PUBLIC COMMENT DRAFT

EXPANDED SITE REVIEW WORK PLAN

FOR THE PROPOSED STRECKER FOREST DEVELOPMENT

WILDWOOD, MISSOURI

Superfund Technical Assessment and Response Team (START)
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Prepared For:

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APPENDICES

1.0 INTRODUCTION

The Tetra Tech EM Inc. (Tetra Tech) Superfund Technical Assessment and Response Team (START) has provided support to the U.S. Environmental Protection Agency (EPA) Region 7 Superfund Division in the development of a work plan for an Expanded Site Review (ESR) at property adjoining a portion of the Ellisville Site located in Wildwood, Missouri[a]. A residential development known as Strecker Forest has been proposed for the subject property (hereafter referred to as ―Strecker Forest"). This work plan discusses site-specific features and presents elements of the sampling strategy and analytical methods proposed for the ESR. The ESR is being conducted to determine if contaminants are present in soil and groundwater at concentrations that may present a threat to human health and the environment for the proposed residential land use. The ESR will also provide additional data to help clarify hydrogeological conditions in the area including the direction of groundwater flow. The proposed sampling and analysis presented in this work plan is intended to characterize soil and groundwater at the Strecker Forest property for the potential presence of volatile organic compounds (VOCs), semi-volatile organic compounds (SVOCs), polychlorinated biphenyls (PCBs), and dioxins. The study area for this ESR includes the entire 18.3 acres of Strecker Forest. This tract includes 23 proposed home sites on the southern portion of the property and an undeveloped ―preservation area" in the northern portion of the property. The study area for this ESR also includes a portion of the Ellisville Site known as the Callahan property located across Strecker Road to the south of Strecker Forest where a former drum burial area was remediated in the early 1980's.

2.0 SITE LOCATION

Strecker Forest is located in Saint Louis County, Missouri (see Appendix A, Figure 1), and includes three parcels of land encompassing 18.3 acres to the north of Strecker Road in Wildwood, Missouri. The three parcels include the former Dozier Property, located at 165 Strecker Road (approximately 5 acres); the former Primm Property, located at 173 Strecker Road (approximately 10 acres); and the former Schoessel Property, located at 177 Strecker Road (approximately 3 acres). These three properties were purchased by W.J. Byrne Builders, Inc., of Glencoe, Missouri, with the intent to develop the proposed Strecker Forest subdivision. The Callahan property is located at 210 Strecker Road.

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[a] The Ellisville Site appears on the National Priorities List (NPL), a list of priority Superfund maintained by the Environmental Protection Agency (EPA).

3.0 SITE DESCRIPTION

Strecker Forest is mostly undeveloped, except for a garage structure and two abandoned homes on the former Dozier and Primm properties. The northern two-thirds of Strecker Forest is covered mostly by hardwood forest. The property is surrounded by suburban residential areas, except to the north and east, where a 12-acre tract with a residence, horse arena and stables is located. Specific features identified in previous investigations of the Strecker Forest property include the abandoned residences on the former Primm and Dozier properties, a “Western Pond Area” in the southwestern quadrant of the site, a “Solid Waste Disposal Area” located in a drainage ravine that cuts through the central portion of the site, an “Old Haul Road” that parallels the drainage ravine, and an “Eastern Disturbed Area” and “National Priorities List (NPL) Area” that are both located in the northeastern portion of the site. The Eastern Disturbed Area and the NPL Area are located adjacent to the Bliss portion of the Ellisville NPL site, sometimes referred to as the Bliss-Ellisville site[b].

The terrain at the Strecker Forest property slopes downward to the north from Strecker Road. There are relatively steep slopes with an elevation change from approximately 720 feet at Strecker Road to approximately 635 feet along a tributary of Caulks Creek at the northeast perimeter of the site in the NPL Area. The intermittent Caulks Creek tributary flows to the north along a ravine in the central portion of Strecker Forest toward the northern border and intersects another intermittent tributary crossing the northeast corner of the Strecker Forest property. All surface water and drainage pathways on the site flow in a northerly direction toward this area.

Features on the Callahan property include a small pond and barn. The terrain at the Callahan property slopes downward to the south from Strecker Road forming two drainageways that intersect another intermittent Caulks Creek tributary near the southernmost property boundary. The small pond receives drainage from the northern portion of the parcel and is located above the former drum burial area (fill area). Strecker Road which separates the Callahan property from Strecker Forest was identified as a ground water divide in one previous investigation of Strecker Forest, but this finding has been questioned in the human health risk assessment subsequently prepared for this property.

[b] The overall Ellisville NPL site includes the Bliss, Callahan, and Rosalie subsites, which are technically defined not by property boundaries, but instead by boundaries of the areas where contamination was found.

4.0 SITE HISTORY

Due to concerns over environmental conditions at Strecker Forest, development has been halted until environmental conditions are better understood. Data generated during this ESR will be incorporated into a comprehensive review of soil and groundwater conditions at and near Strecker Forest. Heightened concerns exist, in part, due to the proximity of Strecker Forest to the Bliss, Callahan, and Rosalie subsites which are all part of the overall Ellisville Site. Strecker Forest is located directly adjacent to the Bliss subsite of the Ellisville site, and the planned Preservation Area actually includes a small (0.15 acre) portion of the Bliss subsite in the northeast corner of the 18.3 acre tract (see Appendix A, Figure 2). The Callahan subsite is located south of Strecker Forest across Strecker Road, and the Rosalie subsite is located approximately 0.5 mile west-southwest of Strecker Forest. Below is a brief summary of each of the three subsites of the Ellisville NPL site:

1. The Bliss subsite borders Strecker Forest to the north and east, and includes a small portion of the Preservation Area in the northeast corner of the Strecker Forest property. Investigative and sampling activities began on September 16, 1980, that identified two waste disposal areas to the northwest of the horse arena. On June 2, 1981, trenching operations guided by eyewitness accounts identified buried drum areas at the Bliss subsite. Several follow-up geophysical surveys were conducted starting in June 1982 and continuing through August 1990. These surveys identified buried waste at a number of locations on the Bliss and contiguous properties. In August 1985, the Missouri Department of Natural Resources (MDNR) placed a liner in the stream bed of the Caulks Creek tributary to stabilize the stream banks, and constructed a berm to divert overland flow from the eroding stream. EPA implemented a final remedial action in 1996 involving excavation and management of soil impacted by dioxin[c] and non-dioxin wastes (bulk hazardous waste, drums, soil, and other materials). During the remedial action, dioxin-contaminated materials were transported to the Times Beach site for thermal treatment (incineration). All non-dioxin hazardous wastes were managed off-site at commercial hazardous waste facilities permitted under the Resource Conservation and Recovery Act (RCRA). Non-hazardous materials were disposed of at a sanitary landfill. During the cleanup, temporary containment structures were erected during excavation activities, and air monitoring was performed to ensure that airborne contaminants were not migrating off site. A total of 24,700 tons of dioxin-contaminated soil, 581 tons of soil contaminated with hazardous substances other than dioxin, and 480 buried drums and other containers of wastes were removed from the site. Confirmation samples were collected to confirm that cleanup activities had achieved cleanup goals, providing for unrestricted use of the remediated property. Once cleanup activities had been completed, excavated areas were backfilled, re-graded, and seeded. The dioxin removal activities included the 0.15 acre area in the extreme northeast corner of the Strecker Forest Property (referred to as the ―NE Area" of Strecker Forest during past investigations) (Ecology and Environment, Inc. 1998). Currently, an investigation of conditions at the Bliss Ellisville site involving monitoring of groundwater and soil vapor conditions is ongoing.

[c] The term ―dioxin" refers to a family of related compounds. Risk related to dioxin-contaminated soils at the Bliss-Ellisville site was primarily driven by 2,3,7,8-TCDD which has the highest toxicity of dioxin compounds.

2. The Callahan subsite is located due south of Strecker Forest. In August 1980, an eyewitness reported drums being buried near a barn on the Callahan property. On December 14, 1981, EPA/MDNR initiated an emergency removal action to excavate the drums. The removal action was completed February 18, 1982, and involved removal of 1,205 drums from the property. Of the 1,205 drums, 613 contained hazardous materials. EPA released a Remedial Investigation for the Ellisville Site on September 21, 1983, that presented results from field investigation performed at the Callahan subsite. On July 10, 1985, EPA selected a remedial action to be performed at the Callahan subsite that included stabilization of soils in the former drum burial area and removal of a plastic cover, blocks, and gravel and fencing remaining from the 1981-82 drum removal. A site removal evaluation (SRE) was conducted by MDNR on January 31, 2005, to determine if any residual soil contamination remained at the site at concentrations that would warrant further response. A Removal Site Evaluation Report was prepared for EPA dated August 5, 2005, which incorporated the findings of the MDNR SRE.

3. The Rosalie subsite is located approximately 0.5 mile west-southwest of Strecker Forest. On July 17, 1980, contractors for the St. Louis Metropolitan Sewer District encountered buried drums on the Rosalie Property while installing a new sewer line along Caulks Creek. The St. Louis Metropolitan Sewer District notified EPA, MDNR, and the U.S. Coast Guard Safety Office about the drums. In September 1980, four areas were identified where drums, pieces of drums, or trash were found. During the initial actions, 267 drums were removed from the Rosalie subsite. On July 10, 1985, a final remedy for the Rosalie subsite was selected by EPA, and implemented by MDNR, which involved off-site disposal of contaminated soil, drums, cans, and debris remaining at two locations. An Environmental Site Assessment (ESA) was conducted January 29-31, 1986, to characterize conditions at all four disposal areas (ELL-01, ELL-02, ELL-03, and ELL-04). Twenty-five soil samples were collected and analyzed for SVOCs; all results were below EPA's RSLs for residential soil.

5.0 PREVIOUS INVESTIGATIONS

Strecker Forest

Several previous environmental investigations of conditions at Strecker Forest have been commissioned by various parties, including the current property owner and developer, W.J. Byrne Builders, Inc., and the City of Wildwood, Missouri. These investigations have been intended to determine whether this property is suitable for residential development based on environmental conditions. These investigations have included Phase I and Phase II ESAs, a data review, and a human health risk assessment. A brief summary of the past investigations at Strecker Forest follows:

1. **Remedial Action confirmation sampling.** A 0.15-acre portion of Strecker Forest property was included in the1996 remedial action performed by EPA that addressed dioxin-contaminated soils. This area is designated as the ―NPL Area" in the extreme northeast corner of the parcel and is depicted on Figure 3 in Appendix A with other features and locations of past sampling events. Soil sampling performed by EPA in February, 1990 established the boundary of dioxin-contaminated soil to be remediated at the Bliss-Ellisville by defining a clean perimeter immediately south of the creek

which flows across the northeast corner of the Strecker Forest parcel. Dioxin[d] was undetected in surface soils at a detection limit of 0.3 parts per billion (ppb) in the area which defined the clean perimeter. Dioxin was detected above the action level of 1 ppb in three sampling areas to the north which were partially located on the Strecker Forest Property (95% upper confidence levels (UCL) of 2.248 ppb, 1.366 ppb, and 1.269 ppb). Soil remediation performed in these areas involved removal of soil in lifts until reaching a residual dioxin concentration of less than 1 ppb in the upper foot (2 feet in stream bed areas) or less than 10 ppb at depths greater than 1 foot (2 feet in stream bed areas). The three sampling areas initially exceeding 1 ppb were further divided into 14 foot by 14 foot cells for remediation. Excavation proceeded by soil removal from individual cells until reaching cleanup criteria. Following soil removal, confirmation sampling was performed to verify that cleanup goals were achieved, and excavated areas were backfilled to original grade and restored. Remediated areas located in the intermittent stream bed were further stabilized with rip rap following backfill.

In addition to management of dioxin-contaminated soil, drum fragments were removed during the 1996 remedial action from the surface of one area located approximately 50 feet west of the southwest corner of the arena building in the northeast portion of Strecker Forest. The Final On-Scene Coordinator's Report (U.S. EPA, 1996a) for this action indicates that following removal of drum fragments, no contamination was observed in the area, and field screening using an immunoassay method did not detect the presence of BTEX compounds at a detection limit of 100 parts per million.

2. **Phase I ESA conducted by SCI Engineering, Inc., (SCI), dated March 15, 2000.** The Phase I ESA identified three environmental concerns (ECs). The first EC was a partially buried drum found near the Bliss property. The second EC was a disturbed area identified in a 1966 aerial photograph. The third EC was the potential for on-site impact due to groundwater migration from the Bliss property.

3. **Phase II ESA conducted by Brucker Engineering, Ltd., (Brucker), dated November 2004.** This report summarized information from the site assessment, for which eight test pits (TP-1 through TP-8) were excavated and subsurface soil samples were collected, nine direct-push subsurface soil samples (GP-A through GP-H) were collected, one sediment sample from a pond was collected, and one excavation pit (A4) soil sample was collected. In all, 19 samples were collected and analyzed for metals, pesticides, PCBs, SVOCs, and VOCs. During excavation of the test pits, the soils were visually inspected for disturbance and screened for VOCs with a photoionization detector (PID). No unusual observations or PID detections were reported. Analytical results were above residential RSLs at GP-F (PCBs), GP-H (naphthalene), TP-6 (PCBs), and A-4 (VOCs and SVOCs). Results also exceeded MRBCA-LDTLs at A-4 (cadmium, 1,3,5-trimethylbenzene, xylenes) and GP-H (PCE and 1,3,5-trimethylbenzene).

4. **Data Review of 18.3-Acre Tract performed by URS, dated May 1, 2008.** No additional environmental data was collected during this study. This data review concluded that the contaminants identified during the previous investigations were limited to an area adjacent to the Bliss subsite. The report suggested an additional investigation to complete delineation of the identified contamination. URS also recommended installing monitoring wells, fencing off the NPL Area, and sampling the solid waste and western pond areas.

5. **Phase II ESA conducted by Mundell & Associates (Mundell), dated March 3, 2010.** This report summarized information from the site assessment that included a geophysical survey, installation and

[d] During the remedial action, 2,3,7,8-TCDD was used as the indicator chemical for dioxin

sampling of seven monitoring wells (MW-1 through MW-7), collection of three groundwater samples from Geoprobe® borings (B-22, B-26, B-33), and collection of 42 soil samples (B-1through B-35 and MW-1 through MW-7). The geophysical survey identified 29 anomalies. After further consideration and acquisition of additional information, only one anomaly was determined to represent potential buried containers. Results that exceeded RSLs for residential soil were identified at B-10 and MW-6 for one or more VOCs, SVOCs, PCBs and/or dioxin. The Mundell report did not reference RSLs; these data were subsequently evaluated against RSLs. Results for soil also exceeded MRBCA lowest default target levels (LDTL) at MW-06 (methylene chloride, 2-methylnaphthalene, 2,4,5-trichlorophenol, 1,2,4-trimethylbenzene, 1,3,5-trimethylbenzene, and xylenes). Analytical results exceeded the EPA Maximum Contaminant Level (MCL) criteria for bis-(2-ethylhexyl) phthalate in a groundwater sample collected from soil boring B-33. Groundwater results exceeded MRBCA-LDTLs at monitoring well MW-6 for 2-methylnaphthalene, 1,2,4-trimethylbenzene, and 1,3,5-trimethylbenzene.

6. **Human Health Risk Assessment (HHRA) prepared by Environmental Stewardship Concepts and Henshel EnviroComm, dated March 14, 2011.** No additional environmental data was collected during this study. The HHRA recommended restricting access and posting the property and performing additional investigation to address identified data gaps and uncertainties.

Figure 3 in Appendix A depicts the Stecker Forest sampling locations from the Brucker and Mundell investigations. Figure 4 in Appendix A depicts the Strecker Forest sampling locations where EPA RSL and/or MRBCA-LDTL soil screening level criteria were exceeded. Table 1 below summarizes the soil screening level exceedences reported in past investigations of Strecker Forest. Table 4 in Appendix B presents a summary of all detected compounds and/or qualified detections in soil sample results reported in past Strecker Forest investigations.

Ground water sampling conducted during past investigations at Strecker Forest is limited to a single set of samples collected from 7 monitoring wells installed on the property and samples from three boreholes during the Mundell Phase II ESA. The reported exceedences of EPA RSL or MRBCA LDTL criteria for ground water are summarized in Table 2 below. The results for all detected compounds and/or qualified detections in groundwater samples collected from Strecker Forest are presented in Appendix B, Table 5.

