Pre-Design Investigation Summary Report
Plant 1
St. Louis Downtown Site
St. Louis, Missouri

Revision 0

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1.0 Introduction

This *Pre-Design Investigation Summary Report* (Report) describes the pre-design investigation activities performed from May 5 through September 27, and November 29, 1999 at Plant 1 of the St. Louis Downtown Site (SLDS) and a summary of the results. This work was performed by IT Corporation (IT) on behalf of the United States Army Corps of Engineers (USACE), St. Louis District, under the Formerly Utilized Sites Remedial Action Program (FUSRAP), Total Environmental Restoration Contract No. DACW41-98-D006, Task Order 0002. The purpose of this investigation was to more accurately delineate Plant 1 soil contamination prior to initiation of remedial action activities (e.g., soil excavation). This additional delineation of the nature and extent of contamination will enable IT Corporation (IT) to accomplish the USACE's twin goals of expediting remediation and disposal cost minimization. Figure 1 has been included to show the different work areas within the SLDS.

Based on data of previous remedial investigations performed by Bechtel National, Inc. (BNI 1990, 1994, 1995), the SLDS model developed by Science Applications International Corporation (SAIC) indicated four areas within Plant 1 that may require remediation:

- Area 1, located in the central portion of Plant 1, is bounded by Buildings G, 17, and 8. This Area is approximately 150 feet (ft) by 165ft in size, and the depth of contamination was documented at less than one ft below cover material (bcm).

- Area 2 is located within a restricted-access area in the southeast corner of Plant 1 adjacent to Buildings 5, 6, and 26. This Area is approximately 200 ft by 250 ft in size, with contamination identified within one ft bcm.

- Area 3, located at the western end of Plant 1, is bounded by Buildings 25, C, and L. The Area is approximately 100 ft by 140 ft in size, with contamination documented at approximately 15 ft bcm.

- Area 4, located at the northwest corner of Building 25, is approximately 40 ft by 35 ft in size, with contamination identified at one ft bcm.

Previous investigations (BNI 1990, 1994, 1995) conducted in these four areas did not characterize the extent of contamination in the shallow and deep zones in sufficient detail to support remedial design. Excavation boundaries were assumed based on these previous results; however, additional delineation of contaminant extent was required to further refine the proposed excavation boundaries. Figure 2 depicts a Plant 1 site plan showing BNI boring

locations and SAIC modeled contamination depth contours utilizing only BNI collected data as the model input.

The following tasks were completed during the Pre-Design Investigation for Plant 1:

- Soil samples were collected from 49 new borings and 19 new near-surface sample locations to further evaluate the depth and horizontal extent of radiological contamination within Areas 1 through 4 of Plant 1 (Sections 3.0, 4.0, 5.0, and 6.0).

- Soil samples were collected from four borings within the area of deep contamination for waste characterization purposes prior to commencement of remedial actions (Section 7.0).

- Soil samples were collected from five borings in Area 3 for geotechnical analysis to assist in the design of building foundation supports and excavation shoring (Section 5.6).

- Walkover surveys were conducted and verification samples collected pursuant to the Multi-Agency Radiation Survey and Site Investigation Manual (MARSSIM) and to investigate areas where data discrepancies existed between IT and BNI co-located borings (Sections 3.7 and 4.5).

- Forty-six additional shallow borings were completed to verify and delineate areas of elevated radiological activity identified during walkover surveys.

2.0 Pre-design Investigation

Gaps in the existing data result in the loss of vertical and horizontal control of a point or area in the SAIC SLDS model. The model uses the next spatial point to establish the location and depth of a contour interval in that area. To determine the site-specific need for additional borings to delineate contaminant extent within the assumed excavation limits, an analysis of the existing data was completed. The analysis was conducted by plotting the radiological data from the existing borings on a separate map for each sample interval. Seven sample intervals were evaluated in Plant 1; 0 to 0.05 ft, 0.05 to 2 ft, 2 to 4 ft, 4 to 6 ft, 6 to 8 ft, 8 to 10 ft, and samples collected below 10 feet (>10 ft) bgs. Data points on each interval map were identified as either having a sample collected or no samples collected from each interval. Analytical results for each interval were compared to the sum of ratio (SOR) for the associated depth as established in the *Record of Decision for the St. Louis Downtown Site* (ROD) (CEMVS, 1998). The data point was then identified on the appropriate interval map as having been sampled and either exceeding or not exceeding the SOR. The interval maps were compared to a SAIC SLDS depth contour model and data gaps identified.

