**Site Background & Current Conditions**
**West Lake Landfill Superfund Site**
**Operable Unit 1**

**Prepared by U.S. EPA, Region 7**
**Submitted December 26, 2017**

# I. SITE BACKGROUND

## A. General Site Location & Description

The West Lake Landfill Superfund Site is a 200-acre, inactive solid waste disposal facility located in Bridgeton, Missouri. The Site lies approximately 18 miles northwest of downtown St. Louis within 2 miles of the St. Louis Lambert International Airport (Figure 3-1). The present channel of the Missouri River is located approximately 2 miles to the west of the Site, which is situated on the eastern boundary of the river's alluvial floodplain. Industrial properties exist both on and adjacent to the Site, and other commercial and residential areas almost completely surround its perimeter.

The Site is composed of three operable units. Operable Unit 1 (OU-1) consists of areas at the Site where radiologically impacted material (RIM)[1] has been identified within surface soil and subsurface solid waste. The remaining surface area of the Site is designated as Operable Unit 2 (OU-2), which consists of several inactive fill areas that contain sanitary waste or demolition debris. The EPA has specifically designated Operable Unit-3 (OU-3) to address potential groundwater contamination at the Site. The U.S. Environmental Protection Agency is lead agency for OU-1 and OU-3, while oversight of OU-2 has been deferred to the Missouri Department of Natural Resources.

This follow-up National Remedy Review Board (NRRB) consultation is limited to the proposed remedy selection for the radiologically impacted areas that constitute OU-1. RIM is located in two landfill disposal areas known as Radiological Areas 1 and 2, as well as in two adjacent parcels of industrial property referred to as the Buffer Zone and Lot 2A2 of the Crossroads Industrial Park (Figure 3-2). Collectively, these parcels comprise OU-1. The RIM within Areas 1 and 2 consist of soils containing radium and thorium isotopes within municipal solid waste, industrial waste, and construction and demolition debris, which may contain other non-radionuclide constituents such as trace metals and volatile organic compounds. In addition, historical soil erosion from sloped portions of Area 2 is believed to have caused the deposition of radionuclides observed in the Buffer Zone and Lot 2A2.

[1] RIM at the Site is defined as any material containing combined radium-226 plus radium-228 or combined thorium-230 plus thorium-232 at levels greater than 5 picocuries per gram (pCi/g) above background. This definition is derived from criteria set forth in the EPA's UMTRCA regulations and agency guidance. See 40 C.F.R. Part 192.

The distribution of RIM within the landfilled areas has been impacted by both natural and anthropogenic processes due to the historical use of radiologically impacted soil as daily cover for landfilling operations. The placement of contaminated soil over the top of compacted but uneven landfill waste resulted in a relatively discontinuous layers of variable thickness. The ultimate location of RIM was also likely impacted by the subsequent placement and compaction of wastes and cover soil, as well as more than 40 years of decomposition, consolidation, and differential settlement of municipal solid waste and other soil materials. This has resulted in irregular occurrences of radionuclides within the larger overall matrix of landfilled refuse, debris, fill material, and quarry spoils in Areas 1 and 2.

## B. Site History

### 1. Landfilling & Disposal of Leached Barium Sulfate: 1939-1973

Between 1939 and 1988, limestone was quarried from the Site, resulting in shallow excavation areas and two deep quarry pits. Beginning as early as 1952, when waste disposal was authorized locally by St. Louis County, portions of the quarries and adjoining areas were used for landfilling municipal refuse, industrial solid waste, and construction debris. After the formation of MDNR in 1974, unregulated disposal areas on the northern portion of the Site were closed and permits issued for disposal of sanitary and demolition wastes in the portion of the Site known as the Bridgeton Landfill North Quarry Pit. Landfilling continued in this area until 1985, when the landfill was expanded into the excavated portion of the Site known as the Bridgeton Landfill South Quarry Pit. During the conclusion of active landfilling operations at the Site, additional wastes were placed over the northwest surface of North Quarry/southwest surface of Area 1, creating what is referred to as the “muffin top”.

