation, Maintenance, and Monitoring
- Section 3 – OMM Modifications Since the Preceding Report
- Section 4 – Evaluation of Effectiveness
- Section 5 – Recommendations and Updated CSM
- Section 6 – References

The remainder of Section 1 summarizes site characteristics, release history, and response actions. Section 2 describes monitoring procedures, and Section 3 documents any modifications from the plans presented in the FIR. Section 4 provides monitoring results and evaluations of MNA effectiveness, and Section 5 includes an updated CSM and recommendations for future monitoring. Section 6 provides references for this report.

1.1 Disposal Site Description

The Site, defined in the MCP as the area where the release "has come to be located," is in the central portion of the 108-acre Property. The approximate universal transverse mercator coordinates for the Site are 4,664,600 North and 312,700 East (World Geodetic System 1984/North American Datum 1983), based on the United States Geological Survey (USGS) Franklin Quadrangle Map, 1987. The Site Location Map, **Figure 1**, shows the regional location of the Site and positions of the nearest municipal water supply wells. Access to the property and Site is obtained via Neponset Street; this road and other Site features are depicted on an aerial photo in **Figure 2**. The Neponset River flows around the Site from the south to the northeast. Ruckaduck Pond is located to the west and was formerly used for water power, with dams maintaining an elevation several feet above the downstream river. An outlet from Ruckaduck Pond (formerly used to power a turbine) traverses the Site through an underground pipe, returning to the river on the east side.

As documented in the Phase II CSA, historical maps [including Sanborn Library, LLC Fire Insurance (Sanborn) Maps] were reviewed to determine the previous owner/operators of the property and the operations history. The Property appears to have been developed by 1832 with a "shingle mill" and two houses south of the Site, and a small pond in the present location of Ruckaduck Pond. A map dated 1852 indicates "Smith’s Mill" and three houses in the same area. A map dated 1888 indicates the Walpole Emery Mill in the same area, and Old Colony Railroad in its present location along the western edge of the Site. Sanborn maps from 1918 indicate that a railroad spur and three "factory" buildings had been constructed, and an open channel or “tailrace” had been constructed downstream of one of the factory buildings to convey water used for powering machinery back to the Neponset River. The BMC reportedly started operations at the property in 1919.

The 1927 and 1944 Sanborn Fire Insurance Maps indicate larger industrial buildings at the property, including a machine shop, casting shed, lumber shed, assembling, welding shop, and office. A 1940 USGS Topographic Map contains more detailed topography in the vicinity of the Site, indicates the boundary of the Cedar Swamp, and shows Cedar Swamp Brook. Historical aerial photographs and facility plans from 1931 to 1978 indicate that the Neponset River was rerouted at different times to facilitate the expansion of buildings and the addition of new ones. The open tailrace channel was filled in and replaced with a buried 24-inch concrete pipe in 1966. The industrial buildings on the Property were expanded several times in the 1960s and 1970s.

BMC primarily manufactured and repaired industrial centrifuges on the Property. BHI acquired BMC in 1989. BMC became an operating unit within Baker Process, Inc., a wholly-owned subsidiary of Baker Hughes Incorporated. Baker Hughes Process Systems, Inc. is the present owner of the Property. Manufacturing operations at the Property were discontinued in 2004, and most buildings associated with the former BMC were demolished by 2008. There is typically one worker at the Property, a security guard. Current human receptors at the Site are limited to occasional trespassers. The Property is zoned Limited Manufacturing, which allows a wide range of commercial, institutional, and residential uses. The Property is also grandfathered for industrial use.

Existing site features are indicated in **Figure 3** and include: a fire pump house (building no. 9), garage (19), and guard shack (21); floors and frost walls of demolished buildings 1, 3, 5, 20, 22, and 23; frost walls of demolished buildings 4, 4A, 6A, 7A, 8, 8A, 12, and 15; and pavement around the former buildings except where it was removed for RAM excavations. Figure 3 also shows remaining subsurface drains that lead to outfalls in the Neponset River. These drains were connected to the former buildings (roof drains or sanitary lines) or to surface catch basins, a few of which still remain as indicated in the figure. Note that the drain line connecting the pond and the river was installed within a former masonry-lined tail race; the masonry was observed in place near the southeast wall of former building 1 during building demolitions, and may still exist on either side of the drain in other areas. Figure 3 shows several subsurface structures which were left in place following building demolition: a 10,000-gallon concrete wastewater sump that was cleaned and filled with sand; several sections of Transite pipe encased in concrete; a 5,000-gallon steel wastewater tank that was closed in place near former building 4 by filling with concrete; and a reinforced-concrete base for a wastewater pump station adjacent to the 5,000-gallon tank. The RAM excavation areas in Figure 3, and the areas above the structures left in place, have been filled to grade with sandy soil.

The area surrounding the property has a mixture of residential and recreational (undeveloped forests and wetlands) uses. There are 273 residences with an estimated 743 residents located within ½-mile of the Site (Weston, 2005). There are presently no inhabited houses or private water supply wells within 500 feet (ft) of the Site. There are no schools, daycare centers, playgrounds, or parks within 500 ft of the Site. The 1987 USGS Franklin quadrangle map depicts the Boyden School located approximately 0.35 mile southeast of the Property, and 0.5 miles southeast of the Site. The nearest public water supply wells are slightly over 1 mile northeast of the Site as indicated in Figure 1.

1.2 Release History and Response Actions

The Site includes multiple RTNs due to the discovery of various releases at the property during recent investigations. Timing of releases is not well known, and the Site was used for manufacturing from at least 1832 to 2004. The RTNs were linked together to facilitate administrative compliance with MCP requirements. Three exposure areas were identified and evaluated in the October 2011 Phase II CSA Report (AMEC 2011b): the Manufacturing Building Area (MBA), the Lead Release Area 3 (LRA3), and the South Rail Spur (SRS). A separate exposure area was addressed in the December 2011 Phase II CSA Addendum (AMEC 2011c): the Demolition Debris Area (DDA). All four areas are indicated in Figure 2. Release Abatement Measures (RAMs) were conducted at several locations within the DDA, MBA, and LRA3 to reduce the mass and concentrations of contaminants at the Site. The CSAs indicate that a condition of No Significant Risk exists for all areas of the Site except groundwater within the MBA, where some monitoring well concentrations exceed drinking water criteria.

The remaining contamination at MBA includes metals (primarily antimony, barium, lead, nickel, and zinc) and Extractable Petroleum Hydrocarbon (EPH) compounds in soil. The concentrations of metals and Semivolatile Organic Compounds (SVOCs) have been reduced significantly by soil excavation RAMs. The remaining elevated concentrations in soil are under and around the former locations of manufacturing buildings. These soil concentrations were found to pose No Significant Risk for current and future foreseeable uses of the Site.

Groundwater sampling indicates elevated concentrations of arsenic and cVOCs in the area adjoining the river downgradient of the manufacturing buildings, and chlorobenzenes in a single well in the North Parking area. Groundwater concentrations in these areas exceed drinking water criteria. The updated extent of these exceedances is provided in Section 2 based on the results of quarterly monitoring. It is unlikely that groundwater at the Site will be used for drinking water, but the Site is within a Potential Drinking Water Source Area designated by the Town of Walpole (Walpole 2007). Considering this designation, groundwater at the Site is categorized as GW-1 under the MCP.

1.3 Hydrogeological Characteristics

The southeastern portion of the Site includes sand and gravel fill in depths of up to 10 feet, generally thickest where the Neponset River was rerouted. Beneath the fill layer, a 5-foot to 10-foot thick silty sand is present, which thins to a few feet in the west where bedrock is at a depth of 10 feet or less. The bedrock surface slopes downward to the east and is typically 20 to 30 feet deep near the river. Where bedrock deepens, the silty sand is underlain by a coarser silty sand and gravel in thicknesses of up to 20 feet. Cross sections including the latest contaminant findings are presented in Section 4.

The majority of borings at the Site were not cored into rock, and drilling refusals are generally interpreted as the bedrock surface unless inconsistent with borings that were cored or hammered to confirm rock. A bedrock low of about 45 ft below ground surface (bgs) occurs in the east-center of the Site near monitoring well MW-708. Bedrock cored during the FIR monitoring well installations consisted of two distinct rock types, conglomerate and shale. The interpreted bedrock surface map is provided in **Figure 4**.

Bedrock at MW-702 to the northwest and MW-710 to the east consisted of alternating layers of consolidated to unconsolidated conglomerate containing a mixture of angular to rounded boulders and sand. The layers consisted of approximately 5-foot thick consolidated rock alternating with approximately 3-foot thick unconsolidated boulders and sand. These alternating layers are consistent with highly fractured and weathered conglomerate material having been repeatedly faulted and folded. Bedrock at MW-708, a few hundred feet west of MW-710, consisted of slightly weathered shale in approximately 2-centimeter thick bedding layers. These layers were oriented vertically, suggesting previous faulting and folding in the area.

The water table beneath the Site occurs approximately 3 to 5 ft bgs in either fill or sand. Bedrock is believed to impede vertical flow as it is generally less transmissive than the shallow sand aquifer, depending on competency. Groundwater in the sand aquifer appears to be discharging to the Neponset River or its associated wetlands during much of the year. The water table in the areas adjacent to the River is less than 1 foot bgs. The horizontal direction of groundwater flow is toward the River from both sides. The vertical direction of flow is upward, discharging to the River. Vertical flow in the vicinity of Ruckaduck Pond is expected to be downward since the dam impounds surface water at an elevation above the water table. Mapped shallow and deep piezometric surfaces for the recent quarterly monitoring events are presented in Section 4.