TABLE 1
STRECKER FOREST PROPERTY
HISTORIC SOIL SAMPLE ANALYTICAL RESULTS SUMMARY
SCREENING LEVEL EXCEEDENCES

Sample Number (Results mg/kg)	Depth (feet bgs)	Date	Benzo(b)fluoranthene	Benzo(a)pyrene	Cadmium	Dibenz(a,h)anthracene	1,2-Dibromo-3-Chloropropane	Ethylbenzene	2,3,7,8-TCDD (Tetrachlorodibenzo-p-dioxin)	Methylene Chloride	2-Methylnaphthalene	Naphthalene	PCBs (arochlor 1248)	PCBs (arochlor 1254)	PCBs (arochlor 1260)	Tetrachloroethene	1,2,4-Trichlorobenzene	2,4,5-Trichlorophenol	1,2,4-Trimethylbenzene	1,3,5-Trimethylbenzene	Xylenes
RSL Residential Soil			0.15	0.015	70	0.015	0.0054	5.4	4.5 pg/g	11	310	3.6	0.22	0.22	0.22	0.55	22	6100	62	780	630
MRBCA LDTL			6.19	0.62	9.31	0.62	0.0011	39.9	NE	0.0176	7.55	0.325	2.2	2.2	2.2	0.141	18.7	0.0293	3.93	0.882	24.7
GP-A	0-3	1/23/04	ND	ND	ND	NA	**0.0029**	ND	NA	**0.0033**	ND	**0.0064**	ND	ND	ND	**0.0029**	**0.0035**	NA	**0.0017**	ND	**0.004**
GP-F	0-3	1/23/04	NA	ND	**2.9**	NA	ND	ND	NA	**0.0039**	ND	ND	ND	ND	**0.36**	**0.0039**	ND	NA	**0.0012**	ND	**6E-04**
GP-H	9-12	1/23/04	NA	ND	**0.36**	NA	ND	**0.47**	NA	ND	**0.42**	**6.1/4.5**	ND	ND	ND	**0.27**	ND	NA	**2.7**	**2.4**	**3.4**
TP-6	Test Pit	1/23/04	NA	ND	ND	NA	ND	ND	NA	ND	ND	ND	ND	**1.1**	ND	**0.0025**	**0.0008**	NA	ND	ND	**8E-04**
A-4	Test Pit	1/23/04	ND	**0.15**	**28.5**	ND	ND	**17**	NA	ND	**2.8**	**11/4.4**	ND	ND	ND	**0.67**	**43**	NA	ND	**53**	**67.8**
B-10	0.5-2	11/5/09	ND	ND	NA	ND	ND	ND	**150**	**0.0014 JB**	ND	ND	ND	ND	**0.033 J**	ND	ND	ND	ND	ND	ND
MW-06	7-10	11/13/09	**0.18 J**	**0.12 J**	NA	**0.11 J**	ND	**7**	**9100 E; 6500 D**	**0.15 J**	**8.1**	**14; 49 D; 37 E**	**0.24**	**0.13**	**0.14**	ND	**0.16 J**	**0.073 J**	**9.2**	**0.95**	**13.1 FB**
MW-06 (dup)	7-10	11/13/09	**0.12 J**	**0.072 J**	NA	**0.073 J**	ND	**44**	**2000**	**1 J**	**5**	**71; 27 E; 22 D**	**0.21**	**0.12**	**0.12**	ND	ND	ND	**58**	**14**	**198**

Notes:

Dioxin Results in parts per trillion

J	Estimated Result. Result is less than the reporting limit.
B	The associated method blank contains analyte at a level above the MDL.
FB	Compound detected in associated field blank.
E	Estimated result.
D	Result was obtained from the analysis of a dilution
Q	Estimated maximum possible concentration
RSL	Regional Screening Level
MRBCA	Missouri Risk-based Corrective Action
LDTL	Lowest default target level
NE	Not established
ND	Not detected
NA	Not analyzed
mg/L	milligrams per kilogram
bgs	below ground surface
dup	duplicate
PCB	polychlorinated biphenyls

TABLE 2 STRECKER FOREST PROPERTY HISTORIC GROUNDWATER SAMPLE ANALYTICAL RESULTS SUMMARY SCREENING LEVEL EXCEEDENCES										
Sample # (Results µg/L)	**Date**	**Bis-(2-ethylhexyl)phthalate**	**Methylene Chloride**	**2-Methylnaphthalene**	**Napthalene**	**Trichloroethene**	**1,2,4-Trimethylbenzene**	**1,3,5-Trimethylbenzene**	**Vinyl Chloride**
EPA MCL		6.0	5.0	NE	NE	5.0	NE	NE	2.0
MRBCA LDTL		6.0	5.0	11.7	1.09	5.0	7.06	7.05	2.0
B-33	11/13/09	**12**	ND	ND	ND	ND	ND	ND	ND
MW-06	11/13/09	ND	**7.2 J B**	**15**	**290 B/300 D/260 E**	**4.2 J**	**180**	**25**	**3.5 J**
MW-06 (dup)	11/13/09	ND	**3.9 J B**	**13**	**390 B/240 D/220 E**	**5.1 J**	**240**	**31**	**3.9 J**

J	Estimated Result. Result is less than the reporting limit.
E	Estimated result.
D	Result was obtained from the analysis of a dilution
B	The associated method blank contains analyte at a level above method detection limit
EPA	Environmental Protection Agency
MCL	Maximum contaminant level
MRBCA	Missouri Risk-based Corrective Action
LDTL	Lowest default target level
NE	Not established
ND	Not detected
NA	Not analyzed
µg/L	micrograms per liter
dup	duplicate

Callahan Property

Several environmental investigations have been conducted at the Callahan subsite subsequent to the drum removal action performed in 1981-1982. A brief summary of the investigations conducted at the Callahan subsite follows:

1. **Remedial Investigation by Black & Veatch Engineers-Architects (Black & Veatch) dated September 21, 1983.** Field activities included collection of seven soil samples (ELL-21through ELL-25, ELL-31, ELL-32) and two surface water samples (ELL-26 and Ell-27). Soil results exceed EPAs residential RSLs at ELL-31 and ELL-32 for methylene chloride and oxirane in

surface soil samples collected from the former drum staging areas. Surface water results were non-detect.

2. **Phase II Environmental Assessment by Brucker dated December 1999.** During this investigation, five composite samples were collected and analyzed for dioxin, PCBs, pesticides, and metals. All sample results were non-detect. A magnetic survey during this investigation showed no evidence of buried metal drums.

3. **Site Reassessment/Post Removal Sampling Report prepared by MDNR, January 31-February 2, 2005.** The purpose of the 2005 MDNR site reassessment at the Callahan property was to determine if any residual soil contamination existed at the site at concentrations that would warrant further removal response. A total of 29 soil and five sediment samples were collected during January 31 through February 2, 2005. All samples were analyzed for base neutral/acid extractables (SVOCs), pesticides/herbicides, PCBs, total RCRA metals, and dioxin. Results exceeded EPA's residential RSL's for soil at EU-6 for ethylbenzene, PCE, and 1,2,4-trimethylbenzene. MRBCA LDTLs for various VOCs and SVOCs were exceeded in samples collected from EU-5 and EU-6.

4. **Removal Site Evaluation Report at Callahan Property Site prepared for EPA dated August 5, 2005.** This report incorporated results of the 2005 MDNR Site Reassessment. No additional environmental data was collected for this effort.

Figure 5 in Appendix A depicts the Callahan property sampling locations from the Black and Veatch and MDNR investigations. Figure 6 in Appendix A depicts the Callahan property sampling locations where RSLs and MRBCA-LDTLs soil screening level criteria were exceeded. Table 3 below summarizes the screening level exceedences for soil sampling reported in past investigations of the Callahan property. Table 6 in Appendix B presents a summary of all detected compounds and/or qualified detections in soil sampling results reported for past investigations at the Callahan property.

Table 7 in Appendix B summarizes RSL and MRBCA LDTL screening level exceedences reported for past investigations at Strecker Forest separated into categories corresponding to each of the areas investigated. Table 8 in Appendix B summarizes RSL and MRBCA LDTL screening level exceedences reported for the previous Black and Veatch and MDNR sampling events at the Callahan property separated by areas investigated. Table 9 in Appendix B summarizes sampling performed during the 1999 ESA at the Callahan property.

TABLE 3
CALLAHAN SUBSITE
HISTORIC SOIL SAMPLE ANALYTICAL RESULTS SUMMARY
SCREENING LEVEL EXCEEDENCES

Sample #	Depth (feet bgs)	Date	Benzene	2,4-Dimethylphenol	Ethylbenzene	Methylene Chloride	4-Methylphenol	Naphthalene	Oxirane (Dimethylene Oxide)	Phenanthrene	Tetrachloroethene	Toulene	1,1,2-Trichloroethane	Trichloroethene	1,2,4-Trimethylbenzene	1,3,5-Trimethylbenzene	Xylenes
RSL Residential Soil			**1.1**	**1200**	**5.4**	**11**	**310**	**3.6**	**0.17**	**NE**	**0.55**	**5000**	**1.1**	**2.8**	**62**	**780**	**630**
Missouri default MRBCA			**0.0561**	**9.37**	**39.9**	**0.0176**	**0.64**	**0.325**	**NE**	**0.0158**	**0.141**	**29.8**	**0.0448**	**0.141**	**3.93**	**0.882**	**24.7**
ELL-31-SL-01		1/6/83	ND	ND	ND	**11.0**	ND	ND	**10.0**	ND	ND	**0.79**	ND	ND	ND	ND	**0.41**
ELL-32-SL-01		1/6/83	ND	ND	ND	**11.4**	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
EU-5, SB-06 (-25)	8	2/1/05	ND	NA	**2.43**	ND	NA	**3.03**	ND	NA	**0.0352**	**32.1**	ND	ND	**17.2**	**6.44**	**8.52**
EU-5, all borings (-26)	Composite (8.5)	2/1/05	NA	**0.177**	NA	NA	ND	**0.601**	NA	ND	NA	NA	NA	NA	NA	NA	NA
Duplicate EU-5 (-27)	Composite (8.5)	2/1/05	NA	**1.31**	NA	NA	**0.729**	**1.69**	NA	ND	NA	NA	NA	NA	NA	NA	NA
EU-6, SB-03 (-33)	7.5	2/2/05	ND	NA	**3.57**	ND	NA	**0.050**	ND	NA	**0.713**	**71.2**	**0.0881**	ND	**5.17**	**0.508**	**13.1**
EU-6, SB-05 (-34)	9.5	2/2/05	**0.156**	NA	**20.1**	ND	NA	**2.95**	ND	NA	**5.72**	**1,180**	ND	ND	**85.6**	**28.7**	**58.4**
EU-6, SB-05 (-35) Dup	9.5	2/2/05	**0.124**	NA	**29.5**	ND	NA	**3.4**	ND	NA	**7.77**	**1,400**	**0.046**	**0.214**	**95.4**	**35.5**	**84.7**
EU-6, all borings (-36)	Composite (refusal)	2/2/05	NA	**11.7**	NA	NA	**4.88**	**0.461**	NA	**0.126**	NA	NA	NA	NA	NA	NA	NA

Notes:

RSL	Regional Screening Level
MRBCA	Missouri Risk-based Corrective Action
LDTL	Lowest default target level
NE	Not established
ND	Not detected
NA	Not analyzed
mg/L	milligrams per kilogram
bgs	below ground surface

6.0 SAMPLING STRATEGY AND METHODOLOGY

As discussed above, conditions at the Strecker Forest property have been previously characterized during Phase II ESAs performed in 2004 and 2010. In addition, conditions in the extreme northeast portion of the property were characterized during past EPA remediation of the adjacent Bliss-Ellisville site. These investigations have provided a great deal of information about conditions at the Strecker Forest property. However, previous studies have recommended additional investigation to address uncertainties regarding potential contaminants in certain portions of the property and hydrogeological conditions in the area. EPA has agreed to perform additional characterization of conditions that could affect Strecker Forest and surrounding areas to increase confidence in the assessment of potential human health risks. The purpose of this ESR is to build upon previous studies to establish a comprehensive data set that will support a valid assessment of human health risks for proposed residential land use at Strecker Forest, and to characterize the potential for conditions to impact existing residences in nearby areas.

The study area for the proposed sampling at the Strecker Forest property includes the entire 18.3 acre tract proposed for development and a portion of the Callahan property to the south of Strecker Road. During the most recent Phase II ESA by Mundell, six areas of interest were identified and investigated on the Strecker Forest Property:

1. The former Dozier and Primm residences near the southeast property boundary.
2. A pond located near the western property boundary in the southwestern portion of the site (Western Pond Area).
3. An existing solid waste disposal area located within a drainage ravine in the central part of the site (Solid Waste Disposal Area).
4. An historical roadway interpreted as a former haul road located along the central drainage ravine (Old Haul Road).
5. An area in the northeastern portion of the site that was identified in the 2000 SCI report as formerly disturbed, based on historical aerial photography from 1966 (Eastern Disturbed Area).
6. An area in the extreme northeast portion of the site that was included in a 1996 cleanup conducted at the adjoining Bliss subsite of the Ellisville NPL site (NPL Area).

The design of the current investigation will consider these previously designated areas, as well as characterizing conditions in several areas excluded from previous studies. The overall investigation strategy will involve a combination of methods used to gather additional data and information that can be used to better characterize potential risks associated with conditions across the property. Following receipt of results, an initial screening level assessment will be performed considering both data generated during this investigation and data from past investigations using appropriate EPA RSL criteria. MRBCA LDTL criteria have been considered in the design of this investigation, but will not be used for the initial screening level assessment of results. Following the initial screening of results, a more in-depth human health risk assessment may be performed if conditions warrant. The scope of the current investigation will include:

- Geophysical investigation for metals
- Exploratory trenching
- Collection of surface soil samples using an incremental sampling protocol
- Collection of subsurface soil samples from borings
- Collection of interior dust samples from existing structures
- Installation of groundwater monitoring wells
- Measurement of static water levels in new and existing monitoring wells
- Collection of groundwater samples from new and existing monitoring wells
- Hydraulic conductivity testing
- Dye tracing studies (DTS).

The various elements of the current investigation will be applied in consideration of existing validated data from previous investigations. In general, data from previous investigations that were not reported as validated data, but were instead assigned a data qualifier code by the analytical laboratory (e.g. J-coded or Q-coded data not further supported by a data validation study) will not be considered representative of actual conditions or directly influence the current study design. In some cases, however, these qualified results may represent data gaps that will be addressed by this current investigation.

Past exceedences of EPA RSLs for residential soils or MRBCA-LDTL screening level criteria will be used to guide the study design. In the absence of other information concerning potential exposure, exceedences of screening level criteria are not a cause of concern for human health, but rather serve as indicators of additional data needs. Certain data acquisition efforts in this current investigation will focus on further characterization of conditions previously identified, and other efforts will be directed at characterizing conditions in areas not previously investigated. In some instances, additional data will be obtained in areas where results from previous investigations were below screening level criteria to confirm the findings of the past studies.

This investigation will include installation and sampling of six monitoring wells to further characterize ground water quality and hydrogeological conditions in the area. Results of ground water monitoring and hydrogeologic studies will be used to assess the potential for vapor intrusion to pose concern for new and existing residential land use.

The selection of analytes for the Expanded Site Review will be based on results of previous investigations. All samples collected from the entire study area, including both Strecker Forest and the Callahan property, will be analyzed for the presence of semi-volatile organic compounds (SVOCs), and polychlorinated biphenyls[e] (PCBs). Analysis for volatile organic compounds (VOCs) will be performed for all subsurface and groundwater samples collected from Strecker Forest and Callahan properties. Analysis for dioxin-related compounds[f] will be performed for samples collected from Strecker Forest, but not for samples collected from the Callahan property, since analysis of samples collected during the three previous Callahan investigations cited above did not detect the presence of dioxin contamination.

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[e] Initial PCB analysis will include Arochlors only. Analysis of second-tier incremental surface soil samples will include PCB congener analysis, if warranted.

[f] Dioxin analysis will include seventeen 2,3,7,8-substituted dioxin and furan congeners that contribute to dioxinTEQ.

Metals will not be included in this Expanded Site Review because previous investigations at both Strecker Forest and the Callahan property did not identify metals concentrations in soil samples at levels exceeding typical background levels for the study area. Arsenic was detected in 19 soil samples collected on Strecker Forest at levels exceeding its RSL for residential soil (0.39 milligrams per kilogram [mg/kg]), and 18 samples exceeded its MRBCA LDTL (3.89 mg/kg); however, the mean concentration of arsenic in soils in Saint Louis County, Missouri, is 10.561 mg/kg (United States Geological Survey [USGS] 2011). Two soil samples contained arsenic at concentrations of 12.1 and 13.6 mg/kg, only marginally exceeding the mean concentration for arsenic in the county. Arsenic was also detected in 11 samples collected from the Callahan property at levels exceeding its RSL for residential soil and its MRBCA LDTL. None of these samples contained arsenic at concentrations that exceeded the mean concentration for arsenic in the county. The arsenic in samples collected from the Strecker Forest and Callahan properties is considered naturally occurring and is not within the scope of the Superfund investigation.