Areas of the Westlake Landfill were radiologically contaminated in 1973 when soil mixed with leached barium sulfate was used as cover for landfilling operations at West Lake Landfill. The contaminated soils originated from a storage and processing facility operated by Cotter Corporation under license from the U.S. Atomic Energy Commission. This facility, located at 9200 Latty Avenue in Hazelwood, Missouri, stored leached barium sulfate and other residual radioactive materials resulting from the extraction and concentration of uranium from various ores by Mallinckrodt Chemical Works under contract for the AEC. After purchasing the materials for mineral recovery in 1966 and 1967, Cotter Corporation contracted with B & K Construction Co. Inc. to dry and transport certain residuals for further processing at its facility in Cañon City, Colorado. Cotter Corporation determined, however, that it was not economically feasible to further process the leached barium sulfate, and the materials remained at the Latty Avenue location. Between July and October of 1973, Cotter Corporation arranged for B & K Construction to mix the leached barium sulfate with topsoil and transport the mixed soil to nearby West Lake Landfill for use as cover for trash. Analysis of historical aerial photography as well as landfill permitting history indicates that these materials may have been stockpiled and used for landfilling operations for a time period continuing after the last of the radiological materials were brought to the Site from Latty Avenue. Factors such as the routine and non-routine application and compaction of these materials as well as differential settlement,

subsidence, and leachate effects over several decades help explain the observations of the discontinuous layers and varied thickness of RIM. In addition, these factors could also have impacted the location, depth, thickness, and volume of RIM not only during placement of the radiological materials in the landfill but also between various site investigations, which have each been separated by more than a decade.

2. Early Site Investigation: 1974-1990

In April 1974, the U.S. Nuclear Regulatory Commission (NRC), as successor to the AEC, visited the Latty Avenue facility to assess the progress of decommissioning activities being performed by Cotter Corporation. It was as a result of this inspection that the NRC discovered Cotter Corporation's disposal of leached barium sulfate at West Lake Landfill. Although a local newspaper initially reported that only 9,000 tons of waste had been transported to the landfill, the NRC concluded that 43,000 tons of mixed waste and soil had been removed from the Latty Avenue facility to West Lake Landfill. Initial discussions with landfill operators led the NRC to conclude that all of the material had been disposed in one northern portion of the landfill, but an aerial survey of the Site identified a second area of contamination to the south. The NRC later commissioned a radiological survey of the West Lake Landfill that identified 13 acres containing approximately 130,000 cubic yards of contaminated soil in the northern portion (Area 2) and 3 acres containing approximately 20,000 cubic yards of contamination in the southern portion (Area 1).[2] In March 1983, the NRC also commissioned the University of Missouri–Columbia, through the Oak Ridge Associated Universities, to produce a separate report that described the environmental characteristics of the Site and evaluated engineered remedial measures to address the radiological materials disposed of at the Site.

3. NPL Listing, RI/FS Investigation, & Proposed Plan: 1990-2008

The EPA added the Site to the National Priorities List by final rule published in the Federal Register on August 30, 1990.[3] On March 3, 1993, the EPA entered into an Administrative Order on Consent with Cotter Corporation (N.S.L.); Laidlaw Waste Systems (Bridgeton), Inc.; Rock Road Industries, Inc.; and the U.S. Department of Energy (collectively, with their corporate successors, "the PRPs") for performance of a Remedial Investigation/Feasibility Study for OU-1.[4] Between 1994 and 2009, the PRPs performed multiple investigations at the Site, including the collection and analysis of waste and soil samples and the monitoring of surface water, sediments, groundwater, and air quality. The results of these evaluations were summarized in a Remedial Investigation (RI), Baseline Risk Assessment (BRA), and Feasibility Study (FS), which were submitted by the PRPs for EPA's review and approval. The state of Missouri was also provided an opportunity to review and comment on these documents.

[2] *Radiological Survey of the West Lake Landfill, St. Louis County, Missouri*, NUREG/CR-2722, Radiation Management Corporation, U.S. Nuclear Regulatory Commission (May 1982).

[3] 55 Fed. Reg. 35502, 35508 (Aug. 30, 1990).

[4] Docket No. VII-93-F-0005.

Based on these reports, the EPA developed a proposed plan for both OU-1 and OU-2 of the Site, which was released for public comment on June 14, 2006. After two public meetings and several extensions, the public comment period was initially closed on December 29, 2006. In response to comments on the levee system and flood plain issues, however, the agency reopened public comment on the proposed plan and held a third public meeting on March 27, 2008. Additional information was placed in the Administrative Record regarding these issues, and public comment was closed again on April 9, 2008. Written transcripts were made of all three public meetings and responses prepared for both written and oral comments received during the public comment period, all of which are included in the Administrative Record.

