BASELINE ECOLOGICAL RISK ASSESSMENT TECHNICAL MEMORANDUM

RADIO MATERIALS CORPORATION SITE
ATTICA, INDIANA

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1.0 INTRODUCTION

Conestoga-Rovers & Associates (CRA) submits this Baseline Ecological Risk Assessment Technical Memorandum (Technical Memorandum) on behalf of Kraft Foods Group, Inc. (Kraft Foods), formerly known as Kraft Foods Global, Inc. This Technical Memorandum presents the problem formulation for the Baseline Ecological Risk Assessment (BERA) for the Radio Materials Corporation (RMC) manufacturing facility in Attica, Fountain County, Indiana (the "Site", see Figure 1). A Screening-Level Ecological Risk Assessment (SLERA) was completed and submitted to the United States Environmental Protection Agency (U.S. EPA) in October 2005, as an appendix to the Phase IIB RCRA Facility Investigation Report (RFI). The ecological risk assessment presented in the Phase IIB report was a conservative SLERA completed consistent with U.S. EPA guidance. The SLERA used conservative screening benchmarks (lowest value within a tier) and exposure assumptions (maximum concentration, 100 percent bioavailability) to identify analytes of potential concern relative to ecological risk relating to the RMC facility.

In a letter dated July 10, 2012, U.S. EPA provided comments on that SLERA. In a letter dated August 31, 2012, CRA, on behalf of Kraft Foods, submitted a response to those comments. On October 9 2012, CRA and Kraft Foods met with U.S. EPA to discuss the comments on the RFI and SLERA. In a letter dated November 1, 2012, U.S. EPA issued additional comments on the SLERA and CRA's responses to comments. This document addresses the issues raised by U.S. EPA in its November 1 letter.

Section 2.0 of this document identifies the constituents of potential ecological concern (COPECs) identified in the SLERA. Section 3.0 provides a description of the Solid Waste Management Units (SWMUs), Areas of Concern (AOCs), Riley Lake, and the former artesian well area. Section 4.0 describes the refinement methods and Section 5.0 presents the results of the refinement process. Section 6.0 presents an evaluation of the potential for risk posed to ecological receptors exposed to surface water at the groundwater-surface interface. Section 7.0 presents the conclusions of CRA's evaluation

Based on the results of this refined evaluation, CRA concludes that there is no risk to ecological receptors for any media (soil, surface water, and sediment) for any of the SWMUs, AOCs, Riley Lake, or the former artesian well area. Consequently, in accordance with U.S. EPA guidance, continuation of the BERA is not necessary, and CRA recommends the ecological risk assessment process be exited at Step 3.

2.0 CONSTITUENTS OF POTENTIAL ECOLOGICAL CONCERN

The SLERA identified a total of 43 chemical constituents as COPECs for soil, sediment, and/or surface water. The 43 COPECs consist of 10 volatile organic compounds (VOCs), 12 semivolatile organic compounds (SVOCs), two low molecular weight (LMW) polycyclic aromatic hydrocarbons (PAHs), one high molecular weight (HMW) PAH, and 18 metals. A constituent was identified as a COPEC if the maximum concentration in a medium (i.e., soil, sediment, or surface water) within a SWMU, AOC, Riley Lake, or the former artesian well area exceeded its ecological screening value (ESV). A constituent was also retained as a COPEC if it was not detected, but the limit of detection (LOD) was higher than its ESV. Table 1 identifies the 43 constituents identified as COPECs and the rationale for retaining each constituent as a COPEC.

The SLERA consisted of Steps 1 and 2 of the eight-step process developed by U.S. EPA (1997) for Ecological Risk Assessments (ERAs). The following analysis presents the methods and results of the next step in the ERA process, Step 3a. As recommended in U.S. EPA's guidance, Step 3 begins with a refinement of the COPECs identified in the SLERA. For the refinement process, assumptions used in the SLERA are evaluated and refined, as appropriate, to be realistic and reflective of Site-specific conditions. For example, background concentrations of naturally occurring constituents, such as metals, are considered. In addition, very conservative ESVs used in the SLERA may be replaced with less conservative, more technically defensible ESVs in this refinement. Constituents that are not eliminated as a result of the refinement process are identified as constituents of ecological concern (CEOCs) and are evaluated, if appropriate, in the BERA.

3.0 DESCRIPTION OF SWMUS AND AOCS

3.1 SWMUS 1 AND 2

SWMU 1 was an outdoor drum storage area located north of Summit Road to the east of Buildings 6 and 7 as shown on Figure 2. The size of SWMU 1 appears to have varied over time to encompass an area ranging from approximately 0.5 acre (150 feet by 150 feet square) to 0.8 acre (250 feet by 150 feet). SWMU 2 is even smaller than SWMU 1 at approximately 0.03 acre. The SWMU 2 area reportedly was operated as an open unlined pit located east of Buildings 6 and 7 from approximately 1963 to 1980 for Site-generated manufacturing byproducts. The dimensions of SWMU 2 were 40 feet long, 30 feet wide, and 6 feet deep.

Vegetative cover in SWMUs 1 and 2 is old field. Grasses and forbs are the predominant forms of vegetation. Shrubs and small trees have become established and are increasing in density as the area undergoes ecological succession. Vegetative cover in SWMUs 1 and 2 is contiguous with a larger area of old field vegetation between Buildings 5 and 8 and adjacent land to the east. A thin band of dense shrub ground separates Buildings 5 and 8 from the agricultural fields to the east.

Volatile organic compounds (VOCs) were the primary contaminants in SWMUs 1 and 2. Interim Corrective Measures (ICMs) were implemented in SWMUs 1 and 2 in 2008 and included soil excavation and ex-situ and in-situ treatment of soil using soil vapor extraction (SVE). The SVE ICMs are currently operating in SWMU 1 and 2. The relatively small size of the area (approximately 1 acre) precludes permanent use of the area by species with even moderate requirements for home range and feeding territory.

3.2 SWMU 5

SWMU 5 was reportedly used for placement of Site-generated manufacturing byproducts from 1950s to about 1963. The manufacturing by-products placed in SWMU 5 reportedly contained chlorinated solvents, acetone, isopropyl alcohol, phenolic resins, ceramic byproduct, waxes, and paints. SWMU is located approximately 200 feet southwest of the main plant building as shown on Figure 2. Reportedly, SWMU 5 was covered with 2 to 3 feet of clayey soil.

Vegetative cover in SWMU 5 is primarily grassy field with scattered young pine trees. Ravine Park is located south of SWMU 5. Vegetative cover in Ravine Park is also primarily grass with some scattered trees. Ecological receptors most likely utilize

SWMU 5 on an intermittent basis. The relatively small size of the area (approximately 0.25 acre) precludes permanent use of the area by species with even moderate requirements for home range and feeding territory.

Approximately 7,000 cubic yards of impacted soil were excavated from SWMU 5 and transported off Site between November 1995 and February 1996. The excavation was reported to be 100 feet by 120 feet, with a maximum depth of 20 feet. ICMs have been implemented in SWMU 5 including treatment of soil using in-situ chemical oxidation (ISCO) and SVE. The SVE system is currently operating in SWMU 5.

3.3 AOC 3A

AOC 3A is a drainage ditch in Ravine Park, located southwest of the main plant building as shown on Figure 2. This drainageway connects with a larger, generally east to west trending drainage channel located farther south in Ravine Park. This drainage ditch contains water only during and shortly after measurable storm events. Vegetative cover in Ravine Park is grass maintained for recreation. Trees are also present throughout Ravine Park.

3.4 AOC 3B

AOC 3B is a narrow man-made drainage ditch located along the eastern property boundary, north of Summit Street that is approximately 3 to 5 feet wide and 400 feet in length (Figure 2). The ditch was excavated to drain runoff to the north toward the former gravel pit south of Building 6. The vegetative cover along the ditch is predominantly small scrub trees, brush, and grasses. During the growing season, agricultural crops provide some cover and foraging habitat. However, between fall harvest and spring planting, little functional habitat is available. Birds may forage on residue left in the field along the ditch following harvest.

This area was remediated by implementing an ICM that included excavation and off-Site disposal of lead-impacted soil.

3.5 RILEY LAKE

Riley Lake is a manmade pond approximately 1.8 acres in size located northwest of the main plant building and south of Summit Street (Figures 2 and 3). Depth of this open water is generally less than 10 feet. The sidewalls of the pond are concrete in poor condition. According to the Site owner, Mr. Joe Riley, the bottom of the pond is constructed of compacted native soil. The open water is recharged by a combination of precipitation and discharge of treated groundwater from the adjacent pump-and-treat system at a rate of approximately 100 gallons per minute (gpm). According to Mr. Riley, the stocked fish species that currently inhabit the pond include largemouth bass, bluegill, and sunfish.

3.6 FORMER ARTESIAN WELL AREA

A former artesian well was present on Riley-owned property north of Summit Road and west of Airport Road (Figure 3). Water from the artesian well formerly flowed north of a relatively densely wooded area located west and northwest of the Riley residence. CRA closed the artesian well in 2005 according to Indiana requirements. The former artesian well is located in an area of generally saturated soil where groundwater seeps are present.

4.0 REFINEMENT METHODOLOGY

4.1 SOIL

4.1.1 OVERVIEW

Thirty-one constituents were identified as COPECs for soil. The 31 constituents consist of three VOCs (cis-1,2-dichloroethene, PCE, and TCE), 12 SVOCs (2,4-dimethylphenol, 2,4-dinitrophenol, 2,6-dinitrotoluene, 2-chloronaphthalene, 2-chlorophenol, aniline, bis(2-chloroethyocxy)methane, butyl benzylphthalate, hexachlorobenzene, hexachlorobutadiene, n-nitrosodimethylamine, and pentachlorophenol), two LMW PAHs (naphthalene and phenanthrene), one HMW PAH (chrysene), and 16 metals (antimony, arsenic, barium, cadmium, chromium, cobalt, copper, iron, lead, manganese, nickel, selenium, silver, thallium, vanadium, and zinc). The three VOCs, all 16 metals, phenanthrene, and chrysene were identified as COPECs based on maximum concentrations greater than their ESVs. None of the other 12 SVOCs and naphthalene was detected in soil samples collected from the Site. However, all were identified as COPECs based on LODs greater than their ESVs. Of the 31 COPECs, pentachlorophenol, cadmium, chromium, copper, lead, and nickel are bioaccumulation chemicals of concern (BCOCs) in soil (TECQ, 2006).

4.1.2 SCREENING AGAINST SITE-SPECIFIC BACKGROUND METAL CONCENTRATIONS

As discussed with U.S. EPA during the meeting of October 9, 2012, the refinement process screens the metals identified in the SLERA as COPECs against Site-specific background values. Samples for calculation of background levels were collected from two depth intervals: 0-0.5 foot below ground surface (bgs) and 1-3 feet bgs at each of the bedrock monitoring wells installed during 2003 (BW-01 through BW-10). These boring locations were considered to be outside of the AOCs and SWMUs and therefore the metals concentrations are considered representative of background concentrations.

These soil samples were analyzed for TAL metals to establish the background concentrations of metals in native surface and subsurface soils. Since exposure of ecological receptors is primarily limited to surficial soil, those samples collected at the 0-0.5 foot bgs depth interval are considered in the calculation of background levels. Those metals with a maximum concentration less than the Site-specific background are eliminated as COPECs. This approach is conservative as it based on a comparison of the full range of concentrations in the assessment areas to an estimate of central tendency for the population of background samples.

As described in the Phase IIB RFI Report (CRA, May 2010), CRA determined background levels of metals in soil using U.S. EPA's ProUCL software (Version 4.00.04). Figure 4 depicts the locations of the background samples and Table 2 identifies the Site-specific background levels for metals. A background level was not calculated for selenium due to the availability of only a single sample. The concentration of 1.6 mg/kg for the single sample is used to screen selenium.

4.1.3 EXPOSURE CONCENTRATIONS

For the Step 3a refinement process, exposure concentrations are based on 95 percent upper confidence limits (UCLs) rather than maximum concentrations. Additionally, statistical outliers are identified and removed from the dataset prior to calculation of UCLs. Outliers are identified using Rosner's test, which is a component of U.S. EPA's ProUCL software program. The refinement process also considers the vertical distribution of the data within the soil profile. Samples in the dataset evaluated in the SLERA were from the depth interval of 0 to 2 feet bgs. However, the depth intervals were not consistent among samples, and depth intervals of 0.0-0.5 foot bgs, 0.5-1.0 foot bgs, 0-2 feet bgs, and 2 feet bgs were represented. As ecological receptors are primarily exposed at the shallower depth intervals, partitioning of concentrations by depth facilitates risk management decisions. Identification of statistical outliers, which may be indicative of "hot spots" also facilitates risk management decisions.

4.1.4 RECEPTOR GROUPS

For PAHs and metals, ecological soil screening levels (ECO-SSLs) have been developed for terrestrial plants, soil invertebrates, avian wildlife, and mammalian wildlife. For PAHs and metals, risk to the four receptor groups identified above is evaluated. For terrestrial plants and soil invertebrates, which lack or have limited motility, the percentage of samples that exceed the ECO-SSLs, if any, is considered. Risk to ecological populations is typically considered to be significant if 20 percent or more of a population is affected. Accordingly, the potential for risk to terrestrial plants and soil invertebrates is considered to be above the threshold for concern if concentrations in more than 20 percent of samples exceed ECO-SSLs. Evaluation of risk to terrestrial plants and soil invertebrates should be considered to be a secondary evaluation, as impacts to plants and invertebrates on private lands are infrequently considered in making risk management decisions. However, the evaluation is included in this refinement document for sake of completeness.

For avian and mammalian wildlife, risk is evaluated using a two-stage process. For the first stage, the 95 percent UCLs are compared to the ECO-SSLs. If a 95 percent UCL is greater than an ECO-SSL, which are based on conservative assumptions, then food chain models will be used to provide a more detailed evaluation of risk to avian and/or mammalian wildlife. If an ECO-SSL for a receptor group is below a Site-specific background level, then Site-specific background is used as a default refinement benchmark.

4.1.5 FOOD CHAIN MODELS

Food chain models are used to evaluate the potential for risk to avian and/or mammalian wildlife for those COPECs with 95 percent UCLs that exceed their ECO-SSLs. In order to identify specific feeding guilds potentially at risk, food chain models for avian and mammalian insectivores, avian and mammalian herbivores, and avian and mammalian carnivores were developed and evaluated.

Indicator species used for the food chain models are the same as those used to develop the ECO-SSLs. American woodcock and short-tailed shrew are indicator species for avian insectivore and mammalian insectivore, respectively. Mourning dove and meadow vole are indicator species for avian and mammalian herbivores, respectively. Red-tailed hawk and long-tailed weasel are indicator species for avian and mammalian top carnivores, respectively. These species were selected as indicator species because they are representative of feeding guilds at the Site and because exposure factors for these species have been established by USEPA (2005a).

Ingestion of COPECs by avian and mammalian wildlife was calculated using the general equation:

$$IR_{total} = ((IR_{food} * Conc_{soil} * Ps) + (IR_{food} * Conc_{food}) + (IR_{water} * Conc_{water}) * AUF \quad \text{(Equation 1)}$$

Where:

IR_{total} = total ingestion rate of COPEC (mg COPEC/kg body weight [wet weight]/day)

IR_{food}	=	ingestion rate of food (kg food [dry weight]/kg body weight [wet weight]/day)
$Conc_{soil}$	=	concentration of COPEC in soil (mg/kg [dry weight])
$Conc_{food}$	=	concentration of COPEC in food (mg/kg [dry weight])
P_s	=	soil ingestion as proportion of diet
IR_{water}	=	ingestion rate of water (L/kg body weight [wet weight]/day)
$Conc_{water}$	=	concentration of COPEC in water (mg/L)
AUF	=	area use factor (proportion of diet obtained from assessment area)

Table 3 identifies the exposure factors for the six indicator species, including body weight, IR_{food}, P_s, IR_{water}, and AUF. Concentrations of COPECs in soil are the 95 percent UCLs. The AUF for all indicator species is assumed to be 1.0 (i.e., all food items are taken from the SWMU or AOC). This is very conservative since the size of all SWMUs/AOCs evaluated is generally less than 1 acre. Water ingested is assumed to come from the surface water of Riley Lake.

4.1.6 COPECS WITH DETECTION LIMITS ABOVE THEIR ESVS

For AOC 3A, several SVOCs were not detected, but retained as COPECs based on LODs that were greater than their ESVs. The refinement of these COPECs considers two lines of evidence. First, all available ecological benchmarks, including the ESVs, are considered. A constituent is eliminated from further evaluation if the LOD is within the range of available ecological benchmarks. Second, the presence of the constituent in other SWMUs and AOCs is considered. If the LOD of a constituent is outside the range of available benchmarks, the constituent is eliminated if it was not detected in other media or in the same media in other SWMUs or AOCs at the Site.

4.2 SEDIMENT

4.2.1 OVERVIEW

Nine constituents were identified as COPECs for the sediment of Riley Lake. The nine constituents consist of seven VOCs (1,1-dichloroethane, 1,1-dichloroethene, 2-butanone, 2-hexanone, 4-methyl-2-pentanone, acetone, and bromomethane), one SVOC (hexachlorobutadiene), two LMW PAHs (naphthalene and phenanthrene), and five metals (antimony, chromium, copper, silver, and zinc). Two other metals, selenium and vanadium, were detected in sediment, but the SLERA did not identify ESVs. Copper and zinc were identified as COPECs because their maximum concentrations are greater than their ESVs. The seven VOCs, one SVOC, and three metals (antimony, cadmium, and silver) were not detected, but were identified as COPECs based on LODs greater than their ESVs. Of the nine COPECs, cadmium, copper, selenium, and zinc are BCOCs in sediment (TECQ, 2006; U.S. EPA, 2000).