Likewise, lead concentrations detected in soils during previous investigations performed within the study area are considered typical of background lead levels found in soil in the area. The mean concentration of lead in soils in Saint Louis County, Missouri, is 40.95 mg/kg (United States Geological Survey [USGS] 2011). Nineteen soil samples collected from the Strecker Forest property contained lead at concentrations exceeding its established MRBCA LDTL of 3.74 mg/kg. One of the samples collected contained lead at a concentration of 272 mg/kg, exceeding the MRBCA Tier 1 risk-based target level (RBTL) for residential land use (surficial soil) of 260 mg/kg, but below the EPA RSL for residential soil of 400 mg/kg. Eleven soil samples from the Callahan property contained lead at concentrations exceeding the MRBCA LDTL. None of the samples contained lead at a concentration that exceeded the Tier 1 RBTL for residential land use (surficial soil). The lead levels detected at the Strecker Forest and Callahan properties during past investigations are consistent with background lead levels reported for the study area and are not within the scope of the Superfund investigation.

Sampling activities for the current investigation will require approximately 2 weeks to complete. EPA will be responsible for obtaining access to the properties and will provide equipment and personnel for subsurface soil investigation (soil borings). MDNR will provide oversight and personnel and equipment for monitoring well installation and hydrogeological investigation (static water level measurement, hydraulic conductivity testing and dye tracing study). Four Tetra Tech START team members (STM) are anticipated to be needed to perform and/or support the activities described in this work plan. Where applicable, the standard operating procedures (SOP) and chain-of-custody (COC) procedures referenced in the attached QAPP will be followed throughout the sampling activities to assure the integrity of the samples from the time of collection until submittal to the laboratory for analysis. Disposal of investigation-derived wastes (IDW) and procedures for equipment and personal decontamination will be addressed in a site-specific Health and Safety Plan (HASP) prepared by the START contractor. Most IDW is expected to consist of disposable sampling supplies (gloves, paper towels, etc.) that will be disposed of off-site as uncontaminated solid waste. The QAPP provided in Appendix C presents specific sampling analytical methods and related quality assurance/quality control (QA/QC) procedures.

6.1 GEOPHYSICAL SURVEY

The geophysical survey will be conducted using two complementary surface geophysical methods—terrain conductivity and total field magnetometry. The terrain conductivity survey will be performed with a Geonics EM-31-MK2 terrain conductivity meter, and the magnetometer survey will be conducted with a Geometrics G-858 MagMapper proton precession magnetometer. Descriptions of the basic principles and applications of these instruments are as follows:

- The EM31-MK2 maps geologic variations, groundwater contaminants, or any subsurface feature associated with changes in ground conductivity, using a patented electromagnetic inductive technique that allows measurements without electrodes or ground contact. With this inductive method, surveys can be carried out under most geologic conditions, including those of high surface resistivity such as sand, gravel, and asphalt. Ground conductivity (quad-phase) and magnetic susceptibility (in-phase) measurements are read directly from an integrated DL600 data logger (which can be easily removed from the console for data transfer). Real-time graphical presentation of the data during data acquisition is possible by connecting a computer directly to the RS232 output port on the front panel with an optional RS232 cable. The effective depth of exploration is about 6 meters, making it ideal for geotechnical and environmental site characterization. Important advantages of the EM31-MK2 over conventional resistivity methods are the speed with which surveys can be performed, the precision with which small changes in conductivity can be measured, and continuous readout and data acquisition while traversing the survey area. Additionally, the in-phase component is particularly useful for detection of buried metallic structures and waste materials (Geonics Limited 2005).

- The G-858 system consists of a belt-mounted display/logging console connected to a cesium sensor mounted on a hand-held counterbalanced staff. The console contains electronics to acquire magnetic field data position (Global Positioning System [GPS] or XY) and display it on an LCD screen for review and editing. The console stores up to 8 hours of data in memory for a single-sensor system and uploads it to a processing computer for detailed analysis (Geometrics 2006). The magnetic data can be used to distinguish nonferrous burials and provide additional characterization of any ferrous burials (depth, mass, etc.).

When used for subsurface exploration, both instruments are susceptible to interferences from surficial sources of magnetic and electromagnetic fields, such as fences, buildings, overhead power lines, vehicles, and reinforced concrete. If such sources are present within or near the survey areas, their effects must be accounted for when interpreting the data. Consequently, large sources of interference at the site could mask the presence of buried materials.

6.1.1 Calibration Procedures

Absolute calibration of the EM-31 is performed by the manufacturer in an area of known and constant conductivity. However, several functional tests will also be performed in the field prior to beginning the survey. A null calibration, phasing check, and instrument sensitivity check will be performed as specified in the EM-31's operating manual. These tests will be performed in an undisturbed area outside of the survey boundaries.

The magnetometer also is calibrated at the factory. However, most magnetometers require tuning in the field to narrow the signal window. This procedure will be performed in an undisturbed area outside of the survey area boundaries, as specified in the G-858's operating manual.

6.1.2 Survey Area and Data Acquisition

The proposed survey areas are the Western Pond Area, the Eastern Disturbed Area, and the former drum burial area (fill area) on the Callahan property. The geophysical survey areas are depicted for the western pond and eastern disturbed areas at Strecker Forest and the fill area at the Callahan property on Figures 7 and 8 in Appendix A which also presents other elements of the current investigation. A survey grid will be established with transects located 5 feet apart across these survey areas, and readings from both instruments will be recorded at 5-foot intervals along each transect.

6.2 EXPLORATORY TRENCHING

A trenching excavation survey will be conducted where anomalies are identified by the geophysical survey. Excavation will be conducted with heavy equipment, and may include skid loaders, bulldozers, excavators, and backhoes, as well as hand tools. Unauthorized access to the site during the investigation will be restricted by the Site Safety Coordinator, and air monitoring will be utilized throughout the assessment to detect any emissions that may threaten workers or neighboring properties. A PID and/or multi-gas meter will be used to determine the presence of VOCs. Excavated trenches will be visually assessed for the presence of waste material. The trench dimensions will vary, depending on location and site conditions. The excavations will continue until undisturbed soil or bedrock is encountered, or the maximum bucket reach of the trenching equipment is achieved.

Each test trench will first be assigned an identification number. Trench sites will be staked prior to excavation activities, based on geophysical anomalies. Locations of trenches will be based upon the results of the geophysical survey and judgment of START and EPA on-site personnel.

An area directly adjacent to each excavation trench will be covered with two layers of 6 mil polyethylene sheeting to stockpile excavated waste, if encountered. The plastic sheeting will be placed downwind of each trench location, and the outer perimeter will be bermed to ensure no runoff leaves the excavation area. If possible, excavated soil will be returned to the trench(es) before the end of each work day. If soil cannot be replaced after each work day, the excavated soil will be covered for protection from the elements.

Exploratory trenching performed at Strecker Forest will follow detailed excavation procedures (Appendix E, health and safety practices for excavation) in order to adhere to applicable environmental and safety standards. Trench dimensions will be contingent on the stability of excavation high-walls and equipment capabilities. If trench high-walls become unstable, excavation equipment will slope high-walls to ensure safe working and operating conditions at each site. The excavation rate will be controlled by a professional operator in order to prevent rupture of intact or sealed containers that may be present.

STMs will observe and record general trends, stratigraphic features, and relative volumes of excavated materials. Native soils encountered will be classified using the Unified Soil Classification System (USCS). Any buried waste will be removed, characterized, and properly disposed of in accordance with applicable local, state, or federal regulations. Following exploratory trenching activities, the site will be returned to pre-excavation condition. The excavator bucket will be used to compact soils during backfilling, and will be used to restore the surface to original grade. Disturbed areas will be reseeded.

6.3 SURFACE SOIL SAMPLING METHODOLOGIES

Surface soil samples will be collected using an incremental soil sampling strategy. This sampling strategy involves collection of many samples from a defined area that are composited for analysis. Individual Decision Units (DUs) are established for the study area and subdivided into a number of Sampling Units (SUs). A multi-aliquot (composite) sample is then collected from each SU. A portion of the composite sample from each SU is combined with portions of composite samples from each of the other sampling units to create a ―top-tier” composite sample representing the entire DU. Initial analysis is performed on the top tier composite sample representing the entire decision unit (DU). A portion of the composite samples from each SU is retained for possible future analysis if the top tier sample analysis indicates the presence of contamination that could exceed a level of concern in individual SUs. For the purpose of the current investigation, each DU will be subdivided into four SUs to implement the incremental sampling methodology described above. A nine aliquot sample will be collected from each SU, homogenized, and split to provide sample portions to be combined to form a top-tier sample for each DU, and other portions retained for subsequent analysis, if required.

Compared to collection of discrete samples, this incremental sampling approach provides greater assurance that potential hot spots are not missed, because many sample aliquots are collected across the entire DU and combined for analysis. Soil samples that are collected and retained from individual SUs within the DU can be analyzed for more definitive characterization in the event the overall top-tier DU sample concentration indicates that individual SUs may exceed a level of concern. This approach involves more resource-intensive sample collection, but provides for an economy of analytical costs, because samples collected from smaller quadrants within larger DUs are analyzed only if the initial sample representing the entire DU indicates the potential presence of contamination.

Incremental soil sampling involves use of techniques to ensure that the sample collection procedures provide data that are scientifically appropriate for the project. A suite of sample collection and preparation techniques is applied that manages the heterogeneous nature of soil contamination to ensure that correct decisions are made. Incremental-based sample preparation reduces the chance of misleading results stemming from sample heterogeneity (as measured by laboratory duplicates and split samples). At larger spatial scales on the order of yards to acres, incremental soil sampling manages field heterogeneity and sample-to-sample variation by means of high-density sample (increment) collection.

Thirty-eight DUs (sometimes referred to as exposure units [EU]) have been established at Strecker Forest to characterize surface soils using an incremental soil sampling approach. Twenty-three DUs have been designated to correspond to individual home site boundaries presented in the preliminary plat for property development. These home site exposure units range from 0.22 to 0.43 acres in area (see Figure 9, Appendix A). The portion of Strecker Forest not planned for residential home sites has been designated as a –preservation area." This preservation area has been divided into eight DUs with areas ranging from 0.96 to 1.17 acres. Seven additional DUs with areas ranging from approximately 0.18 to 0.26 acres have been established near the NPL Area. The purpose of the incremental surface soil sampling in the vicinity of the NPL area is to confirm residual conditions following past cleanup activities and to assess any subsequent impacts from the NPL Area on adjoining areas of Strecker Forest. The seven DUs established to assess conditions at and near the NPL Area conform to the stream features and topography in the area. The 38 DUs established for the Strecker Forest property are depicted on Figure 7 in Appendix A.

Three DUs have been designated on the Callahan property for characterization of surface soils using the incremental sampling approach. One DU corresponds to an area of approximately 0.19 acres, where soils were previously disturbed during the 1981 drum removal activities (fill area). Two additional DUs have been designated in areas that were used for drum staging operations during the 1981-1982 drum removal activities. Records indicate that the northern staging area is approximately 0.23 acres and the western staging area is approximately 0.08 acres in area. The three DUs designated at the Callahan property are depicted on Figure 8 in Appendix A, and may be adjusted due to field conditions encountered or in consideration of geophysical survey results.

As described above, each of the 38 DUs on Strecker Forest and 3 DUs on the Callahan property will be subdivided into four SUs. A composite sample consisting of nine aliquots, each collected from 0 to 2 inches below ground surface (bgs), will be collected in each SU using a clean, dedicated, stainless steel spoon, or equivalent; placed in a clean, disposable aluminum pie pan; and homogenized. The samples from each quadrant will be transferred to 8-ounce jars and stored. A portion of each sample collected from a quadrant will be combined and homogenized to represent one composite sample for the entire DU. Most of this sample will be transferred to two 8-ounce jars and submitted to a Contract Laboratory Program (CLP) laboratory or to the EPA Region 7 laboratory for analysis for SVOCs and PCBs. Samples collected for dioxin analysis will be transferred to a separate 8-ounce jar and submitted to a CLP laboratory or to the EPA Region 7 laboratory for analysis for dioxin toxic equivalency (TEQ) compounds. The remaining portion of the sample will be transferred to sealed sample containers and retained for possible future analysis. All soil samples will be maintained at or below a temperature of 4 degrees Celsius (°C). Pertinent data, including property ownership information, sample locations (GPS coordinates), and analyses to be performed will be recorded on field sheets for each sample. Sketches of the DUs indicating individual SU locations will be prepared in the field.

6.4 SUBSURFACE SOIL SAMPLING METHODOLOGIES

Subsurface soil samples will be collected from 30 locations at the Strecker Forest and Callahan properties (see Figures7 and 8, respectively, in Appendix A). At each of those boring locations, continuous soil cores will be collected with a Geoprobe® direct-push apparatus. Geoprobe® sample locations were selected to address the areas described below and to cover the geographic extent of the site.

At each borehole, a Geoprobe® Macro-Core soil sampler fitted with a disposable polyvinyl chloride (PVC) sleeve will be advanced to 12 feet bgs, groundwater, or refusal, whichever is encountered first. The soil core will be retrieved and screened for VOCs with a PID. Samples for laboratory analysis will be collected (from each borehole) from the 2-foot interval that yields the highest PID reading. If none of the boring intervals indicates elevated PID readings, a sample will be collected from an interval with visible staining or other indication of potential chemical contamination. If no soil intervals exhibit elevated PID levels or visible staining, a sample will be collected from the deepest soil interval along the boring.

Soil samples for analysis for VOCs will be collected following EPA Method 5035. VOC samples will be placed into two 40-milliliter vials preserved with sodium bisulfate (5 grams of soil in each) and two unpreserved 40-milliliter vials (each filled with soil). Then soil from the sample interval will be removed from the PVC sleeve and placed in a disposable aluminum pie pan for homogenization prior to transfer to three 8-ounce jars for the remaining analyses (dioxin TEQ, SVOCs, and PCBs). Following sample collection, excess soil will be returned to the respective boreholes. Remaining void space in the boreholes will be filled with bentonite.

The lithology of the materials encountered, along with any other pertinent information, will be logged by qualified personnel. Soils will be classified and described on boring logs, using the USCS, following methods outlined in ASTM International (ASTM) standard D 2488-93 (ASTM 1993).

Pertinent data, including analyses to be performed and sample location data, will be recorded on field sheets for each sample. All soil samples will be stored in coolers maintained at or below 4 °C pending submittal to the CLP laboratory or to the EPA Region 7 laboratory.

Collection of subsurface soil samples is planned at locations selected in consideration of results of previous subsurface investigations. The following discussion presents the rationale for selection of soil boring locations in each area of interest:

Former Dozier and Primm Residences

Subsurface soil sampling conducted by Mundell (2010) in the vicinity of the former Dozier and Primm residences did not detect the presence of contaminants exceeding RSLs for residential soil or MRBCA LDTLs. No additional subsurface soil sampling is planned for this area.

Western Pond Area

Extensive subsurface soil sampling of the Western Pond Area by Mundell (2010) and Brucker (2004) did not detect the presence of contaminants exceeding RSLs for residential soil or MRBCA LDTLs. In recognition of concerns that have been raised regarding potential for migration of contaminants in this area to shallow groundwater, three soil borings are planned for this area, as depicted on Figure 7 of Appendix A. Following collection of the soil cores, one of these borings will be converted to a permanent monitoring well. Results of the geophysical survey may also guide soil boring locations in this area.

Old Haul Road

The Old Haul Road is located adjacent to the Solid Waste Disposal Area in the central portion of Strecker Forest. Subsurface soil sampling by Mundell (2010) in the vicinity of the central haul road did not detect the presence of contaminants exceeding RSLs for residential soil or MRBCA LDTLs. No additional subsurface soil sampling is planned for this area.

Solid Waste Disposal Area

Subsurface soil sampling by Mundell (2010) in the vicinity of the Solid Waste Disposal Area did not detect the presence of contaminants exceeding RSLs for residential soil or MRBCA LDTLs. Subsurface soil sampling by Brucker (2004) detected the presence of 1,2-dibromo-3-chloropropane (a SVOC) at 0.0029 parts per million (ppm), exceeding the MRBCA LDTL of 0.0011 ppm. Also, Arochlor 1260 was detected at a concentration of 0.36 ppm in a subsurface sample, and Arochlor 1254 was detected at a concentration of 1.1 ppm in a test pit sample, exceeding the MRBCA LDTL of 0.22 ppm for Arochlors. Three additional soil borings are planned for the Solid Waste Disposal Area, as depicted on Figure 7 in Appendix A.