4. Remedy Selection & Supplemental Feasibility Study: 2008-2011

In May 2008, the EPA issued a Record of Decision (ROD) for OU-1 of the Site. The major components of the ROD-selected remedy included installation of a landfill cover meeting the Missouri closure and post-closure care requirements for sanitary landfills, including enhancements such as an armoring layer and radon barrier consistent with standards for uranium mill tailing sites. As part of the remedy, radiologically contaminated surface soils from the Buffer Zone and Lot 2A2 of the Crossroads Industrial Park were to be consolidated into the containment area. In addition, a program for monitoring and control of groundwater, surface water runoff, radon and decomposition gases would have been implemented. Institutional controls and long-term surveillance were to ensure appropriate future land use and ongoing maintenance of the remedy. In issuing the ROD, the EPA recognized that the selected remedy "does not satisfy the statutory preference for treatment as a principal element of the remedy" because "[t]he contaminants are dispersed within large volumes of heterogeneous municipal refuse and demolition debris [and] there are no practicable treatment alternatives . . . ." Nevertheless, the state of Missouri, acting through MDNR, accepted the EPA's selected remedy, stating that "the department accepts remediation that provides containment and isolation of contaminants from human receptors and the environment as the most reasonable option given the circumstances . . . ." Many community members, on the other hand, had expressed a preference for removing the radiological wastes to another facility.

Due in part to ongoing community concern, the EPA determined that additional work was necessary to accomplish the objectives of the RI/FS for OU-1. By letter dated January 11, 2010, the agency requested that the PRPs prepare a Supplemental Feasibility Study (SFS) consisting of an engineering and cost analysis of remedial alternatives that would remove all radioactive waste from the radiologically contaminated areas, Areas 1 and 2. Two "complete rad removal" alternatives were identified in the Statement of Work attached to the EPA's request, namely excavation with off-site commercial disposal and excavation with on-site disposal in an engineered disposal cell. Analysis of these additional alternatives was performed based on existing information provided in the RI, BRA, FS, and ROD for OU-1, as well as supplemental information prepared by the EPA subsequent to issuance of the ROD.

In December 2011, the EPA approved the final SFS and an executive summary of the document. The SFS found that all three remedial alternatives—the ROD-selected remedy and both "complete rad removal" alternatives—were implementable and would meet the EPA's

criteria for long-term protection of human health, welfare, and the environment. The ROD-selected remedy was determined to be both the least expensive alternative and the fastest to implement. By comparison, the on-site disposal alternative was estimated to take the longest to implement while off-site disposal was anticipated to be the costliest alternative. Both excavation alternatives raised implementability issues associated with the excavation and management of contaminated materials (e.g., fugitive dust, stormwater management and treatment, sorting and sampling, decontamination of equipment, and proximity to the St. Louis Lambert International Airport).

### 5. Additional Site Investigation & Response Activity: 2012-2017

After completion of the SFS in 2011, Region 7 consulted with the NRRB on February 29, 2012, because the anticipated costs of each of the remedial alternatives were greater than $25 million. As a result of that consultation and subsequent written comment from the NRRB EPA required additional investigations and evaluations at the Site. In addition, a number of developing site conditions also led to performance of further investigations and response actions, each of which is summarized below.

#### *a) Groundwater Monitoring & Evaluation*

In May 2012 and January 2013, the EPA directed the PRPs to perform additional groundwater sampling at the Site to verify that groundwater quality was consistent with the findings of previous sampling activities conducted as part of the RI and FS. Over 300 groundwater samples from approximately 80 monitoring wells were collected and analyzed between 2012 and 2014, including samples from 8 new monitoring wells installed in 2013. The groundwater samples were analyzed for multiple contaminants, including thorium, uranium, and radium isotopes; trace metals; and volatile organic compounds and semi-volatile organic compounds.

In addition to requiring further groundwater sampling, the EPA sought additional groundwater characterization in partnership with the U.S. Geological Survey (USGS). Between 2012 and 2014, USGS provided research and evaluations in support of the EPA, including identification of water supply wells, sample collection, data reviews, scientific studies, and data interpolations. The results of this work are documented in a report issued by USGS on December 17, 2014 (updated on June 10, 2015), titled *Background Groundwater Quality, Review of 2012–14 Groundwater Data, and Potential Origin of Radium at the West Lake Landfill Site, St. Louis County, Missouri*. The study documented leachate effects in 47 of 83 on-site wells and 13 wells with average dissolved combined radium above the MCL. The USGS report hypothesizes four sources of above-MCL radium at the Site, namely: (1) leaching of RIM; (2) radium within the range of natural background, (3) leaching from non-RIM wastes, and (4) mobilization of naturally occurring radionuclides due to landfill leachate. Based in-part upon these findings, the Region is initiating additional investigation of groundwater at the Site under OU-3.