Where data gaps (both horizontal and vertical) existed or where the modeled contamination boundaries were unsupported by existing data, additional borings were added. Using this process the following borings were completed (Figure 3):

- Forty initial borings to define the subsurface extent (horizontal and vertical) of radiological contamination (B1-1 through B1-40)
- Nine contingency borings to further refine the boundaries of contamination in Area 3 (B1-41 through B1-43 and B1-45 through B1-50)
- Ten near surface soil sampling locations to delineate the extent of near surface contamination (S1-1 through S1-10)
- Nine contingency near surface borings to further refine the extent of near surface contamination in Areas 1, 2, and 3 (S1-11 through S1-19)
- Five geotechnical borings in Area 3 to assist in the design of foundation protection and excavation shoring (B1-G1 through B1-G3, B1-G2A, and B1-G3A)
- Forty-six additional shallow borings were completed to verify and delineate eleven identified areas of elevated radiological activity

Borings were lithologically described and screening results recorded on a boring log in accordance with Appendix E, USACE Logging Manual, *Sampling and Analysis Program Plan for the St. Louis Sites (*SAPP*)*, USACE, 1999. Boring logs for the Plant 1 Pre-Design Investigation are currently retained in the project files located at the IT SLDS facility. Copies of these borings may be obtained upon request. Shallow borings were abandoned according to the Missouri Water Well Drillers Act (Section 256.600 to 256.630 RSMo and 10 CSR 23-1.050). All down hole drilling and sampling equipment, and all non-disposable hand sampling equipment was decontaminated between each boring or sample interval. Decontamination procedures were conducted in accordance with Appendix C of the SAPP (USACE, 1999).

2.1 Clearance of Boring Locations Relative to Underground Utilities

Underground utilities were located and marked prior to the start of sampling activities at Plant 1. Each pre-design investigation boring location was surveyed and the location marked. Upon completion of the survey, Mallinckrodt and IT personnel conducted a site walk to further inspect the proposed boring locations and to tentatively locate subsurface utilities and clear the boring locations. Upon completion of the site walk IT contacted Missouri One-Call to clear public utilities in the area. Lastly, surface geophysical methods were utilized to identify subsurface features in a 10ft radius around each boring location. Boring locations affected by underground utilities were moved to a new location within the cleared 10ft radius around the boring location and the new location was resurveyed.

3.0 Area 1 Sampling Activities

This section describes the pre-design investigation activities conducted in Area 1 of Plant 1 required to determine the extent of radiological contamination in shallow soil. For soils between 0 and 6ft bgs (shallow soil), auger-drilled borings were used to collect soil samples. For near-surface soil (0- to 2ft depth), hand-sampling methods were used rather than auger drilling at some locations which were not accessible by a truck mounted drilling rig. The following sections discuss the sampling methods used.

3.1 Shallow Boring Locations

Five borings, B1-1 through B1-5, were completed in this area and are shown on Figure 3. Figure 4 has also been included detailing Area 1 at a larger scale. The SAIC modeled contamination limit was based on only one shallow soil sample (0 to 0.5 bcm) with concentrations above the SOR limit; a larger analytical data set was required to define the limits of contamination with greater certainty. The southern half of this area is an electrical substation and access was unavailable for sample collection.

Boring B1-3 was installed next to the existing BNI boring with indicated shallow contamination to provide radiological samples necessary for developing field screening correlation factors and to help establish the total depth of contamination. The borings B1-1 through B1-5 were installed to fill data gaps and to help refine the area of suspected contamination.

3.2 Shallow Boring Soil Sampling and Analysis

Shallow borings B1-1 through B1-5 were drilled and sampled to approximately 6ft bcm. The borings were advanced with a truck-mounted drilling rig using hollow-stem augers. Samples were collected by driving continuous 2ft long, 3-inch-diameter split spoons with a 140-pound hammer dropping 30 inches.

Sample intervals for the shallow investigation were approximately 0 to 0.5ft, 0.5 to 4ft, and 4 to 6ft bcm. Recovered soil was screened for radiological contamination using a Ludlum Model 2221 coupled with a Ludlum Model 44-10 (2X2-sodium iodide detector). One discrete soil sample from each interval was collected for confirmation analysis based on the most elevated field screening result from that interval. These discrete samples were submitted to the on-site laboratory for analysis of SLDS radiological contaminants of concern (Ra-226, Ra-228, Th-230,

Th-232, and U-238). Note: All radioisotopic data to include isotopes not stated herein (e.g. Pa-231, Ac-227) are also validated for incorporation into site residual risk assessments.

3.3 Shallow Boring Results

Fifteen soil samples were collected from the 5 shallow borings (B1-1 through B1-5) and submitted to the SLDS Laboratory for radiological analysis. Radiological analytical data are summarized in Table 3-1.

Initial radionuclide analyses completed at the SLDS Laboratory were completed using a limited count time using a gamma spectroscopy method. This method achieved required minimum sensitivity levels for site analytes although thorium-230 detection sensitivity was higher than that which is appropriate for compliance with remediation criteria for the 0.0 to 0.5 bcm interval. However, this was not a concern in Plant 1 since the surface was covered with a minimum of 0.5ft of pavement at all sampling locations.