4.2.2 ORGANICS

The mode of toxicity for the VOCs retained as COPECs is non-polar narcosis, which is a non-specific effect on cellular processes (U.S. EPA, 2008). U.S. EPA (2008) has developed a method to evaluate risk to benthic invertebrates posed by narcotic chemicals based on calculation of final chronic values (FCVs) and equilibrium partitioning (EqP) theory. Calculation of FCVs is based on the octanol-water partitioning coefficient (K_{ow}) and molecular weight of narcotic organic compounds. Calculation of equilibrium partitioning sediment benchmarks (ESB) is based on the organic carbon partitioning coefficient (K_{oc}) of the chemical and the fraction of organic carbon and solids in the sediment. Details of calculation of FCVs and ESBs are provided in U.S. EPA (2008). In the absence of data on organic carbon and grain size, the calculated ESBs conservatively assume 1 percent carbon and 50 percent solids, which utilizes the correction factor identified by Fuchsman (2003).

Hexachlorobutadiene is the only SVOC identified as a COPEC for the sediment of Riley Lake. Unlike the VOCs, narcosis is not the mode of toxicity for hexachlorobutadiene. However, equilibrium partitioning theory can be used to calculate an ESB. Rather than using a FCV based on narcosis, the ESV is used as the input variable.

The LODs for organic COPECs are compared to their ESBs.

4.2.3 METALS

The ESVs for copper, cadmium, and zinc were threshold effect concentrations (TECs) identified by MacDonald et al. (2000). These values are lower tier sediment quality benchmarks, which are essentially concentrations below which adverse impacts to benthic invertebrates are not expected to occur. MacDonald et al. (2000) also identified probable effect concentrations (PECs), which are concentrations above which adverse impacts to benthic invertebrates are expected to occur. For the refinement process, both the TECs and PECs are considered.

The ESVs for antimony and silver were lowest of the sediment benchmark identified for these metals. MacDonald et al. (2000) do not identify TECs or PECs for antimony or silver. The National Oceanic and Atmospheric Administration (NOAA) (1999) identifies effect range-low (ER-L) and effect range-median (ER-M) values for antimony and silver. The ER-Ls and ER-Ms are similar to the TECs and PECs, in that they are benchmarks for no effect and expected effect concentrations, respectively. Both the ER-Ls and ER-Ms are considered for the refinement of antimony and silver, neither of which was detected.

Selenium and vanadium were detected in the sediment of Riley Lake, but were not specifically identified as COPECs based on the absence of ESVs. For these two metals, the Netherlands National Institute of Health and the Environment (Crommentuijn et al., 1997) identify negligible concentrations (NCs) and maximum permissible concentrations (MPCs), which are comparable to the no effect and expected effect concentrations identified by MacDonald et al. (2000) and NOAA (1999). For the refinement process, both the NCs and MPCs are considered as benchmarks.

4.3 SURFACE WATER

4.3.1 OVERVIEW

Eight constituents were identified as COPECs for the surface water of Riley Lake. One constituent (hexachlorobutadiene) was identified as a COPEC for the surface water of in the former artesian well area. The nine COPECs for the surface water of Riley Lake consist of one SVOC (hexachlorobutadiene) and seven metals (beryllium, cadmium, copper, lead, manganese, mercury, and silver). Manganese and mercury were identified as COPECs based on maximum concentrations greater than their ESVs. Hexachlorobenzene (for both Riley Lake and the former artesian well area) and three metals (beryllium, cadmium, and silver) were not detected but were identified as COPECs based on LODs greater than their ESVs. Of the eight COPECs, U.S. EPA Great Lakes Water Quality Initiative (GLWQI, 1995) and TCEQ (2006) identify mercury as a BCOC in surface water. The GLWQI (1995) identifies hexachlorobutadiene as a BCOC.

4.3.2 ORGANICS

Hexachlorobutadiene is the only organic compound identified as a COPEC for surface water. This SVOC was retained as a COPEC based on a LOD greater than its ESV. The refinement process for hexachlorobutadiene considers other available benchmarks, detection in other media, and historical use.

4.3.3 METALS

Magnesium is an essential nutrient and is therefore eliminated as a COPEC. Magnesium will not be evaluated further in Step 3a.

For the refinement process, the criteria for protection of aquatic life by the Indiana Department of Environment Management (IDEM) are used as refinement benchmarks for cadmium, copper, lead, and silver. IDEM does not identify criteria for beryllium or mercury. For mercury, the Recommended National Water Quality Criterion for protection of aquatic life (U.S. EPA, 2009) is used as the refinement benchmark. For beryllium, the lowest of the benchmarks specific to fish (EC_{20}-Fish, EC_{25}-Bass, and Lowest Chronic Value-Fish) is used as identified by Suter and Tsao (1996).

5.0 REFINEMENT OF CONSTITUENT OF POTENTIAL ECOLOGICAL CONCERN

5.1 SCREENING AGAINST SITE-SPECFIC BACKGROUND SOIL LEVELS

5.1.1 SWMUS 1 AND 2

The SLERA identified 16 metals (antimony, arsenic, barium, cadmium, chromium, cobalt, copper, iron, lead, manganese, nickel, selenium, silver, thallium, vanadium, and zinc) as COPECs for SWMUs 1 and 2. Table 4 summarizes the screening of these 16 metals. Information presented in Table 4 includes the Site-specific background level, number of samples, number of samples with detected concentrations, minimum and maximum detected concentrations, and 95 percent upper confidence limits (UCL), and the rationale for retaining or eliminating a metal as a COPEC. Figure 4 depicts the locations of the background samples.

The maximum concentrations of lead (75.9 mg/kg), manganese (1,780 mg/kg), selenium (1.2 mg/kg), and zinc (146 mg/kg) are all below their respective Site-specific background levels. Consequently, lead, manganese, selenium, and zinc are eliminated as COPECs for SWMUs 1 and 2.

The maximum concentrations of antimony (9.04 mg/kg), arsenic (50.1 mg/kg), barium (5,540 mg/kg), cadmium (2.02 mg/kg), chromium (29.7 mg/kg), cobalt (18.1 mg/kg), copper (51.5 mg/kg), iron (50,500 mg/kg), nickel (39 mg/kg), silver (71.8 mg/kg), thallium (0.44 mg/kg), and vanadium (36.7 mg/kg) are above their Site-specific background levels. These 12 metals are retained as COPECs for SWMUs 1 and 2. The UCLs for antimony (1.15 mg/kg) and silver (24.2 mg/kg) are also greater than their background levels.

5.1.2 SWMU 5

The SLERA identified 10 metals (cadmium, chromium, copper, iron, lead, manganese, nickel, selenium, silver, thallium, vanadium, and zinc) as COPECs for SWMU 5. Table 5 summarizes the screening of these 10 metals. Information presented in Table 5 is similar to that presented in Table 4. The maximum concentrations of cadmium (0.405 mg/kg), copper (14.2 mg/kg), iron (20,100 mg/kg), manganese (1,170 mg/kg), nickel (17 mg/kg), selenium (0.50 mg/kg), silver (6.77 mg/kg), thallium (0.222 mg/kg), vanadium (20.6 mg/kg), and zinc (64.2 mg/kg) are all below their Site-specific background levels. Consequently, all 10 metals are eliminated as COPECs for SWMU 5.

5.1.3 AOC 3A

No metals were identified as COPECs for AOC 3A.

5.1.4 AOC 3B

The SLERA identified 15 metals (antimony, barium, cadmium, chromium, copper, iron, lead, manganese, mercury, nickel, selenium, silver, thallium, vanadium, and zinc) as COPECs for AOC 3B. Since completion of the SLERA, soil from AOC 3 has been removed. Confirmation samples were collected and analyzed for lead. Table 6 summarizes the results of the confirmation sampling for lead. The maximum concentration of 287 mg/kg is greater than the Site-specific background level of 114 mg/kg. Consequently, lead is retained as a COPEC for AOC 3B. The UCL for lead (173 mg/kg) is also greater than the background level.

5.1.5 SUMMARY OF BACKGROUND SCREEN

The SLERA identified a total of 16 metals as COPECs. Based on the screening against Site-specific background levels and removal of soil from AOC 3B, manganese, selenium, and zinc are eliminated as COPECs and will not be further evaluated. The elimination of these three metals leaves 13 metals as COPECs. These 13 metals are antimony, arsenic, barium, cadmium, chromium, cobalt, copper, iron, lead, nickel, silver, thallium, and vanadium. Lead will be evaluated as a COPEC only for AOC 3B. The other 12 metals will be evaluated as COPECs for SWMUs 1 and 2. None of the 13 metals will be further evaluated as COPECs for SWMU 5 or AOC 3A.

5.2 REFINEMENT OF COPECS IN SOIL

5.2.1 SWMUS 1 AND 2

5.2.1.1 VOLATILE ORGANIC COMPOUNDS

The three VOCs identified as COPECs for SWMUs 1 and 2 are cis-1,2-dichloroethene, PCE, and TCE. The compound cis-1,2-dichloroethene was identified as a COPEC based on a maximum concentration greater than an ESV of 8.28 mg/kg, which was incorrectly identified in the SLERA as U.S. EPA Region 5 ecological screening level (ESL). The only available ecological benchmarks available for cis-1,2-dichloroethene are the Dutch target and intervention values of 0.2 mg/kg and 1 mg/kg, respectively. The maximum concentration of 23 mg/kg exceeds both Dutch values, so cis-1,2-dichloroethene is retained as a COPEC. PCE and TCE were retained as COPECs based on maximum concentrations that exceeded their ESVs, which were U.S. EPA Region 5 ESLs. Both ESLs are based on exposure of the masked shrew.

The compound cis-1,2-dichloroethene was detected in four of 50 samples. The maximum concentration of 23 mg/kg is an estimated value (J-qualified) in one of two duplicate samples collected at location TP-C-1 at depth of 2 feet bgs in September 2003. The concentration in the duplicate sample, which is also an estimated value, is 0.25 mg/kg. Rosner's test for statistical outliers, using ProUCL, identifies the maximum concentration as an outlier. Removing the statistical outlier, the maximum concentration is 0.25 g/kg, which is the duplicate for location TP-C-1. This value is below the ESV of 8.28 mg/kg. Consequently, cis-1,2—dichloroethene is eliminated as a COEC.

PCE was detected in 41 of 50 samples. As is the case for cis-1,2-dichloroethene, the maximum concentration of 1,000 mg/kg is an estimated value detected in one of the duplicate samples at location TP-C-1. The concentration for the duplicate sample is 20 mg/kg, which is also a qualified value. Rosner's test identifies the maximum concentration of 1,000 mg/kg as a statistical outlier. The value of 1,000 mg/kg as statistical outlier is supported by a concentration that is two orders of magnitude lower in the duplicate sample. With removal of this outlier, the maximum concentration is 53 mg/kg at sample location TP-D-3, which was detected a depth of 2 feet bgs in September 2003. The concentration of 53 mg/kg is greater than the ESV of 9.92 mg/kg. The 95 percent UCL of 13.3 mg/kg is also slightly greater than the ESV. The only two values greater than the ESV are concentrations of 20 mg/kg for TP-C-1 and 53 mg/kg for TP-D-3. Based on only two samples with concentrations that slightly exceed the conservative ESV at a depth of 2 feet bgs, with its limited potential for exposure of ecological receptors, it is reasonable to eliminate PCE as a COEC.

TCE was detected in 18 of 50 samples. As is the case for cis-1,2-dichloroethene and PCE, the maximum concentration of 77 mg/kg is an estimated value detected in one of the duplicate samples at location TP-C-1. The concentration in the duplicate sample is 0.92 mg/kg, which is also a qualified value. Rosner's test identifies the maximum concentration of 77 mg/kg as a statistical outlier. The value of 77 mg/kg as statistical outlier is supported by a concentration that is two orders of magnitude lower in the duplicate sample. With removal of this outlier, the maximum concentration is 13 mg/kg at sample location TP-D-3, which was detected a depth of 2 feet bgs in September 2003. The concentration of 13 mg/kg is slightly greater than ESV of 12.4 mg/kg. The 95 percent UCL of 3.16 mg/kg is below the ESV. The value of 13 mg/kg for TP-D-3 is the only concentration greater than the ESV. Based on only one sample with a concentration that slightly exceeds the conservative ESV, detected at a depth of 2 feet bgs, and a 95 percent UCL below the ESV, it is reasonable to eliminate TCE as a COPEC.

5.2.1.2 METALS

TERRESTRIAL PLANTS

After screening against Site-specific background levels, 13 metals were retained as COPECs for SWMUs 1 and 2. As discussed in Section 4.1.4, risk to terrestrial plants, soil invertebrates, avian wildlife, and mammalian wildlife is then evaluated for these remaining 13 metals. Table 7 summarizes the refinement of the evaluation for terrestrial plants exposed to metals in SWMUs 1 and 2. Information presented in Table 7 includes the ECO-SSLs (if available), Site-specific background levels, number of samples, minimum and maximum detected concentrations, 95 percent UCLs (calculated using ProUCL), the number and percentage of samples with concentrations greater than the ECO-SLLs, and the number and percent of samples with concentrations greater than the Site-specific background level (if an ECO-SSL is not available or the ECO-SSL is less than the Site-specific background).

For cadmium, copper, and silver, the maximum concentrations are below their ECO-SSLs. For cobalt, concentrations in three samples 6.1 percent exceed its ECO-SSL. For nickel, the concentration in one sample (2.0 percent) exceeds its ECO-SSL. Based on a threshold of 20 percent, the potential for risk to terrestrial plants does not exceed the threshold for concern for cadmium, cobalt, copper, nickel, or silver. Figure 2 depicts the locations of SWMUs and AOCs at the Site and Figure 5 identifies the location of samples with concentrations of cobalt and nickel that exceed their ECO-SSLs.

ECO-SSLs specific to terrestrial plants are not available for antimony, arsenic, barium, chromium, iron, thallium, and vanadium. Therefore, as stated above, the Site-specific background is used as the default refinement benchmark. One or more samples for all seven samples have concentrations greater than their Site-specific background concentrations. The percentage of samples with concentrations greater than background range from 2.0 percent for chromium and vanadium to 15 percent for arsenic. Based on a threshold of 20 percent, the potential for risk to terrestrial plants does not exceed the threshold for concern antimony, arsenic, barium, chromium, iron, thallium, or vanadium.

SOIL INVERTEBRATES

Table 8 summarizes the refinement of the evaluation of soil invertebrates exposed to metals in SWMUs 1 and 2. Information presented in Table 8 is similar to that presented in Table 7.

ECO-SSLs are available for antimony, arsenic, cadmium, copper, nickel, and vanadium. None of the samples from these SWMUs have concentrations of antimony, cadmium, copper, nickel, and vanadium that exceed their ECO-SSLs. The concentration of arsenic in one sample (1.9 percent) exceeds its ECO-SSL. Figure 5 identifies the location of the one sample with a concentration of arsenic that exceeds its ECO-SSL. Based on a threshold of 20 percent, the potential for risk to soil invertebrates does not exceed the threshold for concern for risk to terrestrial plants for antimony, arsenic, cadmium, copper, nickel, or vanadium.

ECO-SSLs specific to soil invertebrates are not available for barium, chromium, cobalt, iron, silver, and thallium. One or more samples for all seven metals have concentrations greater than background. The percentage of samples with concentrations greater than background ranges from 2.0 percent for chromium to 12 percent for iron. Based on a threshold of 20 percent, the potential for risk to soil invertebrates does not exceed the threshold for concern barium, chromium, iron, thallium, and vanadium.

AVIAN WILDLIFE

Table 9 summarizes the initial step in the refinement of the evaluation of avian wildlife exposed to metals in SWMUs 1 and 2. Information presented in Table 9 includes the ECO-SSL specific to avian wildlife, number of samples, minimum and maximum detected concentrations, 95 percent UCLs, refinement quotient (RQ) for the 95 percent UCLs, and background concentrations (if an ECO-SSL is not available). The refinement quotient is the 95 percent UCL concentration divided by the ECO-SSL or Site-specific background. If the RQ is greater than 1.0, then potential risk is further evaluated using food chain models.

ECO-SSLs specific to avian wildlife are available for arsenic, barium, cadmium, chromium, cobalt, copper, nickel, silver, and vanadium. The RQs for barium (2.5) and silver (5.8) are greater than 1.0. The ECO-SSL for barium (330 mg/kg) is less than the Site-specific background level (897 mg/kg). Incorporating that Site-specific background into the RQ calculation yields an RQ of 0.91, which is below 1.0.

ECO-SSLs specific to avian wildlife are not available for antimony, iron, and thallium. The RQs for iron (0.81) and thallium (0.58) are below 1.0. The RQ for antimony (1.9) is greater than 1.0.

In the initial refinement step, antimony and silver are carried forward for further evaluation of risk to avian wildlife using food chain models. As discussed in Section 4.1.5, food chain models have been developed for avian insectivores (American woodcock), herbivores (mourning dove), and carnivores (red-tailed hawk). Table 3 identifies the exposure factors and ingestion rates for the three indicator species. Table 10 identifies the equations for calculating uptake for soil-to-invertebrate, soil-to-terrestrial plants, and soil-to-small mammals. These equations were taken from the source documents for derivation of the ECO-SSLs for antimony (U.S. EPA, 2005b) and silver (U.S. EPA, 2006). Table 11 identifies the calculated potential concentrations of antimony and silver in soil invertebrates, terrestrial plants, and small mammals.

Table 12 summarizes the results of the food chain models for avian wildlife. The potential for risk is determined by dividing total ingestion (IRtotal in Equation 1) by a toxicity reference value (TRV) to produce a hazard quotient (HQ). A HQ greater than 1.0 identifies a potential for risk. Two levels of TRVs are typically identified for chemical constituents. The no observed adverse effect level (NOAEL) is a dose, expressed as mg/kg-day, below which ecologically significant effects are not expected to occur. The lowest adverse effect level (LOAEL) is the lowest dose at which adverse effects are expected to occur.