*b) Subsurface Smoldering Event*

In December 2010, Bridgeton Landfill, LLC, detected changes in its landfill gas extraction system that indicated the presence of an exothermic (heat-generating) subsurface chemical reaction in a portion of the South Quarry of the Bridgeton Landfill. This event, commonly referred to as a "subsurface smoldering event" or "SSE," produces elevated temperatures and excess carbon monoxide within the landfill and offensive odors in the neighboring community. The North Quarry of the Bridgeton Landfill is adjacent to Area 1 (Figure 3-2). Due to concerns raised by the community and others about the ongoing SSE, the EPA and MDNR took a series of steps to better understand and address Site conditions related to the SSE.

Beginning in January 2013, Region 7 partnered with the EPA's Office of Emergency Management (OEM) to conduct radiological and infrared surveys over the West Lake Landfill. OEM manages the Airborne Spectral Photometric Environmental Collection Technology (ASPECT) program, which was used to identify areas of elevated gamma radiation in OU-1 as well as heat signatures associated with the SSE occurring in OU-2. The ASPECT surveys occurred on March 8, 2013, and the EPA published its findings in May 2013. The survey confirmed data showing the presence of radiological wastes in previously identified areas that comprise Areas 1 and 2 of OU-1. Due to limitations of the infrared imagery, however, the infrared survey did not show any temperature differences that could be attributed to the SSE.

In 2014, the PRPs prepared a qualitative evaluation of the potential impacts of the SSE on OU-1. EPA's Office of Research and Development (ORD) reviewed this evaluation and stated that natural radon production rates would be expected to continue in the presence of a SSE and radon could be more readily released if surface cracks or fissures developed due to heat desiccation-induced effects. In 2015, the EPA began developing pyrolysis test methods to estimate the potential health effects of an SSE encountering RIM at the Site. Region 7 worked closely with experts from ORD, USGS, the U.S. Army Corps of Engineers, MDNR, and agency contractors to design a study that could accurately test the effects of pyrolysis on radon emanation from RIM. The study was concluded in 2016 and indicated that increased temperatures associated with a smoldering event would not be expected to increase radon emanation.

In addition to these research efforts, the EPA pursued interim response actions at the Site through enforcement. On December 31, 2015, the agency announced its decision to proceed with installation of engineering controls and construction of an isolation barrier system to mitigate potential impacts of the OU-2 SSE on RIM located in Area 1. Pursuant to an Administrative Settlement Agreement and Order on Consent, EPA required Bridgeton Landfill, LLC to install a heat extraction system using cooling loops in the North Quarry, three lines of temperature monitoring probes in the North Quarry, as well as an ethylene vinyl alcohol (EVOH) cover over large portions of the Bridgeton Landfill North Quarry.

*c) RIM Characterization*

The EPA directed the PRPs to perform a series of field investigations between 2014 and 2015 to further characterize the location of RIM in OU-1. These investigations were undertaken in response to NRRB recommendations, and the results were also used to evaluate possible locations and other considerations associated with the construction of SSE-related engineering controls between the North Quarry of Bridgeton Landfill and Area 1 of OU-1. During these investigations RIM was identified under a portion of the North Quarry "muffin top" which is southwest of previously identified RIM locations in an area where solid wastes were placed as a part of the closure activities in the North Quarry). At EPA's direction, the investigation scope was expanded to define the extent of RIM in southern portions of Area 1. A detailed presentation of the extent of RIM at the Site has been provided separately to the NRRB.

*d) Off-Site Investigations*

In May 2014, in response to public concerns, the EPA undertook evaluation of potential off-site impacts at the Bridgeton Municipal Athletic Complex (BMAC), which is located approximately one mile northeast of the Site (Figure 3-2). The agency collected surface soil samples and conducted overland gamma surveys of exterior surfaces at BMAC and two nearby reference areas to assess the presence of radiological materials. The results of the sampling from this investigation did not identify RIM at BMAC. Following completion of this effort, the EPA announced that the facility is suitable for public use and requires no further environmental response.

In addition, and again in response to public claims, in December 2016 the EPA screened areas within and around two homes located in the Spanish Village residential subdivision, located approximately 1.5 miles southwest of the Site (Figure 3-2). This effort included use of alpha, beta, and gamma screening tools to support sample collection of exterior soil samples and interior surface and bulk dust samples. Between the two homes, more than 140 samples were collected and analyzed to determine the concentrations of various radionuclides, including radionuclides associated with Manhattan Project waste. Soil sampling results were within normal background ranges for the analyzed radionuclides, and the results of interior wipe sampling were below the EPA's residential screening levels. The sampling results also did not identify contamination or other materials associated with the RIM found at the Site.