Groundwater flow directions in specific areas of the MBA vary depending on water table conditions. Groundwater elevations were mapped for monitoring events in October 2006, July 2008, and April 2009 in the Remedial Action Plan (RAP; AMEC 2011d), and based on river flow records these three times appear to represent a range of typical median, low, and high water tables, respectively. Significant changes in the water table surface are apparent between the three events, particularly in the southeast portion of the Site. Aside from precipitation and river flow, another difference between the events was that in 2006 the MBA buildings and pavement were still intact; while in 2007 the buildings were demolished and some pavement removed resulting in the present Site conditions. Removal of the impervious structures may have affected infiltration patterns. Lateral groundwater seepage velocities in the sandy soils are estimated to range between 0.1 and 0.9 feet per day in the MBA, based on these three mapped events.

2.0 OPERATION, MAINTENANCE, AND MONITORING [310 CMR 40.0892(2)(A)]

The MNA remedy consists of an Active Remedial Monitoring Program as defined at 310 CMR 40.0006. The type and frequency of Operation, Maintenance, and Monitoring (OMM) under this program is summarized below.

2.1 Monitoring Network Design and Operation

The locations of monitoring wells are indicated in **Figure 5**. Initial process monitoring was conducted in the first year of OMM (August 2012 – August 2013) through quarterly sampling and measurements of water levels in the monitoring wells and river. Analytical parameters are summarized in **Table 1**. The groundwater flow setting appears to be relatively dynamic considering variability in levels of the adjacent river and pond; therefore additional water level measurements will be collected at two or more intervals following at least one major storm event. The storm monitoring events, originally proposed to be completed during the first year of monitoring, have not been completed to date. An effort will be made to conduct the measurements during the second year of monitoring to evaluate whether such storms have temporal affects on flow direction or rate that are not apparent in the quarterly sampling events. Monitoring well road boxes and protective covers will be inspected and maintained as needed during sampling events. Monitoring wells will be redeveloped if needed based on observations during purging and sampling.

Groundwater sampling at wells and temporary screens is performed with low-flow sampling techniques using a peristaltic pump. The pump is equipped with dedicated polyethylene tubing. The pump intake is lowered slowly into the well to the approximate center of the saturated screen section, and remains at least two feet above the bottom of the well to prevent the disturbance of any sediment which may be present. The water level is measured and recorded before starting the pump. Sampling records from previously sampled wells are reviewed in order to determine initial flow rates, or purging will be started at flow rates of approximately 0.2 to 0.5 liters per minute. The flow rate is adjusted to ensure that little or no drawdown (less than 0.3 feet) occurs in the well. If this level of drawdown cannot be sustained, the pumping rate is reduced to the minimum capabilities of the pump to avoid pumping the well dry. The level of the water is not allowed to drop below the intake on the pump to avoid the possible entrainment of air into the sample. If the recharge rate is very low, sampling commences as soon as the well has recharged to a sufficient level to purge one system volume (volume of pump and tubing) and then the appropriate volume of sample is collected.

During the purging of the well, the field parameters (pH, temperature, conductivity, dissolved oxygen, redox potential and turbidity) are monitored every 3 to 5 minutes, or as appropriate, using a flow-through cell, until the parameters stabilize. Field parameters are considered stabilized when, for three consecutive readings, the temperature is within ± 3%, pH is within ± 0.1, dissolved oxygen is within ± 10% or changes less than 0.3 mg/L, redox potential is within ± 10 mV, conductivity is within ± 3%, and turbidity is within ± 10%. An attempt is made to purge the well until turbidity of the purged water is less than 5 nephelometric turbidity units (ntu).

After purging is completed, groundwater samples are pumped directly into the proper sample containers. All sample containers are filled by allowing the pump discharge to flow gently down the inside of the container with minimal turbulence. Samples requiring dissolved constituent analysis are collected by pumping water through a new 0.45 µm filter into the appropriate sample container using a peristaltic pump and new silicone tubing. Sample containers, preservatives, volumes, hold times, and shipping requirements are summarized in Table 1. Selection of wells for dissolved gas analysis is based on results from the previous sampling round. Each sample is labeled and placed into a cooler with ice for shipment to the laboratory. Sampling activities are documented using pre-printed field data sheets to record well purging and any field screening results. Purge water is collected until sampling is complete, then returned to the monitoring well in accordance with the MCP.

2.2 Control of OHM Spills and Accidents

Site activities consist of groundwater sampling and analysis and water table measurements. Limited amounts of Oil or Hazardous Material (OHM) are associated with these activities, mainly consisting of petroleum or lubricants in vehicles or generators. Equipment containing OHM is operated in paved areas to the extent possible. Safe engineering and construction practices are implemented during for all phases of work, as described in the Health and Safety Plan in the FIR.

Spills of OHM will be reported and addressed in accordance with the MCP. Any impacted material resulting from a spill of machine oil or other hazardous substances will be placed in 55-gallon waste disposal drums or other approved containers for waste characterization, off-site transportation, and disposal. Equipment that comes in contact with contaminant residuals in soil or groundwater will be decontaminated before leaving the Site. Any wash water used will be managed as described in Section 2.3. No spills of OHM occurred during the current reporting period

2.3 Waste Management

Minimal soil and water waste is generated during field activities at the site. Excess groundwater collected during sampling is poured back into the boring or well from which it was obtained as required by MassDEP. Development water that cannot be returned to the boring or well, and all decontamination water and spill wastes is containerized and characterized for disposal at a licensed offsite waste facility. When wa ste is generated from site activities, characterization and disposal is conducted within 90 days of generation.

2.4 Measures to Avoid Adverse Impacts

Field crews periodically traverse and work within wooded and wetland areas east of the Neponset River to sample four monitoring well locations. Work within wetland and riverfront areas complies with an Order of Conditions from the Walpole Conservation Commission, which specifies best management practices to minimize adverse impacts to these sensitive areas.

2.5 Permits, Licenses, and Approvals

No federal permits or approvals are required to implement this plan. The work is conducted under the direction of a Licensed Site Professional under the MCP as indicated in Section 1, and is subject to the Public Involvement requirements of the MCP. The public notification letter for this report is provided in **Appendix A**. The BWSC Transmittal Form required under the MCP will be provided in **Appendix B** in the paper copy of this RMR, following final eDEP submittal.

Site activities within 100-foot wetland buffers and 200-foot Riverfront Area buffers are subject to the wetland protection requirements of the Walpole Conservation Commission and will comply with their Order of Conditions. All waste materials generated during response actions that cannot be reused are transported to appropriately licensed disposal facilities, in accordance with state and federal regulations.

3.0 OMM MODIFICATIONS SINCE THE PRECEDING REPORT [310 CMR 40.0892(2)(B)]

There were no modifications to OMM made during the current reporting period.

Although not an OMM modification, it is noted that water table measurements following a major storm event were not conducted during the six-month period covered in this report. This storm event monitoring will be conducted during the next six-month period, weather permitting.

Recommendations for any future modifications, based on the results in Section 4, are provided in Section 5 of this report.

4.0 EVALUATION OF EFFECTIVENESS [310 CMR 40.0892(2)(C)]

MNA is expected to reduce concentrations of contaminants to below drinking water standards in the shallow sand aquifer at the Site, and to achieve or approach background levels. For the purpose of Presumptive Certainty in achieving or approaching background, in accordance with MassDEP Policy WSC-04-160, it is assumed that the background level of arsenic is approached at a level of 5 ppb which is one-half of the GW-1 criterion for this contaminant. Similarly for cVOCs and chlorobenzenes background would be approached at one-half of the GW-1 standards: 35 ppb for TCB; 2.5 ppb for PCE, TCE, or DCB; and 1 ppb for VC.

The principal MNA processes are expected to include desorption, dilution, and biodegradation, considering site conditions described in the CSA (AMEC 2011c). The Site has relatively fast groundwater flow with seepage velocities estimated in the range of 37 to 330 ft/yr through sandy material. Neponset River flow is estimated at 200 to 400 times greater than the groundwater discharge, based on estimates in the CSA. Anaerobic conditions and dechlorination products are observed in wells having organic contaminants. Because releases are believed to be at least decades old, plumes of contaminants likely have achieved steady state or declining concentrations. However, source removals in portions of the vadose and saturated zones during 2005 – 2008 may have affected hydrogeology and plume stability in some areas. Therefore, in the absence of any continuing sources, contaminants sorbed to the aquifer matrix are expected to continue desorbing to groundwater, biodegrading (for organics) in the aquifer, and discharging to the river. Plumes appear to be relatively dilute based on low ratios of contaminant maximum concentrations to solubilities (<0.08%), and plume widths are generally less than 200 feet.

MNA effectiveness will be demonstrated through declining contaminant concentrations and reduced plume size within a reasonable timeframe, and persistence of site conditions favorable to MNA processes. Data analysis includes graphic or tabular displays of the following measurements for COCs and geochemical indicators:

- groundwater flow directions
- groundwater and surface water flow rates
- plume extent (horizontal & vertical)
- concentrations versus time

Data analysis includes evaluation of plume stability and loss of contaminant mass, and where possible estimates of remediation times. Evaluation of progress in achieving cleanup goals can be difficult due to subsurface and/or measurement variability, and seasonal or storm-related variations in groundwater movement. Therefore, multiple lines of evidence will be used to reduce uncertainty in evaluating the overall effectiveness. Following the evaluations in this section, the CSM will be updated in Section 5 as needed to ensure that it considers all viable hypotheses for explaining the data.