Eastern Disturbed Area

Subsurface sampling by Brucker (2004) detected the presence of one metal (cadmium) exceeding the MRBCA LDTL, one SVOC (benzo(a)pyrene) exceeding the RSL for residential soil, and six VOCs (ethylbenzene, naphthalene, PCE, 1,2,4-trichlorobenzene, 1,3,5-trimethylbenzene, and xylene) exceeding MRBCA criteria and/or RSLs for residential soil. These screening level exceedences were reported in a single sample of soil excavated using a high-lift loader and are presented on Figure 4, Appendix A. Other samples collected by EPA (Black & Veatch 1983), Brucker (2004), and Mundell (2010) did not show the presence of contaminants above EPA RSLs for residential soil or MRBCA LDTL criteria in the Eastern Disturbed Area. Collection of four additional borings is planned near the 2004 Brucker sample location A-4 (location of previous elevated levels), as depicted on Figure 7 in Appendix A. Results of the geophysical survey may also guide soil boring locations in this area.

NPL Area

Subsurface sampling by Mundell (2010) identified the presence of dioxins, six VOCs (ethylbenzene, 2-methylnapthalene, naphthalene, 1,2,4-trimethylbenzene, 1,3,5-trimethylbenzene, and xylene), and Arochlor 1248 at levels exceeding EPA RSLs for residential soil or MRBCA LDTL criteria in one subsurface soil sample collected at location MW-6. Dioxins were also detected above the EPA RSL for residential soil in subsurface soil samples collected by Mundell at location B-10. In addition, subsurface sampling by Brucker (2004) identified the presence of three VOCs (naphthalene, PCE, and 1,3,5-trichlorobenzene) in a single subsurface sample location GP-H. These screening level exceedences are presented in Figure 4, Appendix A. No contaminant concentrations exceeded EPA RSLs for residential soil or MRBCA LDTLs in the remaining nine Mundell borings and two Brucker borings collected from the NPL Area. Six additional borings in close proximity to Mundell MW-6 and Brucker boring GP-H are planned for this investigation, as depicted on Figure 7 in Appendix A.

Additional Areas in Strecker Forest

Eight additional soil borings are planned for Strecker Forest in areas that were not characterized during previous investigations. The locations of these eight additional soil borings were selected to improve the spatial distribution of subsurface sampling points. These additional soil borings (SB-01, -02, -03, -04, -08, -10, -11 and -19) were located in eight areas at the Strecker Forest property which were most remote from previous subsurface sampling points. These additional soil boring locations are depicted in Appendix A, Figure 7.

Callahan Fill Area

During the 2005 MDNR investigation of the former drum burial area at the Callahan property, a number of VOCs and SVOCs exceeding MRBCA LDTLs were identified in subsurface soils, including: naphthalene, toluene, 1,2,4-trimethylbenzene, 1,3,5-trimethylbenzene, 4-methylphenol, PCE, 1,1,2-trichloroethane, ethylbenzene, xylene, trichloroethene, 2,4-dimethylphenol, and phenanthrene. These exceedences are presented in Appendix A, Figure 6. Of these compounds, only PCE, ethylbenzene, and 1,2,4-trimethylbenzene exceeded EPA RSLs for residential soil. To better define the boundary of potentially impacted soils, incremental soil sampling and four additional soil borings are planned for this investigation in the Callahan fill area, as depicted on Figure 8 in Appendix A.

Callahan Former Drum Staging Areas

During the 1983 EPA Remedial Investigation (RI), surface soil sampling at the two former drum staging areas on the Callahan property identified the presence of methylene chloride and oxirane (both VOCs) that exceeded RSLs for residential soil and/or MRBCA LDTLs. These exceedences are shown in Appendix A, Figure 6. Subsurface sampling by MDNR in 2005 did not detect exceedences of EPA RSLs for residential soil or MRBCA LDTL criteria. No additional soil borings are planned for the former drum staging areas at the Callahan property; however, incremental sampling of surface soils in both former drum staging areas will occur during the investigation, as described above.

6.5 DUST SAMPLING

Interior dust samples will be collected from the former Primm and Dozier residences. Whole dust samples will be collected at two locations in each residence and analyzed to determine dioxin TEQ concentrations. Wipe samples will not be collected as part of this effort. The sampling protocol will be based, with minor modifications, on ASTM Method ―Standard Practice for Collection of Floor Dust for Chemical Analysis" (ASTM 2000). For each sample, two measuring tapes will be placed and taped down so that they are parallel to each other and on either side of each sampling area. A High Volume Small Surface Sampler (HVS3) will be used to collect the sample. Efforts will be made to collect a minimum of 10 grams of total dust in order to yield an analytical detection limit of 1 part per trillion (ppt). If the amount of dust collected from the initial sampling area at each location is not sufficient, secondary areas will be marked and sampled, as needed. Pertinent data, including analyses to be performed, sample location data, total surface area of the location, and surface types from which the sample was collected, will be recorded on field sheets for each sample. All dust samples will be stored in coolers maintained at or below 4 °C pending submittal to the CLP laboratory or to the EPA Region 7 laboratory.

6.6 GROUNDWATER MONITORING WELL INSTALLATION

Six new monitoring wells will be installed at the location of six selected soil borings during the current investigation to better determine groundwater flow patterns at the site and to further characterize shallow ground water quality. Three of the new monitoring wells are to be installed on the Strecker Forest property and are depicted on Figure 7 in Appendix A (MW-08, -09, and -10). Three additional monitoring wells will be completed at the locations of three soil borings on the Callahan property and are depicted on Figure 8 in Appendix A (MW-C01, -C02, and C-03). The monitoring wells will be installed by the MDNR Division of Geology and Land Survey (DGLS) in accordance with standard procedures.

Well borings will be completed using air rotary or air hammer methods. The lithology of the materials encountered, along with any other pertinent information, will be logged by qualified personnel. Soils will be classified and described on boring logs, using the USCS, following methods outlined in ASTM standard D 2488 - 93 (ASTM 1993).

The monitoring wells will be constructed in accordance with 10 CSR 23-4.010 through 10 CSR 23-4.080 (Missouri Well Construction Rules). Well risers for the monitoring wells will consist of 2-inch-diameter Schedule 40 PVC. Riser sections will be joined by threaded joint couplings, to form water-tight unions. Each riser section will be kept in its factory wrapping and off of the ground until it is installed in the borehole.

Depending on hydrologic conditions, either 10-foot-long well screens or 20-foot-long screens will be installed. The screens will be continuous wrap, Schedule 40 PVC, with 0.010-inch slot size. The bottom of each screen will be capped with a PVC plug. The annular space around the well screen will be backfilled with clean, washed, well-rounded silica sand sized to perform as a filter between the formation material and the well screen. The filter pack will extend approximately 1 foot below and 2 to 4 feet above the well screen. The grain size of the filter pack material is expected to be 10-20 mesh.

A minimum 3-foot-thick bentonite seal will be tremied or gravity fed into place in the annular space above the well screen and filter pack sand. The seal will be composed of commercially manufactured sodium bentonite pellets or granules. The bentonite pellet seal will be allowed to hydrate a minimum of 2 hours before grouting begins. If the bentonite seal is positioned above the water table, granular bentonite will be installed in 1-foot lifts, with each lift hydrated a minimum of 20 minutes before the next lift is placed. Clean, potable water will be added to hydrate the bentonite. After placement of the final lift, the granular bentonite seal will be allowed to hydrate an additional 2 hours before grouting begins.

Twenty-percent bentonite grout or Portland cement grout will be placed above the bentonite seal to the ground surface. Grout will be placed by pumping through a side-discharging tremie pipe, with the lower end of the tremie pipe located within 3 feet of the top of the bentonite seal. Pumping will continue until undiluted grout flows from the borehole at the ground surface.

Upon completion, each well will be secured with a protective cover (with a locking top) installed around the well casing, which will be no more than 2.5 feet above grade. The annular space between the well and protective cover will be filled with sand to approximately 6 inches below the top of the well. A hole will be drilled into the protective cover, approximately 2 inches above grade, to allow for drainage. Concrete pads to be installed around each well will be a minimum of 4 feet by 4 feet square by 4 inches thick, and sloped away from the well, with the top outer edge at the ground level elevation. A permanent corrosion-resistant tag will be affixed to the well cap or to the inside of the well vault or vault lid. The tag will clearly identify the well number, depth, screened interval, and date of installation. The well will also be clearly identified as a groundwater monitoring well.

6.6.1 Well Development

Within 1 week after each well has been constructed, but no sooner than 48 hours after grouting is completed, well development will be completed. The objectives of well development are to: (1) assure that groundwater enters the well screen freely, thus yielding a representative groundwater sample and an accurate water level measurement; (2) remove all water that may have been introduced during drilling and well installation; and (3) remove very fine-grained sediment in the filter pack and nearby formation so that groundwater samples are not highly turbid and silting of the well does not occur.

Groundwater levels and total well depths will be measured prior to and after development. Development will consist of mechanical surging (with a surge block) and bailing or pumping for a minimum of 2 hours. Sediment that enters the well during this process will be removed by periodic bailing or pumping. At the end of that time, the well will be continuously pumped for a minimum of 15 minutes using an electric submersible pump. Temperature, pH, specific conductivity, and turbidity will be monitored during pumping. Pumping will continue until these parameters have stabilized (within 0.2 pH units or a 10-percent-maximum difference among three consecutive readings of each of all other parameters), and the water is clear and free of fines.

6.6.2 Groundwater Level Measurements

Seasonal static water level measurements will be taken at the monitoring wells to define variation in groundwater gradients over an annual cycle. Electronic pressure transducers may be utilized to obtain groundwater levels. All groundwater level and well depth measurements will be made relative to an established reference point on the well casing (a notch at the top of the PVC casing), and will be documented in the field logbook. By convention, this reference point is usually placed on the north side of the top of the casing. The newly constructed monitoring wells will be surveyed to determine top of casing (at the reference point) and ground surface elevations, as well as northing and easting coordinates. The ground surface elevation will be measured by the surveyor as the approximate median ground elevation of a well upon a topographically sloped surface.

6.7 GROUNDWATER SAMPLING

The seven existing monitoring wells on the Strecker Forest property and the six new wells will be sampled to better characterize groundwater quality in the study area. Groundwater levels will be measured at all monitoring wells prior to purging for sampling. After each well has been developed (but no sooner than 24 hours after) the wells will be bailed or pumped in preparation for groundwater sampling. A minimum of three borehole volumes of groundwater will be removed prior to sampling. Temperature, pH, specific conductivity, and turbidity will be monitored during pumping. Pumping will continue until these parameters have stabilized (within 0.2 pH units or a 10-percent-maximum difference among three consecutive readings of each of all other parameters), and the water is clear and free of fines.

After the parameters have stabilized, the groundwater samples will be collected. The groundwater samples will be submitted to the CLP laboratory or to the EPA Region 7 laboratory to be analyzed for VOCs, SVOCs, dioxin TEQs, and PCBs. Water samples submitted for VOCs analysis will be collected in four 40-milliliter vials and preserved with hydrochloric acid (HCl) to a pH <2. Water samples submitted for analyses for SVOCs and PCBs will be collected in two 80-ounce amber glass jugs. Water samples submitted for analysis for dioxin TEQs will be collected in one 1-liter amber glass bottle. All water samples will be stored in coolers maintained at or below 4 °C pending submittal to the laboratory. A field sheet will be completed for each groundwater sample location. The field sheets will include the following information: water quality parameters, purge times, estimated purge volumes, property ownership information, sample locations, and analyses to be performed.

6.8 HYDRAULIC CONDUCTIVITY TESTING

Slug tests will be performed at multiple monitoring wells to estimate the hydraulic conductivity and groundwater flow rate. Hydraulic conductivity (K) will be used to estimate the travel time for the dye tracing study (DTS) discussed in Section 6.9. A slug test involves instantaneous injection or withdrawal of a volume or slug of water or solid cylinder. Thus, a known volume of water is displaced within a well, and the resulting artificial fluctuation of the groundwater level is measured. The specific step-by-step procedures that will be used to conduct the slug tests follow:

1. Connect water-level transducer to the appropriate programmed computer. Synchronize the computer and transducer clocks. Check the battery in the transducer to ensure full power supply. Select a logging rate of one reading per second. Set the transducer to start logging data. Record in the field logbook the transducer ID number being used.

2. Manually measure the depth to water with a water level indicator. Lower the transducer down the well and place it at least 2 feet deeper than the length of the slug. The depth of the transducer should not exceed the maximum design depth for the transducer used. Fasten the transducer data cable or string holding the transducer at the top of the well so it cannot move. Let the transducer equilibrate to the well for at least 15 minutes. Measure the water level again to see if the level has returned to equilibrium after the insertion of the transducer in the water. If it has not, repeat this step in 5-minute intervals until equilibrium is reached. Record this information in the field logbook.

3. Lower the slug into the well and place the slug just above the water level. Lower the slug quickly into the water.

4. Monitor the water level until it has recovered to within 90% of the static water level. The falling head portion of the slug test is now complete.

5. Allow time for the water level to recover to a static condition. Quickly pull the slug out of the water.

6. Monitor the water level until it has recovered to within 90% of the static water level.

7. Stop transducer from logging data. Download the data file from the transducer and record the file name in the field logbook. The data obtained from the transducer should be reviewed in the field to determine if the test should be repeated.

The data obtained from the slug tests will be analyzed manually, as well as with software programs such as Aquifer Test for Windows, AQTESOLV, AquiferWin32, or equivalent.

Pertinent data, such as the monitoring well number, transducer ID number, static groundwater level, and slug test start and end times, will be recorded in the field logbook.

6.9 DYE TRACING STUDY

After hydraulic conductivity and groundwater flow direction have been determined, a Dye Tracing Study (DTS) will be conducted to assist in determining preferential pathways in bedrock fractures, which are not readily or easily determined by traditional drilling means. During this study, dye will be injected into upgradient monitoring wells, and groundwater samples will be collected from the monitoring well network and Lewis Spring to trace the dye through the subsurface environment. Lewis Spring is located approximately 3 miles northeast of the site and is a discharge point for shallow groundwater recharge in the Strecker Forest area (see Figure 1, Appendix A). Different dyes may be used for the DTS—including fluorescein, eosine, and rhodamine WT, or equivalent. The dyes are environmentally safe and pose no risk to humans or to aquatic life at the concentrations used in professionally directed groundwater tracing work.

The DTS design considers the potential for interference (analytical peaks in or near acceptable wavelength ranges) by naturally fluorescing substances or similar manmade dyes. To investigate potential sources of fluorescence interference in groundwater, background sampling will be conducted for at least 2 weeks (two sampling periods).

Each dye will be transported to its respective injection point in a dedicated container. The dyes will be transported in compartments separate from those holding the monitoring materials. Personnel handling the dyes will not handle the monitoring materials. Dedicated funnels will be used at each injection point to introduce the dye. All disposable materials used during dye introduction will be disposed of after use at each injection point and replaced with new materials prior to commencing dye introduction at the next well. A dilute solution of bleach will be available to neutralize spilled dye. No injection location will be subsequently used for monitoring the presence of dye. Prior to introducing a dye, water will be added through a funnel to wet the well casing/riser pipe. This will help to prevent dye loss to the inside surface of the well casing. The entire volume of the dye will be introduced as a single slug. Each well will be flushed with a minimum of 10 gallons of municipal water at a rate equivalent to the hydraulic conductivity.

Initially, the monitoring of dye transport through the aquifer system will be accomplished by setting carbon composite samplers at each station for one-week time intervals. Grab samples of water will also be collected to determine dye concentrations at known points in time. After 1 week, the carbon samplers will be collected from their respective stations, along with grab samples. Dedicated, disposable bailers will be used to collect the grab samples from the screened portion of each well. The collected samples will be transferred to 4-ounce polypropylene containers for subsequent analysis.

Groundwater levels will be measured prior to sample collection. To prevent cross-contamination, new latex gloves will be used at each sample station. All samples will be stored in a box or cooler to shield them from sunlight to prevent the dye from degrading. Carbon composite samplers will be bagged separately from the water samples. The first round of carbon samplers will be deployed 1 day prior to dye introduction to ensure that any rapid movement through the aquifer system will be identified. During the first 6 weeks after dye introduction, carbon samplers will be set and retrieved on a weekly basis. After the initial six rounds of weekly sampling, carbon samplers will be set biweekly for 12 weeks. The carbon samplers will be set once per month thereafter until termination. The monitoring wells will be monitored for dye for the maximum duration deemed practical based on conservative estimates of dye travel time (based on hydraulic conductivity).

Laboratory analysis of tracer recovery packets will be performed by MDNR DGLS, using a Hitachi F-4500 spectrofluorometer, or equivalent. The MDNR DGLS Water Tracing SOP is provided in Appendix E.

7.0 QUALITY CONTROL

Duplicate samples of soil, and groundwater will be collected, as specified in Table 1 and Section 2.5 of the QAPP form (Appendix C). To evaluate sample QC, one trip blank and one field blank will be collected (water samples), as specified in Section 2.5 of the QAPP form. Two rinsate water samples will also be collected from drill rods and sampling tools. All reusable sampling supplies and drill rods will be decontaminated between sampling locations.