*e) Stormwater & Sediment Sampling*

In 2016, the EPA directed the PRPs to conduct stormwater sampling during and following rain events. Since that time, more than 60 stormwater samples have been collected and analyzed for both landfill contaminants and uranium, radium, and thorium isotopes. The agency has evaluated existing stormwater data and determined that all results obtained to date are below the site-specific preliminary remediation goal calculated for exposure to stormwater at the Site. In addition to sampling of stormwater, the PRPs, EPA, and MDNR have each collected and analyzed numerous sediment samples from locations near the perimeter of the Site. While one of the collected samples initially met the definition of RIM, follow-up confirmation sampling in and

around that location did not. Based on these results, the EPA announced in August 2017 that stormwater and sediment at the perimeter of the site do not pose an unacceptable risk to public health.

*f) Non-Combustible Cover*

A brush fire occurred on a portion of OU-2 on October 24, 2015. Following this surface fire, on December 10, 2015, the EPA issued a Unilateral Administrative Order directing the PRPs to develop and implement surface fire prevention measures at OU-1. This action resulted in the placement of a rock layer and geo-textile materials over surface RIM as an interim engineering control until a final remedy is implemented. In addition to construction of this "non-combustible cover," the UAO required the PRPs to coordinate with local first responders to develop and fully implement a site-specific Incident Management Plan for OU-1. The UAO further requires development and implementation of a vegetation sampling plan, which has yet to be completed.

## C. Current Contaminant Conditions

### 1. Radionuclide & Chemical Occurrences in OU-1

As described above, radiological constituents are present in soil materials that have become interspersed within a matrix of landfilled refuse, debris, fill material, and quarry spoils in Areas 1 and 2. While the majority of the radiological occurrences are found in the subsurface of these areas, RIM is present at the surface in some portions of Areas 1 and 2. Radiological occurrences have also been documented in surface soils of the Buffer Zone and Lot 2A2, believed to be the result of historical soil erosion from the berm of Area 2 prior to growth of current vegetation.

In general, these occurrences of RIM consist of radionuclides in the Uranium-238 decay series. Thorium-232 and Radium-224 isotopes from the Thorium-232 decay series are also present above background concentrations although at a lesser frequency and at lower activity levels. Accordingly, cleanup criteria were developed for radium, thorium, and uranium isotopes, which are the primary radionuclides of concern at the Site. Specifically, the EPA has defined RIM at the Site as any material containing combined Radium-226 plus Radium-228 or combined Thorium-230 plus Thorium-232 at levels greater than 5 pCi/g above background. These values are based on criteria set forth in regulations promulgated by the EPA pursuant to the Uranium Mine Tailings Radiation Control Act of 1978 (UMTRCA)[5] and attainment of risk-based radiological cleanup levels specified in agency guidance.[6] Additionally, RIM has been defined based on the concentrations of uranium isotopes. A criteria of 50 pCi/g plus background total uranium has been proposed based on remediation goals established for certain FUSRAP sites in

[5] *Health and Environmental Protection Standards for Uranium and Thorium Mill Tailings*, 40 C.F.R. Part 192.

[6] *Establishment of Cleanup Levels for CERCLA Sites with Radioactive Contamination*, OSWER Directive No. 9200.4-18 (Aug. 22, 1997); *Use of Soil Cleanup Criteria in 40 CFR Part 192 as Remediation Goals for CERCLA Sites*, OSWER Directive No. 9200.4-25 (Feb. 12, 1998).

the St. Louis area. This criterion is being further evaluated site specifically in the Remedial Investigation Addendum and Final Feasibility Study. No instances of RIM have been identified using the uranium criteria without also containing either radium and thorium above their criteria. The following numerical definitions of RIM are defined for the Site:

- Radium-226 plus Radium-228 = 7.9 pCi/g
- Thorium-230 plus Thorium-232 = 7.9 pCi/g
- Uranium-234 plus Uranium-235 plus Uranium-238 = 54.5 pCi/g

Applying these criteria, the lateral extent of Area 1 has been shown to encompass approximately 17.6 acres immediately to the southeast of the main access road to the Site. Area 2, meanwhile, consists of approximately 47.8 acres along the northern boundary of the Site. Vertical depth and thickness of RIM occurrences was determined through evaluation of data from downhole gamma logging, core sample gamma scans, and core sample alpha scans. Using these data, RIM has been identified in Area 1 at intervals ranging in thickness between 0.2 to 19 feet (4.3 feet on average) and in Area 2 between 1 and 25 feet (7.4 feet on average). Overall, the data indicate that 93 percent of the intervals in Area 1 are less than 9.5 feet thick, and 76 percent of intervals in Area 2 are less than 10.4 feet thick. Additionally, multiple intervals of RIM were identified within a single boring in various locations within both Area 1 (e.g., AC-1, AC-2, and AC-3) and Area 2 (e.g., PVC-10, WL-209, WL-210, WL-214, AC-24, and AC-26A).