4.1 Flow Rates and Storm Effects

Water table measurements were collected at shallow and deep (above bedrock) wells at the beginning of each monitoring event, on February 25 and May 28, 2013. Shallow and deep water level contours were prepared for these two dates and are provided in **Figures 6 and 7**.

Neponset River flows at the nearest stream gauge in Norwood MA are indicated in the right panel of **Figure 8**, and averaged 127 cubic feet per second (cfs) on February 25, 2013 and 39 cfs on May 28, 2013. The water table elevations in February averaged one to two feet higher in elevation than in May, which correlates with an upward trend in river flows during February and a downward trend in May. The dates of earlier water table maps, which appear in the FIR or RAP, are indicated in the left panel of Figure 8 along with the river flow at each event. The long-term median data in Figure 8 suggest that by late February the river flow typically has increased to about 70% of the spring maximum, and by late May the flow has decreased to less than half of this maximum. Actual river flows on the recent measurement dates appeared to be near the long-term median values.

Like the most recent maps from 2012, the latest results show an inflection of the shallow water table downward at MW-714S and to a lesser extent at MB-MW-367, or a slight mounding of the water table in the area between MB-MW-365 and MW-712S. An upward vertical gradient has been observed at MW-714 since measurements began at this location in September 2012. The shallow water table contours in this area may reflect varying degrees of infiltration through surficial fill due to variations in fill material and degree of compaction, or greater infiltration in low areas where runoff ponds. The latter possibility seems a likely explanation for water table mounding around MB-MW-365, since a small pond is visible at that location in one of the aerial photos (Figures 6-7).

Lateral hydraulic gradients were calculated for the area between MW-711 and MW-709/710, which is near the center of the cVOC plume where it discharges to the river. Lateral gradients for shallow wells across the top of the aquifer were 0.017 ft/ft in February and 0.012 ft/ft in May. Lateral gradients for deep wells across the bottom of the aquifer were 0.004 ft/ft in February and 0.007 ft/ft in May.

The lateral seepage velocity was calculated for the bottom of the aquifer in this same area near the center of the cVOC plume, which is the depth where the majority of contaminants are present. The bottom of the aquifer in this area consists of silty sand and gravel, which is comparable to the aquifer material at DD-MW-201 where hydraulic conductivity was measured during the DDA Phase II investigations (Weston 2007a). Based on the above lateral gradients, and the measured hydraulic conductivity of 13 ft/day for silty sand & gravel at DD-MW-201, and assuming an effective porosity of 0.23, the lateral seepage velocity at the bottom of the aquifer in this area is estimated to average 0.31 ft/day for the monitoring period.

Comparison of shallow and deep elevations for the same date suggests the following vertical gradients:

- flat or slight upward gradients in the northern part of the site where the aquifer is thinner;
- generally downward gradients in the central area, except at MW-714; and
- flat or upward gradients in the east near the Neponset river.

Figures 6a-b and 7a-b show the gradient direction at well pairs using up and down arrows, or “=” for a flat gradient.

Bedrock well measurements at three locations on Figures 6b and 7b indicate upward vertical gradients between bedrock and the overlying sand aquifer in the northern portion of the site, but no significant gradient in the central or river/eastern portions. Bedrock water levels were measured at MW-702B in the north, MW-708B in the central area, and MW-710M and MW-710B near the river. Upward gradients of 0.48 ft and 0.46 ft were observed between the bedrock and deep aquifer screens at MW-702 during the February and May synoptic gauging events respectively. There was no significant vertical gradient between MW-708B and the nearby deep well MB-MW-364 during the two events, with head differences of 0.04 ft between the two screens. Slight head variations (0.17-0.27 ft) were observed between MW-710M (shallow bedrock) and MW-710B (deeper bedrock) during the two events, but no significant difference was observed between MW-710B and MW-710D (0.05-0.07 ft).

As noted in Section 3, the water table measurements that were proposed in the FIR to follow a major storm event were not conducted during the six-month period ending in June 2013. This monitoring will be scheduled during the next year, weather permitting.

4.2 Contaminant Extent

This section of the RMR documents the latest findings regarding the extent of groundwater contamination. Sampling logs are provided in **Appendix C**, and complete laboratory results (including non-detects) are provided in tabular form in **Appendix D**. Summaries of detections are provided for geochemical indicators in **Table 2**, and for COCs in **Table 3**. Tables 2 and 3 include the results since installation of new wells in June 2012 for comparison to the recent results; older results are in grey font in these tables. The data in Table 2 are also charted in a bar graph to allow visual comparison of sample results; ORP data were divided by 10, Chloride data were divided by 5, and DO data were multiplied by 5 to improve visibility on the chart scale. The horizontal and vertical extents of contamination based on these data are described in the subsections that follow. Horizontal extents are illustrated in **Figure 9**, and vertical extents are shown in **Figures 10 to 13**.

Evaluations of contaminant concentration trends over time and distance are presented in Section 4.3. Geochemistry data are discussed primarily in Section 4.4 in the context of attenuation processes. The concentrations listed parenthetically in the following text are for the most recent (May/June) sampling round unless otherwise specified.

4.2.1 Horizontal Extent of Contamination

The horizontal extent of DCB detected above the 5 ppb MMCL is unchanged compared to the previous Phase V RMR (AMEC 2013a) and includes only deep well NP-MW-601 (6.2 ppb) and bedrock well MW-702B (4.2 ppb). Although the most recent concentration of DCB at MW-702B was below the MMCL, the well will continue to be depicted within the DCB area (**Figure 9)** until longer-term trends substantiate the June results, and exclusion of this well from the delineation of the DCB area is warranted. Results for MW-700S, MW-701S, MW-702S/D, and the shallow/deep pair NP-MW-602/603 remained non-detect for DCB. The concentration of TCB exceeded the 70 ppb MMCL in deep well NP-MW-601 during the March round (81 ppb) and in the field duplicate in the June round (83 ppb); however, the normal sample result for the June round (63 ppb) was below the MMCL. Concentrations of TCB observed in bedrock at well MW-702B exceeded the MMCL for the first time in the March round (72 ppb) when DCB was also at a peak (7 ppb), but TCB decreased to the lowest concentrations observed to date in this well by the June round (38 ppb).

The horizontal extent of arsenic detected above the 10 ppb MMCL is unchanged compared to the previous RMR. Exceedances above the MMCL were observed in two wells during the current reporting period, LR-MW-122 (11.6 ppb) and MW-706S (21.2). Arsenic detections were below the MMCL at LR-MW-121 (not detected), MW-703S (0.8 ppb), MW-705S (not detected), and MB-MW-371 (0.9 ppb). Except where not detected, the arsenic concentrations were slightly higher in the June round compared to those observed during the March round, when LR-MW-122 (1.4 ppb) and MW-706S (13.9 ppb) had their lowest values measured to date.

Three wells had new exceedances of cVOCs during the current reporting period; PCE (21 ppb) and TCE (14 ppb) at MB-MW-363 in March, VC (2.2 ppb) at MW-707D in June, and PCE (5.2 ppb) at MW-714D in June. It is believed that the anomalous sample results observed at MB-MW-363 are the result of a sample error and not a true representation of actual chemical concentrations at this location. Specifically, it appears that MB-MW-362 (the adjacent deep well) was sampled twice in March and one of the samples was labeled as MB-MW-363. This opinion is based on 1) preceding and succeeding sampling rounds for MB-MW-363 which were all non-detect; 2) geochemical data for MB-MW-363 that does not correspond with typical results observed at this location, particularly the high sulfate and ORP values (**Table 2**); and 3) the March results for MB-MW-363 are virtually identical to the results for MB-MW-362 for both COCs and geochemistry, which would be anomalous based on the historic results.

The new exceedances did not change the delineation of the horizontal extent of contamination lines (**Figure 9**), because they were already within the previously defined bounds of the cVOC exceedance area. Also noteworthy was the significant increase of PCE observed at MW-714S. This well is located at the up-gradient extent of the cVOC plume, and is the shallow well associated with MW-714D which as mentioned above, had the first-time exceedance of PCE in March. Sample results for the remainder of the monitoring wells not discussed above were generally consistent with previous sampling rounds. A discussion of concentration changes over time is provided in Section 4.3.

The northern PCE extent was revised during the previous RMR based on the results for deep wells MW-708D and MW-707D. No changes were made in this RMR based on the data collected during the current reporting period. MW-708D had low-level detects of cVOCs in the June 2012 sample, but was non-detect for cVOCs in the following four rounds (September 2012 through June 2013). cVOC detects in April 2012 at Geoprobe GW042B, coupled with the June detections at MW-708D, suggested a connection between the GW042B detections and the main plume to the southeast, as theorized in the FIR. However, this connection now seems less likely considering not only the latest non-detects at MW-708D, but also the depth and strength of the April 2012 detections at GW042B (PCE = 19 ppb at 20-24 ft bgs). cVOC concentrations rose slightly in MW-707D to 7.1 ppb by March 2013, slightly exceeding the MMCL for the past three rounds. Data collected during the current reporting period supports the modifications to the PCE extent made in the previous RMR.