A review of this data indicated that all soil samples collected from the shallow borings completed in Area 1 were below the SOR of 1 for the radiological chemicals of concern (COC).

3.4 Near-Surface Soil Sampling Locations

Initially, four near-surface soil sampling locations (S-1 through S-4) were completed to obtain data from the upper 2ft of soil in those portions of Area 1 where the limits of suspected contamination were not adequately defined. Analytical results from previous sampling efforts indicated areas where contaminant levels exceeded the cleanup criteria; however, no sampling was completed to bound the lateral and vertical extent of contamination. The four initial shallow sampling locations were completed to define this area. Subsequent to reviewing the associated analytical data from these locations, three additional locations (S1-11, S1-12, and S1-18) were added to further refine radiological impact detected in S1-4. These locations are identified on Figures 3 and 4.

3.5 Near-Surface Soil Sampling and Analysis

Near-surface soil samples were collected from below any foundation or pavement. At these locations, one sample was collected from the 0- to 0.5ft bcm interval and the other from greater than 0.5 to 2ft bcm interval. All samples were field screened prior to submission for laboratory analysis. Samples were submitted to the on-site or Hazelwood Interim Storage Site (HISS) laboratory for analysis of SLDS radiological COC.

3.6 Near-Surface Sampling Results

Eight soil samples were collected from the initial four borings (S1-1 through S1-4) and submitted to the SLDS Laboratory for radiological analysis. A review of this data indicated that the soil sample collected from S1-4 at the 1.0 to 1.5ft bgs interval was above cleanup criteria for Th-230 with a concentration of 17.40 picoCuries per gram (pCi/g). All other initial results were below the cleanup criteria. Based on this data, two additional near-surface sampling locations (S1-11 and S1-12) were completed 20ft radially outward from S1-4, and one boring (S1-18) was located immediately adjacent to S1-4 to confirm the impacted area detected by S1-4. Soil samples collected from these additional locations were below the SOR of 1 for the radiological COC. All radiological analytical data for the near-surface borings are summarized in Table 3-1.

3.7 Walkover Screening and Verification Sampling

Walkover surveys were accomplished in accordance with MARSSIM and also to investigate a data discrepancy that existed between the IT collected sample results and analytical results previously reported by BNI in the Remedial Investigation (RI). In an attempt to resolve these discrepancies, walkover surveys were conducted adjacent to BNI borings with radiological contamination above the SOR which was not confirmed by co-located IT borings.

A walkover survey was conducted utilizing a 2X2-sodium iodide detector in the vicinity of BNI boring locations. Elevated radiological activity detected during these surveys was noted and marked on the pavement. Three areas of elevated radiological activity, locations 2, 3, and 10, were identified in Area 1 of Plant (Figures 3 and 4).

3.7.1 Elevated Radiological Activity Location 2

Elevated radiological activity location 2 was identified in Area 1 adjacent to the south wall of Building "G" approximately 20ft north of near surface sampling location S1-3. Samples SLD03340 and SLD03341 were collected at 1.0 and 1.5ft bgs respectively by coring through the pavement material within the area of elevated activity and advancing a boring utilizing a hand auger to 2.0 feet bgs.

Analytical results for soil sample SLD03340 indicated an SOR value of 30.31 while sample SLD03341 indicated a SOR value of 0.23 for radiological COCs.

Based on a review of this data, six additional shallow borings were completed to determine the horizontal extent of radiological impact detected in elevated radiological activity location 2. These borings (SLD03621, SLD03623, SLD03624, SLD03639, SLD03640, and SLD03660)

were completed at 10ft horizontal intervals to depths of 1.5 to 3.5 ft bgs.

Laboratory analysis of the seven soil samples collected from the additional borings indicated SOR values of less than 1 for radiological COCs.

3.7.2 Elevated Radiological Activity Location 3

Elevated radiological activity location 3 was identified in Area 1 adjacent to Boring B1-3 on the west side of Building 8. Samples SLD03299, SLD03300, SLD03301 and SLD03302 were collected at 1.0ft, 1.5ft, 2.5ft, and 3.0ft bgs respectively by coring through the paved cover material and advancing a boring utilizing a hand auger to 3.5ft bgs.

Analytical results for soil sample SLD03299 indicated an SOR value of 11.92. Results for soil samples SLD03300 through SLD03302 indicated SOR values of less than 1 for radiological COC.

Based on a review of this data, one additional shallow boring was completed to determine the horizontal extent of radiological impact detected in elevated radiological activity location 3. This boring (SLD03661) was completed west of elevated location 3 to a depth of 3.5 bgs.