The source document for the ECO-SSLs for antimony (U.S. EPA, 2005b) states that data sufficient to develop TRVs for avian receptors are not available. Consultation of several other sources did not identify TRVs for antimony. Consequently, risk to avian wildlife exposed to antimony in soil cannot be evaluated. For silver, the selected NOAEL of 2.02 mg/kg-day is the lowest LOAEL for reproduction or growth identified in the source document, divided by an uncertainty factor of 10. The LOAEL of 20.2 mg/kg-day is the lowest LOEAL for reproduction and growth.

For American woodcock, the indicator species for avian insectivores, the HQ based on the NOAEL (3.7) is greater than 1.0, whereas the HQ based on the LOAEL (0.38) is less than 1.0. The HQs for mourning dove (herbivore) and red-tailed hawk (carnivore), based on the NOAELs are 0.25 and 0.019, respectively. These values, which are both less than 1.0, indicate no reasonable potential for risk. The results for the American woodcock also indicate little potential for ecologically significant effects. The marginally elevated HQ of 3.7 based on the NOAEL assumes that all food is consumed from

SWMUs 1 and 2, 100 percent bioavailability of silver from soil, and NOAEL to LOAEL uncertainty factor of 10.

MAMMALIAN WILDLIFE

Table 13 summarizes the initial step in the refinement of the evaluation of mammalian wildlife exposed to metals in SWMUs 1 and 2. Information presented in Table 13 is similar to that presented in Table 9 for avian wildlife.

ECO-SSLs specific to mammalian wildlife are available for antimony, arsenic, cadmium, chromium, cobalt, copper, nickel, silver, and vanadium. The RQs for antimony (4.3), cadmium (1.7), and silver (1.9) are greater than 1.0. The ECO-SSLs for antimony (0.27 mg/kg) and cadmium (0.36) are less than their Site-specific background levels. For antimony, the RQ based on the Site-specific background level (0.606 mg/kg) is also greater than 1.0. For cadmium, the RQ based on the Site-specific background level (1.13 mg/kg) is below 1.0.

Based on the initial refinement step, antimony and silver are carried forward for further evaluation using food chain models. Table 14 summarizes the result of the food chain models for short-tailed shrew (insectivore), meadow vole (herbivore), and the long-tailed weasel (carnivores). Table 3 and Table 11 identify the exposure factors and exposure concentrations, respectively.

For antimony, the NOAEL of 0.059 mg/kg-day is the lowest NOAEL for growth and reproduction identified in the source document (U.S. EPA, 2005b). The LOAEL of 0.59 mg/kg-day is the lowest LOEAL for those studies that report both a NOAEL and LOAEL (i.e., bounded). For silver, the selected NOAEL of 6.02 mg/kg-day is the lowest LOAEL for reproduction or growth identified in the source document, divided by an uncertainty factor of 10. The LOAEL of 60.2 mg/kg-day is the lowest LOEAL for reproduction and growth.

For short-tailed shrew (insectivore), the HQ for antimony based on the NOAEL (HQ_{NOAEL} = 3.4) is greater than 1.0. The HQ based on the LOAEL (HQ_{LOAEL} = 0.34) is below 1.0. For meadow vole (herbivore) and long-tailed weasel (carnivore) the HQs based on the NOAEL are 0.11 and 0.13, respectively. For silver, the HQ for short-tailed shrew (insectivore) based on the NOAEL is slightly greater than 1.0 (HQ_{NOAEL} = 1.4). The HQ based on the LOAEL (HQ_{LOAEL} = 0.15) is below 1.0. For meadow vole (herbivore) and long-tailed weasel (carnivore), the HQs based on the NOAEL are less than 1.0. These results demonstrate that risk to mammalian wildlife exposed to antimony and silver in SWMUs 1 and 2 is below the threshold for concern.

5.2.1.3 SUMMARY FOR SWMUS 1 AND 2

Refinement of the evaluation of the VOCs and metals identified as COPECs for SWMUs 1 and 2 demonstrates that risk to ecological receptors exposed to soil does not exceed the threshold of concern. For all three VOCs, the maximum concentrations are for duplicate samples collected at a depth of 2 feet bgs, where ecological receptors have a limited potential for exposure to VOCs. Furthermore, the concentrations reported for the duplicates differ by several orders of magnitude, with the higher of the concentrations being identified as statistical outliers from data for samples from other locations. With removal of the outliers, no concentrations exceed the ESV for cis-1,2-dichloroethene, and only one and two samples exceed the ESVs for TCE and PCE, respectively.

For metals, a small percentage (< 6.1 percent) of samples have concentrations of cobalt and nickel that exceed the ECO-SSLs for terrestrial plants. There are no visible signs of vegetative stress in SWMUs 1 and 2. The concentration of arsenic in one sample exceeds the ECO-SSL for soil invertebrates. As discussed in Section 4.1.4, a threshold of 20 percent of samples with concentrations greater than the ECO-SSLs for terrestrial plants and soil invertebrates is identified as the threshold for concern. With the exception of antimony and silver, the 95 percent UCL concentrations of metals identified as COPECs are below the ECO-SLLs for avian and mammalian wildlife. Food chain models indicate that antimony and silver do not pose a potential for risk above the threshold for concern.

5.2.2 SWMU 5

The SLERA identified 10 metals as COPECs for SWMU 5. The screening against Site-specific background levels eliminated all ten metals as COPECs.

5.2.3 AOC 3A

5.2.3.1 SEMIVOLATILE ORGANIC COMPOUNDS

The SLERA identified 12 SVOCs, exclusive of PAHs, as COPECs for AOC 3A. None of the 12 SVOCs was detected, but all were identified as COPECs based on LODs greater than their ESVs. For all SVOCs, the ESVs were the ESLs identified by U.S. EPA

Region 5, which are based on the masked shrew. For the refinement process, other available ecological benchmarks are considered. Table 15 identifies the available benchmarks for the SVOCs identified as COPECs.

Table 16 summarizes the results of the refinement of SVOCs in soil for AOC 3A. As can be seen in Table 6 and Table 7, multiple ecological benchmarks are available only for 2,4-dinitrophenol (3 benchmarks), 2-chlorophenol (2 benchmarks), hexachlorobenzene (3 benchmarks), and pentachlorophenol (9 benchmarks). For 2,4-dinitrophenol, hexachlorobenzene, and pentachlorophenol, the detection limits are within the range of available ecological benchmarks. Consequently, 2,4-dinitrophenol, hexachlorobenzene, and pentachlorophenol are eliminated as COPECs.

For the remaining nine SVOCs, the detection limits are greater than all available ecological benchmarks. This does not necessarily indicate a potential for risk, only that the presence of these SVOCs above their ESVs in the surface soil of AOC 3A is uncertain. AOC 3A is a drainage ditch that receives runoff from Riley Lake. To further evaluate the potential presence of these SVOCs in AOC 3A, the presence of these SVOCs in Riley Lake is considered. As documented in Table 8.8 and Table 8.10 of the SLERA, none of these nine SVOCs were detected in either the sediment or surface water of Riley Lake. Even if present, the small size and low value of AOC 3A as habitat for ecological receptors limit the potential for risk. Consequently, 2,4-dimethylphenol, 2,6-dinitrotoluene, 2-chloronaphthalene, 2-chlorophenol, aniline, bis(2-chloroethoxy)methane, butyl benzylphthalate, Hexachlorobutadiene, and n-nitrosodimethylamine can reasonably be eliminated as COPECs.

5.2.3.2 POLYCYCLIC AROMATIC HYDROCARBONS

The SLERA identified two LMW PAHs (naphthalene and phenanthrene) and one HMW PAH (chrysene) as COPECs for AOC 3A. Naphthalene was identified as a COPEC based on a maximum concentration greater than its ESV. Chrysene and phenanthrene were not detected, but were identified as COPECs because their LODs were greater than their ESVs.

Since the RFI was submitted in 2005, U.S. EPA has published ECO-SSLs for LMW and HMW PAHs (U.S. EPA, 2007). For LMW PAHs, the ECO-SSLs for soil invertebrates and mammalian wildlife are 29 mg/kg and 100 mg/kg, respectively. For HMW PAHs, the ECO-SSLs for soil invertebrates and mammalian wildlife are 18 mg/kg and 1.1 mg/kg, respectively. According to U.S. EPA (2007), data sufficient to develop ECO-SSLs for terrestrial plants and avian wildlife are not available. The lower of the ECO-SSLs for

LMW (29 Mg/kg for soil invertebrates) and HMW (1.1 mg/kg for mammalian wildlife) are used to re-screen LMW and HMW PAHs detected in AOC 3A.

For the re-screening, all PAHs are considered. The LMW PAHs are 2-methylnaphthalene, acenaphthene, acenaphthylene, fluorene, naphthalene, and phenanthrene. The LMW PAHs are benzo(a)anthracene, benzo(a)pyrene, benzo(b)fluorene, benzo(g,h,i)perylene, benzo(k)fluorene, chrysene, dibenz(a,h)anthracene, fluoranthene, indeno(1,2,3-cd)pyrene, and pyrene. Concentrations of the six LMW PAHs in a sample were summed to provide a concentration for LMW PAHs in that sample. Similarly, concentrations of the ten HMW PAHs in a sample were summed to provide a concentration of HMW PAHs. For those individual PAHs not detected, a value equal to one-half the detection limit was conservatively assigned, and included in the calculation of LMW and HWM PAHs.

Table 17 summarizes the re-screening of PAHs. For LMW PAHs, the maximum concentration of 1.98 mg/kg is below the ECO-SSL of 29 mg/kg for soil invertebrates. Consequently, all LMW PAHs are eliminated as COECS. For HMW PAHs, the maximum concentration of 5.1 mg/kg is below the ECO-SSL for soil invertebrates, but greater than the ECO-SSL of 1.1 mg/kg for HMW PAHs. Consequently, HMW PAHs are retained for further evaluation of risk to avian and mammalian wildlife using food chain models.

Table 18 summarizes the result of the food chain models for American woodcock (insectivore), mourning dove (herbivore), and red-tailed hawk (carnivore). Table 3 and Table 11 identify the exposure factors and exposure concentrations, respectively. The source document for derivation of the ECO-SSLs for PAHs identifies a single study that identified NOAELs and LOAELs for HMW PAHs for avian wildlife. These are the NOAEL (2.0 mg/kg-day) and LOAEL (20 mg/kg-day) used for the food chain models.

For all three indicator species, the HQs based on the NOAEL are less than 1.0.

Table 19 summarizes the result of the food chain models for short-tailed shrew (insectivore), meadow vole (herbivore), and long-tailed weasel (carnivore). Table 3 and Table 11 identify the exposure factors and exposure concentrations, respectively. The NOAEL of 0.615 mg/kg is the highest bound NOAEL less than lowest bound LOAEL for growth and reproduction identified in the source document (U.S. EPA, 2007). The LOAEL of 31.8 mg/kg-day is the 20th percentile of the bounded LOEALs for growth and reproduction.

For short-tailed shrew (insectivore), the HQ for HMW PAHs based on the NOAEL (HQ_{NOAEL} = 3.6) is greater than 1.0. The HQ based on the LOAEL (HQ_{LOAEL} = 0.070) is below 1.0. For meadow vole (herbivore) and long-tailed weasel (carnivore) the HQs based on the NOAEL are 0.13 and 0.025, respectively. These results demonstrate that risk to mammalian wildlife exposed to HMW PAHs in AOC 3A is below the threshold for concern.

5.2.3.3 SUMMARY FOR AOC 3A

Refinement of the SVOCs and PAHs identified as COPECs for AOC 3A demonstrates that risk to ecological receptors exposed to soil does not exceed the threshold of concern. Exclusive of PAHs, the SVOCs were not detected, but were identified as COPECs based on LODs greater than their ESVs. The LODs of 2,4-dinitrophenol, hexachlorobenzene, and pentachlorophenol are within the range of available ecological benchmarks. Of the remaining SVOCs, none were detected in the surface water or sediment of Riley Lake, which discharges into AOC 3A.

For PAHs, LMW PAHs were eliminated as COPEC based on maximum concentration below the lowest of the ECO-SSLs. For HMW PAHs, the maximum concentration exceeded the ECO-SSL for mammalian wildlife, but the food chain models identified no potential for risk above the threshold for concern.

5.2.4 AOC 3B

5.2.4.1 METALS

The SLERA identified 15 metals as COPECs for AOC 3B. Since submittal of the RFI in 2005, soil has been removed and confirmation sampling has been conducted using lead as an indicator. Screening against Site-specific background levels identified the maximum (287 mg/kg) and 95 percent UCL (176 mg/kg) concentrations that are greater than Site-specific background (114 mg/kg). The refinement process for lead in AOC 3B is similar to that conducted for other metals for SWMUs 1 and 2.

Table 7 summarizes the refinement of the evaluation of risk to terrestrial plants. Concentrations in three of the eight confirmation samples exceed the lead ECO-SSL of 120 mg/kg for terrestrial plants. Figure 6 depicts the locations where the lead concentrations exceeded the ECO-SSLs for terrestrial plants.

Table 8 summarizes the refinement of the evaluation of risk to soil invertebrates. Concentrations in all samples are below the ECO-SSL of 1,700 mg/kg for soil invertebrates.

Table 9 summarizes the refinement of the evaluation of risk to avian wildlife. The RQ based on the ECO-SSL (11 mg/kg), which is an order of magnitude lower than Site-specific background (114 mg/kg), is 16. The HQ based on the 95 percent UCL concentration is 1.5, which is also greater than 1.0. Table 13 summarizes the refinement of risk to mammalian wildlife. The RQ based on the ECO-SSL (56 mg/kg), which is approximately one-half Site-specific background, is 3.1. The HQ based on the 95 percent UCL concentration is 1.5. Based on these results, lead is carried forward for further evaluation using food chain models for both avian and mammalian wildlife.

Table 20 summarizes the results of the food chain models for American woodcock (insectivore), mourning dove (herbivore), and red-tailed hawk (carnivore). Table 3 and Table 11 identify the exposure factors and exposure concentrations, respectively. The NOAEL of 1.63 mg/kg is highest bounded NOAEL less than the lowest bounded LOAEL for growth and reproduction identified in the source document (U.S. EPA, 2007). The LOAEL of13.3 mg/kg-day is the 20th percentile of the bounded LOAELs for growth and reproduction.

For American woodcock, the indicator species for avian insectivores, the HQ based on the NOAEL ($HQ_{NOAEL} = 6.9$) is greater than 1.0, whereas the HQ based on the LOAEL ($HQ_{LOAEL} = 0.85$) is less than 1.0. Similarly, for mourning dove (herbivore), the HQ based on the NOAEL ($HQ_{NOAEL} = 2.4$) is greater than 1.0, whereas the HQ based on the LOAEL ($HQ_{LOAEL} = 0.30$) is less than 1.0. For red-tailed hawk (carnivore), the HQs for the NOAEL ($HQ_{NOAEL} = 0.33$) is less than 1.0. These results demonstrate that risk to avian wildlife exposed to lead in AOC 3B is below the threshold for concern.

Table 21 summarizes the result of the food chain models for short-tailed shrew (insectivore), meadow vole (herbivore), and long-tailed weasel (carnivore). Table 3 and Table 11 identify the exposure factors and exposure concentrations, respectively. The NOAEL of4.7 mg/kg is the highest bounded NOAEL for growth and reproduction below the lowest bounded LOAEL identified in the source document (U.S. EPA, 2005b). The LOAEL of28.7 mg/kg-day is the 20th percentile of the bounded LOEALs for growth and reproduction.

For short-tailed shrew (insectivore), the HQ for HMW PAHs based on the NOAEL ($HQ_{NOAEL} = 2.0$) is greater than 1.0. The HQ based on the LOAEL ($HQ_{LOAEL} = 0.33$) is below 1.0. For meadow vole (herbivore) and long-tailed weasel (carnivore) the HQs based on the NOAEL are 0.17 and 0.27, respectively. These results demonstrate that risk to mammalian wildlife exposed to lead in AOC 3B is below the threshold for concern.

5.2.4.2 SUMMARY FOR AOC 3B

Refinement of the evaluation of lead in AOC 3B demonstrate that risk to ecological receptors exposed to soil does not exceed the threshold of concern. Whereas the concentrations in three of the eight confirmation samples exceed the ECO-SSL for terrestrial plants, concentrations in all eight samples are below the ECO-SSL for soil invertebrates. The 95 percent UCL concentration is greater than ECO-SSLs for avian and mammalian wildlife. However, food chain models indicate that the potential for risk to avian and mammalian wildlife is below the threshold for concern. As discussed in Section 3.4, AOC 3B is a drainage ditch in an area of active agricultural use and provides limited habitat for wildlife.

5.3 REFINEMENT OF COPECS IN SEDIMENT

5.3.1 VOLATILE ORGANIC COMPOUNDS

The SLERA identified seven VOCs as COPECs for the sediment of Riley Lake. The seven VOCs are 1,1-dichloroethane, 1,1-dichloroethene, 2-butanone, 2-hexanone, 4,-methy-2-pentanone, acetone, and bromomethane. All seven VOCs were identified as COPECs based on LODs that exceeded their ESVs. As discussed in Section 4.2.2, these seven VOCs will be refined using ESBs calculated following the methodology of U.S. EPA (2008), which is based on the narcosis mode of toxicity and equilibrium partitioning.

Table 22 summarizes the refinement of the evaluation of the VOCs in the sediment of Riley Lake. For all seven VOCs, the detection limits are below their ESBs.

5.3.2 SEMIVOLATILE ORGANIC COMPOUNDS

The SLERA identified hexachlorobutadiene as a COPEC based on a LOD greater than its ESV. As is the case for VOCs, hexachlorobutadiene is refined using an ESB. Table 22 summarizes the refinement of hexachlorobutadiene. The detection limits for hexachlorobutadiene (73 to 80 µg/kg) are greater than its ESB of 2.7 µg/kg. There is no evidence that hexachlorobutadiene is present at the site at concentrations that would pose risk to ecological receptors. It was not detected in the surface water of Riley Lake, soil, or groundwater. Furthermore, there is no evidence that it was historically used or stored within the assessment area.