4.2.2 Vertical Extent of Contamination

The vertical extent of groundwater contamination is indicated in Figure 10 for DCB, and in Figures 11 to 13 for cVOCs, using cross-sections along the lines indicated in Figure 9. Arsenic extent above the MMCL has been identified as a shallow plume based on monitoring wells and Geoprobe results, as described in the FIR.

The vertical extent of DCB indicated in Figure 10 is unchanged from the previous RMR depiction. Although the concentration of DCB observed at MW-702B dropped below the MMCL value for the first time during the June 2013 sampling event, it was determined that the well would continue to be included within the delineated boundary of the DCB area for the current reporting period. This decision is appropriate given the concentrations of DCB and TCB peaked during the March 2013 sampling round (see Section 4.3). Inclusion of MW-702B in the delineation of the DCB area will be re-evaluated during the next reporting period to determine if downward concentration trends continue and exclusion of this well from the delineated boundary of this area is warranted.

The DCB results suggest that chlorobenzene contamination above MMCLs in this area is limited to the relatively thin (12-foot thick) sand aquifer and the underlying bedrock surface. Upward vertical gradients of 0.58 ft and 0.51 ft from shallow bedrock to the sand aquifer were observed at MW-702B/D/S during the March and June monitoring events respectively.

The vertical extents of PCE and other cVOCs are indicated in Figures 11 to 13. The estimated area of cVOCs depicted on the figures remains unchanged from the last RMR. Note the horizontal scales differ on these cross-sections but the vertical scales are the same. Extent of contamination is drawn to include all well screens where June 2013 samples had contaminants exceeding the MMCLs. Extent of contamination also includes all April 2012 Geoprobe samples exceeding the MMCLs. Compared to the depiction in the FIR, the vertical extent is similar in terms of the majority of contamination above MMCLs occurring 10 or more feet below the water table within the site, and surfacing along the eastern edge in the area of the river. The water table elevation has been updated to represent conditions observed during the latest (5/28/13) synoptic gauging round.

4.3 Concentrations over Time

Plots of contaminant concentrations over time at monitoring wells with current or historic GW-1 exceedances are presented in **Figures 14 and 15** for DCB/TCB; **Figures 16 and 17** for arsenic; and **Figures 18 to 28** for cVOCs. Note that results for new monitoring wells cover only a one-year duration, therefore limited conclusions regarding trends are possible for these new wells. Additional sampling data will be added to the plots in future semiannual reports. Results are discussed by contaminant type in the following paragraphs.

DCB/TCB results include seven years of measurements at NP-MW-601. During this period TCB has generally been detected below the 70 ppb GW-1, with single exceedances in December 2007 (82 ppb), November 2012 (85 ppb), and February 2013 (81 ppb). DCB has generally been detected slightly above the 5 ppb GW-1, in the range of 5.4-8.2 ppb. The concentrations of TCB and DCB observed at NP-MW-601 follow the same general trends over time; however, the magnitude of TCB concentrations is much more exaggerated compared to that of DCB. cVOCs observed at MW-702B showed little variation in 2012 with concentrations ranging between 58-63 ppb for TCB, and 5.5-6.1 ppb for DCB. During the March 2013 round TCB and DCB peaked at 72 ppb and 7 ppb respectively for MW-702B; however by May, concentrations of both compounds dropped to lows of 38 ppb and 4.2 ppb respectively. The concentration observed in March for MW-702B was the first time TCB exceeded the MMCL of 70 ppb in the year of measurements for this new well.

Arsenic results include six years of measurements at LR-MW-122. During this period arsenic has been detected in the range of 1.4-16 ppb except for August 2006 and July 2010 (34 ppb and 75 ppb, respectively). Arsenic concentrations preceding and succeeding these two dates were near the 10 ppb GW-1 standard. Arsenic concentrations at MW-706S were 13.9 ppb in March and 21.2 ppb in June. Arsenic concentrations at both locations were at historic lows during the March round, and rebounded slightly by June. In each case, concentrations observed during the reporting period were consistent with average historical trends.

cVOC measurements are available for a period of six years for LR-MW-129, near five years for MB-MW-362, and approximately four years for MB-MW-374. Trends of individual cVOC analytes (PCE, TCE, and VC) were generally consistent for a given well, and are plotted on Figures 18-20. Concentrations of cVOCs in LR-MW-129 declined rapidly over the initial year (2007-2008); and all analytes were not detectible at the laboratory reporting limit for the past year. Concentrations at MB-MW-362 show a sharp increase between late 2009 and mid 2010, and then a decline to the recent PCE (17 ppb) and TCE (8.8 ppb) exceedances in November 2012. cVOC concentrations observed at MB-MW-362 rebounded slightly during the current reporting period from the historic low observed in November 2012. Concentrations at MB-MW-374 were near GW-1 criteria until mid-2010, then generally increased to the recent PCE (64 ppb; March 2013), TCE (16 ppb; November 2012 and March 2013), and VC (10 ppb; November 2012) exceedances. The June sampling round shows slight decreases in PCE, TCE and VC at this well.

Concentrations of cVOCs at the new wells with GW-1 exceedances generally showed the following trends over the one year of measurements to date, as indicated in Figures 21-26:

- Flat with concentrations near GW-1 criteria at MW-704S
- Fluctuating concentrations above GW-1 criteria at MW-709S
- Flat with concentrations near GW-1 criteria at MW-709D
- Flat with concentrations slightly above GW-1 criteria at MW-710S
- Flat with concentrations slightly above GW-1 criteria at MW-710M
- Slightly increasing then decreasing with concentrations above GW-1 criteria at MW-711D
- Flat with concentrations near GW-1 criteria at MW-713D
- Significantly increasing concentrations of PCE, slightly increasing concentrations of TCE, and relatively flat concentrations of VC; all with concentrations above GW-1 criteria at MW-714S.

Average concentrations of cVOCs were plotted along two potential groundwater flow paths for the recent measurements at new wells. The first flow path is from MW-711D to MW-709 to MW-704, a distance of 290 feet. The results for shallow and deep screens at the latter two locations were averaged; the resulting PCE, TCE, and VC concentrations are presented in **Figures 29, 30, and 31** respectively. PCE concentrations generally decline over this path, but there are upward peaks in TCE and VC at MW-709 due to the increases in recent concentrations at MW-709S (see also Figure 22). Concentrations of all three analytes are near or below the GW-1 at the downgradient location MW-704 for all five events.

The second flow path is from MB-MW-374 to MW-713D, a distance of 151 feet; the PCE, TCE, and VC concentrations are presented in **Figures 32, 33, and 34** respectively. PCE concentrations show the sharpest decline over this path. TCE and VC concentrations increased slightly along this path for the June 2012 event, but decrease along this path for the four latest monitoring events. Concentrations of all three analytes are near the GW-1 at the downgradient well for all five events.

4.4 Geochemistry and Daughter Products

The aquifer geochemistry affects chemical and biological reactions for COC transformation, and daughter products are direct evidence of these transformations. Detections of geochemical indicators are summarized and charted in Table 2, including the June 2012 data that were presented in the FIR. The data in Table 2 were manipulated as follows to optimize visual comparison of sample results in the chart; ORP data were divided by 10, Chloride data were divided by 5, and DO data were multiplied by 5. These multipliers and divisors are indicated in the Table 2 row headings and chart legend. Detections of COCs and daughter products are summarized in Table 3. Selected groundwater samples were analyzed for the dissolved gas methane, which is an indicator of microbial activity, and the gases ethene and ethane which are daughter products of PCE. Geochemistry results and daughter products are discussed for each plume area in the following paragraphs.

The shallow (12-foot thick) sand aquifer in the DCB plume area generally appears to be aerobic, with DO > 2 ppm at the shallow screens MW-700S, -701S, and -702S. However, DO was < 0.4 ppm at deep well NP-MW-601 and <1.3 ppm at bedrock well MW-702B, indicating anaerobic conditions within the plume. Of note is the DO values observed during the current reporting period, which were 5-12 times greater than those observed in 2012 for MW-702B. DCB and chlorobenzene (CB) are anaerobic daughter products of TCB, and have been detected in the two plume wells but not in other wells in the area. Concentrations of CB, and DCB isomers other than 1,4-DCB, are in the range of 1-4 ppb.

The arsenic plume occurs in shallow water table wells with DO generally between 1 and 2 ppm, and ORP near zero. The plume does not appear to be associated with reducing conditions that would promote the mobility of arsenic adsorbed to (or naturally occurring in) soil.

DO (generally <1 ppm) and ORP (generally <0 mV) levels are low enough within the cVOC plumes to be favorable to anaerobic reduction. Concentrations of sulfate (generally <20 mg/l) and nitrate (generally <1 mg/l) in the cVOC plumes are not expected to inhibit reductive dechlorination. Concentrations of PCE and its daughter products are illustrated for the center of the main cVOC plume in **Figures 35 and 36** for the March and June results, respectively. These figures use a colored ring to depict different analytes, with the ring size being proportional to analyte concentration. The concentrations for shallow and deep well screens at MW-709 and MW-710 are averaged for the purpose of these depictions. The maximum ring size is based on the PCE maximum during the period: 92 ppb at MB-MW-374 in June. Analytes are listed in the legend in the order of the reductive dechlorination pathway, e.g. cis-1,2-dichloroethene (DCE) is intermediate between TCE and VC. Chloride levels were highest in shallow wells, do not seem to correlate with possible degradation of cVOCs, and were not included in the figures.