IDW, which will consist primarily of used gloves, used tubing, etc., will be disposed of as uncontaminated solid waste. Issues pertaining to decontamination of personnel and sampling equipment will be addressed in a site-specific HASP to be developed by START. Decontamination solutions generated on site will be containerized and left on site pending analysis for all contaminants of concern prior to disposal. Water generated from decontamination procedures will be containerized in 55-gallon drums to determine if treatment is required prior to disposal. A composite sample of this investigation-derived waste (IDW) will be collected to assess if the IDW requires treatment prior to disposal. The IDW composite samples will be submitted to the CPL laboratory or the EPA Region 7 laboratory to be analyzed for VOCs, SVOCs, PCBs, and dioxin TEQ. Soil and rock cuttings and water from monitoring well purging and development will be deposited on-site in accordance with routine practice. All samples will be stored in coolers maintained at or below 4° C pending submittal to the EPA Region 7 laboratory.

8.0 ANALYTICAL METHODS

Appropriate containers and physical/chemical preservation techniques will be employed during the field activities to help ensure that representative analytical results are obtained. All samples will be submitted to designated CLP laboratories or to the EPA Region 7 laboratory in Kansas City, Kansas, for analysis. An Analytical Services Request (ASR) form will be completed by the Tetra Tech START Project

Manager and submitted to the EPA Region 7 laboratory. Submittal of samples to the laboratories is expected during summer, 2011, pending stakeholder review and final QAPP approval. All samples will be analyzed according to SOPs and methods referenced on the QAPP form. Standard turnaround times and detection limits for those methods will be adequate for this project.

9.0 REFERENCES

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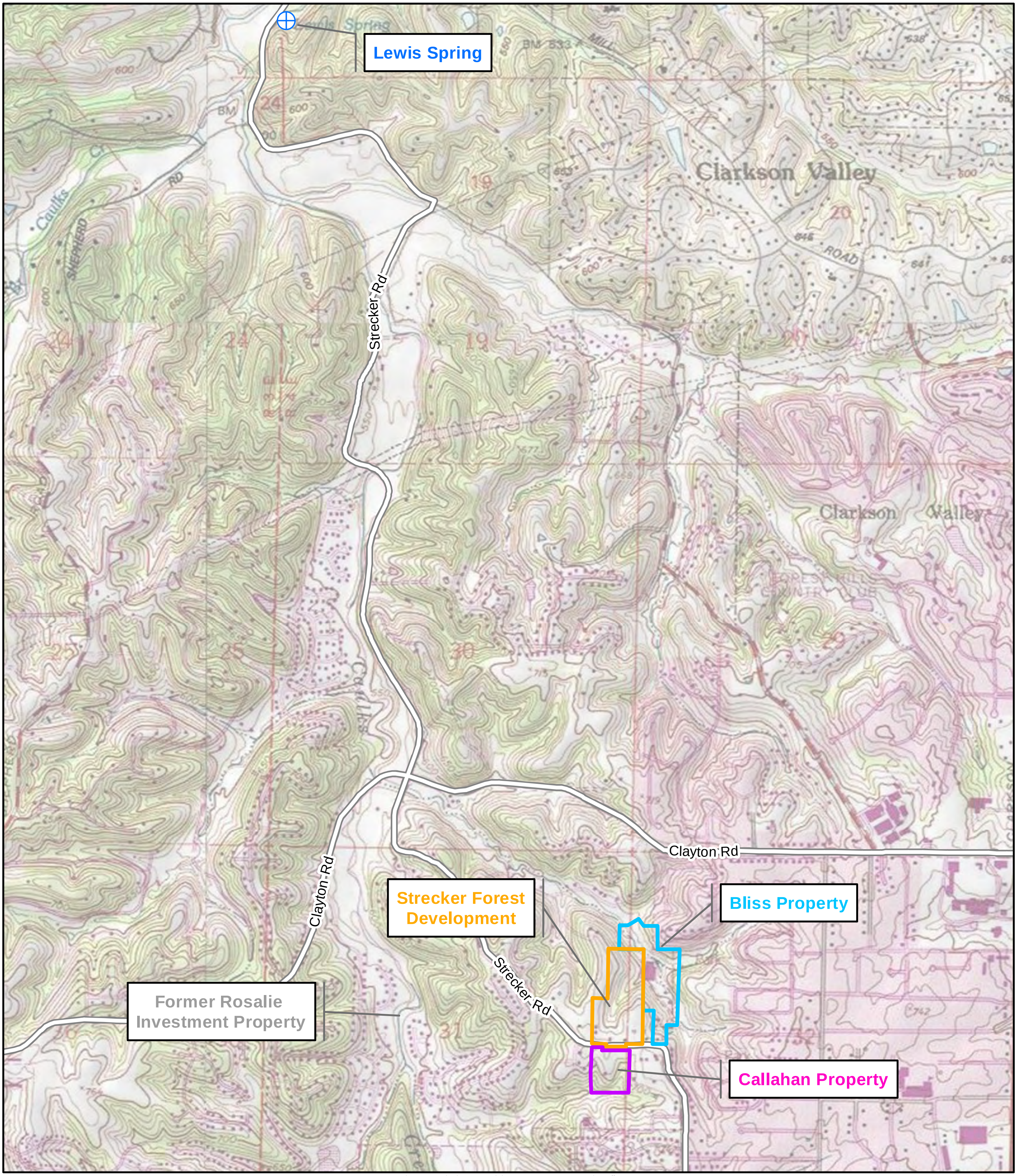
APPENDIX A

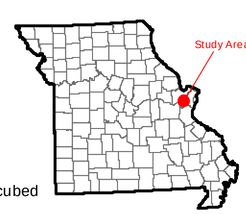
FIGURES



NOTE: The Environmental Protection Agency does not guarantee the accuracy, completeness, or timeliness of the information shown, and shall not be liable for any injury or loss resulting from reliance upon the information shown.
7/1/2011 CjM
Locator Map.mxd

Data Sources:
USGS Topoquad

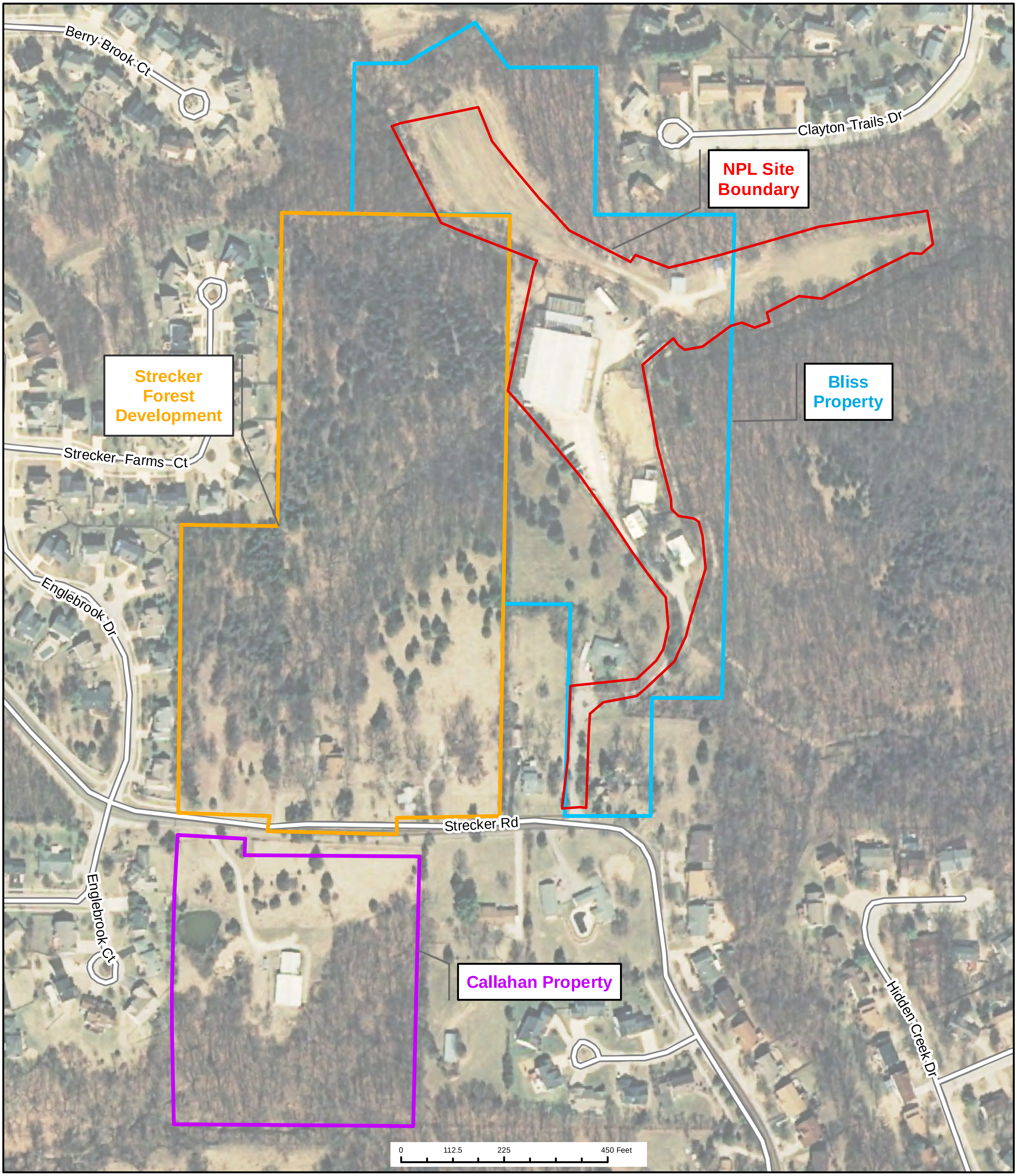
GDT Streets 2007



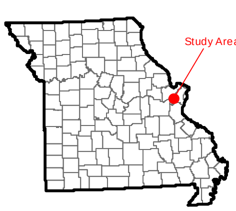
0 0.125 0.25 0.5 Miles

- Lewis Spring
- Callahan Property
- Proposed Strecker Forest Development
- Bliss Property

Figure 1
Locator Map
Ellisville NPL Site and proposed Strecker Forest Development



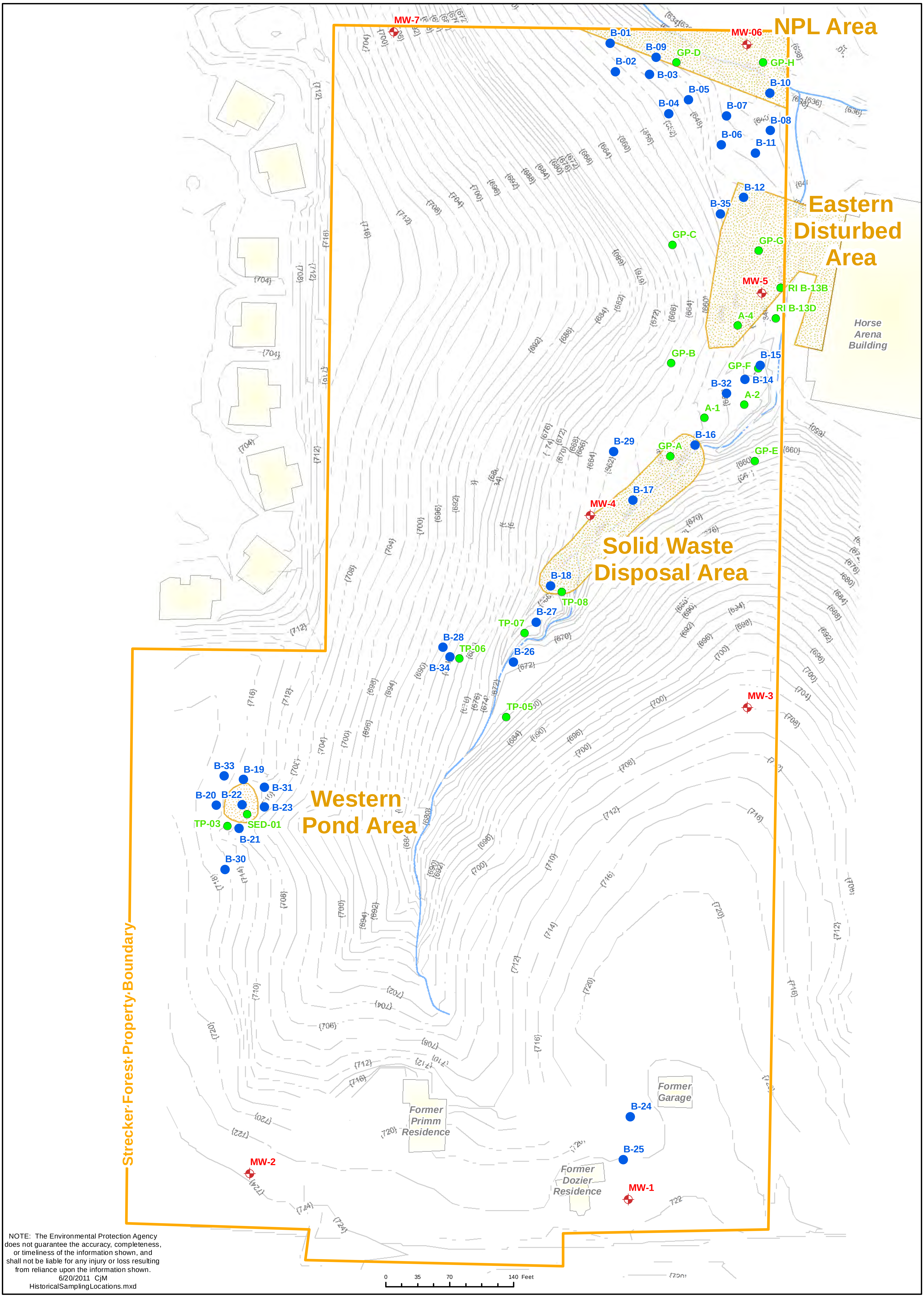
NOTE: The Environmental Protection Agency does not guarantee the accuracy, completeness, or timeliness of the information shown, and shall not be liable for any injury or loss resulting from reliance upon the information shown.
7/1/2011 CjM
Study Area Map.mxd



Data Sources:
USGS Missouri Aerial Imagery 2007 (2 foot)
GDT Streets (2007)

- NPL Site Boundary
- Callahan Property
- Proposed Strecker Forest Development
- Bliss Property

Figure 2
Study Area
Strecker Forest Development



Data Sources:
Mundell Report, 2011
-Strecker Forest Boundary
-Contours
-House Locations
-Screening Locations

USEPA
-EPA Regional Screening Level (RSL) Table, 2011

Missouri Risk-Based Corrective Action (MRBCA), June 2006
-Lowest Default Target Levels (LDTL)

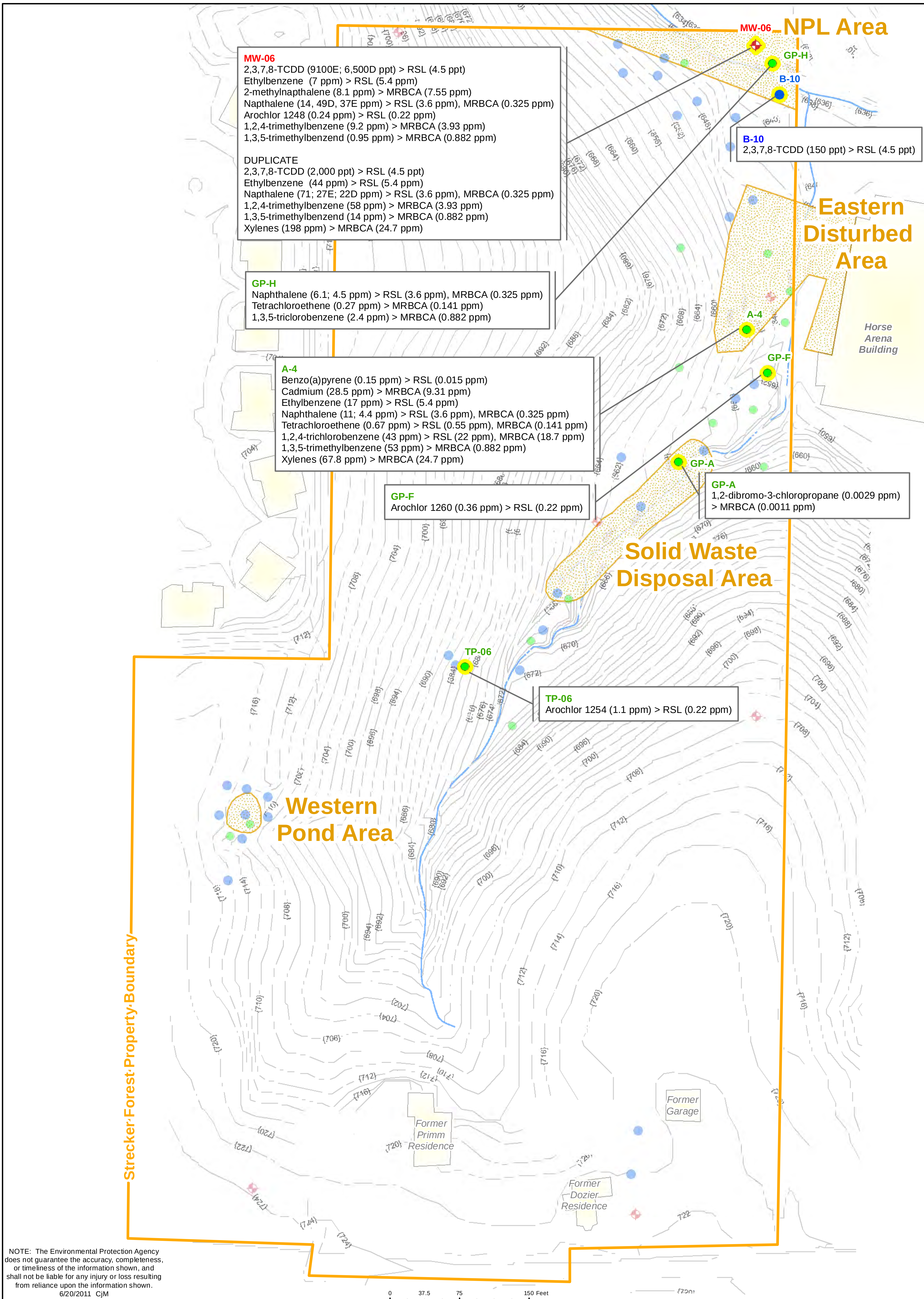
URS Data Review, May 2008
-Eastern Disturbed Area Boundary