5.3.3 METALS

The SLERA identified seven metals as COPECs for the sediment of Riley Lake. Copper and zinc were identified as COPECs based on maximum concentrations that exceeded their respective ESVs. Antimony, cadmium, and silver were identified as COPECs based on LODs greater than their ESVs. As discussed in Section 4.3.2, metal are refined by comparing concentrations with lower tier and upper tier sediment quality benchmarks. Table 23 identifies the lower tier and upper tier benchmarks for antimony, cadmium, copper, selenium, silver, vanadium, and zinc.

Table 24 summarizes the refinement of the evaluations of metals identified as COPECs for the sediment of Riley Lake. Information presented in Table 24 includes the lower tier and upper tier benchmarks, the source of the refinement, maximum detected concentrations (copper, selenium, vanadium, and zinc), and minimum and maximum detection limits (antimony, cadmium, and silver). For copper, selenium, and zinc, Table 24 also identifies the RQs for the lower tier and upper tier benchmarks.

The maximum detected concentrations of selenium and vanadium are less than their respective lower tier benchmarks. The $HQ_{Lower\ Tier}$s, are 0.28 and 0.14 for selenium and vanadium, respectively. For copper and zinc, the maximum concentrations exceed their lower tier benchmarks, but are below the upper tier benchmarks. For copper, the $HQ_{Lower\ Tier}$ and $HQ_{Upper\ Tier}$ are 1.6 and 0.33, respectively. For zinc, the $HQ_{Lower\ Tier}$ and $HQ_{Upper\ Tier}$ are 1.3 and 0.35, respectively. Based on the relatively low $HQ_{Upper\ Tier}$s ($\leq$ 0.35), it can be reasonably concluded that copper and zinc do not pose a potential for risk to benthic invertebrates above the threshold for concern.

For antimony, cadmium, and silver, the detection limits are above their lower tier benchmarks, but well below their upper tier benchmarks. According, it can reasonably be concluded that antimony, cadmium, and silver are not present in the sediment of Riley Lake at concentrations that would pose risk to benthic invertebrates.

5.3.4 SUMMARY FOR SEDIMENT OF RILEY LAKE

The refinement of the evaluation of the VOCs, SVOCs, and metals identified as COPECs for the sediment of Riley Lake demonstrates that the potential for risk to ecological receptors is below the threshold for concern. Seven VOCs and one SVOC were not detected, but had LODs greater than their ESVs. The LODs for all VOCs are below their ESBs, which were calculated following the methodology of U.S. EPA (2008). The LODs for hexachlorobutadiene are greater than its ESB. However, hexachlorobutadiene can be eliminated as a COPEC as it has not been detected in any other media and there is no evidence of historical use or storage. The maximum concentrations of copper, selenium, vanadium, and zinc and the detection limits of antimony, cadmium, and silver are substantially below their upper tier benchmarks.

Copper and zinc were detected in the sediment of Riley Lake and are BCOCs for sediment. As BCOCs, there is a potential for bioaccumulation in fish and consumption of fish by avian and mammalian piscivores. Given the relatively low concentrations of copper and zinc, the small size and limited potential for Riley Lake to support a large fish community and the large foraging range of most piscivores, risk to avian and mammalian wildlife due to consumption of fish from Riley Lake is not expected to be significant. Consequently, use of food chain models to assess risk to avian and mammalian piscivores is not considered necessary or appropriate.

5.4 REFINEMENT OF COPECS IN SURFACE WATER

5.4.1 RILEY LAKE

5.4.1.1 SEMIVOLATILE ORGANIC COMPOUNDS

Hexachlorobutadiene is the only SVOC identified as a COPEC for the surface water of Riley Lake and the Artesian Well. This SVOC was not detected, but was retained as a COPEC based on an LOD greater than its ESV. The ESV for hexachlorobutadiene in the SLERA was U.S. EPA Region 5 ESL of 0.053 μg/L, which is below the LOD of 2.0 μg/L. U.S. EPA Region 4 and Region 6 identify a screening benchmark of 0.93 μg/L. The LOD of 2.0 μg/L is also greater than the other available benchmarks. There is no evidence that hexachlorobutadiene is present at the site at concentrations that would pose risk to ecological receptors. It was not detected in the sediment of Riley Lake, soil, or groundwater. Furthermore, there is no evidence that it was historically used or stored within the assessment area.

5.4.1.2 METALS

Six metals were identified as COPECs for the surface water of Riley Lake. As discussed in Section 4.3.3, refinement benchmarks, in order of priority, are water quality criteria identified by IDEM (cadmium, copper, lead, and silver), or the National Recommended Water Quality Criteria (NRWQC) (mercury), or Suter and Tsao (1996) (beryllium). Table 25 summarizes the refinement of COPECs in the surface water of Riley Lake. Information in Table 25 includes the refinement benchmarks and their source, maximum detected concentration (mercury), and minimum and maximum detection limits (beryllium, cadmium, copper, lead, and silver).

Mercury is the only metal COPEC detected in the surface water of Riley Lake. The maximum concentration (0.05 µg/L) is below NRWQC of 0.77 µg/L. The LODs for copper and lead are below the water quality criteria for protection of aquatic life identified by IDEM.

For beryllium, the refinement is 21 µg/L, which is the lowest of the EC20-Fish (148 µg/L), EC25-Bass (21 µg/L), and Lowest Chronic Value-Fish (57 µg/L) identified by Suter and Tsao (1996). The LOD of 5.0 µg/L is below this refinement benchmark.

For cadmium and silver, the LODs exceed their refinement benchmarks. This result does not imply that cadmium and silver pose risk to aquatic receptors, only that their presence in the surface water of Riley Lake at concentrations above their ESVs is uncertain. Neither cadmium nor silver was detected in the sediment of Riley Lake. Both are naturally occurring metals that were detected in soil within the assessment area, as well as the Site-specific background samples. Furthermore, there is no indication that cadmium was used in manufacturing processes or stored on site. Based on these multiple lines of evidence, it can reasonably be concluded that cadmium and silver are not present in the surface water of Riley Lake that would pose risk to aquatic receptors.

5.4.1.3 SUMMARY FOR THE SURFACE WATER OF RILEY LAKE

The refinement of the evaluation of the SVOCs and metals identified as COPECs for the surface water of Riley Lake shows that the potential for risk to ecological receptors is below the threshold for concern. Mercury is the only COPEC that was detected in surface water. The maximum concentration is below its refinement benchmark. One SVOC and five metals were not detected, but had LODs greater than their ESVs. The LODs for three of the metals (beryllium, copper, and lead) are below their refinement benchmarks. The LODs for hexachlorobutadiene, cadmium, and silver are greater than their refinement benchmarks. Multiple lines of evidence demonstrate that hexachlorobutadiene, cadmium, and silver are not present in the surface water of Riley Lake at concentrations that pose risk to ecological receptors.

5.4.1.4 SUMMARY FOR THE SURFACE WATER OF RILEY LAKE

The refinement of the evaluation of the SVOCs and metals identified as COPECs for the surface water of Riley Lake demonstrates that the potential for risk to ecological receptors is below the threshold for concern. Mercury is the only COPEC that was detected in surface water. The maximum concentration is below its refinement benchmark. One SVOC and five metals were not detected, but had LODs greater than their ESVs. The LODs for three of the metals (beryllium, copper, and lead) are below their refinement benchmarks. The LODs for hexachlorobutadiene, cadmium, and silver are greater than their refinement benchmarks. Multiple lines of evidence demonstrate that hexachlorobutadiene, cadmium, and silver are not present in the surface water of Riley Lake at concentrations that pose risk to ecological receptors.

5.5 FORMER ARTESIAN WELL

Hexachlorobutadiene is the only constituent identified as a COPEC for the surface water in the former artesian well. This SVOC was not detected, but was identified as a COPEC based on a LOD that was greater than its ESV. The ESV for hexachlorobutadiene in the SLERA was U.S. EPA Region 5 ESL of 0.053 µg/L, which is below the LOD of 2.0 µg/L. U.S. EPA Region 4 and Region 6 identify a screening benchmark of 0.93 µg/L. The LOD of 2.0 µg/L is also greater than the other available benchmarks. There is no evidence that hexachlorobutadiene is present at the site at concentrations that would pose risk to ecological receptors. It was not detected in the sediment of Riley Lake, soil, or groundwater. Furthermore, there is no evidence that it was historically used or stored within the assessment area. For the SLERA, soil was sampled in the vicinity of the former artesian well, with none of the constituents analyzed for being identified as COPECs. Consequently, the vicinity of the former artesian well does not pose unacceptable risk to ecological receptors.

6.0 GROUNDWATER-SURFACE WATER INTERFACE

One of the comments from U.S. EPA dated November 1, 2012, requested that potential risk to ecological receptors at the groundwater-surface water interface be addressed. This issue is addressed in this review using two lines of evidence. One line of evidence is the data from the sampling of surface water in 2012. The second line of evidence is data for groundwater collected at monitoring wells OB-9, OB-14, and OB-32.

Table 26 summarizes the data from the surface water collected and analyzed in 2012. Information presented in Table 26 includes the number of samples, number of samples with detected concentrations, FOD, maximum concentration and sample with the maximum concentration, ESV (which are those used in the SLERA), and SQ. The VOCs cis-1,2-dichloroethene, PCE, and TCE were detected in one or more sample. For all three VOCs, the maximum concentrations are below their conservative ESVs. Assuming that groundwater is the source of the VOCs in surface water, it can be concluded that cis-1,2-dichloroethene, PCE, and TCE do not pose a potential for risk to ecological receptors above the threshold for concern (see Figure 7 for groundwater monitoring well locations).

The second line of evidence considered in this evaluation of the groundwater-surface interface is data from monitoring wells OB-9, OB-14, and OB-32. Wells OB-9 and OB-14 are upgradient of seeps observed within the assessment area. Well OB-32 is side gradient to the seeps.

Table 27 summarizes the data for well OB-9. Information presented in Table 27 is similar to that presented in Table 26. Eight VOCs have been detected in well OB-09. The eight VOCs are carbon disulfide, cis-1,2-dichloroethene, naphthalene (which can also be a considered a SVOC), PCE, toluene, trans-1,2-dichloroethene, TCE, and vinyl chloride. For all eight of these VOCs, the maximum concentrations are less than their conservative ESVs.

Table 28 summarizes the data for well OB-14. Information presented in Table 28 is similar to that presented in Table 27. Seven VOCs have been detected in well OB-14. The seven VOCs are carbon disulfide, chloromethane, cis-1,2-dichloroethene, naphthalene, PCE, toluene, trans-1,2-dichloroethene, and TCE. For all seven of these VOCs, the maximum concentrations are less than their conservative ESVs.

Table 29 summarizes the data for well OB-32. Information presented in Table 29 is similar to that presented in Table 28. Ten VOCs and one SVOC have been detected in well OB-38. The ten VOCs are carbon disulfide, chloroform, cis-1,2-dichloroethene, naphthalene, o-xylene, PCE, toluene, trans-1,2-dichloroethene, TCE, and vinyl chloride. Phenol is the one SVOC that has been detected. For nine of these VOCs (carbon disulfide, chloroform, cis-1,2-dichloroethene, naphthalene, o-xylene, toluene, trans-1,2-dichloroethene, TCE, and vinyl chloride) and phenol, the maximum concentrations are less than their conservative ESVs.

The concentrations of PCE in four of the samples from well OB-32 exceeded the conservative ESV of 45 µg/L. These exceedences should not be taken as evidence of risk to ecological receptors from surface water based on two primary lines of evidence. First, the data are for groundwater, not surface water. When exposed to air, PCE tends to volatilize. Consequently, concentrations in groundwater will be higher than in surface water to which ecological receptors could potentially be exposed. Second, the FCV based on the narcosis mode of toxicity is 213 µg/L. Based on that value, all concentrations of PCE detected in Well OB-32 are below the threshold of concern for ecological receptors.

Based on the evaluation of the surface water samples collected in 2012 and groundwater data monitoring wells OB-09, OB-14, and OB-32, it can reasonably be concluded that the potential for risk to ecological receptors at the groundwater-surface interface is below the threshold for concern.

7.0 CONCLUSIONS

This document presents the methods and results for refinement of the evaluation of the 43 constituents identified as COPECs in the SLERA. In accordance with U.S. EPA guidance, this refinement process used alternative benchmarks, food chain models, and realistic exposure factors to identify constituents that warrant further assessment in the BERA. Based on the results of this refined evaluation, CRA concludes there is no unacceptable risk to ecological receptors for any media (soil, surface water, and sediment) for any of the SWMUs, AOCs, Riley Lake, or the former Artesian Well relating to the RMC facility. Consequently, in accordance with U.S. EPA guidance, continuation of the BERA is not necessary, and CRA recommends that the ecological risk assessment process be exited at Step 3.

8.0 REFERENCES

Conestoga-Rovers & Associates. 2010. Phase IIB RFI Report. May 2010.

Crommentuijn, T., M.D. Polder, and E.J. van de Plassche. 1997. Maximum Permissible Concentrations and Negligible Concentrations for Metals, Taking Background Concentrations into Account. National Institute of Public Health and the Environment, Bilthoven, The Netherlands. Report No. 601501 001.

Fuchsman, P.C. 2003. Modification of the Equilibrium Partitioning Approach for Volatile Organic Compounds in Sediment. Environ. Toxicol. Chem. 22532-1534.

MacDonald, D. D., C.G. Ingersoll, and T.A. Berger. 2000. Development and Evaluation of Consensus-Based Sediment Quality Guidelines for Freshwater Ecosystems. Arch. Environ. Contam. Toxicol. 39:20-31.

National Oceanic and Atmospheric Administration. 1999. National Oceanic and Atmospheric Administration, Sediment Quality Guidelines for the National Status and Trends Program. June 12, 1999.

Suter II, G.W. and C.L. Tsao. 1996. Toxicological Benchmarks for Screening Potential Contaminants of Concern for Effects on Aquatic Biota. 1996 Revision. Oak Ridge National Laboratory, Oak Ridge, TN. ES/ER/TM-96/R2.

Texas Commission on Environmental Quality. 2006. Update to Guidance for Conducting Ecological Risk Assessments at Remediation Sites in Texas RG-263-(Revised). January 2006 Version.

U.S. Environmental Protection Agency. 1995. Great Lakes Water Quality Initiative.

U.S. Environmental Protection Agency. 1997. Ecological Risk Assessment Guidance for Superfund, Process for Designing and Conducting Ecological Risk Assessment.

U.S. Environmental Protection Agency. 2000. Bioaccumulation Testing and Interpretation for the Purpose of Sediment Quality Assessment. Status and Needs. Office of Water and Office of Solid Waste. EPA-823-R-00-001. February 2000.

U.S. Environmental Protection Agency. 2005a. Guidance for Developing Ecological Soil Screening Levels. OSWER Directive 92857-55. Office of Solid Waste and Emergency and Remedial Response. Revised February 2005.

U.S. Environmental Protection Agency. 2005b. Ecological Soil Screening Levels for Antimony. Interim Final. OSWER Directive 9285.7-61. Office of Solid Waste and Emergency Response. February 2005.

U.S. Environmental Protection Agency. 2005c. Ecological Soil Screening Levels for Lead. Interim Final. OSWER Directive 9285.7-70. Office of Solid Waste and Emergency Response. March 2005.

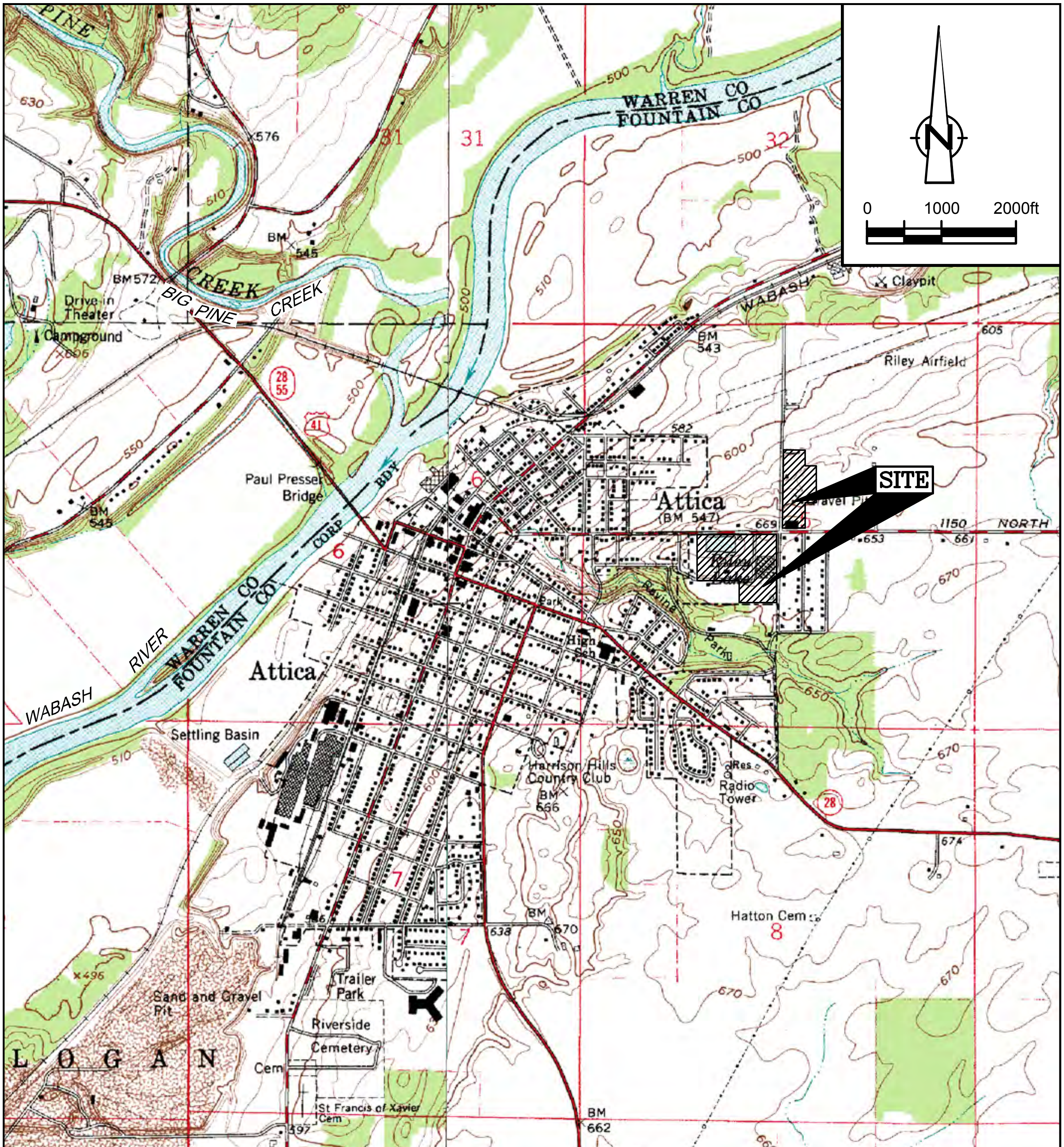
U.S. Environmental Protection Agency. 2006. Ecological Soil Screening Levels for Silver. September 2006. OSWER Directive 9285.7-77.