Figures 35 to **36** show a recent increase in the concentrations of all analytes present in downgradient monitoring wells MW-709, MW-710, and MB-MW-362. Conversely, the wells located upgradient (MB-MW-374 and MW-711D), show overall decreasing concentrations of these compounds between the two latest sampling rounds. Proportions of daughter products to PCE are higher in the downgradient wells which suggest that biodegradation is occurring as the plume nears the river. One exception to this statement is the distinct increase of ethane observed at MW-711D between the March and June rounds. The relatively high ethane at MW-711D is not accompanied by other daughter products; typically this well has had higher concentrations of ethane compared to other wells in the area, and the concentrations observed in June are consistent with historical data. Southwest of the area depicted in these figures, daughter product concentrations are also relatively high at MW-714S, where DCE (13 ppb) and TCE (34 ppb) concentrations were second only to MW-709S (32 ppb and 72 ppb, respectively) in the latest sampling results.

Methane, a biological indicator rather than a daughter product, had the highest levels detected at MW-709S (806-925 ppb), MW-709D (177-477 ppb), MW-711D (262-946 ppb), and MB-MW-374 (627-686 ppb) as indicated in Table 3. Little variation was observed in ferrous iron levels, another biological indicator, over the plume area (Table 2).

Geochemistry and daughter product results in the cVOC areas suggest that significant reductive dechlorination of PCE is occurring throughout the site.

4.5 Estimates of Mass Loss & Plume Stability

MNA is expected to reduce concentrations of contaminants at this site principally by the processes of desorption, dilution, and biodegradation. These processes are expected to be interrelated, for example increased precipitation may speed both desorption of contaminants from the aquifer matrix to groundwater, and dilution due to greater groundwater discharge to the river and increased surface water flow. Note that an increase in the rate of desorption of contaminants may increase groundwater concentrations in some areas in the short term, as greater mass is being removed from the solid aquifer matrix. Fluctuations in desorption may result from changes in water table elevation or gradient, including preferential flow paths along infrastructure or geologic anomalies below the water table.

Evaluation of contaminant mass loss and plume stability considers the above evaluations of COC extent in Section 4.2, changes in concentrations over time discussed in Section 4.3, and the geochemical conditions and daughter products evaluated in Section 4.4. These evaluations also consider the groundwater flow conditions described in Section 4.1, and are presented below by analyte type. Any changes to the Conceptual Site Model (CSM) and MNA program based on this evaluation are indicated below, and summarized in Section 5.

The DCB/TCB plume at NP-MW-601 and MW-702B shows evidence of mass loss based on the presence of daughter products. DCB is an anaerobic degradation intermediate of TCB, and the maxima for both compounds have coincided in time. DO and ORP results are relatively low at these two wells, indicating continuing anaerobic conditions. Recent concentrations of parent and daughter COCs are decreasing, suggesting decreased desorption in the short term. Plume shape appears to be stable and is oriented around two wells about 60 feet apart, in line with groundwater flow. No significant changes in groundwater flow conditions were noted for this area. With TCB results recently fluctuating above the GW-1 criteria at NP-MW-601, at a level similar to a 2007 event, the expected remediation time becomes more difficult to estimate. Pending further results to evaluate this trend, the CSM at this location does not warrant changes. Modification to the sampling frequency of the present well network is recommended, and discussed in Section 5.2.

Evaluation of the arsenic plume surrounding MW-706S suffers from a relatively short (one year) duration of measurements, but results at this plume center well are consistent with the long-term trends for downgradient well LR-MW-122. Results at both wells indicate that arsenic concentrations may fluctuate from levels around the 10 ppb GW-1 criterion up to about 80 ppb. Mass loss is expected as groundwater in the plume area discharges into surface waters of the Neponset River and associated wetlands. Plume shape appears to be stable and is oriented around two wells about 100 feet apart, in line with groundwater flow. No significant changes in groundwater flow conditions were noted for this area. Remediation times of at least five years are expected based on the short-term and long-term fluctuations in concentrations observed at MW-706S and LR-MW-122, respectively. There are no significant changes to the CSM at this location, and continued quarterly monitoring with the present well network is recommended.

The cVOC plume shape is unchanged from the previous reporting period. Concentrations of PCE and daughter products have increased at some interior monitoring points (i.e. MB-MW-362) and decreased at others (i.e. MB-MW-374) compared to the previous period, and appear to be relatively unchanged over much of the plume. An increase in the PCE concentration that started during the last reporting period in shallow well MW-714S has continued, suggesting increased desorption of residual cVOC from surface soil or the uppermost layers of the aquifer matrix at this southwestern location. cVOC concentrations for the deep well (MW-714D) at this location have generally remained below the GW-1 criteria.

Geochemical conditions in the cVOC plume continue to be favorable for reductive dechlorination, and daughter products are observed in both plume lobes. Methane concentrations indicate the most biological activity is occurring at locations with elevated cVOC concentrations, such that biodegradation is a significant process for mass removal. Additional mass loss is expected as groundwater in the plume area discharges into surface waters of the Neponset River and associated wetlands. Groundwater flow conditions are similar to previous observations, including an apparent downward inflection of the water table near MW-714. An upward vertical gradient has been observed at MW-714 since measurements began at this location in September 2012. These hydraulic data, coupled with the increasing cVOC concentrations at this location, may reflect increased infiltration through surficial fill in the area.

Considering fluctuations in cVOC plume concentrations and the short data record (one year) for the majority of in-plume wells, the expected remediation time is difficult to estimate at present. Remediation time will be reevaluated in future semiannual monitoring reports. Continued quarterly monitoring of wells within the plume is recommended. Modifications to sampling frequency of wells outside of the plume areas are recommended, and are discussed in Section 5.2.

5.0 RECOMMENDATIONS AND CSM [310 CMR 40.0892(2)(D)]

5.1 Conceptual Site Model

Groundwater data collected during the current reporting period are generally consistent with historic conditions, and do not warrant changes to the Conceptual Site Model. The current CSM for the site is discussed below.

The estimated areas of groundwater contamination exceeding MMCLs or background concentrations are indicated in **Figures 9** and **10-13**. Arsenic contamination is observed at the water table, DCB contamination is near the bottom of a thin (12-foot thick) sand aquifer and in the underlying bedrock surface, and PCE contamination is in the deepest part of the sand aquifer (up to 35 ft bgs). The Neponset River appears to be a groundwater discharge area based on measured horizontal and vertical gradients around the Site. PCE and TCE have been identified at one monitoring location east of the river, at higher concentrations in the shallow compared to the deep screen, and appear to be discharging to surface water in this area. Sediment and surface water concentrations in the river suggest that the contaminant discharge from groundwater to the river has not resulted in measureable concentrations of contaminants in the river. A CSA completed for the river where it borders the Site found a condition of No Significant Risk for river receptors (Weston 2007b).

The CSAs for the Site (AMEC 2011b, AMEC 2011c) found no current pathway between Site contaminants and the Town's water supply wells located 1.2 miles to the northeast (**Figure 1**), but the potential for movement in this direction warrants monitoring. The town supply wells draw water from surficial sands and gravel above bedrock, in the High Yield (>300 gpm) aquifer mapped by USGS northeast of the Site. The bedrock surface in the supply well area is 62 to 80 feet bgs, compared to 10 to 40 feet bgs at the Site; bedrock slopes downward to the northeast along the river valley. The potential for contaminant migration to the Town's supply wells would appear to be greatest for non-aqueous phase liquid (NAPL) chlorinated organic compounds which are denser than water, but NAPL has not been observed at the Site. The chlorinated organic compounds encountered at the BMC site have been in the dissolved phase rather than NAPL. In this dissolved form the density contrast has no effect on migration, compared to advection, dispersion, and other processes. Dissolved phase concentrations at the BMC site do not suggest the presence of NAPL.

No significant sources of groundwater contaminants are known to remain at the Site. Source control has occurred through soil excavation RAMs in the areas in and upgradient from arsenic and some cVOC groundwater contamination. The RAM around Building 6/6A, upgradient from arsenic detected in LR-MW-122, included the removal of soil having arsenic above background levels. The RAM around Building 7A/7C and LRA2, upgradient from cVOCs detected in LR-MW-129, included removing soil with metals and oily contamination that was not known to contain cVOCs. Above-ground structures and below-ground tanks associated with former manufacturing operations have been removed as of early 2008, and it is possible that these structures included source materials. Except for arsenic, groundwater contaminants are generally found below the water table, which suggests that there are no continuing releases from the surface or shallow soils.

The installed well network and sampling procedures described in this report meet the design requirements identified in the FIR. Monitoring wells are focused along plume centerlines and discharge areas. Monitoring locations include shallow, deep, and bedrock screens as appropriate to measure changes in nature and extent of contaminants.

5.2 OMM Revisions or Corrective Measures

MNA will be continued as a Permanent Solution if evaluations of site data demonstrate that natural attenuation is occurring at rates that will achieve drinking water standards and approach background levels in a reasonable timeframe. In the RAP this timeframe was identified as up to 10 years for MNA. Determination of satisfactory reductions in concentrations considers multiple lines of evidence including temporal trends in individual wells, estimates of mass reduction, and distribution of contaminants and geochemical conditions. The data presented in this report indicate that natural attenuation is occurring in the areas of MMCL exceedances. No significant changes in the CSM are warranted based on the latest measurements, and the estimated remediation timeframe of 10 years from 2012 is assumed to be the same.