As for depth, the top of RIM intervals in Area 1 averaged approximately 28 feet below ground surface (bgs), ranging in depth from 0 (at the surface) to 89 feet bgs. The base of RIM intervals in Area 1 averaged 32 feet bgs, ranging between 5 and 96 feet bgs. In Area 2, the depth to uppermost RIM intervals ranges from 0 to 42.5 feet bgs, while depth to the lowermost limit of RIM intervals is between 1 and 42.5 feet bgs. The depth between the ground surface and certain RIM intervals is greater in Area 1 than it is in Area 2 because additional municipal wastes were disposed of in the above-grade portion of the North Quarry, including over portions of previously unidentified RIM at the time in the southwestern corner of Area 1.

Evaluation of the extent of RIM in Areas 1 and 2 has been performed using geostatistical methods. Specifically, the extent of RIM is estimated in three dimensions using indicator kriging, which is a method commonly used to identify regions of the subsurface that exhibit properties exceeding one or more defined threshold criterion (i.e., concentration). Interpolation of data points that exceed a specified threshold concentration of RIM, for example, results in a continuous 3D distribution model that is suitable for providing estimates of the extent and volume of RIM. As described above, the occurrence of RIM is highly variable as a function of depth. The best estimate of the volume of RIM within Areas 1 and 2 are 54,200 and 281,000 cubic yards respectively.

Radiological analysis of all data indicating the presence of RIM—i.e., 7.9 pCi/g combined Radium-226 and Radium-228 or combined Thorium-230 and Thorium-232—revealed that activity levels of Thorium-230 were greater than those of Radium-226. Because these data indicate that Radium-226 and Thorium-230 activity levels are not yet in equilibrium, it is anticipated that levels of Radium-226 will increase over time until concentrations of Radium-226

reach that of its parent, Thorium-230. In 1,000 years, the in-growth of Radium-226 levels in Areas 1 and 2 due to the decay of Thorium-230 is expected to result in an estimated Radium-226 activity level of 444 pCi/g in Area 1 and 852 pCi/g in Area 2. Peak radium levels are expected to occur in approximately 9,000 years, at which time Radium-226 activities will be approximately 815 pCi/G in Area 1 and 1970 pCi/g in Area 2. The projected increase in Radium-226 levels over time will result in both increased radiation levels and increased radon gas generation over time.

In addition to RIM, other chemical constituents are present in landfill wastes. Overall, the occurrences and concentrations of non-radiological chemical constituents are consistent with the disposal of municipal solid waste. There is also potential that some of the waste materials at the Site could display characteristics of hazardous waste because disposal operations at West Lake Landfill pre-date the adoption of federal and state regulations prohibiting disposal of hazardous wastes in solid waste landfills. As part of the OU-1 field investigation and laboratory analyses, soil and waste samples from the Site have been analyzed for a number of non-radiological constituents, including priority pollutant metals (antimony, arsenic, beryllium, cadmium, chromium, copper, lead, mercury, nickel, selenium, thallium, and zinc) and cyanide; total petroleum hydrocarbons (TPH); volatile organic compounds (VOCs) and semi-volatile organic compounds (SVOCs); and pesticides and poly-chlorinated biphenyls (PCBs). Based on these analyses, it is possible that some of the waste materials in Areas 1 and 2 contain various metals, benzene, chloroform, and 1-4 dichlorobenzene. While RCRA regulatory authorities do not apply to wastes placed into a disposal unit prior to RCRA's effective date, waste classification, handling, and disposal requirements may adhere to wastes that are excavated and removed from the Site.

2. Contaminant Impacts to Other Media

Radionuclide impacts to other environmental media have also been investigated at and near the Site. Specifically, analyses of ambient air, stormwater, surface water, sediment, and groundwater have been conducted to assess the potential for RIM transport to off-site locations.