U.S. Environmental Protection Agency. 2007. Ecological Soil Screening Levels for Polycyclic Aromatic Hydrocarbons (PAHs). Interim Final. June 2007b. OSWER Directive 9285.7-78.

U.S. Environmental Protection Agency. 2008. Procedures of the Derivation of Equilibrium Partitioning Sediment Benchmarks (ESBs) for the Protection of Benthic Organisms: Compendium of Tier 2 Values for Nonionic Organics. EPA-600-R-02-016. Office of Research and Development. Washington, DC 20460.

U.S. Environmental Protection Agency. 2009a. National Recommended Water Quality Criteria. Office of Water, Office of Science and Technology. 4304T.

FIGURES



SOURCE: ATTICA AND WILLIAMSPORT, INDIANA
U.S.G.S. TOPOGRAPIC MAPS

INDIANA

figure 1

SITE LOCATION
RADIO MATERIALS CORPORATION
Attica, Indiana

19190-00(054)GN-WA005 FEB 13/2013

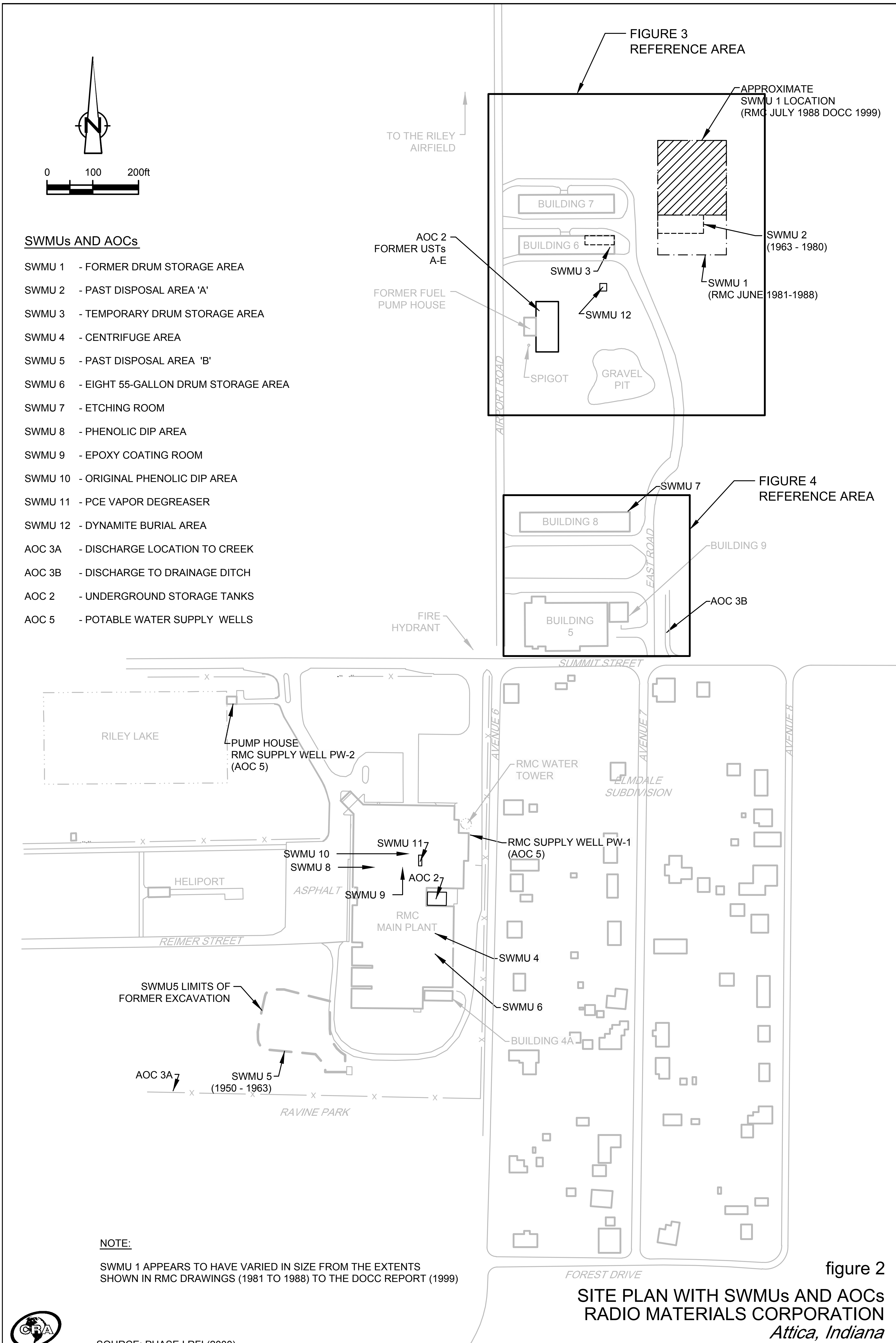


figure 2

SITE PLAN WITH SWMUs AND AOCs
RADIO MATERIALS CORPORATION
Attica, Indiana

19190-00(054)GN-WA002 FEB 8/2013

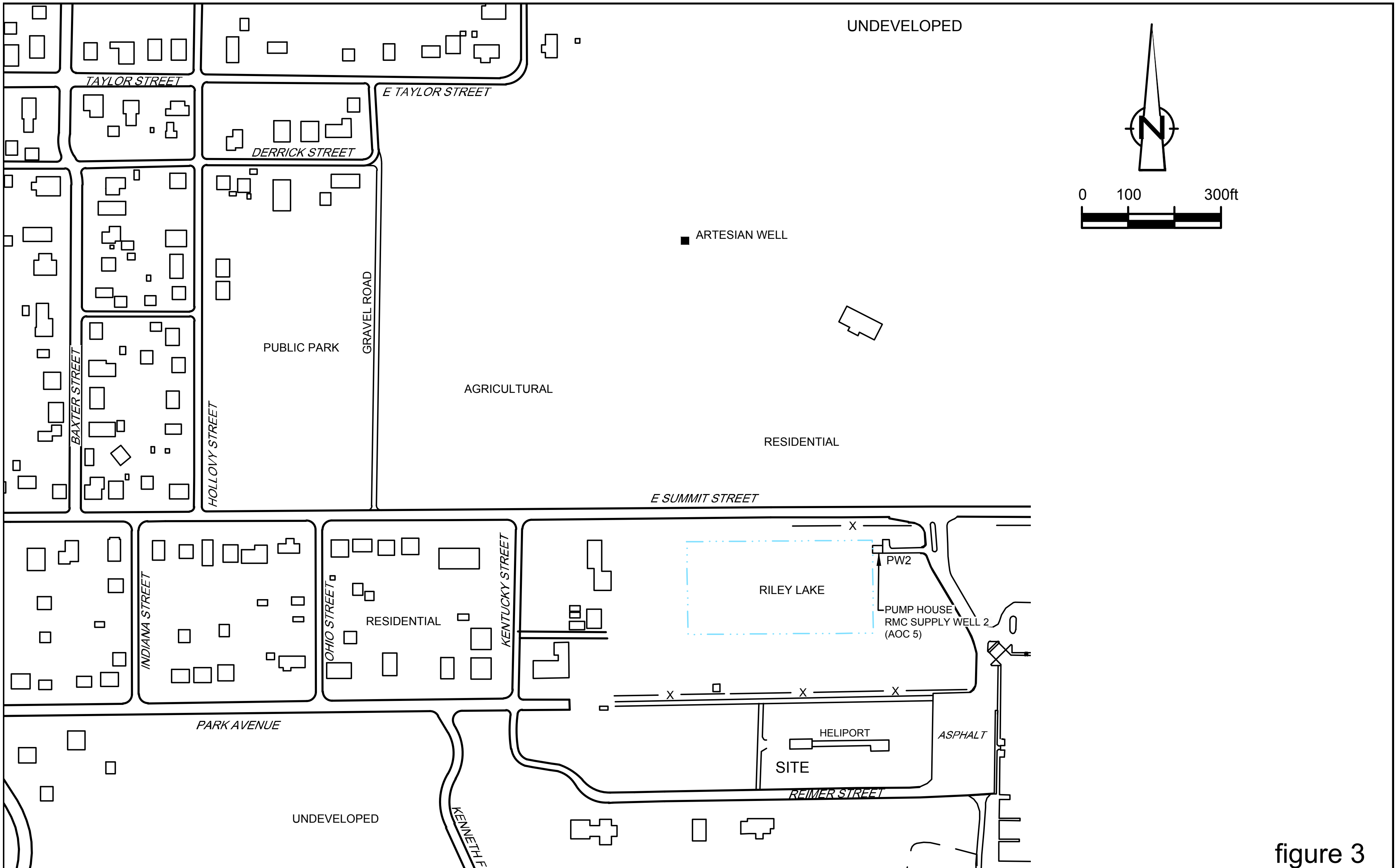


figure 3

ARTESIAN WELL AREA
RADIO MATERIALS CORPORATION
Attica, Indiana

19190-00(054)GN-WA006 FEB 13/2013

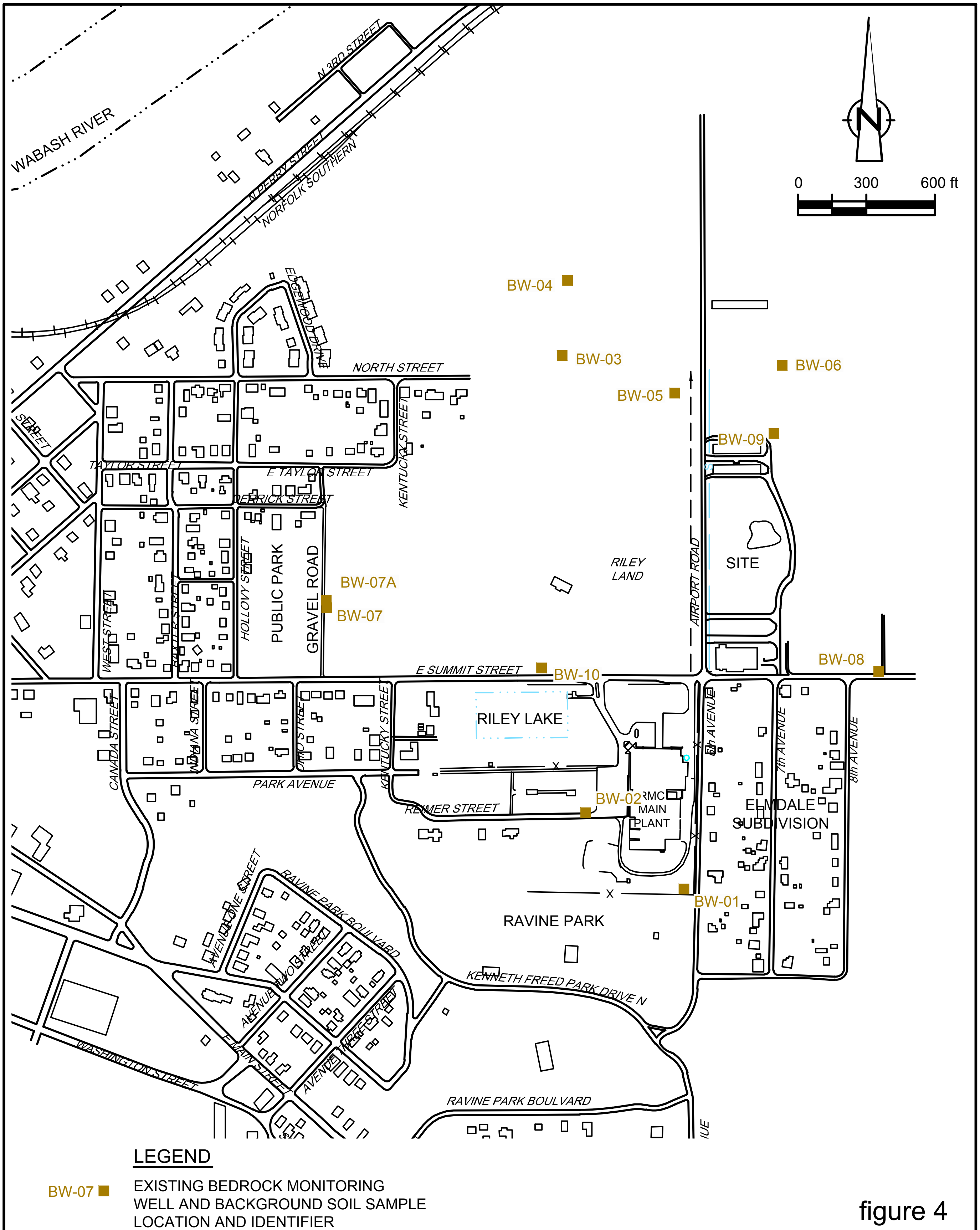
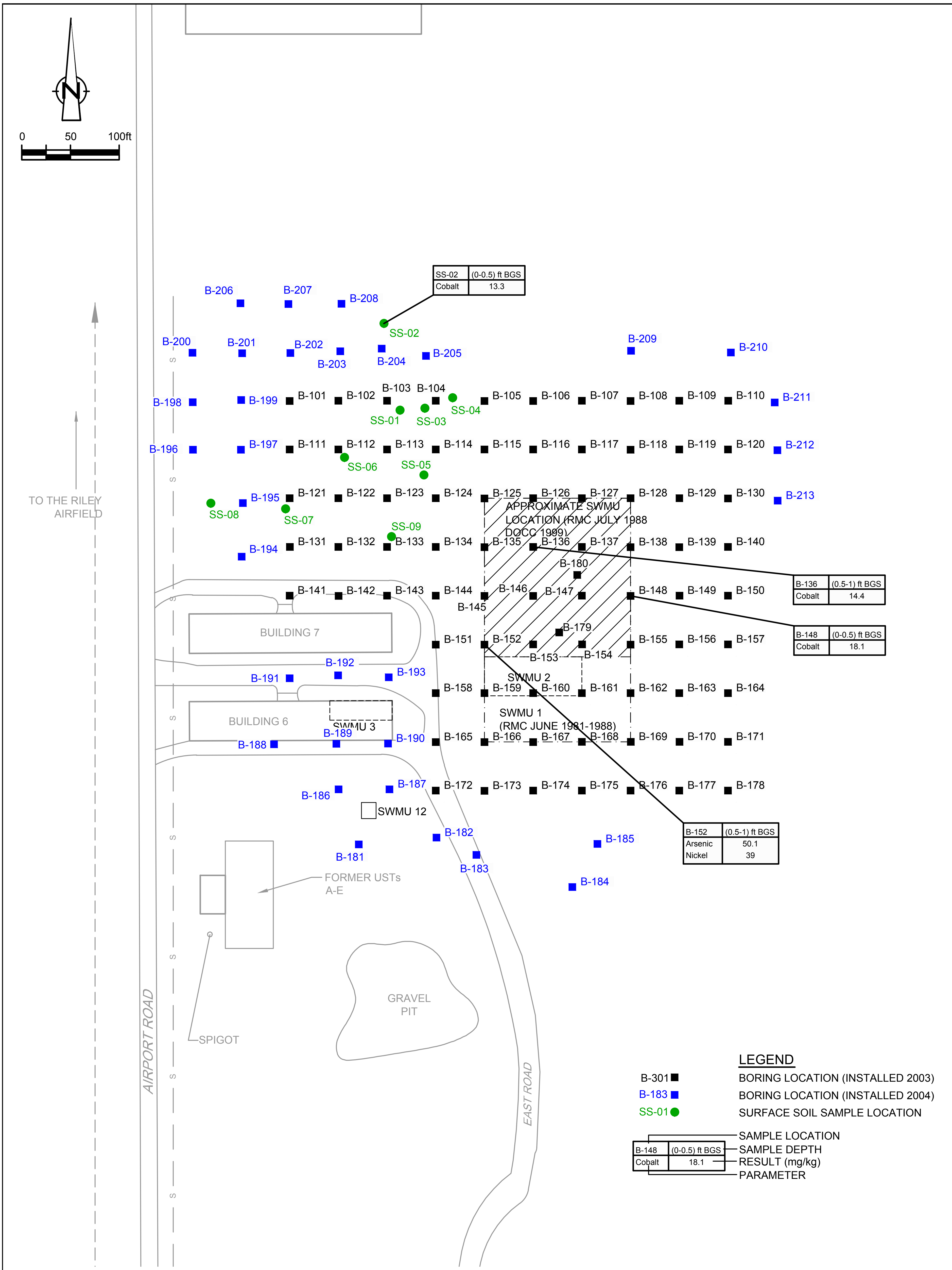


figure 4

BACKGROUND SOIL SAMPLE LOCATIONS
RADIO MATERIALS CORPORATION
Attica, Indiana

19190-00(054)GN-WA001 FEB 13/2013



NOTE:
SWMU 1 REPORTEDLY VARIED IN SIZE FROM THE EXTENT SHOWN IN RMC DRAWINGS (1981 TO 1988) TO THE DOCC REPORT (1999).