This semiannual RMR coincides with one year of initial process monitoring as described in the FIR (AMEC 2012). Initial process monitoring has confirmed that key MNA processes are underway and a transition to long-term performance monitoring is appropriate. Long-term monitoring is designed to confirm that site conditions remain suitable for MNA, and that overall contaminant concentrations and mass are decreasing within a reasonable timeframe.

Long-term monitoring will include continued quarterly sampling at five locations within the plumes that have had significant fluctuations in recent contaminant concentrations above the MMCLs. Semiannual sampling will be performed for 10 other wells within the horizontal and vertical extent of the plume areas where previous quarterly sampling shows little variation in concentrations. Annual sampling will be performed for 23 wells along the plume lateral or vertical edges where concentrations are below MMCLs. Analytes for long-term monitoring will consist of the contaminants exceeding MMCLs and their primary breakdown products. Dissolved gases, chloride, and ferrous iron will no longer be analyzed as indicators of final breakdown products or microbial activity. Also, nitrate and sulfate analyses are no longer needed to confirm favorable geochemical conditions based on the initial quarterly monitoring. The revised OMM program for long-term monitoring is summarized in **Table 4**. Water levels at all of the monitoring wells, including those sampled on a semi-annual or annual basis, will continue to be gauged on a quarterly basis.

If MNA measurements suggest that some portions of the Site will not achieve a Permanent Solution, then supplemental MCP documents for design and construction of contingent remedies will be prepared. The following types of measurements will be considered as evidence of the need for contingent remedies:

- Contaminant concentrations exhibit an increasing trend not expected based on monitoring to date,
- Near-source wells exhibit large concentration increases indicative of a new or renewed release,
- Contaminants are identified in monitoring wells located outside the original plume boundary or other specified compliance boundary,

- Contaminant concentrations are not decreasing at a rate necessary to meet the remediation objectives,
- Changes in land and/or ground-water use will adversely affect the protectiveness of the MNA remedy, and
- Contaminants are identified in locations posing unacceptable risk to human or ecological receptors.

Multiple lines of evidence will be used to determine the need for contingent remedies, to account for the uncertainty associated with variability in subsurface conditions. The evaluations of these types of measurements will be conducted in accordance with USEPA guidance for performance monitoring of MNA (EPA 2004).

5.3 Remedy Operation Status

Remedy Operation Status was achieved in February 2013. Based on the data presented in this RMR and the conclusions summarized in Sections 5.1 and 5.2, MNA is still considered a viable Permanent Solution for the Site and meets the requirements for Remedy Operation Status.

6.0 REFERENCES

AMEC 2013a. Phase V Status and Remedial Monitoring Report, Prepared by AMEC Environment &Infrastructure, Inc. for Baker Hughes Inc. Final, January 2013.

AMEC 2013b. Remedy Operation Status Opinion, Former Bird Machine Company Site. Prepared by AMEC Environment &Infrastructure, Inc. for Baker Hughes Inc. Final, February 13, 2013.

AMEC 2012. Phase IV Final Inspection Report, Former Bird Machine Company Site. Prepared by AMEC Earth & Environmental Inc. for Baker Hughes Inc. Final, August 2012.

AMEC 2011a. Response Action Outcome Statement for RTN 4-3024222, Former Bird Machine Company Site. Prepared by AMEC Earth & Environmental Inc. for Baker Hughes Inc. Final, December 2011.

AMEC 2011b. Phase II Comprehensive Site Assessment Report for RTN 4-3024222, Former Bird Machine Company Site. Prepared by AMEC Earth & Environmental Inc. for Baker Hughes Inc. Final, October 2011.

AMEC 2011c. Phase II Comprehensive Site Assessment Addendum for RTN 4-3024222, Former Bird Machine Company Site. Prepared by AMEC Earth & Environmental Inc. for Baker Hughes Inc. Final, December 2011.

AMEC 2011d. Phase III Remedial Action Plan for RTN 4-3024222, Former Bird Machine Company Site. Prepared by AMEC Earth & Environmental Inc. for Baker Hughes Inc. Final, December 2011.

Walpole 2007. Letter from John Spillane, Chairman, Town of Walpole Board of Water & Sewer Commissioners, to Dina Kuykendall, BHI. October 25, 2007.

Weston 2005. Phase I Initial Site Investigation Report for RTN 3-0024222, Bird Machine Company Manufacturing Building Area. Prepared by Weston Solutions Inc. for Baker Process Inc. September 14, 2005.

Weston 2007a. Phase II Comprehensive Site Assessment for Demolition Debris Area, RTN 4-3024105. Prepared by Weston Solutions Inc. for Baker Process Inc. July 30, 2007.

Weston 2007b. Phase II Comprehensive Site Assessment for Release of Hydrocarbons to the Neponset River Site, RTN 4-3023575. Prepared by Weston Solutions Inc. for Baker Process Inc. January 25, 2007.