N E S W

- Brucker Soil Samples
- Mundell Soil Borings
- Mundell Monitoring Wells

Figure 3
Historical Sampling

Strecker Forest
Wildwood, Missouri



Data Sources:
Mundell Report, 2011
-Strecker Forest Boundary
-Contours
-House Locations
-Screening Locations

USEPA
-EPA Regional Screening Level (RSL) Table, 2011

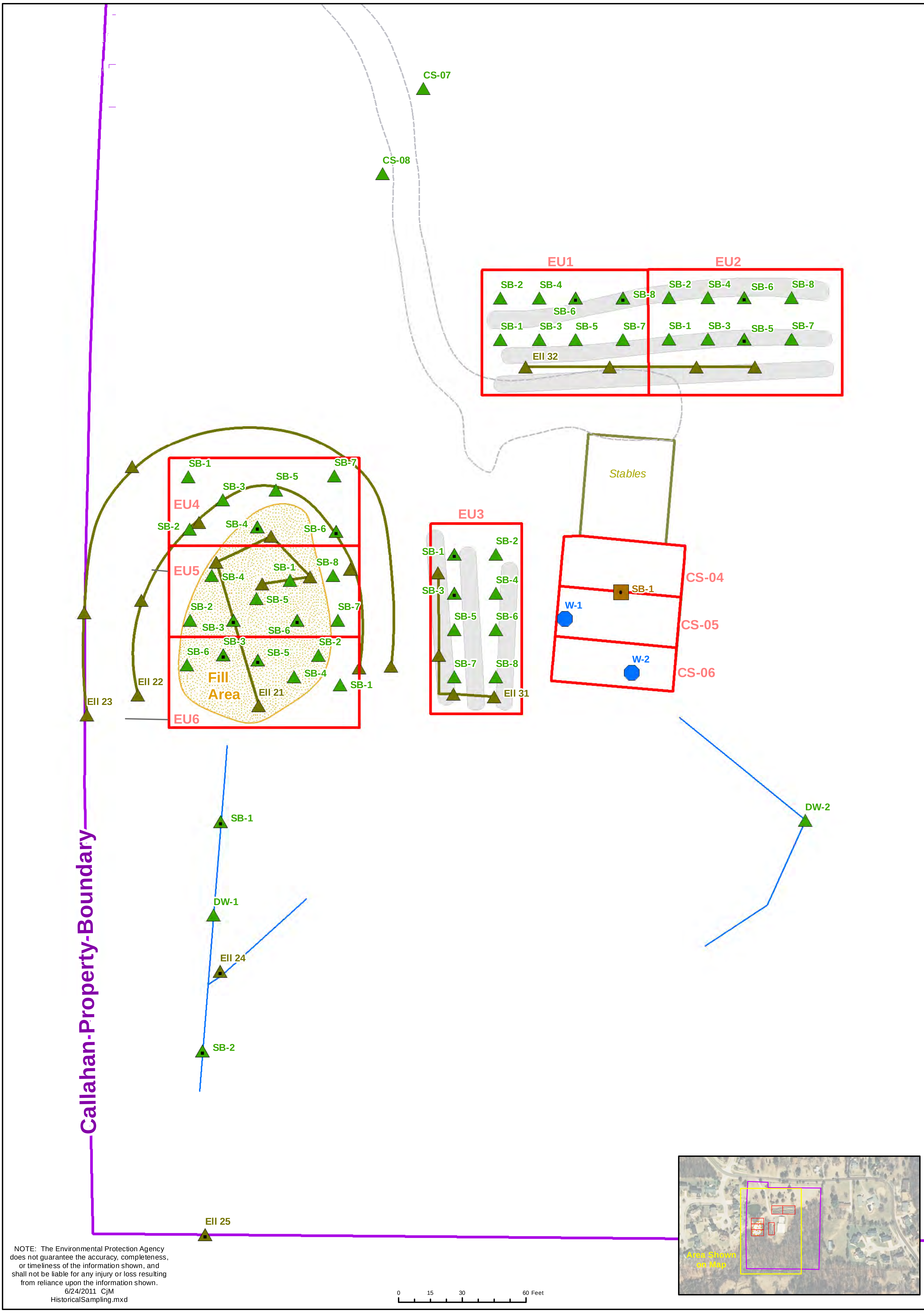
Missouri Risk-Based Corrective Action (MRBCA), June 2006
-Lowest Default Target Levels (LDTL)

URS Data Review, May 2008
-Eastern Disturbed Area Boundary

EPA MDNR Screening Level Exceedence (Highlighted)

- Brucker Soil Samples
- Mundell Soil Borings
- Mundell Monitoring Wells
- Existing Structures

Figure 4
Historical Screening Level Exceedences
Strecker Forest
Wildwood, Missouri



Data Sources:

MDNR Site Reassessment, 2005
-MDNR Exposure Units

USEPA Remedial Investigation, 2003
-EPA Regional Screening Level (RSL) Table

Missouri Risk-Based Corrective Action (MRBCA), June 2006
-Lowest Default Target Levels (LDTL)

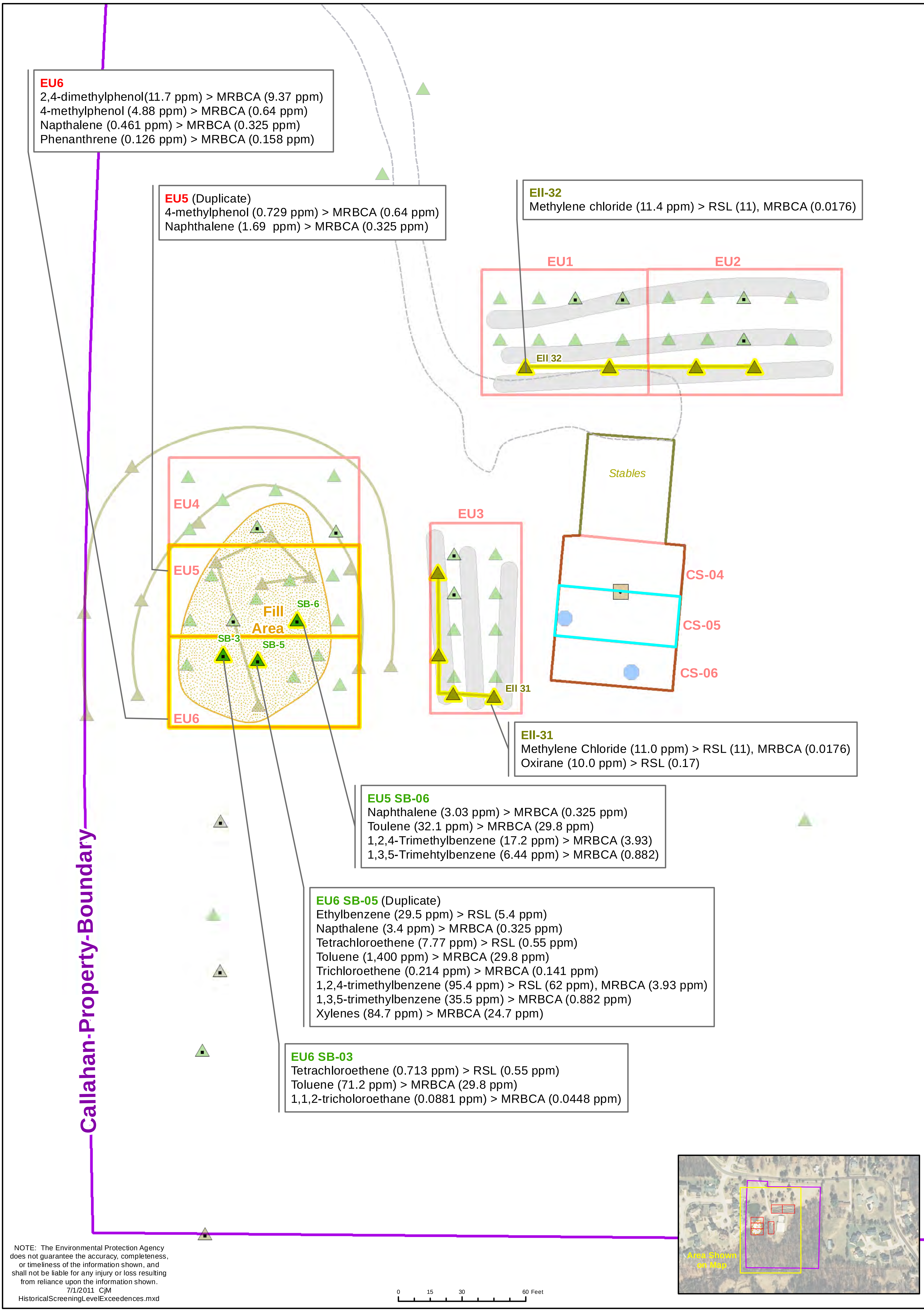
Discrete Sample (Dot)

- 2005 MDNR Exposure Unit Boundaries
- 2005 MDNR Exposure Unit (EU) Samples
- 2005 MDNR Barn Wipe Samples
- 2005 MDNR Barn Soil Borings
- 1983 EPA RI Soil Samples
- Drainage Way
- Callahan Property
- Drum Staging Locations
- Approximate Fill Area

Figure 5

Historical Sampling

Callahan Property
Wildwood, Missouri



Data Sources:

MDNR Site Reassessment, 2005
-MDNR Exposure Units

USEPA Remedial Investigation, 2003
-EPA Regional Screening Level (RSL) Table

Missouri Risk-Based Corrective Action (MRBCA), June 2006
-Lowest Default Target Levels (LDTL)

Exceedence (Highlighted)

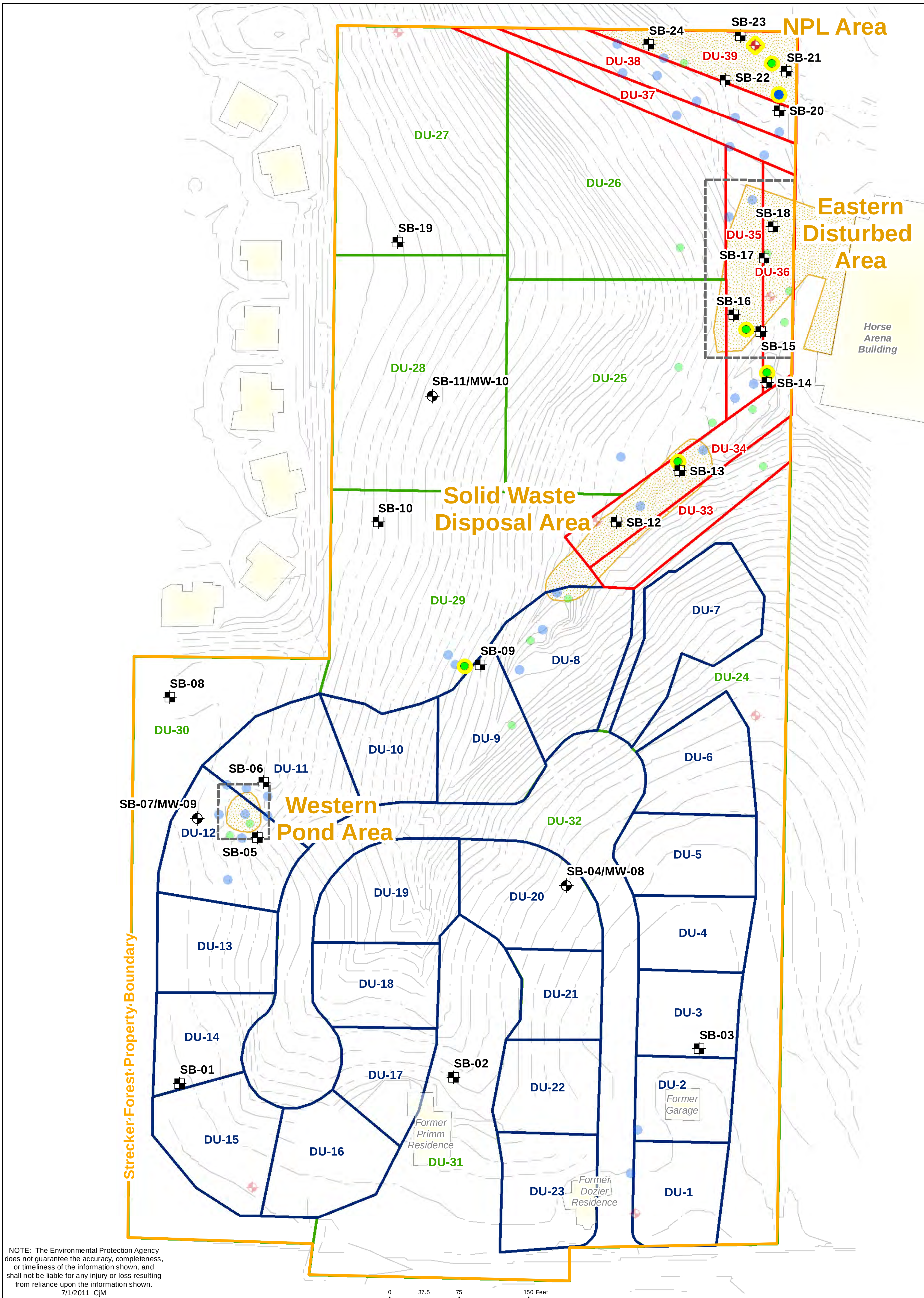
Discrete Sample (Dot)

- 2005 MDNR Exposure Unit Boundaries
- 2005 MDNR Exposure Unit (EU) Samples
- 2005 MDNR Barn Wipe Samples
- 2005 MDNR Barn Soil Borings
- 1983 EPA RI Soil Samples
- Callahan Property
- Drum Staging Locations
- Approximate Fill Area

Figure 6

Historical Screening Level Exceedences

Callahan Property
Wildwood, Missouri



Data Sources:
Mundell Report, 2011
-Strecker Forest Boundary
-Contours
-House Locations

USEPA
-EPA Regional Screening Level (RSL) Table, 2011

Missouri Risk-Based Corrective Action (MRBCA), June 2006
-Lowest Default Target Levels (LDTL)