figure 5

METALS DETECTIONS ABOVE ECOLOGICAL SOIL SCREENING LEVELS
RADIO MATERIALS CORPORATION
Attica, Indiana

CRA

19190-00(054)GN-WA004 FEB 13/2013

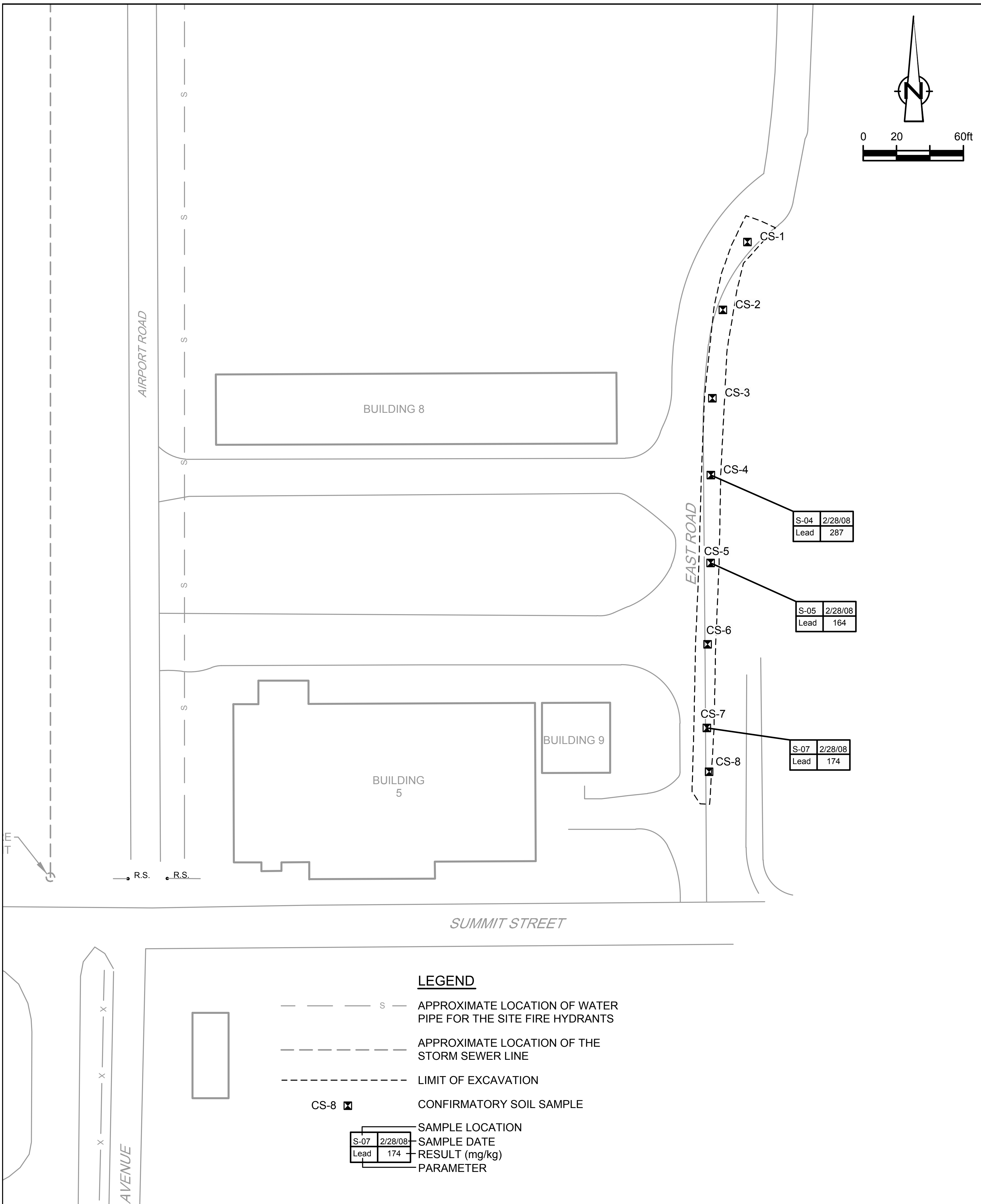
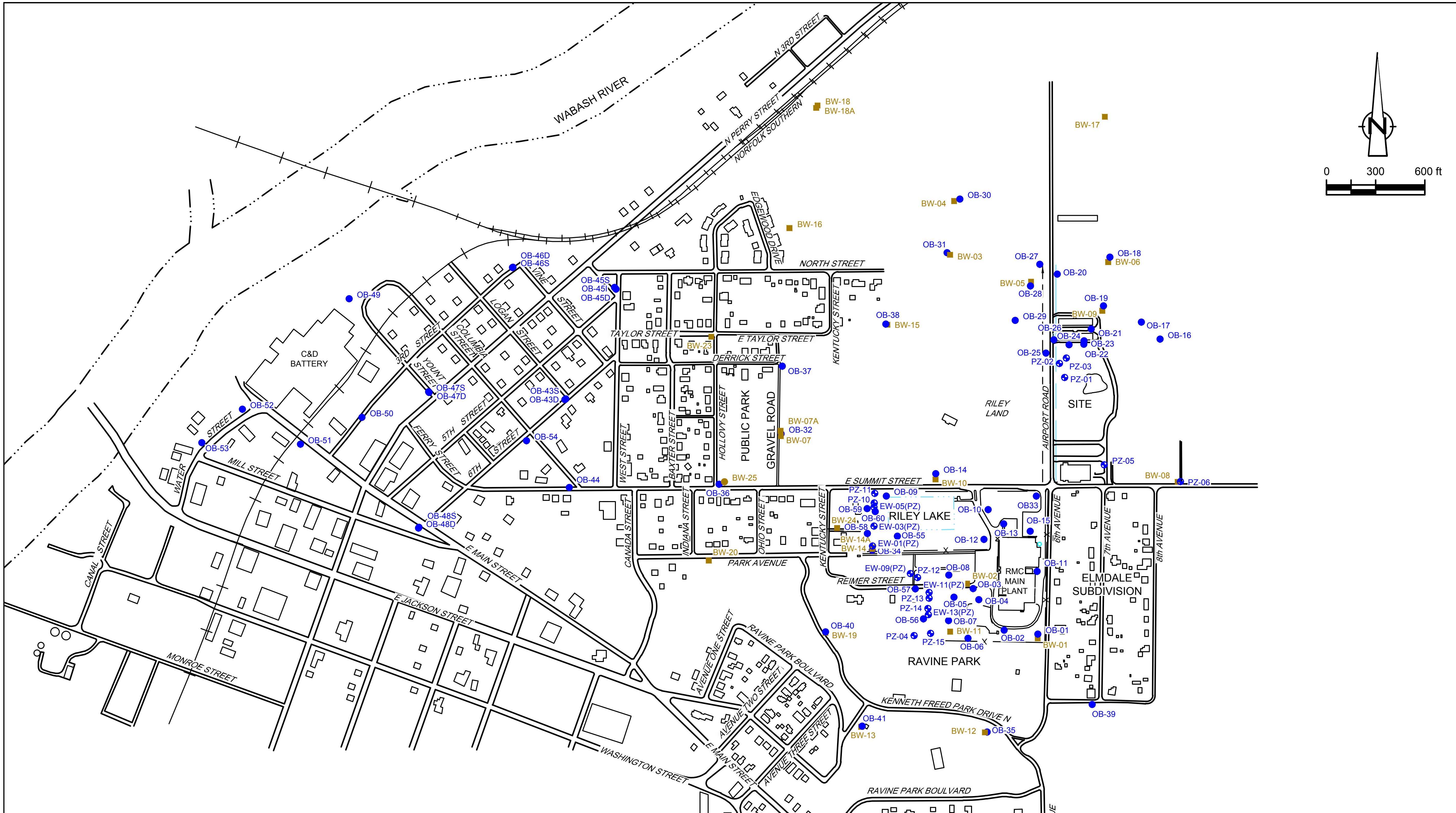


figure 6

LEAD DETECTIONS ABOVE PLANT ECOLOGICAL SCREENING LEVELS
AOC 3B CONFIRMATORY SOIL SAMPLES
RADIO MATERIALS CORPORATION
Attica, Indiana

19190-00(054)GN-WA003 FEB 13/2013



LEGEND

OB-34 ●	EXISTING OVERBURDEN MONITORING WELL LOCATION AND IDENTIFIER
BW-7 ■	EXISTING BEDROCK MONITORING WELL LOCATION AND IDENTIFIER
PZ-01 ◉	EXISTING OVERBURDEN PIEZOMETER LOCATION

figure 7

PIEZOMETER AND MONITORING WELL LOCATIONS
RADIO MATERIALS CORPORATION
Attica, Indiana

19190-00(054)GN-WA007 FEB 13/2013

TABLES

TABLE 1

CONSTITUENTS OF POTENTIAL ECOLOGICAL CONCERNED IDENTIFIED IN THE SLERA
RADIO MATERIALS CORPORATION
ATTICA INDIANA

COPEC	*Surface Soil*				*Riley Lake*		*Artesian Well*
	SWMUs 1 and 2	*SWMU 5*	*AOC 3A*	*AOC 3B*	*Sediment*	*Surface Water*	*Surface Water*
Volatile Organic Compounds (VOCs)							
1,1-Dichloroethane					LOD < ESV		
1,1-Dichloroethene					LOD < ESV		
2-Butanone					LOD < ESV		
2-Hexanone					LOD < ESV		
4-Methyl-2-Pentanone					LOD < ESV		
Acetone					LOD < ESV		
Bromomethane					LOD < ESV		
cis-1,2-Dichloroethene	SQ = 2.8						
Tetrachloroethene	SQ = 101						
Trichloroethene	SQ = 6.2						
Semi-Volatile Organic Compounds (VOCs)							
2,4-Dimethylphenol			LOD > ESV				
2,4-Dinitrophenol			LOD > ESV				
2,6 Dinitrotoluene			LOD > ESV				
2-Chloronaphthalene			LOD > ESV				
2-Chlorophenol			LOD > ESV				
Aniline			LOD > ESV				
Bis(2-chloroethoxy)methane			LOD > ESV				
Butyl benzylphthalate			LOD > ESV				
Hexachlorobenzene			LOD > ESV				
Hexchlorobutadiene			LOD > ESV		LOD > ESV	LOD < ESV	LOD < ESV
N-nitrosodimethylamine			LOD > ESV				
Pentachlorophenol			LOD > ESV				

TABLE 1

CONSTITUENTS OF POTENTIAL ECOLOGICAL CONCERNED IDENTIFIED IN THE SLERA
RADIO MATERIALS CORPORATION
ATTICA INDIANA

COPEC	*Surface Soil*				*Riley Lake*		*Artesian Well*
	SWMUs 1 and 2	*SWMU 5*	*AOC 3A*	*AOC 3B*	*Sediment*	*Surface Water*	*Surface Water*
Polycyclic Aromatic Hydrocarbons (PAHs)							
Low Molecular Weight PAHs							
Naphthalene			LOD < ESV				
Phenanthrene			SQ = 6.6				
High Molecular Weight PAHs							
Chrysene			SQ = 2.2				
Metals							
Antimony	SQ = 31			SQ = 97	LOD < ESV		
Arsenic	SQ = 2.8						
Barium	SQ = 17			SQ = 2.7			
Beryllium						LOD < ESV	
Cadmium	SQ = 5.6	SQ = 1.1		SQ = 12	LOD < ESV	LOD < ESV	
Chromium	SQ = 1.1			SQ = 1.8			
Cobalt	SQ = 1.4						
Copper	SQ = 368	SQ = 101		SQ = 2,457	SQ = 1.6	LOD < ESV	
Iron	SQ = 253	SQ = 101		SQ = 119			
Lead	SQ = 4.7			SQ = 572		LOD < ESV	
Manganese	SQ = 18	SQ = 12		SQ = 5.9		SQ = 26	
Mercury				SQ = 1.1		SQ = 38	
Nickel	SQ = 2.9	SQ = 1.3		SQ = 1.4			
Selenium	SQ = 43	SQ = 18		SQ = 54			
Silver	SQ = 18	SQ = 1.7		SQ = 15	LOD < ESV	LOD < ESV	
Thallium	SQ = 7.7	SQ = 3.9		SQ = 4.7			
Vanadium	SQ = 23	SQ = 13		SQ = 14			
Zinc	SQ = 22	SQ = 9.7		SQ = 1,076	SQ = 1.3		

Notes:
COPEC - Constituent of Potential Ecological Concern
ESV - Ecological Screening Value
LOD - Limit of Detection
SQ - Screening Quotient

TABLE 2

SITE-SPECIFIC BACKGROUND LEVELS
RADIO MATERIALS CORPORATION
ATTICA, INDIANA

COPEC	*No. Samples*	*Data Distribution*	*Background Method*	*Site-Specific Background Level*
Metals (mg/kg)				
Antimony	9	Gamma	99% WH Approx. Gamma UPL	0.606
Arsenic	9	Gamma	99% WH Approx. Gamma UPL	17.9
Barium	9	Not Normal	Nonparametric 99% UPL	897
Cadmium	9	Gamma	99% WH Approx. Gamma UPL	1.125
Chromium	9	Normal	Normal 99% UPL (t)	25.0
Cobalt	9	Normal	Normal 99% UPL (t)	14.7
Copper	9	Normal	Normal 99% UPL (t)	25.1
Iron	9	Gamma	99% WH Approx. Gamma UPL	31,942
Lead	9	Gamma	99% WH Approx. Gamma UPL	114
Manganese	9	Normal	Normal 99% UPL (t)	2,276
Nickel	9	Gamma	99% WH Approx. Gamma UPL	36.07
Selenium	1	n/a	n/a	n/a
Silver	9	Not Normal	Nonparametric 99% UPL	12.6
Thallium	9	Normal	Normal 99% UPL (t)	0.38
Vanadium	9	Normal	Normal 99% UPL (t)	33.7
Zinc	9	Normal	Normal 99% UPL (t)	151

Notes:
COPEC - Constituent of Potential Ecological Concern
n/a - Value not available
UPL - Upper Probability Limit
WH - Wilson-Hilferty

TABLE 3

EXPOSURE FACTORS FOR AVIAN AND MAMMALIAN INDICATOR SPECIES
RADIO MATERIAL CORPORATION
ATTICA, INDIANA

Parameter	*Units*	*American Woodcock*	*Mouring Dove*	*Red-Tailed Hawk*	*Short-Tailed Shrew*	*Meadow Vole*	*Long-Tailed Weasel*
Body Weight	kg	0.18	0.12	1.13	0.02	0.02	0.19
Ingestion							
IR_{Food}	mg/kg bw/day	0.142	0.137	0.026	0.167	0.076	0.071
IR_{Water}	L/kg/day	0.019	0.014	0.064	0.004	0.003	0.022
P_s	Unitless	0.164	0.139	0.057	0.03	0.032	0.043
Diet							
Terrestrial Invertebrates	Percent	100	0	0	100	0	0
Terrestrial Plants	Percent	0	100	0	0	100	0
Small Terrestrial Mammals	Percent	0	0	100	0	0	100
Area Use							
Diet from SWMU/AOC	Unitless	1	1	1	1	1	1
Bioavailability	Percent	100	100	100	100	100	100

Notes:

BW - Body Weight

Body Weight from Table 12A-1 of USEPA (1999)

IR_{Food} is arithmetic mean of mean food intake rates identified in Table 1 of Attachment 4-1 of USEPA (2005)

IR_{Water} from Table 12A-3 of USEPA (1999)

P_s from Table 4-1 of USEPA (2005)

TABLE 4

SCREENING OF METALS AGAINST BACKGROUND -SWMUs 1 AND 2
RADIO MATERIALS CORPORATION
ATTICA, INDIANA

COPEC	*Site-Specific Background Level*	*SWMUs 1 and 2*					*Retain as COPEC*	*Rationale*
		No. Samples	*No. Detects*	*Min. Detected*	*Max Detected*	*95% UCL*		
Metals (mg/kg)								
Antimony	**0.606**	**50**	**49**	**0.04**	**9.04**	**1.15**	**YES**	**Max > BG**
Arsenic	**17.9**	**54**	**54**	**2.0**	**50.1**	**9.4**	**YES**	**Max > BG**
Barium	**897**	**50**	**50**	**9.6**	**5,540**	**811.6**	**YES**	**Max > BG**
Cadmium	**1.125**	**50**	**50**	**0.101**	**2.02**	**0.626**	**YES**	**Max > BG**
Chromium	**25**	**50**	**50**	**5.0**	**29.7**	**15.5**	**YES**	**Max > BG**
Cobalt	**14.7**	**50**	**50**	**3.2**	**18.1**	**10.2**	**YES**	**Max > BG**
Copper	**25.1**	**50**	**50**	**6.7**	**51.5**	**19.0**	**YES**	**Max > BG**
Iron	**31,942**	**50**	**50**	**8,650**	**50,500**	**25,931**	**YES**	**Max > BG**
Lead	114	50	50	6.3	75.9	28.3	No	Max < BG
Manganese	2,276	50	50	279	1,780	1,012	No	Max < BG
Nickel	**36.1**	**50**	**50**	**9.29**	**39**	**18.0**	**YES**	**Max < BG**
Selenium	1.6	50	18	0.20	1.2	0.43	No	Max < BG
Silver	**12.6**	**50**	**46**	**0.02**	**71.8**	**24.2**	**YES**	**Max < BG**
Thallium	**0.38**	**50**	**50**	**0.09**	**0.44**	**0.22**	**YES**	**Max < BG**
Vanadium	**33.7**	**50**	**50**	**7.02**	**36.7**	**21.5**	**YES**	**Max < BG**
Zinc	151	50	50	36.2	146	69.4	No	Max < BG

Notes:
COPEC - Constituent of Potential Ecological Concern
UCL - Upper Confidence Limit