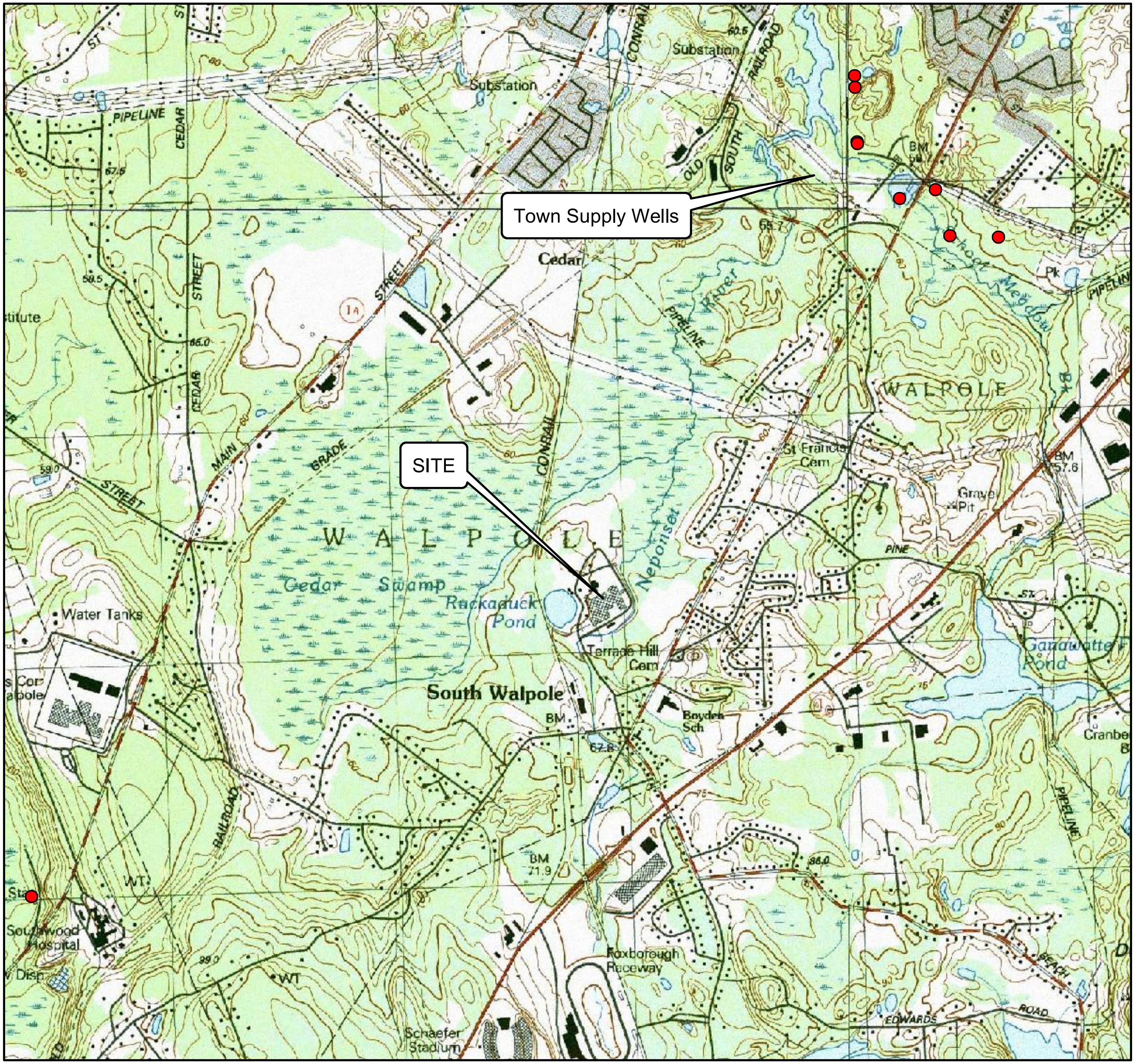


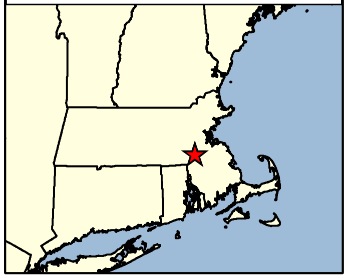
FIGURE 1

SITE LOCATION MAP

Bird Machine Inc. Company

100 Neponset Street
Walpole, MA

Location of Site



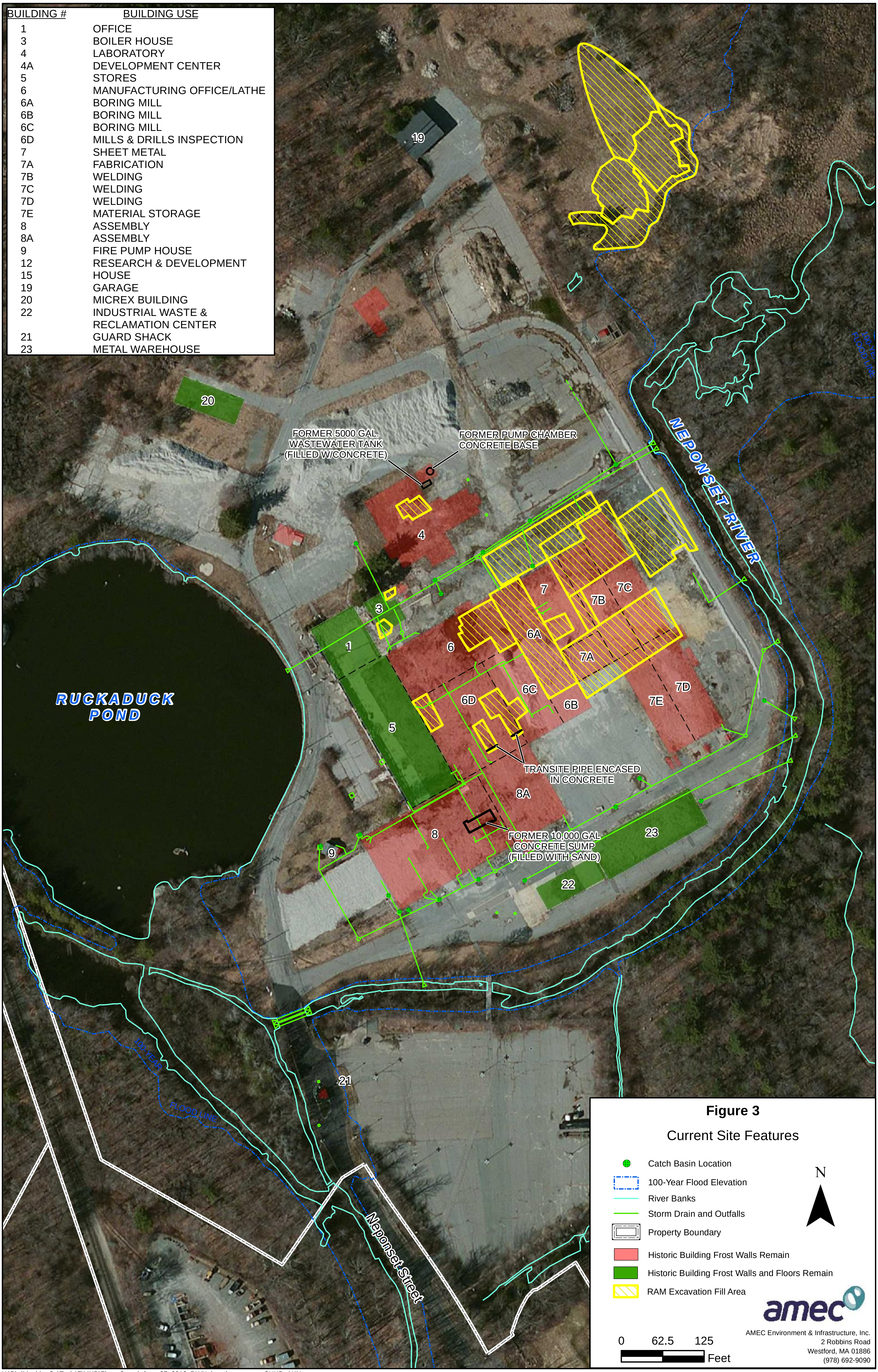
Source: MassGIS, 2001.

0 2,000 Feet

amec

AMEC Earth & Environmental, Inc.
2 Robbins Road
Westford, MA 01886
(978) 692-9090

H:\BirdMachineCo\Task18\MXD\Figure2_DisposalSiteBoundary.mxd June 27, 2012 DWN: jonathan.penney CHKD: AKN



H:\BirdMachineCo\Task17\MXD\Figure3.mxd June 27, 2012 DWN: jonathan.penney CHKD: AKN

Source: Building data from Weston Solutions. Imagery provided by BING, 2010.