*a) Radon Gas & Fugitive Dust in Atmospheric Air*

The PRPs and the EPA have each undertaken extensive air monitoring at and near the Site to confirm continued protectiveness of air quality. With respect to radionuclides, contaminants can be transported to the atmosphere either as a gas (in the form of radon isotopes) or as fugitive dust (in the case of other radionuclides). Radon gas, for one, is discharged at the Site into the atmosphere as a result of the decay of radium. Analysis of radon flux measurements has shown that average emissions of radon from the surface of Areas 1 and 2 are within the EPA's promulgated standard of 20 $pCi/m^2s$ for uranium mill tailings. Radon emitted in this way is subject to natural dilution and dispersion processes active in the atmosphere.

The EPA has also performed air monitoring at 5 off-site stations, four of which were located in the vicinity of the Site and one that was located in St. Charles, Missouri. Monitoring data collected from all of these locations between 2015 and 2016 were below on-site and off-site reference standards promulgated by the EPA. In addition, the values obtained from the EPA's

background reference station in St. Charles are similar to those measured at the 13 perimeter air monitoring stations.

Pursuant to a negotiated settlement with Bridgeton Landfill, LLC, 13 air monitoring stations were installed along the perimeter of the Site in 2015 in order to obtain baseline air monitoring data for the Site. Six of these monitors surround OU-1 Area 1, six others surround Area 2, and the thirteenth monitor is located in the southwest corner of the Site. Monitoring at these locations is ongoing and ensures coverage around Areas 1 and 2 under all wind directions. To date all radionuclide results have remained below the NRC's limits for public exposure.

Migration of radionuclides through fugitive dust has also been studied. Fugitive dust monitoring was conducted in 1996 at one location each in Area 1 and Area 2 during the OU-1 Remedial Investigation. The results of fugitive dust samples collected in Area 1 indicated that levels at the downwind location were similar to or lower than levels found at the upwind location. There may have been radionuclide transport via fugitive dust within Area 2, however meaningful interpretation of the results is difficult because the levels were very low. Additional analysis of fugitive dust has been accomplished since 2015, when air monitoring stations were installed around the perimeter of the Site. As compared to results obtained from 5 off-site air monitoring locations, the median and maximum gross alpha levels in fugitive dust collected from the perimeter air monitoring stations were less than those observed at the off-site locations. Gross beta results obtained from the on-site stations were comparable to the gross beta results obtained from the off-site monitoring locations. Additionally, all median and maximum values for isotopic uranium, isotopic thorium, and combined radium obtained from the on-site stations are lower than the median and maximum results found at the off-site stations.

*b) Stormwater, Surface Water, & Sediment*

Radionuclides in Areas 1 and 2 could potentially be transported to other portions of the Site or to off-site areas via precipitation runoff. Due to the potential for such impacts, as well as actual and potential human receptors of off-site migration, multiple sampling efforts have been conducted to determine whether radionuclides are present in stormwater runoff, surface water, or sediments at and around the Site.

Based on current understanding, stormwater from Areas 1 and 2 is ultimately transported to one of four surface water bodies at or near the Site. Within Area 2, two closed topographic depressions are created by a perimeter berm and receive runoff from the northern portion of Area 2. Runoff from the southwestern portion of Area 2, on the other hand, ponds at the Buffer Zone where, given sufficient quantity, it can be transported as overland flow into a culvert that conveys stormwater to the Earth City Stormwater Flood Control Channel. Runoff from remaining portions of Area 2, as well as all runoff from Area 1, ultimately flows through a perimeter drainage ditch located along the northeast side of the landfill adjacent to St. Charles Rock Road which then flows to a fourth surface water body located north of Area 2.

Stormwater and sediments have been sampled in each of these water bodies except the closed basins in Area 2. Between 1995 and 1997, stormwater was sampled at four locations in Area 1 and six locations in Area 2. Results of these samples indicated the presence of radium