TABLE 5

SCREENING OF METALS AGAINST BACKGROUND -SWMU 5
RADIO MATERIALS CORPORATION
ATTICA, INDIANA

COPEC	*Site-Specific Background*	*SWMU 5*					*Retain as COPEC*	*Rationale*
		No. Samples	*No. Detects*	*Min. Detected*	*Max Detected*	*95% UCL*		
Metals (mg/kg)								
Cadmium	1.125	10	10	0.129	0.405	0.282	No	Max < BG
Copper	25.1	10	10	9.09	14.2	12.2	No	Max < BG
Iron	31,942	10	10	12,200	20,100	18,044	No	Max < BG
Manganese	2,276	10	10	383	1,170	957	No	Max < BG
Nickel	36.1	10	10	10.8	17	15.3	No	Max < BG
Selenium	1.6	10	10	0.20	0.50	0.46	No	Max < BG
Silver	12.6	10	10	0.052	6.77	4.01	No	Max < BG
Thallium	0.38	10	10	0.121	0.222	0.193	No	Max < BG
Vanadium	33.7	10	10	12.7	20.6	18.5	No	Max < BG
Zinc	151	10	10	38.8	64.2	59.2	No	Max < BG

Notes:
COPEC - Constituent of Potential Ecological Concern
UCL - Upper Confidence Limit

TABLE 6

SCREENING OF METALS AGAINST BACKGROUND -AOC 3B
RADIO MATERIALS CORPORATION
ATTICA, INDIANA

COPEC	*Site-Specific Background*	*SWMU 5*					*Retain as COPEC*	*Rationale*
		No. Samples	*No. Detects*	*Min. Detected*	*Max Detected*	*95% UCL*		
Metals (mg/kg)								
Lead	**114**	**8**	**8**	**16.7**	**287**	**173**	**YES**	**Max > BG**

Notes:
COPEC - Constituent of Potential Ecological Concern
UCL - Upper Confidence Limit

TABLE 7

REFINEMENT OF SOIL COPECs - SWMUs 1 AND 2 - TERRESTRIAL PLANTS
RADIO MATERIALS CORPORATION
ATTICA, INDIANA

COPEC	*ECO-SSL*	*Site-Specific Background*	*No. Samples*	*Minimum Detected*	*Maximum Detected*	*95% UCL*	*No. > ECO-SSL*	*Percent > ECO-SSL*	*No. > Background*	*Percent > Background*
SWMUs 1 and 2										
Metals (mg/kg)										
Antimony	n/a	0.606	49	0.05	9.04	1.15	---	---	2	4.1%
Arsenic	n/a	17.9	53	2.0	50.1	9.4	---	---	8	15%
Barium	n/a	897	49	9.6	5,540	812	---	---	2	4.1%
Cadmium	32	1.13	49	0.101	2.02	0.626	0	0%	---	---
Chromium	n/a	25.0	49	5.0	29.7	15.5	---	---	1	2.0%
Cobalt	13	14.7	49	3.2	18.1	10.2	3	6.1%	---	---
Copper	70	25.1	49	6.7	38.85	19.0	0	0%	---	---
Iron	n/a	31,942	49	8,650	50,500	25,931	---	---	6	12%
Nickel	38	36.1	49	9.29	39.0	18.0	1	2.0%	---	---
Silver	560	12.6	49	0.024	71.8	24.2	0	0%	---	---
Thallium	n/a	0.38	49	0.09	0.44	0.22	---	---	2	4.1%
Vanadium	n/a	33.7	49	7.02	36.7	21.5	---	---	1	2.0%
AOC 3B										
Metals (mg/kg)										
Lead	120	114	8	16.7	2,857	114	3	38%	---	---

Notes:

COEC - Constituent of Ecological Concern
COPEC - Constituent of Potential Ecological Concern
ECO-SSL - Ecological Soil Screening Level
HMW - High Molecular Weight
LMW - Low Molecular Weight
PAH - Polycyclic Aromatic Hydrocarbon
UCL - Upper Confidence Limit

TABLE 8

REFINEMENT OF SOIL COPECs -SWMUs 1 AND 2 - SOIL INVERTEBRATES
RADIO MATERIALS CORPORATION
ATTICA, INDIANA

COPEC	*ECO-SSL*	*Site-Specific Background*	*No. Samples*	*Minimum Detected*	*Maximum Detected*	*95% UCL*	*No. > ECO-SSL*	*Percent > ECO-SSL*	*No. > Background*	*Percent > Background*	*Retain as COEC*
SWMUs 1 and 2											
Metals (mg/kg)											
Antimony	78	0.606	49	0.05	9.04	1.15	0	0%	---	---	No
Arsenic	18	17.9	53	2.0	50.1	9.4	1	1.9%	---	---	No
Barium	n/a	897	49	9.6	5,540	812	---	---	2	4.1%	No
Cadmium	140	1.13	49	0.101	2.02	0.626	0	0%	---	---	No
Chromium	n/a	25.0	49	5.0	29.7	15.5	---	---	1	2.0%	No
Cobalt	n/a	14.7	49	3.2	18.1	10.2	---	---	2	4.1%	No
Copper	80	25.1	49	6.7	38.85	19.0	0	0%	---	---	No
Iron	n/a	31,942	49	8,650	50,500	25,931	---	---	6	12%	No
Nickel	280	36.1	49	9.29	39.0	18.0	0	0%	---	---	No
Silver	n/a	12.6	49	0.024	71.8	24.2	---	---	2	4.1%	No
Thallium	n/a	0.38	49	0.09	0.44	0.22	---	---	2	4.1%	No
Vanadium	120	33.7	49	7.02	36.7	21.5	0	0%	---	---	No
AOC 3B											
Metals (mg/kg)											
Lead	1,700	114	8	16.7	287	173	0	0%	---	---	No

Notes:

COEC - Constituent of Ecological Concern
COPEC - Constituent of Potential Ecological Concern
ECO-SSL - Ecological Soil Screening Level
HMW - High Molecular Weight
LMW - Low Molecular Weight
PAH - Polycyclic Aromatic Hydrocarbon
UCL - Upper Confidence Limit

TABLE 9

REFINEMENT OF SOIL COPECs -AVIAN WILDLIFE
RADIO MATERIALS CORPORATION
ATTICA, INDIANA

COPEC	*Units*	*ECO-SSL*	*Site-Specific Background*	*No. Samples*	*Minimum Detected*	*Maximum Detected*	*95% UCL*	*RQ $_{ECO-SSL}$*	*RQ $_{Background}$*	*Retain for Further Evaluation*
SWMUs 1 ad 2										
Metals (mg/kg)										
Antimony	mg/kg	**n/a**	**0.606**	**49**	**0.05**	**9.04**	**1.15**	**---**	**1.9**	**YES**
Arsenic	mg/kg	43	17.9	53	2.0	50.1	9.4	0.22	---	No
Barium	mg/kg	330	897	49	9.6	5,540	812	**2.5**	0.91	No
Cadmium	mg/kg	0.77	1.13	49	0.101	2.02	0.626	0.81	---	No
Chromium	mg/kg	26	25.0	49	5.0	29.7	15.5	0.60	---	No
Cobalt	mg/kg	120	14.7	49	3.2	18.1	10.2	0.085	---	No
Copper	mg/kg	28	25.1	49	6.7	38.85	19.0	0.68	---	No
Iron	mg/kg	n/a	31,942	49	8,650	50,500	25,931	---	0.81	No
Nickel	mg/kg	210	36.1	49	9.29	39.0	18.0	0.086	---	No
Silver	mg/kg	**4.2**	**12.6**	**49**	**0.024**	**71.8**	**24.2**	**5.8**	**1.9**	**YES**
Thallium	mg/kg	n/a	0.38	49	0.09	0.44	0.22	---	0.58	No
Vanadium	mg/kg	7.8	33.7	49	7.02	36.7	21.5	**2.8**	0.64	No
AOC 3B										
Metals (mg/kg)										
Lead	**mg/kg**	**11**	**114**	**8**	**16.7**	**287**	**173**	**16**	**1.5**	**YES**

Notes:

COPEC - Constituent of Potential Ecological Concern
ECO-SSL - Ecological Soil Screening Level
HMW - High Molecular Weight
LMW - Low Molecular Weight
PAH - Polycyclic Aromatic Hydrocarbon
RQ - Refinement Quotient
UCL - Upper Confidence Limit

TABLE 10

UPTAKE FACTORS FOR FOOD CHAIN MODELS
RADIO MATERIALS CORPORATION
ATTICA, INDIANA

COPEC	*Soil to Invertebrate*	*Soil to Plant*	*Soil to Small Mammal*
Polycyclic Aromatic Hydrocarbons			
HMW PAHs	$2.6 * Conc_{Soil}$	$exp(0.9469 * ln(Conc_{Soil}) - 1.7026)$	$0 * Conc_{Diet}$
Metals			
Antimony	$1.0 * Conc_{Soil}$	$exp(0.938 * ln(Conc_{Soil}) - 3.233)$	$0.05 * Conc_{Invertebrates}$
Lead	$exp(0.807 * ln(Conc_{Soil}) - 0.218)$	$exp(0.561 * ln(Conc_{Soil}) - 1.328)$	$exp(0.4422 * ln(Conc_{Soil}) + 0.0761$
Silver	$2.045 * Conc_{Soil}$	$0.014 * Conc_{Soil}$	$0.004 * Conc_{Soil}$

Notes:

$Conc_{Soil}$ - Concentration in Diet (assumed to consist of 100% soil invertebrates)
$Conc_{Soil}$ - Soil Concentration
$Conc_{Invertbrates}$ - Concentration in Soil Invertebrates
Uptake factors from Table 4a of USEPA (2005)

TABLE 11

EXPOSURE CONCENTRATIONS FOR FOOD CHAIN MODELS
RADIO MATERIAL CORPORATION
ATTICA, INDIANA

COPEC	*SOIL*	*WATER*	*SOIL INVERTEBRATES*	*TERRESTRIAL PLANTS*	*SMALL TERRESTRIAL MAMMALS*
	mg/kg dw	*mg/L*	*mg/kg dw*	*mg/kg dw*	*mg/kg dw*
SWMUs 1 and 2					
Meals					
Antimony	1.15	0	1.15	0.045	0.058
Silver	24.2	0	49.5	0.339	0.097
AOC 3A					
Polycyclic Aromatic Hydrocarbons					
HMW PAHs	5.06	0	13.2	0.846	0
AOC 3B					
Metals					
Lead	173	0	51.5	4.77	10.5

Notes:
COPEC - Constituent of Potential Ecological Concern
DW - Dry Weight
HMW - High Molecular Weight
PAH - Polycyclic Aromatic Hydrocarbon

TABLE 12

SUMMARY OF FOOD CHAIN FOR AVIAN RECEPTORS EXPOSED TO SURFACE SOIL - SWMUs 1 and 2
RADIO MATERIALS CORPORATION
ATTICA, INDIANA

Indicator Species	*COPEC*	*Ingestion (mg/kg-day)*				*NOAEL (mg/kg-day)*	*HQ NOAEL*	*LOAEL (mg'kg-day)*	*HQ LOAEL*	*Retain as COEC*
		Food	*Water*	*Soil*	*Total*					
American Woodcock (Insectivore)	***Metals***									
	Antimony	0.16	0	0.027	0.19	n/a	---	n/a	---	No
	Silver	7.0	0	0.56	7.6	2.02	**3.7**	20.2	0.38	No
Mourning Dove (Herbivore)	***Metals***									
	Antimony	0.006	0	0.022	0.028	n/a	---	n/a	---	No
	Silver	0.046	0	0.46	0.507	2.02	0.25	---	---	No
Red-Tailed Hawk (Carnivore)	***Metals***									
	Antimony	0.002	0	0.002	0.003	n/a	---	n/a	---	No
	Silver	0.003	0	0.036	0.036	2.02	0.019	---	---	No

Notes:

COEC - Constituent of Ecological Concern
COPEC - Constituent of Potential Ecological Concern
HQ - Hazard Quotient
LOAEL - Lowest Observed Adverse Effect Level
NOAEL - No Observed Adverse Effect Level
TRV - Toxicity Reference Value

Silver NOAEL - Lowest LOAEL/10 in ECO-SSL source doceument (USEPA, 2006)
Silver LOAEL - Lowest LOAEL in ECO-SSL source documdent (USEPA, 2006)

TABLE 13

REFINEMENT OF SOIL COPECs -MAMMALIAN WILDLIFE
RADIO MATERIALS CORPORATION
ATTICA, INDIANA

COPEC	*Units*	*ECO-SSL*	*Site-Specific Background*	*No. Samples*	*Minimum Detected*	*Maximum Detected*	*95% UCL*	*RQ ECO-SSL*	*RQ Background*	*Retain for Further Evaluation*
					SWMUs 1 and 2					
Metals (mg/kg)										
Antimony	**mg/kg**	**0.27**	**0.606**	**49**	**0.05**	**9.04**	**1.15**	**4.3**	**1.9**	**YES**
Arsenic	mg/kg	46	17.9	53	2.0	50.1	9.4	0.20	---	No
Barium	mg/kg	2,000	897	49	9.6	5,540	812	0.41	---	No
Cadmium	mg/kg	0.36	1.13	49	0.101	2.02	0.626	**1.7**	0.56	No
Chromium	mg/kg	34	25.0	49	5.0	29.7	15.5	0.46	---	No
Cobalt	mg/kg	230	14.7	49	3.2	18.1	10.2	0.044	---	No
Copper	mg/kg	49	25.1	49	6.7	38.85	19.0	0.39	---	No
Iron	mg/kg	n/a	31,942	49	8,650	50,500	25,931	---	0.81	No
Nickel	mg/kg	130	36.1	49	9.29	39.0	18.0	0.14	---	No
Silver	**mg/kg**	**14**	**12.6**	**49**	**0.024**	**71.8**	**24.2**	**1.7**	**1.9**	**YES**
Thallium	mg/kg	n/a	0.38	49	0.09	0.44	0.22	---	0.58	No
Vanadium	mg/kg	280	33.7	49	7.02	36.7	21.5	0.077	---	No
					AOC 3B					
Metals (mg/kg)										
Lead	**mg/kg**	**56**	**114**	**8**	**16.7**	**287**	**173**	**3.1**	**1.5**	**YES**

Notes:

COPEC - Constituent of Potential Ecological Concern
ECO-SSL - Ecological Soil Screening Level
HMW - High Molecular Weight
LMW - Low Molecular Weight
PAH - Polycyclic Aromatic Hydrocarbon
RQ - Refinement Quotient
UCL - Upper Confidence Limit

TABLE 14

SUMMARY OF FOOD CHAIN FOR AVIAN RECEPTORS EXPOSED TO SURFACE SOIL - SWMU 5
RADIO MATERIALS CORPORATION
ATTICA, INDIANA

Indicator Species	*COPEC*	*Ingestion (mg/kg-day)*				*NOAEL (mg/kg-day)*	*HQ NOAEL*	*LOAEL (mg'kg-day)*	*HQ LOAEL*	*Retain as COEC*
		Food	*Water*	*Soil*	*Total*					
Short-Tailed Shrew (Insectivore)	***Metals***									
	Antimony	0.19	0	0.006	0.20	0.059	**3.4**	0.59	0.34	No
	Silver	8.3	0	0.12	9.0	6.02	**1.4**	60.2	0.15	No
Meadow Vole (Herbivore)	***Metals***									
	Antimony	0.003	0	0.003	0.006	0.059	0.11	---	---	No
	Silver	0.026	0	0.059	0.085	6.02	0.014	---	---	No
Long-Tailed Weasel (Carnivore)	***Metals***									
	Antimony	0.004	0	0.004	0.008	0.059	0.13	---	---	No
	Silver	0.003	0	0.036	0.036	6.02	0.006	---	---	No

Notes:

COEC - Constituent of Ecological Concern
COPEC - Constituent of Potential Ecological Concern
HQ - Hazard Quotient
LOAEL - Lowest Observed Adverse Effect Level
NOAEL - No Observed Adverse Effect Level
TRV - Toxicity Reference Value

Antimony NOAEL - Lowest NOAEL in ECO-SSL source document (USEPA, 2005b)
Antimony LOAEL - Lowest LOAEL in ECO-SSL source document (USEPA, 2005b)
Silver NOAEL - Lowest LOAEL/10 in ECO-SSL source document (USEPA, 2006)
Silver LOAEL - Lowest LOAEL in ECO-SSL source document (USEPA, 2006)

TABLE 15

ECOLOGICAL SOIL BENCHMARKS FOR SEMI-VOLATILE ORGANIC COMPOUNDS
RADIO MATERIALS CORPORATION
ATTICA, INDIANA

COPEC	*Dutch*	*ECO-SSL*				*ORNL*			*U.S. EPA*	
	Intervention	*Avian*	*Invert*	*Mammal*	*Plants*	*Inverts*	*Microbes*	*Plants*	*Region 4*	*Region 5*
Semi-Volatile Organic Compounds (mg/kg)										
2,4-Dimethylphenol										0.01
2,4-Dinitrophenol								20	20	0.0609
2,6 Dinitrotoluene										0.0328
2-Chloronaphthalene										0.012
2-Chlorophenol									0.01	0.243
Aniline										0.0568
Bis(2-chloroethoxy)methane										0.925
Butyl benzylphthalate										0.239
Hexachlorobenzene							1,000		0.0025	0.199
Hexchlorobutadiene										0.0398
N-nitrosodimethylamine										0.0000321
Pentachlorophenol	5.0	2.1	31	2.8	5.0	6.0	400	3.0	0.002	0.119

Notes:
Blank Cell - Ecological Benchmark not available
COPEC - Constituent of Potential Ecological Concern
ECO-SSL - Ecological Soil Screening Level
ORNL - Oak Ridge National Laboratory