Laboratory analysis of the two soil samples collected from the additional boring indicated SOR values of less than 1. Based on this information, elevated location 3 is bounded by boring B1-4 to the north, SLD03361 and SLD02400 to the south, and B1-3 to the west.

3.7.3 Elevated Radiological Activity Location 10

As discussed in Section 3.6, the soil sample collected from near surface location S1-4 at the 1.0 to 1.5ft bgs interval indicated an SOR value of 1.07. Thee additional near surface sampling locations were completed (S1-11, S1-12, and S1-18) to delineate this area of radiological impact. Analytical results for the additional samples indicated SOR values of less than 1.

Further attempts to confirm and delineate radiological impact detected in near surface sampling location S1-4 were accomplished by completing three additional shallow borings adjacent to S1-4 (SLD04832, SLD04834, and SLD04836). Analytical results for soil samples collected from these additional borings indicated SOR values of less than 1. Based on this data, elevated radiological activity location 10, as identified on Figures 3 and 4, is adjacent to S1-4 and is bounded by S1-11, S1-12, SLD04832, SLD04834, SLD04836, and B1-5.

4.0 Area 2 Sampling Activities

This section defines the pre-design investigation activities completed in Area 2 of Plant 1 to determine the extent of radiological contamination in shallow soils between 0- and 6ft bcm.

4.1 Shallow Boring Locations

Eighteen boring locations (B1-6 through B1-23) were completed in Area 2 to better define contamination in shallow soils. Borings B1-6 through B1-23 are shown on Figure 3. Figure 5 has also been included detailing Area 2 at a larger scale. Boring locations were selected based on previous analytical results and the interpreted excavation boundary from the three-dimensional model. The new borings were placed between existing borings to further evaluate the horizontal and vertical extent of contamination at 20- to 40ft horizontal intervals around the previously identified contaminant plume.

All borings were drilled, sampled, and screened using the methods described in Section 3.2.

4.2 Shallow Boring Results

Fifty soil samples were collected from the 18 shallow borings (B1-6 through B1-23) and submitted to the SLDS or HISS Laboratory for radiological analysis (Table 3-1). A review of this data indicated that soil samples collected from the shallow borings in Area 2 were below the SOR of 1 for the radiological COC with the exception of the 2.0 to 2.5ft bgs sample collected from B1-9. This sample indicated a radium-226 concentration of 17.64 pCi/g.

4.3 Near-Surface Soil Sampling Locations

Initially, six near-surface soil sampling locations (S1-5 through S1-10) were completed to obtain data from the upper 2ft of soil in those portions of Area 2 where the limits of known contamination, as determined by the BNI investigation, were not adequately bounded. Four additional near surface sampling locations (S1-14 through S1-17) were added to confirm and delineate shallow contamination detected in boring B1-9, and one near surface boring (S1-19) was added to confirm shallow contamination detected by BNI during the RI near the southern boundary of Area 2.

Samples were submitted to the on-site or HISS laboratory for analysis of SLDS radiological COC.

All near-surface borings were installed, and the soil samples collected and screened, using the methods described in Section 3.5.

4.4 Near-Surface Sampling Results

A review of analytical data (Table 3-1) indicated that soil samples collected from near-surface locations (S1-5 through S1-10) in Area 2 of Plant 1 were below the SOR of 1 for the radiological COC.

4.5 Walkover Screening and Verification Sampling

Walkover surveys were accomplished in accordance with MARSSIM and also to investigate a discrepancy that existed between the IT collected sample results and analytical results previously reported by BNI in the RI. In an attempt to resolve these discrepancies, walkover surveys were conducted adjacent to BNI borings with radiological contamination above the SOR which was not confirmed by co-located IT borings.

A walkover survey was conducted utilizing a 2X2-sodium iodide detector in the vicinity of BNI boring locations. Elevated radiological activity detected during these surveys was noted and marked on the pavement. Six areas of elevated radiological activity, locations 4 through 8 and 11 were identified in Area 2 of Plant 1 (Figures 3 and 5).

4.5.1 Elevated Radiological Activity Location 4

Elevated radiological location 4 was identified near the southeast corner of Building 26 adjacent to near surface sampling location S1-19. Soil boring SLD03255 was completed in this area and drilled to a total depth of 5ft bgs. Samples SLD03255 and SLD03256 were collected at 2.0ft bgs and 3.5ft bgs respectively.

Analytical results for samples SLD03255 and SLD03256 indicated SORs of 1,090.82 and 1.30 respectively for radiological COC.

Based on a review of this data, four additional shallow borings were completed to determine the horizontal and vertical extent of radiological impact detected in elevated radiological activity location 4. These borings (SLD03633, SLD03641, SLD03643, and SLD03651) were completed at 10ft horizontal intervals to depths of 3.5 to 5.0ft bgs around elevated location 4.