URS Data Review, May 2008
-Eastern Disturbed Area Boundary

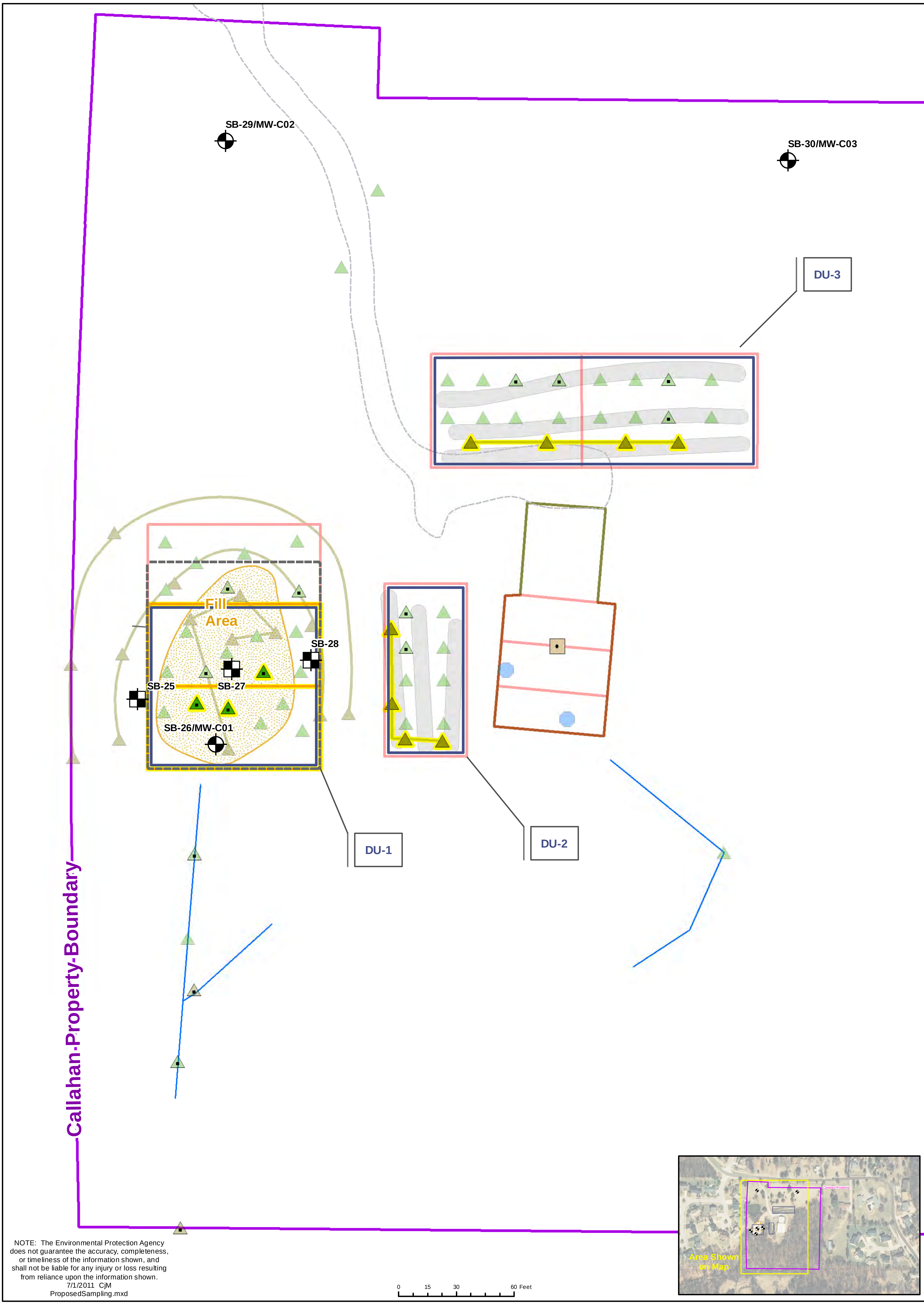
EPA MDNR Screening Level Exceedence (Highlighted)

EPA Proposed Soil Boring Locations
EPA Proposed Monitoring Wells
Mundell Monitoring Wells
Mundell Soil Borings
Brucker Soil Samples

Geophysical Survey Area

Incremental Sampling Decision Units
NPL Assessment Area
Residential Home Sites
Preservation Area

Figure 7
EPA Proposed Sampling
Strecker Forest
Wildwood, Missouri



Data Sources:

MDNR Site Reassessment, 2005
-MDNR Exposure Units

USEPA Remedial Investigation, 2003
-EPA Regional Screening Level (RSL) Table

Missouri Risk-Based Corrective Action (MRBCA), June 2006
-Lowest Default Target Levels (LDTL)

Exceedence (Highlighted)

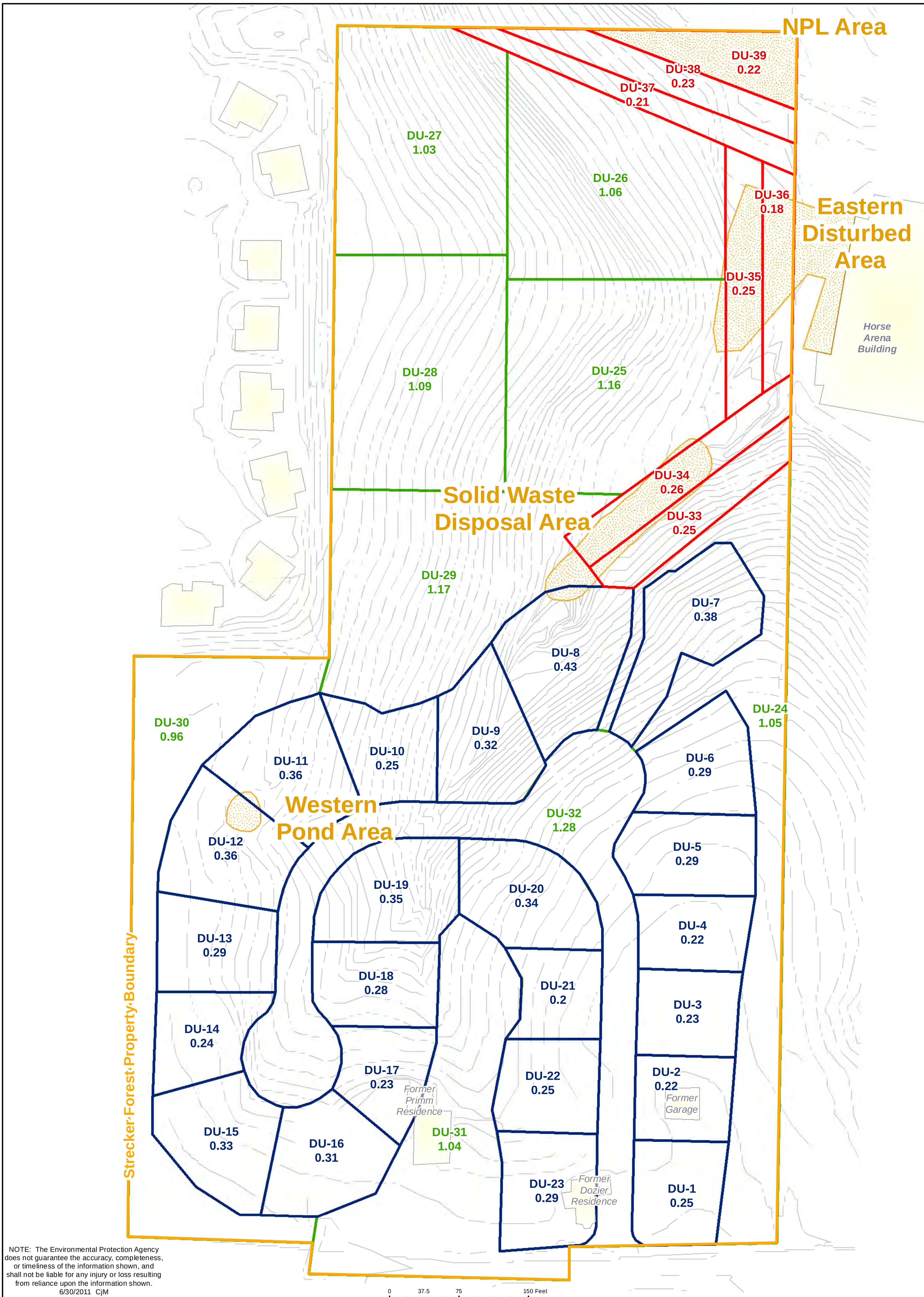
Discrete Sample (Dot)

- Proposed Monitoring Wells
- Proposed Borings
- Proposed Decision Unit Boundaries
- 1983 EPA RI Soil Samples
- 2005 MDNR Exposure Unit Boundaries
- 2005 MDNR Exposure Unit (EU) Samples
- 2005 MDNR Barn Wipe Samples
- 2005 MDNR Barn Soil Borings
- Drainage Way
- Callahan Property
- Drum Staging Locations
- Approximate Fill Area
- Geophysical Survey Area

Figure 8

EPA Proposed Sampling

Callahan Property
Wildwood, Missouri



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6/30/2011 CjM
DecisionUnits.mxd

Data Sources:
Mundell Report, 2011
-Strecker Forest Boundary
-Contours
-House Locations

Incremental Sampling Decision Units (acres)

- NPL Assessment Area
- Residential Home Sites
- Preservation Area

Figure 9
EPA Decision Units
Strecker Forest
Wildwood, Missouri

APPENDIX B

TABLES

Table 4. Callahan Property Analytical Results - Detections (results in mg/kg)

Sample #	Depth (feet)	Date	Pesticides	SVOCs	Phenols	VOCs	Dioxin	PCBs	Metals	Acetone	Arsenic	Barium	Benzene	Benzoic Acid	2,6-Bis(1,1-dimethylethyl)-4-methylphenol	Bis-(2-Ethylhexyl)phthalate	2-Butanone (MEK)	n-Butylbenzene	Cadmium	Chromium	Cyanide	1,3,5-Cycloheptatriene	Cyclohexane	Cyclohexanol	n-Cyclohexylcyclohexanamine	11-Decyldocosane	1,2-Dichlorobenzene	1,1-Dichloroethane	1,2-Dichloroethane	cis-1,2-Dichloroethene	1,3-Diisocyanatomethylbenzene	2,4-Dimethylphenol	1,2-Dimethoxyethane	Di-n-butyl phthalate	Eicosane	Ethylbenzene	Fluorene	Fluorotrichloromethane (Freon 11)	Hexadecanoic Acid	Hexatriacontane
EPA Residential Soil Screening										61,000	0.39	15,000	1.1	240,000		35	28,000		70		1600		7000				1900	3.3	0.43	160		1200		6100		5.4	2300			
Missouri default MRBCA										4.2	3.89	2,040	0.0561	84.8		347	7.3	41.6	9.31	7,460	77.1						56.1	0.18		0.521		9.37				39.9	211			
ELL-21-SS-01		12/29/82	X	X		X	X	X		ND	NA	NA	ND	ND	5.50	13.0	ND	ND	NA	NA	NA	20.0	660	ND	ND	27.0	ND	ND	ND	ND	ND	ND	ND	ND	50.0	ND	ND	ND	ND	43.0
ELL-24-SL-01		12/30/82	X	X		X	X	X		ND	NA	NA	ND	ND	ND	16.0	ND	ND	NA	NA	NA	0.17	ND	0.17	0.99	ND	ND	ND	ND	ND	0.2	ND	ND	ND	ND	ND	ND	0.0038	ND	ND
ELL-25-SL-01		12/30/82	X	X		X	X	X		ND	NA	NA	ND	ND	ND	1.0	ND	ND	NA	NA	NA	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	0.0039	1.1	ND
ELL-31-SL-01		1/6/83	X	X		X	X	X		ND	NA	NA	ND	ND	ND	5.6	ND	ND	NA	NA	NA	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	8.0	ND	ND	ND	ND	ND	ND	ND
ELL-32-SL-01		1/6/83	X	X		X	X	X		ND	NA	NA	ND	ND	ND	4.8	ND	ND	NA	NA	NA	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
ELL-22-SS-01	5	2/15/83	X	X		X	X	X		ND	NA	NA	ND	ND	ND	1.4	ND	ND	NA	NA	NA	0.38	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
ELL-23-SS-01	15	2/16/83	X	X		X	X	X		ND	NA	NA	ND	ND	ND	ND	ND	ND	NA	NA	NA	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
NDSA (North Drum Storage Area)	Composite	12/10/99	X		X		X	X	X	NA	4.98	161	NA	NA	NA	NA	NA	NA	ND	14.0	ND	NA	NA	NA	NA	NA	NA	NA	NA	NA	ND	ND	ND	ND	ND	NA	NA	NA	NA	NA
SDSA (South Drum Storage Area)	Composite	12/10/99	X		X		X	X	X	NA	5.38	141	NA	NA	NA	NA	NA	NA	ND	13.9	ND	NA	NA	NA	NA	NA	NA	NA	NA	NA	ND	ND	ND	ND	ND	NA	NA	NA	NA	NA
CFA 1 (Callahan Fill Area)	Composite	12/10/99	X		X		X	X	X	NA	3.67	89.9	NA	NA	NA	NA	NA	NA	2.09	34.0	0.16	NA	NA	NA	NA	NA	NA	NA	NA	NA	ND	ND	ND	ND	ND	NA	NA	NA	NA	NA
GAC 1 (Test Pit Below Fill Area)	Composite	12/10/99	X		X		X	X	X	NA	4.17	77.9	NA	NA	NA	NA	NA	NA	1.09	43.7	0.30	NA	NA	NA	NA	NA	NA	NA	NA	NA	ND	ND	ND	ND	ND	NA	NA	NA	NA	NA
EU-1, SB-06 (-01)	1.5	1/31/05				X				ND	NA	NA	ND	ND	NA	NA	ND	ND	NA	NA	NA	NA	NA	NA	NA	NA	ND	ND	ND	ND	NA	NA	NA	NA	NA	ND	NA	NA	NA	NA
EU-1, SB-08 (-02)	2.0	1/31/05				X				ND	NA	NA	ND	ND	NA	NA	ND	ND	NA	NA	NA	NA	NA	NA	NA	NA	ND	ND	ND	ND	NA	NA	NA	NA	NA	ND	NA	NA	NA	NA
EU-1, all borings (-03)	Composite (1.5)	1/31/05	X	X			X	X	X	NA	3.3	63.1	NA	NA	ND	ND	NA	NA	ND	12.5	ND	ND	ND	ND	ND	ND	NA	NA	NA	NA	ND	ND	ND	ND	ND	NA	ND	ND	ND	ND
EU-2, SB-05 (-04)	2.0	1/31/05				X				ND	NA	NA	ND	ND	NA	NA	ND	ND	NA	NA	NA	NA	NA	NA	NA	NA	ND	ND	ND	ND	NA	NA	NA	NA	NA	ND	NA	NA	NA	NA
EU-2, SB-06 (-05)	1.75	1/31/05				X				ND	NA	NA	ND	ND	NA	NA	ND	ND	NA	NA	NA	NA	NA	NA	NA	NA	ND	ND	ND	ND	NA	NA	NA	NA	NA	ND	NA	NA	NA	NA
EU-2, all borings (-06)	Composite (1.25)	1/31/05	X	X			X	X	X	NA	3.13	12.3	NA	NA	ND	ND	NA	NA	0.122	12.6	ND	ND	ND	ND	ND	ND	NA	NA	NA	NA	ND	ND	ND	ND	ND	NA	ND	ND	ND	ND
EU-3, SB-03 (-07)	2.0	1/31/05				X				ND	NA	NA	ND	ND	NA	NA	ND	ND	NA	NA	NA	NA	NA	NA	NA	NA	ND	ND	ND	ND	NA	NA	NA	NA	NA	ND	NA	NA	NA	NA
EU-3, SB-01 (-08)	2.0	1/31/05				X				ND	NA	NA	ND	ND	NA	NA	ND	ND	NA	NA	NA	NA	NA	NA	NA	NA	ND	ND	ND	ND	NA	NA	NA	NA	NA	ND	NA	NA	NA	NA
EU-3, all borings (-09)	Composite (1.75)	1/31/05	X	X			X	X	X	NA	4.63	126	NA	NA	ND	ND	NA	NA	0.0251	18.3	ND	ND	ND	ND	ND	ND	NA	NA	NA	NA	ND	ND	ND	ND	ND	NA	ND	ND	ND	ND
SB-1, barn floor (-10)	0.6	1/31/05					X			NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
SB-1, barn floor (-11)	1	1/31/05					X			NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
SB-1, barn floor (-12)	1.5	1/31/05					X			NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Barn Floor north 1/3 (-13)	0.2	1/31/05					X			NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Barn Floor center 1/3 (-14)	0.2	1/31/05					X			NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Barn Floor south 1/3 (-15)	0.2	1/31/05					X			NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Access road east (-16)	0.2	1/31/05					X			NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Access road west (-17)	0.2	1/31/05					X			NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
W-1 barn west wall (-19)		2/1/05					X			NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
W-2 barn south wall (-20)		2/1/05					X			NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
EU-5, SB-03 (-21)	9.0	2/1/05				X				ND	NA	NA	ND	ND	NA	NA	ND	0.0278	NA	NA	NA	NA	NA	NA	NA	NA	ND	ND	ND	ND	NA	NA	NA	NA	NA	ND	NA	NA	NA	NA
SB-1, drainageway (-22)	1.5	2/1/05				X				ND	NA	NA	ND	ND	NA	NA	ND	ND	NA	NA	NA	NA	NA	NA	NA	NA	ND	ND	ND	ND	NA	NA	NA	NA	NA	ND	NA	NA	NA	NA
SB-2, drainageway (-23)	1.5	2/1/05				X				ND	NA	NA	ND	ND	NA	NA	ND	ND	NA	NA	NA	NA	NA	NA	NA	NA	ND	ND	ND	ND	NA	NA	NA	NA	NA	ND	NA	NA	NA	NA
DW1 drainageway (-24)	0.2	2/1/05					X			NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
EU-5, SB-06 (-25)	8	2/1/05				X				ND	NA	NA	ND	ND	NA	NA	ND	0.687	NA	NA	NA	NA	NA	NA	NA	NA	ND	ND	ND	ND	NA	NA	NA	NA	NA	2.43	NA	NA	NA	NA
EU-5, all borings (-26)	Composite (8.5)	2/1/05	X	X			X	X	X	NA	4.28	144	NA	0.263	ND	1.26	NA	NA	0.294	54.8	ND	ND	ND	ND	ND	ND	NA	NA	NA	NA	ND	0.177	ND	ND	ND	NA	ND	ND	ND	ND
Duplicate EU-5 (-27)	Composite (8.5)	2/1/05	X	X			X	X	X	NA	4.61	110	NA	0.787	ND	0.834	NA	NA	0.198	32.2	ND	ND	ND	ND	ND	ND	NA	NA	NA	NA	ND	1.31	ND	ND	ND	NA	0.138	ND	ND	ND
EU-4, SB-06 (-28)	1.5	2/1/05				X				ND	NA	NA	ND	ND	NA	NA	ND	ND	NA	NA	NA	NA	NA	NA	NA	NA	ND	ND	ND	ND	NA	NA	NA	NA	NA	ND	NA	NA	NA	NA
EU-4, SB-04 (-29)	3.5	2/1/05				X				ND	NA	NA	ND	ND	NA	NA	ND	ND	NA	NA	NA	NA	NA	NA	NA	NA	ND	ND	ND	ND	NA	NA	NA	NA	NA	ND	NA	NA	NA	NA
EU-4, all borings (-30)	Composite (refusal)	2/1/05	X	X			X	X	X	NA	6.55	58.3	NA	NA	ND	ND	NA	NA	0.025	212	ND	ND	ND	ND	ND	ND	NA	NA	NA	NA	ND	ND	ND	ND	ND	NA	ND	ND	ND	ND
DW2 drainageway (-31)	0.2	2/2/05					X			NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Pond (-32)		2/2/05	X	X		X	X	X	X	ND	4.98	105	ND	ND	ND	ND	ND	ND	0.116	16.2	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	0.288	ND	ND	ND	ND	ND	ND
EU-6, SB-03 (-33)	7.5	2/2/05				X				ND	NA	NA	ND	ND	NA	NA	ND	0.087	NA	NA	NA	NA	NA	NA	NA	NA	ND	ND	ND	ND	NA	NA	NA	NA	NA	3.57	NA	NA	NA	NA
EU-6, SB-05 (-34)	9.5	2/2/05				X				0.633	NA	NA	0.156	ND	NA	NA	0.907	6.83	NA	NA	NA	NA	NA	NA	NA	NA	ND	0.0565	0.0436	0.419	NA	NA	NA	NA	NA	20.1	NA	NA	NA	NA
EU-6, SB-05 (-35) Dup	9.5	2/2/05				X				0.589	NA	NA	0.124	ND	NA	NA	0.968	8.32	NA	NA	NA	NA	NA	NA	NA	NA	ND	ND	0.034	0.297	NA	NA	NA	NA	NA	29.5	NA	NA	NA	NA
EU-6, all borings (-36)	Composite (refusal)	2/2/05	X	X			X	X	X	NA	NA	0.017	NA	NA	ND	16.0	NA	NA	0.123	12.2	ND	ND	ND	ND	ND	ND	0.133	NA	NA	NA	ND	11.7	ND	1.48	ND	NA	0.422	ND	ND	ND