TABLE 16

REFINEMENT OF COPECS IN SOIL - SEMI-VOLATILE ORGANIC COMPOUNDS
RADIO MATERIALS CORPORATION
ATTICA, INDIANA

COPEC	*Detection Limit*	*Ecological Benchmarks*			*Detection Limits Within Range of Ecological Benchmarks*
		No. Benchmarks	*Minimum*	*Maximum*	
Semi-Volatile Organic Compounds (mg/kg)					
2,4-Dimethylphenol	0.31	1	0.01	0.01	No
2,4-Dinitrophenol	1.9	3	0.0609	20	Yes
2,6 Dinitrotoluene	0.31	1	0.0328	0.0328	No
2-Chloronaphthalene	0.31	1	0.0122	0.0122	No
2-Chlorophenol	0.31	2	0.01	0.243	No
Aniline	0.94	1	0.0568	0.0568	No
Bis(2-chloroethoxy)methane	0.31	1	0.302	0.302	No
Butyl benzylphthalate	0.31	1	0.239	0.239	No
Hexachlorobenzene	0.31	3	0.025	1,000	Yes
Hexchlorobutadiene	0.31	1	0.0398	0.0398	No
N-nitrosodimethylamine	1.9	1	0.0000321	0.0000321	No
Pentachlorophenol	1.9	9	0.002	400	Yes

Notes:
COPEC - Constituent of Potential Ecological Concern

TABLE 17

SCREENING OF LOW MOLECULAR AND HIGH MOLECULAR WEIGHT PAHs IN SOIL - AOC 3A
RADIO MATERIALS CORPORATION
ATTICA, INDIANA

COPEC	*Re-Screening Value*	*AOC 3A*					*Max > Re-Screening Value*	*Retain for Further Evaluation*
		No. Samples	*No. Detects*	*Min. Detected*	*Max Detected*	*95% UCL*		
Polycyclic Aromatic Hydrocarbons (mg/kg)								
Low Molecular Weight PAHs	29	7	2	1.02	1.98	1.51	No	No
High Molecular Weight PAHs	1.1	7	2	1.20	5.10	5.06	Yes	Yes

Notes:
PAH - Polycyclic Aromatic Hydrocarbon
UCL - Upper Confidence Limit

TABLE 18

SUMMARY OF FOOD CHAIN FOR AVIAN RECEPTORS EXPOSED TO SURFACE SOIL - AOC 3A
RADIO MATERIALS CORPORATION
ATTICA, INDIANA

Indicator Species	*COPEC*	*Ingestion (mg/kg-day)*				*NOAEL (mg/kg-day)*	*HQ NOAEL*	*LOAEL (mg'kg-day)*	*HQ LOAEL*	*Retain as COEC*
		Food	*Water*	*Soil*	*Total*					
American Woodcock (Insectivore)	*Polycyclic Aromatic Hydrocarbons*									
	HMW PAHs	1.86	0	0.12	1.98	2.0	0.99	---	---	No
Mourning Dove (Herbivore)	*Polycyclic Aromatic Hydrocarbons*									
	HMW PAHs	0.12	0	0.096	0.21	2.0	0.11	---	---	No
Red-Tailed Hawk (Carnivore)	*Polycyclic Aromatic Hydrocarbons*									
	HMW PAHs	0	0	0.008	0.008	2.0	0.004	---	---	No

Notes:

COEC - Constituent of Ecological Concern
COPEC - Constituent of Potential Ecological Concern
HMW - High Molecular Weight
HQ - Hazard Quotient
LOAEL - Lowest Observed Adverse Effect Level
NOAEL - No Observed Adverse Effect Level
PAH - Polycyclic Aromatic Hydrocarbon
TRV - Toxicity Reference Value

HMW PAHs NOAEL - Lowest NOAEL in ECO-SSL source document (USEPA, 2007)

TABLE 19

SUMMARY OF FOOD CHAIN FOR MAMMALIAN RECEPTORS EXPOSED TO SURFACE SOIL - AOC 3A
RADIO MATERIALS CORPORATION
ATTICA, INDIANA

Indicator Species	*COPEC*	*Ingestion (mg/kg-day)*				*NOAEL (mg/kg-day)*	*HQ NOAEL*	*LOAEL (mg'kg-day)*	*HQ LOAEL*	*Retain as COEC*
		Food	*Water*	*Soil*	*Total*					
Short-Tailed Shrew (Insectivore)	***Polycyclic Aromatic Hydrocarbons***									
	HMW PAHs	2.2	0	0.025	2.23	0.615	**3.6**	31.8	0.070	No
Meadow Vole (Herbivore)	***Polycyclic Aromatic Hydrocarbons***									
	HMW PAHs	0.065	0	0.012	0.077	0.615	0.13	---	---	No
Long-Tailed Weasel (Carnivore)	***Polycyclic Aromatic Hydrocarbons***									
	HMW PAHs	0	0	0.015	0.015	0.615	0.025	---	---	No

Notes:

COEC - Constituent of Ecological Concern
COPEC - Constituent of Potential Ecological Concern
HMW - High Molecular Weight
HQ - Hazard Quotient
LOAEL - Lowest Observed Adverse Effect Level
NOAEL - No Observed Adverse Effect Level
PAH - Polycyclic Aromatic Hydrocarbon
TRV - Toxicity Reference Value

HMW PAHs NOAEL - Highest bounded NOAEL below the lowest bounded LOEAEL in USEPA source document (USEPA, 2007)
HMW PAHs LOAEL - 20th percentile of LOAELs for growth and reproduction in ECO-SSL source document (USEPA, 2007)

TABLE 20

SUMMARY OF FOOD CHAIN FOR AVIAN RECEPTORS EXPOSED TO SURFACE SOIL - AOC 3B
RADIO MATERIALS CORPORATION
ATTICA, INDIANA

Indicator Species	*COPEC*	*Ingestion (mg/kg-day)*				*NOAEL (mg/kg-day)*	*HQ NOAEL*	*LOAEL (mg'kg-day)*	*HQ LOAEL*	*Retain as COEC*
		Food	*Water*	*Soil*	*Total*					
American Woodcock (Insectivore)	***Metals***									
	Lead	7.3	0	4.0	11.3	1.63	**6.9**	13.3	0.85	No
Mourning Dove (Herbivore)	***Metals***									
	Lead	0.65	0	3.3	4.0	1.63	**2.4**	13.3	0.30	No
Red-Tailed Hawk (Carnivore)	***Metals***									
	Lead	0.28	0	0.26	0.53	1.63	0.33	---	---	No

Notes:

COEC - Constituent of Ecological Concern
COPEC - Constituent of Potential Ecological Concern
HQ - Hazard Quotient
LOAEL - Lowest Observed Adverse Effect Level
NOAEL - No Observed Adverse Effect Level
TRV - Toxicity Reference Value

Lead NOAEL - Highest bounded NOAEL below the lowest bounded LOEAL in USEPA source document (USEPA, 2005c)
Lead LOAEL - 20th percentile of LOAELs for growth and reproduction in ECO-SSL source document (USEPA, 2005c)

TABLE 21

SUMMARY OF FOOD CHAIN FOR MAMMALIAN RECEPTORS EXPOSED TO SURFACE SOIL - AOC 3B
RADIO MATERIALS CORPORATION
ATTICA, INDIANA

Indicator Species	*COPEC*	*Ingestion (mg/kg-day)*				*NOAEL (mg/kg-day)*	*HQ NOAEL*	*LOAEL (mg'kg-day)*	*HQ LOAEL*	*Retain as COEC*
		Food	*Water*	*Soil*	*Total*					
Short-Tailed Shrew (Insectivore)	*Metals*									
	Lead	8.6	0	0.87	9.47	4.7	2.0	28.7	0.33	No
Meadow Vole (Herbivore)	*Metals*									
	Lead	0.36	0	0.42	0.79	4.7	0.17	---	---	No
Long-Tailed Weasel (Carnivore)	*Metals*									
	Lead	0.75	0	0.53	1.3	4.7	0.27	---	---	No

Notes:

COEC - Constituent of Ecological Concern
COPEC - Constituent of Potential Ecological Concern
HQ - Hazard Quotient
LOAEL - Lowest Observed Adverse Effect Level
NOAEL - No Observed Adverse Effect Level
TRV - Toxicity Reference Value

Lead NOAEL - Highest bounded NOAEL below the lowest bounded LOEEL in USEPA source document (USEPA, 2005c)
Lead LOAEL - 20th percentile of LOAELs for growth and reproduction in ECO-SSL source document (USEPA, 2005c)

TABLE 22

REFINMENT OF SEDIMENT COPECs - ORGANIC COMPOUNDS
RADIO MATERIALS CORPORATION
ATTICA, INDIANA

COPEC	*Units*	*ESB*	*Minimum Detection Limit*	*Maximum Detection Limit*	*Detection Limit < ESB*	*Retain as COEC*
Volatile Organic Compounds (µg/kg)						
1,1-Dichloroethane	µg/kg	10,600	19	20	Yes	No
1,1-Dichloroethene	µg/kg	2,400	19	20	Yes	No
2-Butanone	µg/kg	287,000	73	80	Yes	No
2-Hexanone	µg/kg	42,700	73	80	Yes	No
4-Methyl-2-Pentanone	µg/kg	55,800	73	80	Yes	No
Acetone	µg/kg	242,000	73	80	Yes	No
Bromomethane	µg/kg	50,200	19	20	Yes	No
Semi-Volatile Organic Compounds (µg/kg)						
Hexachlorobutadiene	µg/kg	2.7	73	80	Yes	No*

Notes:

COEC - Constituent of Ecological Concern
COPEC - Constituent of Potential Ecological Concern
ESB - Equilibrium Partitioning Sediment Benchmark
No * - See text for discussion and rationale for elimination

TABLE 23

REFINEMENT BENCHMARKS FOR METALS IN SEDIMENT
RADIO MATERIALS CORPORATION
ATTICA, INDIANA

COPEC	*MacDonald et al. (2000)*		*NOAA (1999)*		*Crommentuijn et al. (1997)*	
	TEC	*PEC*	*ER-L*	*ER-M*	*NC*	*MPC*
Metals (mg/kg)						
Antimony	---	---	2.0	25	---	---
Cadmium	0.99	4.98	---	---	---	---
Copper	31.6	149	---	---	---	---
Selenium	---	---	---	---	0.72	2.9
Silver	---	---	1.0	3.7	---	---
Vanadium	---	---	---	---	42	56
Zinc	121	459	---	---	---	---

Notes:
COPEC - Constituent of Potential Ecological Concern
ER-L - Effect Range Low
ER - M - Effect Range-Median
MPC - Maximum Permissible Concentration
NC - Negligible Concentration
PEC - Probable Effect Concentration
TEC - Threshold Effect Concentration

TABLE 24

REFINEMENT OF SEDIMENT COPECs - METALS
RADIO MATERIALS CORPORATION
ATTICA, INDIANA

COPEC	*Benchmarks*			*Maximum Detected Concentration*			*Detection Limits*			*Retain as COPEC*
	Lower Tier	*Upper Tier*	*Source*	*Value*	*RQ Lower Tier*	*RQ Upper Tier*	*Minimum*	*Maximum*	*Detection Limit Within Range of Benchmarks*	
Metals (mg/kg)										
Antimony	2.0	25	a	ND	---	---	9.7	10.5	Yes	No
Cadmium	0.99	4.98	b	ND	---	---	1.0	1.1	Yes	No
Copper	31.6	149	b	49.1	**1.6**	0.33	---	---	---	No
Selenium	0.72	2.9	c	0.20	0.28	0.069	---	---	---	No
Silver	1.0	3.7	a	ND	---	---	1.9	2.1	Yes	No
Vanadium	42	56	c	5.9	0.14	0.11	---	---	---	No
Zinc	121	459	b	162	**1.3**	0.35	---	---	---	No

Notes:
a - NOAA (1999)
b - MacDonald et al. (2000)
c - Crommentuijn et al. (1997)
COPEC - Constituent of Potential Ecological Concern
ND - Constituent Not Detected
RQ - Refinement Quotient

TABLE 25

REFINMENT OF SEDIMENT SURFACE WATER
RADIO MATERIALS CORPORATION
ATTICA, INDIANA

COPEC	*Refinement Benchmark*	*Source*	*Maximum Detected Concentration*	*Maximum < Refinement Benchmark*	*Minimum Detection Limit*	*Maximum Detection Limit*	*Detection Limits < Refinement Benchmark*	*Retain as COEC*
				RILEY LAKE				
Semi-Volatile Organic Compounds (µg/L)								
Hexachlorobutadiene	31	a	---	---	2.0	2.0	Yes	No
Metals								
Beryllium	21	b	---	---	5.0	5.0	Yes	No
Cadmium	1.7	c	---	---	5.0	5.0	No	No
Copper	21	c	---	---	10	10	Yes	No
Lead	5.3	c	---	---	2.0	2.0	Yes	No
Mercury	0.77	d	0.05	Yes	---	---	---	No
Silver	5.7	c	---	---	10	10	No	No
				ARTESIAN WELL				
Semi-Volatile Organic Compounds (µg/L)								
Hexachlorobutadiene	31	a	---	---	2.0	2.0	Yes	No

Notes:

a - Final Chronic Value (FCV) - Narcosis (U.S. EPA, 2008)
b - EC_{25} - Bass (Suter and Tsao, 1996)
c - Indiana Department of Environmental Management (http://www.in.gov/idem/5513.htm)
d - National Recommended Water Quality Criteria (U.S. EPA, 2009)
COEC - Constituent of Ecological Concern
COPEC - Constituent of Potential Ecological Concern

TABLE 26

ORGANIC COMPOUNDS DETECTED IN 2012 SURFACE WATER SAMPLES
RADIO MATERIALS CORPORATION
ATTICA, INDIANA

Constituent	*No. Samples*	*No. Detects*	*FOD*	*Maximum Concentration*	*Location of Maximum*	*ESV*	*Source*	*Screening Quotient*	*Pass/Fail Screen*
Volatile Organic Compounds (µg/L)									
cis-1,2-Dichloroethene	3	1	33%	70	MG-003/MG-004	970	EPA R5	0.072	Pass
Tetrachloroethene	3	1	33%	1.8	MG-003/MG-004	45	EPA R5	0.04	Pass
Trichloroethene	3	2	67%	1.1	MG-003/MG-004	47	EPA R5	0.02	Pass

Notes:
ESV - Ecological Screening Value
FOD - Frequency of Detection

TABLE 27

ORGANIC COMPOUNDS DETECTED IN GROUNDWATER IN VICINITY OF SEEPS - WELL 0B-09
RADIO MATERIALS CORPORATION
ATTICA, INDIANA

Constituent	*No. Samples*	*No. Detects*	*FOD*	*Maximum Concentration*	*ESV*	*Source*	*Screening Quotient*	*Pass/Fail Screen*
Volatile Organic Compounds (µg/L)								
Carbon Disulfide	23	1	4.3%	0.09	15	EPA R5	0.006	Pass
cis-1,2-Dichloroethene	23	4	17%	5.9	970	EPA R5	0.006	Pass
Naphthalene	23	1	4.3%	0.12	15	EPA R5	0.008	Pass
Tetrachloroethene	23	22	96%	4.1	45	EPA R5	0.091	Pass
Toluene	23	3	13%	4.1	253	EPA R5	0.016	Pass
trans-1,2-Dichloroethene	23	1	4.3%	0.19	970	EPA R5	0.0002	Pass
Trichloroethene	23	23	100%	12	47	EPA R5	0.26	Pass
Vinyl Chloride	23	1	4.3%	6.0	930	EPA R5	0.006	Pass

Notes:
ESV - Ecological Screening Value
FOD - Frequency of Detection

TABLE 28

ORGANIC COMPOUNDS DETECTED IN GROUNDWATER IN VICINITY OF SEEPS - WELL 0B-14
RADIO MATERIALS CORPORATION
ATTICA, INDIANA

Constituent	*No. Samples*	*No. Detects*	*FOD*	*Maximum Concentration*	*ESV*	*Source*	*Screening Quotient*	*Pass/Fail Screen*
Volatile Organic Compounds (µg/L)								
Carbon Disulfide	23	1	4.3%	0.10	15	EPA R5	0.007	Pass
Chloromethane	23	3	13%	0.17	940	EPA R5	0.0002	Pass
cis-1,2-Dichloroethene	24	1	4.2%	0.05	970	EPA R5	0.0001	Pass
Naphthalene	23	1	4.3%	0.49	15	EPA R5	0.033	Pass
Tetrachloroethene	24	8	33%	0.28	45	EPA R5	0.006	Pass
Toluene	23	3	13%	0.21	253	EPA R5	0.0008	Pass
Trichloroethene	24	24	100%	19	47	EPA R5	0.40	Pass

Notes:
ESV - Ecological Screening Value
FOD - Frequency of Detection

TABLE 29

ORGANIC COMPOUNDS DETECTED IN GROUNDWATER IN VICINITY OF SEEPS - WELL 0B-32
RADIO MATERIALS CORPORATION
ATTICA, INDIANA

Constituent	*No. Samples*	*No. Detects*	*FOD*	*Maximum Concentration*	*ESV*	*Source*	*Screening Quotient*	*Pass/Fail Screen*
Volatile Organic Compounds (µg/L)								
Carbon Disulfide	22	2	9.1%	1.0	15	EPA R5	0.067	Pass
Chloroform	22	1	4.5%	0.25	140	EPA R4	0.002	Pass
cis-1,2-Dichloroethene	22	1	4.5%	33	970	EPA R5	0.034	Pass
Naphthalene	22	5	23%	1.0	15	EPA R5	0.067	Pass
o-Xylene	22	1	4.5%	0.25	27	EPA R6	0.009	Pass
Tetrachloroethene	22	21	95%	53	45	EPA R5	1.2	FAIL
Toluene	22	4	18%	0.3	253	EPA R5	0.001	Pass
trans-1,2-Dichloroethene	22	5	23%	0.46	970	EPA R5	0.0005	Pass
Trichloroethene	22	21	95%	42	47	EPA R5	0.89	Pass
Vinyl Chloride	22	5	23%	0.3	930	EPA R5	0.0003	Pass
Semi-Volatile Organic Compounds (µg/L)								
Phenol	1	1	100%	7.5	180	EPA R5	0.042	Pass

Notes:
ESV - Ecological Screening Value
FOD - Frequency of Detection