Laboratory analysis of the eight soil samples collected from the four additional borings indicated

SOR values of less than 1.

4.5.2 Elevated Radiological Activity Location 5

Elevated radiological activity location 5 was identified during the walkover survey east of Building 26, adjacent to shallow boring B1-10. Samples were collected in this area by removing a $2ft^2$ section of pavement, screening the fill material, and collecting a composite grab sample of elevated areas within 8-10 inches bgs (SLD03257). Additionally, two split spoon samples were driven to approximately 3ft bgs within the area of removed pavement. Screening results for these two split spoon samples did not indicate any readings above background levels; therefore, no soil was retained for laboratory analysis.

Laboratory analysis of soil sample SLD03257 indicated an SOR value of 6.20 for radiological COC.

Based on a review of this data, three additional shallow borings were completed to determine the vertical and horizontal extent of radiological impact detected in elevated radiological activity location 5. These borings (SLD03645, SLD03649, and SLD03650) were completed at 10ft horizontal intervals to depths of 3.5 to 4.5ft bgs.

Laboratory analysis of the three soil samples collected from the three additional borings indicated SOR values of less than 1.

4.5.3 Elevated Radiological Activity Location 6

Elevated radiological activity location 6 was identified approximately 2ft south of shallow boring B1-20. Samples SLD03248 and SLD03249 were collected by advancing a boring to 4.5ft bgs adjacent to boring B1-20. Additional samples were collected by removing a $1ft^2$ section of pavement and collecting 2 grab samples of radiologically elevated fill material immediately below the pavement (SLD03250 and SLD03254). Two shallow borings were then completed within the section of removed pavement to a depth of 3.5ft bgs. A total of three samples were collected from these two borings (SLD03251 through SLD03253).

Analytical results for samples SLD03248 and SLD03249 indicated concentrations below the SOR value of 1 for radiological COC. Samples SLD03250 through SLD03254 were above the SOR of 1 for radiological COC. Radium-226 was the primary radionuclide detected with concentrations ranging from 18.85 pCi/g to 968.98 pCi/g (Table 3-1).

Based on a review of this data, three additional shallow borings were completed to determine the

vertical and horizontal extent of radiological impact detected in elevated radiological activity location 6. These borings (SLD03637, SLD03646, and SLD03648) were completed at 10ft horizontal intervals to depths of 3.5 to 4.5ft bgs.

Laboratory analysis of the five soil samples collected from the three additional borings indicated SOR values of less than 1.

4.5.4 Elevated Radiological Activity Location 7

Elevated radiological location 7 was identified several feet north of Boring B1-23 within the secured area northwest of Building 26. Soil samples SLD03297 and SLD03298 were collected with a hand auger at 2.5ft and 4.5ft bgs respectively.

Analytical results for samples SLD03297 and SLD03298 indicated SOR values of 1.16 and 3.51 respectively for radiological COC.

Based on a review of this data, one additional shallow boring was completed to determine the horizontal extent of radiological impact detected in elevated radiological activity location 7. This boring (SLD03629) was completed approximately 10ft east of elevated location 7 to a depth of 4.5ft bgs.

Laboratory analysis of the soil sample collected from boring SLD03648 indicated an SOR value of less than 1. Based on this information, elevated location 7 is bounded by B1-23, SLD03629, B1-21, and B1-16.

4.5.5 Elevated Radiological Activity Location 8

Elevated radiological location 8 was identified adjacent to the east wall of Building 6 between borings B1-15 and B1-16. Based on walkover survey data, this area is expected to be approximately 9 square feet (ft^2). Soil Boring SLD03294 was completed in this area and drilled to a total depth of 1.5ft bgs. Samples SLD03294, SLD03295 and SLD03296 were all collected from 0.5 to 1.0ft immediately below pavement cover.

Analytical results for soil samples SLD03294, SLD03295 and SLD03296 indicated SOR values of 3.99, 8.82, and 27.91 for radiological COC respectively.

Based on a review of this data, three additional shallow borings were completed to determine the horizontal extent of radiological impact detected in elevated radiological activity location 8. These borings (SLD03625, SLD03627, and SLD03631) were completed adjacent to elevated

location 8 to a maximum depth of 4.5 bgs.

Laboratory analysis of the soil sample collected from these three borings indicated SOR values of less than 1. Based on this data, elevated location 8, is bounded by SLD03627, SLD03631, B1-15, and SLD03625.

4.5.6 Elevated Radiological Activity Location 11

Elevated radiological activity location 11 was identified by shallow boring B1-9. As discussed in Section 4.2 and 4.3, the sample collected from the 2.0 to 2.5ft bgs interval indicated an SOR value of 1.10. Four additional near surface sampling locations were added to delineate this area of radiological impact (S1-14 – S1-17). Soil samples collected from these additional near surface locations indicated SOR values of less than 1.