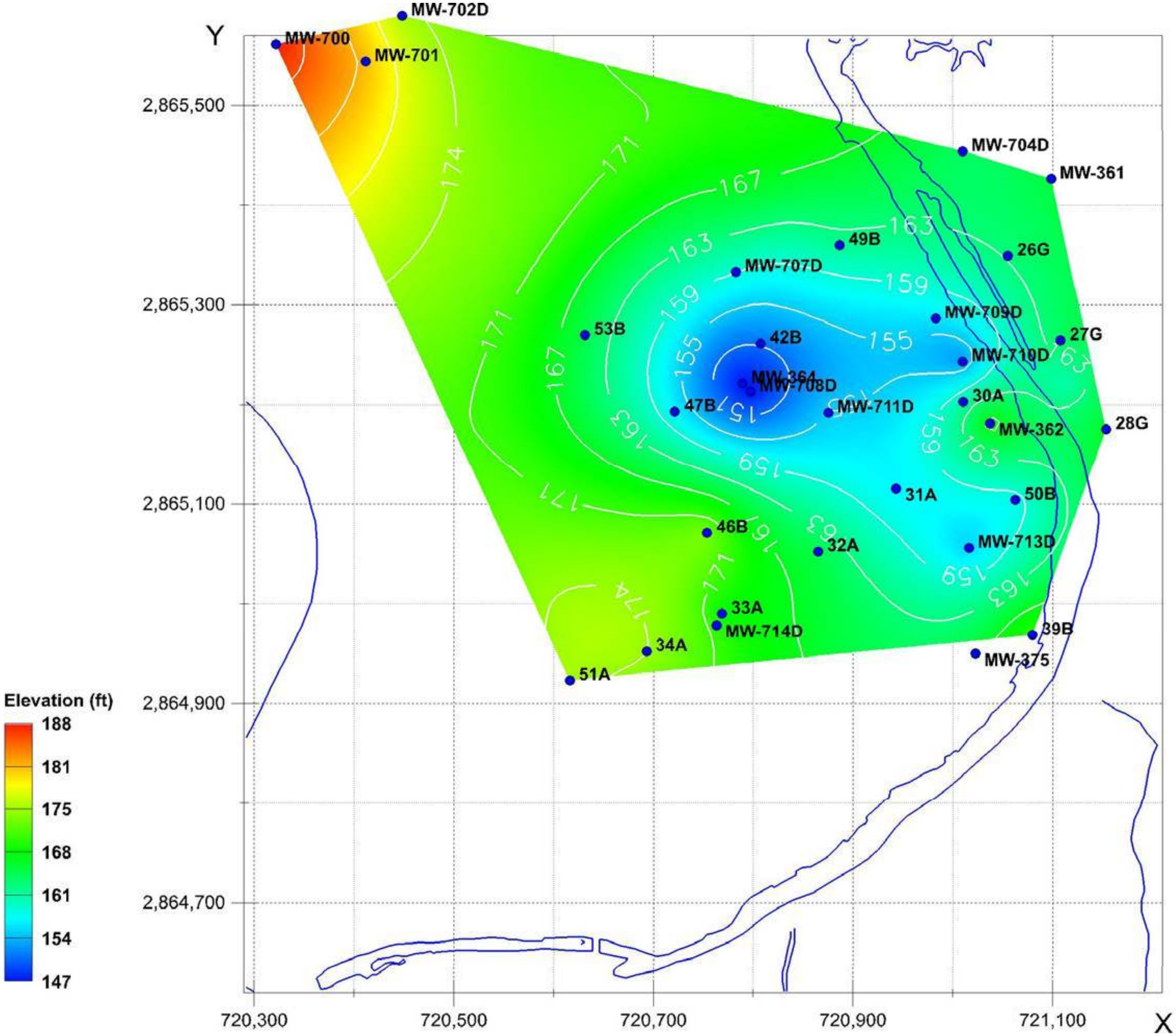


Figure 4 – Bedrock Elevations from Drilling

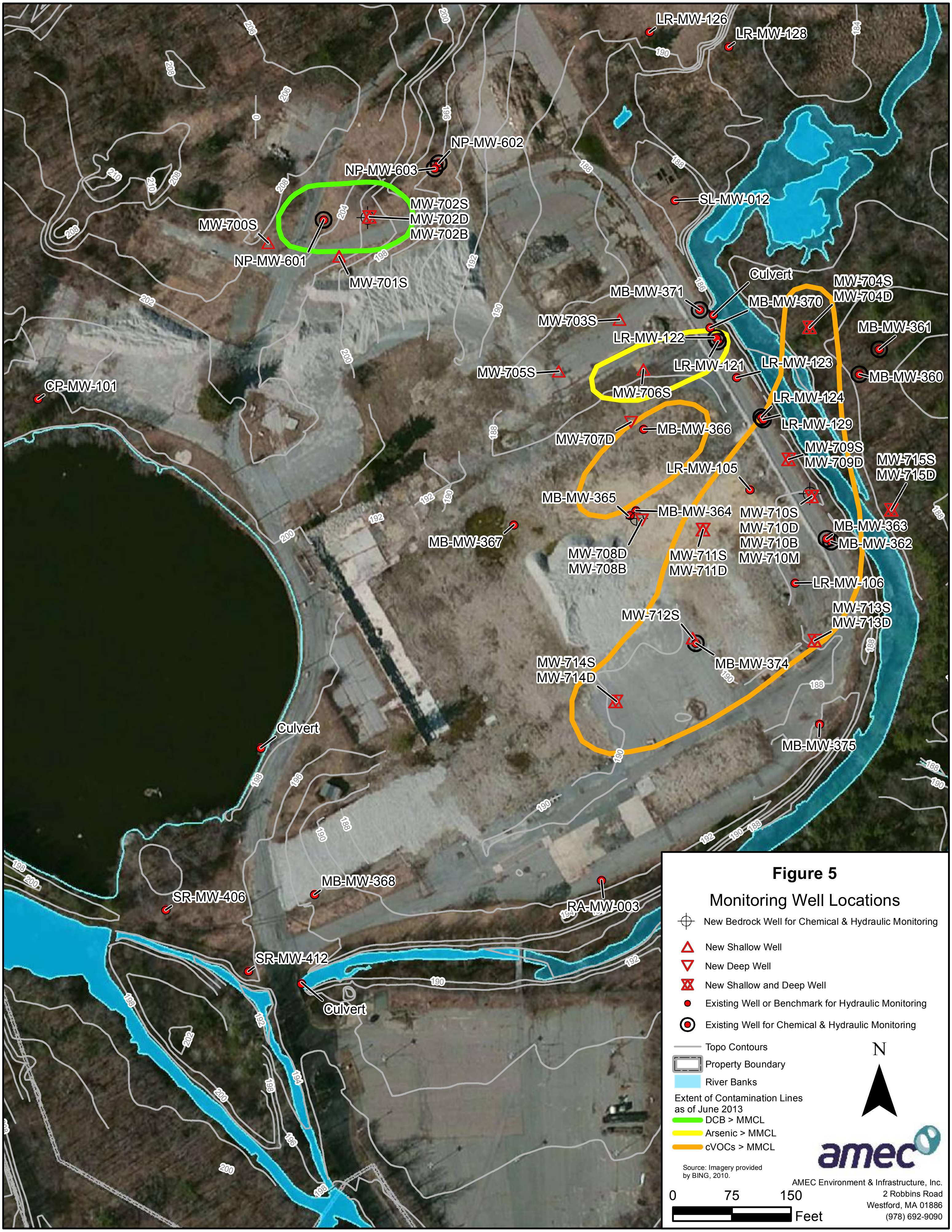


Figure 5
Monitoring Well Locations
New Bedrock Well for Chemical & Hydraulic Monitoring
New Shallow Well
New Deep Well
New Shallow and Deep Well
Existing Well or Benchmark for Hydraulic Monitoring
Existing Well for Chemical & Hydraulic Monitoring
Topo Contours
Property Boundary
River Banks
Extent of Contamination Lines
as of June 2013
DCB > MMCL
Arsenic > MMCL
cVOCs > MMCL
Source: Imagery provided
by BING, 2010.
N
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2 Robbins Road
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(978) 692-9090
0
75
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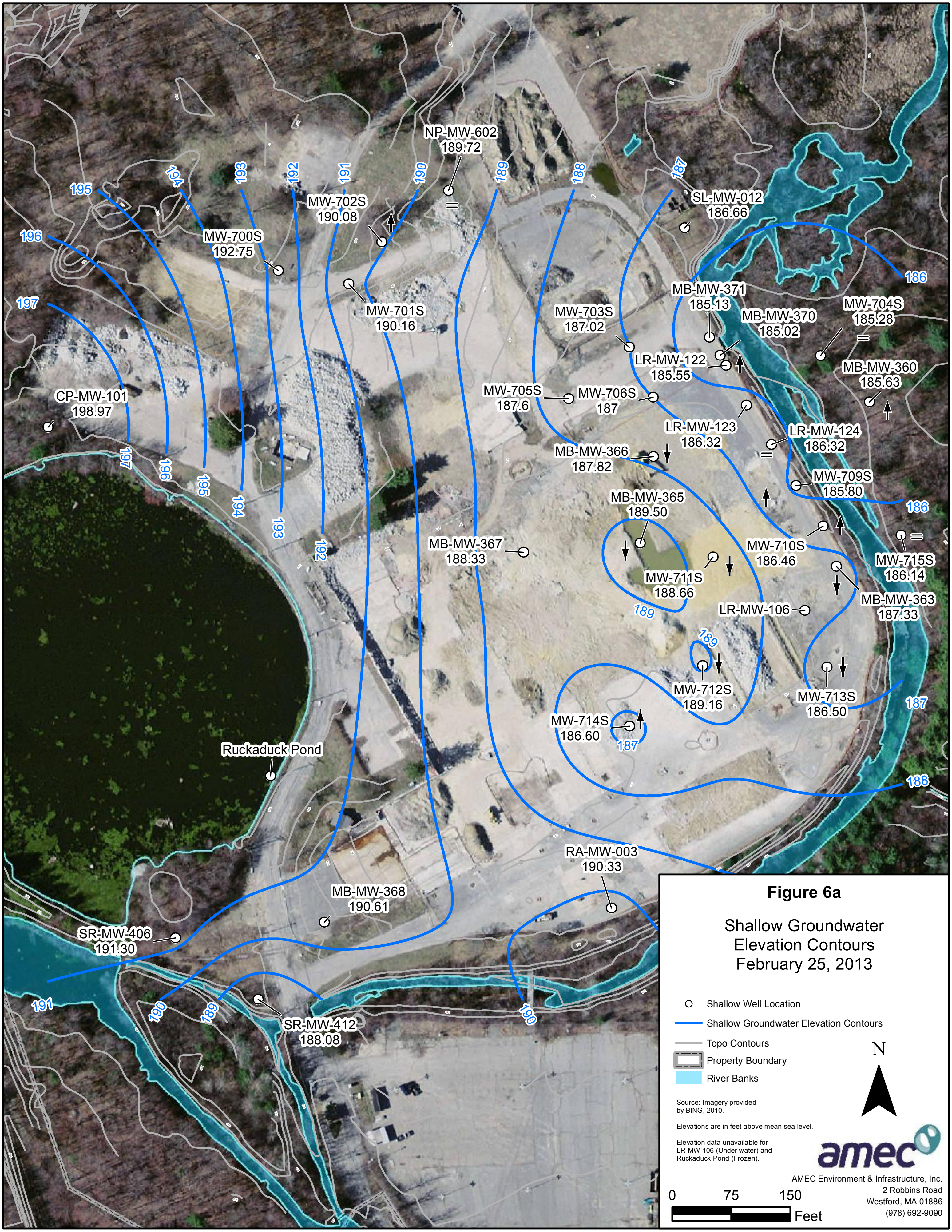
Feet
LR-MW-126
LR-MW-128
NP-MW-602
NP-MW-603
SL-MW-012
MW-702S
MW-702D
MW-702B
MW-700S
NP-MW-601
MW-701S
Culvert
MB-MW-371
MB-MW-370
MW-704S
MW-704D
MW-703S
LR-MW-122
MB-MW-361
MW-705S
LR-MW-121
LR-MW-123
MB-MW-360
MW-706S
CP-MW-101
LR-MW-124
MW-707D
MB-MW-366
LR-MW-129
MW-709S
MW-709D
MW-715S
MW-715D
LR-MW-105
MB-MW-365
MB-MW-364
MW-710S
MW-710D
MW-710B
MW-710M
MB-MW-363
MB-MW-362
MB-MW-367
MW-708D
MW-708B
MW-711S
MW-711D
LR-MW-106
MW-713S
MW-713D
MW-712S
MB-MW-374
MW-714S
MW-714D
Culvert
MB-MW-375
MB-MW-368
SR-MW-406
RA-MW-003
SR-MW-412
Culvert



NP-MW-602
189.72
SL-MW-012
186.66
MW-702S
190.08
MW-700S
192.75
MW-701S
190.16
MW-703S
187.02
MB-MW-371
185.13
MB-MW-370
185.02
MW-704S
185.28
LR-MW-122
185.55
MB-MW-360
185.63
CP-MW-101
198.97
MW-705S
187.6
MW-706S
187
LR-MW-123
186.32
LR-MW-124
186.32
MB-MW-366
187.82
MW-709S
185.80
MB-MW-365
189.50
MB-MW-367
188.33
MW-710S
186.46
MW-715S
186.14
MW-711S
188.66
MB-MW-363
187.33
LR-MW-106
MW-712S
189.16
MW-713S
186.50
MW-714S
186.60
Ruckaduck Pond
RA-MW-003
190.33
MB-MW-368
190.61
SR-MW-406
191.30
SR-MW-412
188.08
195
196
197
194
193
192
191
190
189
188
187
186
Figure 6a
Shallow Groundwater
Elevation Contours
February 25, 2013
Shallow Well Location
Shallow Groundwater Elevation Contours
Topo Contours
Property Boundary
River Banks
N
Source: Imagery provided by BING, 2010.
Elevations are in feet above mean sea level.
Elevation data unavailable for LR-MW-106 (Under water) and Ruckaduck Pond (Frozen).
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0
75
150
Feet