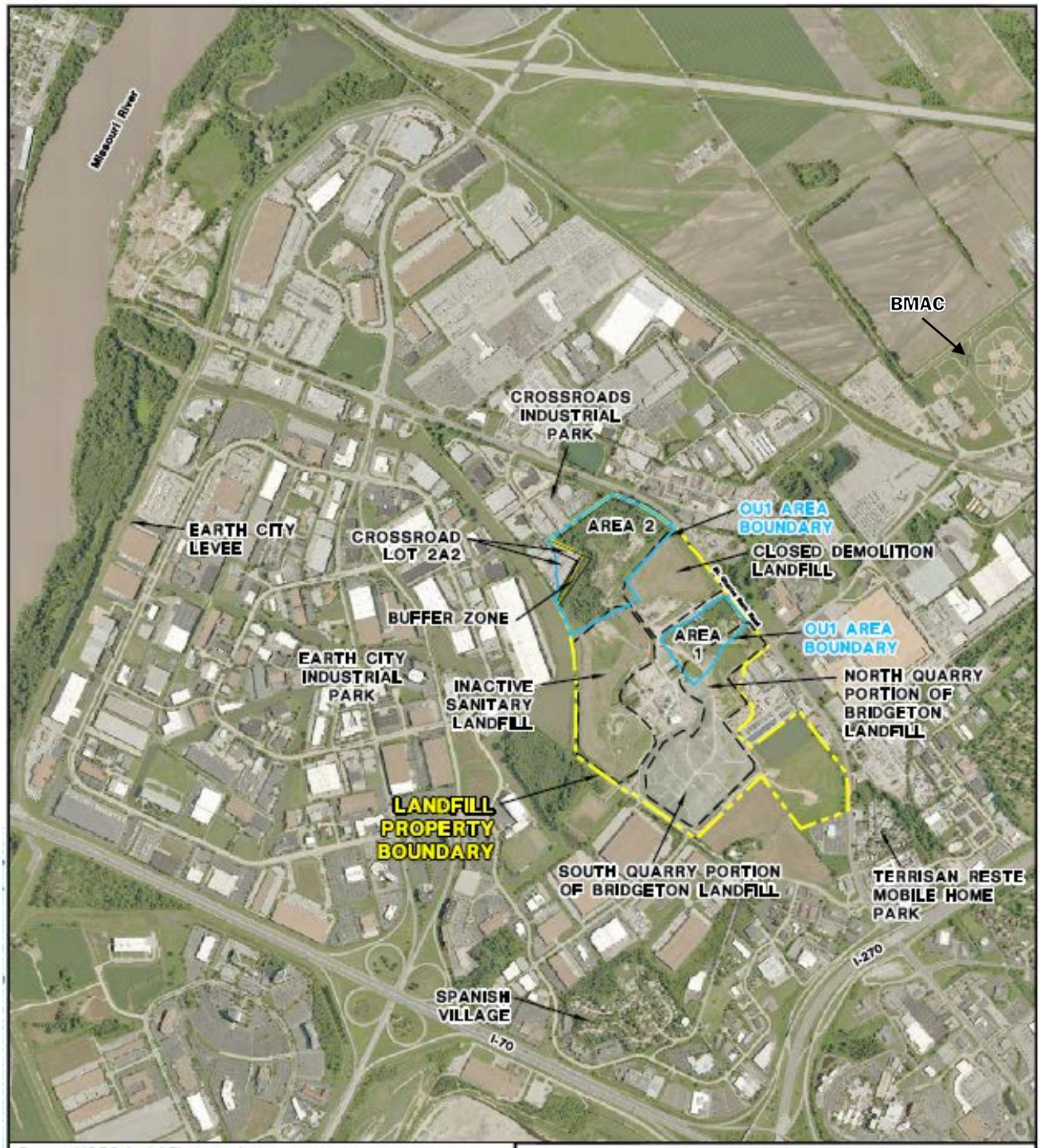
above drinking water standard in only one location in the southern portion of Area 2 in April 1996; subsequent sampling at this location in May 1997 showed radium levels within the drinking water standard of 5 pCi/g. Since 2016, stormwater monitoring has also been performed in 11 additional locations.


Figure 3-1

Site Vicinity Map

West Lake Landfill OU-1 RI Addendum

EMSI Engineering Management Support, Inc.


Missouri River
BMAC
CROSSROADS INDUSTRIAL PARK
EARTH CITY LEVEE
CROSSROAD LOT 2A2
AREA 2
OU1 AREA BOUNDARY
CLOSED DEMOLITION LANDFILL
BUFFER ZONE
AREA 1
OU1 AREA BOUNDARY
EARTH CITY INDUSTRIAL PARK
INACTIVE SANITARY LANDFILL
NORTH QUARRY PORTION OF BRIDGETON LANDFILL
LANDFILL PROPERTY BOUNDARY
SOUTH QUARRY PORTION OF BRIDGETON LANDFILL
TERRISAN RESTE MOBILE HOME PARK
I-270
SPANISH VILLAGE
I-70
Source: USGS Aerial Photography
DRAFT
N
0
2000
SCALE IN FEET
Figure 3-2
Site Location Map
West Lake Landfill OU-1 RI Addendum
EMSI Engineering Management Support, Inc.