Further attempts to confirm and delineate the radiological impact identified in shallow boring B1-9 included the completion of two additional borings (SLD04838 and SLD04840). Soil samples collected from boring SLD04838 at depths of 0.5 to 1.5ft bgs and 1.2 to 2.5ft bgs indicated SOR values of less than 1 for radiological COC. Soil samples collected from boring SLD04840 at depths of 0.5 to 1.2ft bgs and 1.2 to 2.4ft bgs indicated SOR values of 1.26 and 1.10 respectively for radiological COC. Based on this data, elevated radiological activity location 11, is bounded by B1-8, SLD04838, and S1-16.

5.0 Area 3 Sampling Activities

This section describes the pre-design investigation activities completed for Area 3 of Plant 1 to determine the extent of radiological contamination in shallow soil and confirm the extent of contamination in deep soil. The BNI investigation in this area (1990, 1994, and 1995) indicated contamination at a maximum depth of 10ft bgs.

5.1 Shallow Boring Locations

Five initial borings, B1-32 through B1-36, were completed to determine the extent of radiological contamination in shallow soil in Area 3. Based on the analytical results of these borings, five additional shallow borings were completed (B1-41 through B1-43, B1-45, and B1-46) to further delineate the extent of contamination in shallow soil in Area 3. The locations of these shallow soil borings are shown on Figure 3. Figure 6 was included detailing Area 3 at a larger scale.

All shallow borings were drilled, sampled, and screened using the methods described in Section 3.2.

5.2 Shallow Boring Results

A review of analytical data (Table 3-1) indicated that radiological impact was detected above the SOR of 1 for COC in soil samples collected from boring B1-36 at a maximum depth of 5.5ft bgs. Soil samples collected from borings B1-32 through B1-35 were below the SOR of 1 for radiological COC. Six additional shallow borings (B1-41 through B1-43, and B1-45, through and B1-47) were added to refine the boundaries of radiological contamination identified in Area 3 (K-pad area). Analytical data (Table 3-1) for soil samples collected from these borings indicated that radiological COC were below the SOR of 1 with the exception of boring B1-47 which indicated contamination above the SOR to a depth of 6ft bgs.

5.3 Deep Boring Locations

Eight deep soil borings were initially completed in Area 3 (B1-24 through B1-31). Three additional deep boring locations were completed following the review of data obtained from the initial borings (B1-48 through B1-50). The boring locations were selected based on existing soil boring analytical results (BNI, 1994, 1995) and the interpreted contamination boundary from the

SAIC three-dimensional model. In general, the eight initial deep borings were placed at 20ft horizontal intervals around the previously identified soil contamination plume and between existing borings to further evaluate the depth of contamination identified by the BNI investigation. The three additional borings were added to further refine contamination detected by the initial eight borings. This boring density provides an estimate of the plume boundary and confirms the limits of deep contamination.

5.4 Deep Boring Soil Sampling and Analysis

Borings B1-24 through B1-31 were drilled and sampled to a maximum depth of 18ft bgs. Boring B1-48 was drilled to 22ft and borings B1-49 and B1-50 were drilled to 14 and 13ft bgs respectively. All borings were advanced with a truck-mounted drill rig using hollow-stem augers. Samples were collected with a 3-inch-diameter 2ft long split spoon to 6ft below cover. Samples collected below 6ft were collected with a CME-type 5ft split-barrel sampler. Recovered soil was radiologically screened with a Ludlum Model 2221 coupled with a Ludlum Model 44-10 (2X2 sodium iodide detector). Samples of recovered soil were placed in one-quart sample containers with tight fitting lids and submitted for radiological analysis. An IT field geologist selected samples for radiological analysis based on the following criteria:

- Sampling of the upper 6ft of the deep boring was consistent with the shallow boring sample intervals described in Section 3.2.

- Samples collected from below 6ft in depth were obtained from that portion of the recovered soil core with the most elevated field screening results. Soil sampling continued until field screening results from one 5ft core was below cleanup criteria.

Samples were submitted to the on-site and HISS Laboratories for expedited analysis of SLDS radiological COC.

5.5 Deep Soil Boring Results

Radiological impact was detected above the SOR of 1 for COCs in soil samples collected from borings B1-24, B1-25, B1-29, and B1-30 (Table 3-1). Depths of contamination ranged from 7.5ft in B1-24 to 16.5ft bgs in B1-30. Based on a review of this data, three additional deep borings (B1-48 through B1-50) were added to further delineate contamination in this area. Radiological contamination above the SOR of 1 was detected in borings B1-49 and B1-50 at 9.5 to 10ft bgs and 11.0 to 11.5ft bgs respectively. Figures 3 and 6 show depth of contamination contours in Area 3 based on collected analytical data.

Based on this investigation, it is concluded that due to evidence of radiological contamination, this area (Area 3) will require remedial action. IT will prepare a Work Area-Specific Description (WASD) design package to address the contamination detected in Area 3. This WASD will be prepared and submitted under separate cover.

5.6 Geotechnical Borings

Three initial borings were installed in Area 3 (B1-G1, B1-G2, and B1-G3) for the purpose of collecting samples to be submitted for geotechnical analysis. Two additional borings were completed to obtain additional information on the physical characteristics of subsurface soils adjacent to Building C. Ten soil samples were collected from the borings and analyzed for the parameters listed in Table 5-1. Details regarding these results will be included in the WASD for Plant 1.

5.7 Walkover Screening and Verification Sampling

Walkover surveys were accomplished in accordance with MARISSIM and to investigate a discrepancy that existed between the IT collected sample results and analytical results previously reported by BNI in the RI. In an attempt to resolve these discrepancies, walkover surveys were conducted adjacent to BNI borings with radiological contamination above the SOR which was not confirmed by co-located IT borings.

A walkover survey was conducted utilizing a 2X2-sodium iodide detector in the vicinity of BNI boring locations. Elevated radiological activity detected during these surveys was noted and marked on the pavement. Two areas of elevated radiological activity were identified in Area 3 of Plant 1 (Figures 3 and 6).

5.7.1 Elevated Radiological Activity Location 1

Elevated radiological activity location 1 was identified adjacent to the south wall of Building 25 near the Electrical Sub-Station C-1. Soil samples were collected in this area by coring through the surface pavement material and advancing boring SLD03331 to 3 feet utilizing a hand auger. Soil samples SLD03331 and SLD03332 were collected at 0.5 - 1.0ft bgs and 2.0 - 2.5ft bgs respectively.

Laboratory analysis of soil samples SLD03331 and SLD03332 indicated SOR values of 93.78 and 5.92 respectively for radiological COCs.

Based on a review of this data, four additional shallow hand augered borings were completed to determine the vertical and horizontal extent of radiological impact detected in elevated area 1. These borings (SLD03653, SLD03655, SLD03657, and SLD03658) were completed at 10ft horizontal intervals to depths of 2.5 to 4.0ft bgs around boring SLD03331.
Laboratory analysis of the seven soil samples collected from the four additional hand augered borings indicated SOR values of less than 1, with the exception of soil sample SLD03657 collected at a depth of 1.5ft bgs which indicated an SOR value of 3.26.

5.7.2 Elevated Radiological Activity Location 9

Elevated radiological activity location 9 was identified by Class 2 boring SLD02384 located near the northwest corner of Building C adjacent to the former K building foundation. Analytical results from this boring indicated an SOR value of 3.56 for the sample collected from the 3.5 to 4ft bgs interval.

Three additional borings were completed to delineate the radiological impact identified by this boring. Analytical results from these borings (SLD03615, SLD03617, and SLD03619) indicated SOR values of less than one for the radiological COC. Based on this data, elevated radiological activity location 9 is identified as the area immediately surrounding Class 2 Boring SLD02384 as shown on Figures 3 and 6.

6.0 Area 4 Sampling Activities

This section describes the pre-design investigation activities completed for Area 4 of Plant 1 to determine the vertical and horizontal extent of radiological contamination in soil. The BNI investigation in this area indicated contamination extends to less than 2ft bgs. Radiological samples collected in Area 4 were submitted to the on-site laboratory.

6.1 Shallow Boring Locations

Four new borings, B1-37 through B1-40, were completed to better define the extent of suspected contamination in shallow soils. The locations of these borings are shown on Figure P1-2. All borings were drilled, sampled, and screened using the methods described in Section 3.2. The depth of these borings was approximately 6ft bcm.

6.2 Shallow Boring Results

Eleven soil samples were collected from the four shallow borings (B1-37 through B1-40) and submitted to the SLDS Lab for radiological analysis (Table 3-1). A review of this data indicated that all soil samples collected from the shallow borings in Area 4 were below the SOR of 1 for the radiological COC.

7.0 Waste Characterization Activities

A grab sample was collected from four borings in Plant1. These borings were located within the area of contamination in location 3 to confirm the waste falls within waste profiles for acceptance at the designated disposal facility.

One initial grab sample, collected from boring B1-24, was submitted for analysis to Quanterra Environmental Services laboratory, which holds a radiological license. The sample was analyzed for toxicity characteristic leaching procedure (TCLP) volatile and semi-volatile organics, pesticides, herbicides, and metals (8 Resource, Conservation and Recovery Act [RCRA] metals plus copper and zinc), and total polychlorinated biphenyls (PCBs). Analyses also included fluoride, pH, paint filter, flashpoint, TOX, reactive cyanide, and reactive sulfide. Analytical results of this initial sample indicated concentration of cadmium (1.3 mg/L) which slightly exceeded the toxicity characteristic limit of 1.0 mg/L. In order to confirm this result, six additional grab samples were collected from three borings near B1-24 (B1-25, B1-49, and B1-50) and analyzed for TCLP RCRA metals. While these confirmation samples did not indicate cadmium present above the laboratory detection limit, results did show that TCLP lead was above RCRA levels of 5.0 mg/L in the soil sample collected from B1-50 at the 2ft to 2.5ft bgs interval. Lead concentration in the TCLP extract for this sample was 6.8 mg/L. Waste sampling analytical results are summarized in Table 7-1 and laboratory data sheets are included in Appendix A.

The regulatory requirement for determination of toxicity characteristic in 40 CFR 261.24 requires a "representative sample." This is not specifically defined. If sample results are averaged, using twice the detection limit as the concentration for non-detect samples, the "composite" analytical results indicate that the soil is non-hazardous. This is consistent with the waste profiling requirements for the disposal site which is accepting the soil as non-hazardous low level waste.

Additionally, pursuant to 40 CFR 261.4(e)(4), source special nuclear, and by-product material to include 11e (2) by–product materials are specially excluded as "hazardous waste" thus soil is contaminated as a result of 11e(2) materials to include associated chemicals such as lead is not a hazardous waste requiring special treatment and processing.

8.0 Class 2 Survey

A Final Status Survey was performed previously by SAIC. Based on information provided by this survey, it was concluded that the Plant 1 area contained both Class 1 and Class 2 Survey Units. There was no Class 3 Survey Units identified within the Plant 1 boundary (CEMVS). Class 1 and 2 Survey Units are discussed in the following section.

8.1 Class 1 and 2 Survey Units

SAIC defined the Class 2 Survey Units and sample locations within Plant 1. Three survey units were established within Plant 1; Unit 1 is approximately 3,702 square meters, Unit 2 is approximately 5,339 square meters, and Unit 3 is approximately 4,548 square meters. Due to the presence of buildings within the boundaries of Units 1, 2, and 3 the space accessible for sampling is reduced to an area considerably smaller than the 5,000 square meters area as defined by MARSSIM. A total of 61 Final Status Survey sample locations, 20 in Unit 1, 22 in Unit 2, and 19 in Unit 3, were proposed for Plant 1.

Based on the results of the Pre-Design Investigation for Plant 1, 12 Class 1 areas were identified. The Class 1 areas consist of one area of deep radiological impact located beneath the former K building foundation and 11 isolated areas of shallow radiological impact. The sum of all Class 1 areas equates to approximately 583 square meters. Each Class 1 area is identified on Figure 3 with associated depth to contamination contours. The remediation of the deep area of radiological impact will be addressed in the WASD prepared for Plant 1. The remediation of the shallow areas of elevated radiological activity will be discussed in the *Remedial Action Work Description for Isolated Areas of Elevated Radiological Activity, Plants 1 and 2, St. Louis Downtown Site, St. Louis Missouri.*

Results of the Class 2 sampling activities indicated SOR values of less than 1 for all locations, with the exception of SLD02384, located adjacent to the northwest corner of Building C. Analytical results for the sample collected from Class 2 boring SLD02384 at a depth of approximately 4ft bgs indicated an SOR value of 3.56 for radiological COC. Results of the SAIC Final Status Survey will be submitted under separate cover. Class 2 boring locations are shown on Figure 3.

9.0 References

Bechtel National, Incorporated, 1995, *Remedial Investigation Addendum for the St. Louis Site, St. Louis, Missouri*, DOE/OR/21950-132, St. Louis, MO.

Bechtel National, Incorporated, 1994, *Remedial Investigation Report for the St. Louis Downtown Site, St. Louis, Missouri*, DOE/OR/21949-280, Oak Ridge, TN.

Bechtel National, Incorporated, 1990, *Radiological, Chemical, and Hydrogeological Characterization Report for the St. Louis Downtown Site in St. Louis, Missouri*, Revision 1, DOE/OR/20722-258, Oak Ridge, TN.

U.S Army Corps of Engineers St. Louis District (CEMVS), 1998, *Record of Decision for the St. Louis Downtown Site, St. Louis, Missouri*, Formerly Utilized Sites Remedial Action Program, St. Louis MO.

Table 5-1
Summary of Predesign Investigation Geotechnical Testing Parameters

Physical Testing Parameter	Test Method	Number of Tests
Moisture Content	ASTM[a] D2216-92	7
Unconsolidated-undrained Triaxial Shear	ASTM D 2850	4
Unconfined Compressive Strength	ASTM D2166-91	7
Particle Size	ASTM D 422-63e	7
Atterberg Limits	ASTM D 4318-95a	7
Permeability	ASTM D5084-90	3

[a]American Society for Testing and Materials

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