Table 4. Callahan Property Analytical Results - Detections (cont.)

(results in mg/kg)

Sample #	1,3-Isobenzofurandione	Isophorone	Isopropylbenzene	p-Isopropyltoluene	Lead	Mercury	2-Methoxyethanol	Methylene Chloride	Methylester Formic Acid	2-Methylnaphthalene	2-Methylphenol	4-Methylphenol	4-Methyl-2-pentanone	Methyl-t-butyl-ether	Naphthalene	Oxirane (Dimethylene Oxide)	PCB-1254	PCB-1260	Pentacosane	Phenanthrene	Phenol	2-Propenylidenecyclobutene	n-Propylbenzene	Selenium	Silver	Styrene	Tetrachloroethene	Toulene	1,1,2-Trichloroethane	Trichloroethene	1,2,4-Trimethylbenzene	1,3,5-Trimethylbenzene	Xylenes
EPA Residential Soil Screening			2100		400	5.6	180	11		310	3100	310	5300	43	3.6	0.17	0.22	0.22			18,000			390	390	6300	0.55	5000	1.1	2.8	62	780	630
Missouri default MRBCA		5.69	10.5		3.74	2.19		0.0176		7.55	11.1	0.64		0.398	0.325		2.2	2.2		0.0158	25.6		13.0	6.27	16.2	11.7	0.141	29.8	0.0448	0.141	3.93	0.882	24.7
ELL-21-SS-01	ND	ND	ND	ND	NA	NA	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	90.0	ND	ND	ND	ND	NA	NA	ND	ND	ND	ND	ND	ND	ND	ND
ELL-24-SL-01	0.51	ND	ND	ND	NA	NA	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	NA	NA	ND	ND	ND	ND	ND	ND	ND	ND
ELL-25-SL-01	ND	ND	ND	ND	NA	NA	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	NA	NA	ND	ND	ND	ND	ND	ND	ND	ND
ELL-31-SL-01	ND	ND	ND	ND	NA	NA	10.0	11.0	5.0	ND	ND	ND	ND	ND	ND	10.0	ND	ND	ND	ND	ND	ND	ND	NA	NA	ND	ND	0.79	ND	ND	ND	ND	0.41
ELL-32-SL-01	ND	2.4	ND	ND	NA	NA	ND	11.4	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	NA	NA	ND	ND	ND	ND	ND	ND	ND	ND
ELL-22-SS-01	ND	ND	ND	ND	NA	NA	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	0.189	ND	ND	ND	ND	ND	ND	NA	NA	ND	ND	ND	ND	ND	ND	ND	0.3
ELL-23-SS-01	ND	ND	ND	ND	NA	NA	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	0.28	ND	NA	NA	ND	ND	ND	ND	ND	ND	ND	ND
NDSA (North Drum Storage Area)	NA	NA	NA	NA	7.64	ND	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	ND	ND	NA	NA	NA	NA	NA	ND	ND	NA	NA	NA	NA	NA	NA	NA	NA
SDSA (South Drum Storage Area)	NA	NA	NA	NA	8.29	ND	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	ND	ND	NA	NA	NA	NA	NA	ND	ND	NA	NA	NA	NA	NA	NA	NA	NA
CFA 1 (Callahan Fill Area)	NA	NA	NA	NA	170	ND	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	ND	ND	NA	NA	NA	NA	NA	ND	ND	NA	NA	NA	NA	NA	NA	NA	NA
GAC 1 (Test Pit Below Fill Area)	NA	NA	NA	NA	189	ND	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	ND	ND	NA	NA	NA	NA	NA	ND	ND	NA	NA	NA	NA	NA	NA	NA	NA
EU-1, SB-06 (-01)	NA	ND	ND	ND	NA	NA	ND	ND	ND	NA	NA	NA	ND	ND	ND	ND	NA	NA	NA	NA	NA	ND	ND	NA	NA	ND	ND	ND	ND	ND	ND	ND	ND
EU-1, SB-08 (-02)	NA	ND	ND	ND	NA	NA	ND	ND	ND	NA	NA	NA	ND	ND	ND	ND	NA	NA	NA	NA	NA	ND	ND	NA	NA	ND	ND	ND	ND	ND	ND	ND	ND
EU-1, all borings (-03)	ND	NA	NA	NA	9.45	0.0203	NA	NA	NA	ND	ND	ND	NA	NA	ND	NA	ND	ND	ND	ND	ND	NA	NA	ND	ND	NA	NA	NA	NA	NA	NA	NA	NA
EU-2, SB-05 (-04)	NA	ND	ND	ND	NA	NA	ND	ND	ND	NA	NA	NA	ND	ND	ND	ND	NA	NA	NA	NA	NA	ND	ND	NA	NA	ND	ND	ND	ND	ND	ND	ND	ND
EU-2, SB-06 (-05)	NA	ND	ND	ND	NA	NA	ND	ND	ND	NA	NA	NA	ND	ND	ND	ND	NA	NA	NA	NA	NA	ND	ND	NA	NA	ND	ND	ND	ND	ND	ND	ND	ND
EU-2, all borings (-06)	ND	NA	NA	NA	19.2	0.0188	NA	NA	NA	ND	ND	ND	NA	NA	ND	NA	ND	ND	ND	ND	ND	NA	NA	ND	0.25	NA	NA	NA	NA	NA	NA	NA	NA
EU-3, SB-03 (-07)	NA	ND	ND	ND	NA	NA	ND	ND	ND	NA	NA	NA	ND	ND	ND	ND	NA	NA	NA	NA	NA	ND	ND	NA	NA	ND	ND	ND	ND	ND	ND	ND	ND
EU-3, SB-01 (-08)	NA	ND	ND	ND	NA	NA	ND	ND	ND	NA	NA	NA	ND	ND	ND	ND	NA	NA	NA	NA	NA	ND	ND	NA	NA	ND	ND	ND	ND	ND	ND	ND	ND
EU-3, all borings (-09)	ND	NA	NA	NA	7.67	0.0212	NA	NA	NA	ND	ND	ND	NA	NA	ND	NA	ND	ND	ND	ND	ND	NA	NA	ND	ND	NA	NA	NA	NA	NA	NA	NA	NA
SB-1, barn floor (-10)	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
SB-1, barn floor (-11)	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
SB-1, barn floor (-12)	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Barn Floor north 1/3 (-13)	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Barn Floor center 1/3 (-14)	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Barn Floor south 1/3 (-15)	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Access road east (-16)	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Access road west (-17)	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
W-1 barn west wall (-19)	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
W-2 barn south wall (-20)	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
EU-5, SB-03 (-21)	NA	ND	ND	0.0139	NA	NA	ND	ND	ND	NA	NA	NA	ND	ND	ND	NA	NA	NA	NA	NA	NA	ND	ND	NA	NA	ND	ND	ND	ND	ND	0.11	0.0387	ND
SB-1, drainageway (-22)	NA	ND	ND	ND	NA	NA	ND	ND	ND	NA	NA	NA	ND	ND	ND	NA	NA	NA	NA	NA	NA	ND	ND	NA	NA	ND	ND	ND	ND	ND	ND	ND	ND
SB-2, drainageway (-23)	NA	ND	ND	ND	NA	NA	ND	ND	ND	NA	NA	NA	ND	ND	ND	NA	NA	NA	NA	NA	NA	ND	ND	NA	NA	ND	ND	ND	ND	ND	ND	ND	ND
DW1 drainageway (-24)	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	ND	ND	ND	ND	ND	ND	ND	ND
EU-5, SB-06 (-25)	NA	ND	0.674	0.169	NA	NA	ND	ND	ND	NA	NA	NA	ND	ND	3.03	ND	NA	NA	NA	NA	NA	ND	ND	NA	NA	ND	0.0352	32.1	ND	ND	17.2	6.44	8.52
EU-5, all borings (-26)	ND	NA	NA	NA	197	0.0268	NA	NA	NA	0.303	ND	ND	NA	NA	0.601	NA	ND	0.020	ND	ND	ND	NA	NA	ND	ND	NA	NA	NA	NA	NA	NA	NA	NA
Duplicate EU-5 (-27)	ND	NA	NA	NA	128	0.0258	NA	NA	NA	0.776	ND	0.729	NA	NA	1.69	NA	ND	ND	ND	ND	ND	NA	NA	0.5	0.25	NA	NA	NA	NA	NA	NA	NA	NA
EU-4, SB-06 (-28)	NA	ND	ND	ND	NA	NA	ND	ND	ND	NA	NA	NA	ND	ND	ND	ND	NA	NA	NA	NA	NA	ND	ND	NA	NA	ND	ND	ND	ND	ND	ND	ND	ND
EU-4, SB-04 (-29)	NA	ND	ND	ND	NA	NA	ND	ND	ND	NA	NA	NA	ND	ND	ND	ND	NA	NA	NA	NA	NA	ND	ND	NA	NA	ND	ND	ND	ND	ND	ND	ND	ND
EU-4, all borings (-30)	ND	NA	NA	NA	5.29	0.016	NA	NA	NA	ND	ND	ND	NA	NA	ND	NA	ND	ND	ND	ND	ND	NA	NA	ND	ND	NA	NA	NA	NA	NA	NA	NA	NA
DW2 drainageway (-31)	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Pond (-32)	ND	ND	ND	ND	204	0.0418	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
EU-6, SB-03 (-33)	NA	ND	0.141	0.0483	NA	NA	ND	ND	ND	NA	NA	NA	ND	0.0231	0.050	ND	NA	NA	NA	NA	NA	ND	0.233	NA	NA	0.0329	0.713	71.2	0.0881	ND	5.17	0.508	13.1
EU-6, SB-05 (-34)	NA	ND	4.29	2.78	NA	NA	ND	ND	ND	NA	NA	NA	0.508	ND	2.95	ND	NA	NA	NA	NA	NA	ND	ND	NA	NA	ND	5.72	1,180	ND	ND	85.6	28.7	58.4
EU-6, SB-05 (-35) Dup	NA	ND	5.45	3.51	NA	NA	ND	ND	ND	NA	NA	NA	0.467	ND	3.4	ND	NA	NA	NA	NA	NA	ND	0.013	NA	NA	ND	7.77	1,400	0.046	0.214	95.4	35.5	84.7
EU-6, all borings (-36)	ND	NA	NA	NA	5.1	0.0125	NA	NA	NA	0.148	0.818	4.88	NA	NA	0.461	NA	ND	ND	ND	0.126	0.146	NA	NA	ND	ND	NA	NA	NA	NA	NA	NA	NA	NA

Table 5. Strecker Ground Water Sampling Results - Detections (results in µg/L except dioxins pg/L)

Sample # (Results µg/L)	Date	Dioxins	PCB	SVOCs	VOCs	Benzene	Bis-(2-ethylhexyl)phthalate	n-Butylbenzene	sec-Butylbenzene	tert-Butylbenzene	Chloroethane	Chloroform	Chloromethane	1,2-Dichlorobenzene	1,1-Dichloroethane	1,1-Dichloroethene	cis-1,2-Dichloroethene	trans-1,2-Dichloroethene	Ethylbenzene
MCL						5.0	6.0					80		600		7.0	70	100	700
MRBCA default values						5.0	6.0	98.9	106	103	48.5	80	18.3	600	24.9	7.0	70	100	700
B-22	11/16/09	X	X	X	X	0.032 J B	1.8 J	ND	ND	ND	ND	ND	0.077 J	ND	ND	ND	ND	ND	ND
B-26	11/5/09	X	X	X	X	0.13 J B	2.9 J B	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
B-33	11/13/09	X	X	X	X	ND	12	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
MW-01	10/15/09	X	X	X	X	ND	4.7 J	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
MW-02	10/15/09	X	X	X	X	ND	5.6 J	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
MW-03	11/3/09	X	X	X	X	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
MW-04	10/19/09	X	X	X	X	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	0.089 J	ND	ND
MW-05	11/5/09	X	X	X	X	ND	ND	ND	ND	ND	ND	0.29 J	ND	ND	0.24 J	0.096 J	4.5	ND	ND
MW-06	11/13/09	X	X	X	X	0.51 J	ND	19 J	4.6 J	1.5 J	3.5 J	ND	ND	1.1 J	2.1 J	ND	10 J	ND	160
MW-06 (dup)	11/13/09	X	X	X	X	0.43 J	ND	29	6.2 J	1.8 J	4.3 J	ND	ND	1.6 J	2.4 J	ND	12	0.84 J	190
MW-07	11/3/09	X	X	X	X	ND	1.8 J	ND	ND	ND	ND	ND	ND	ND	ND	0.05 J	0.066 J	ND	0.045 J

Sample # (Results µg/L)	1,2,3,4,6,7,8-HpCDD (Heptadioxin)	1,2,3,4,6,7,8-HpCDF (Heptafuran)	1,2,3,4,6,7,8-HxCDF	1,2,3,6,7,8-HxCDD (hexafuran)	1,2,3,6,7,8-HxCDF (hexafuran)	1,2,3,7,8,9-HxCDD (hexadioxin)	2,3,7,8-TCDD (Tetrachlorodibenzo-p-dioxin)	1,2,3,4,6,7,8,9-OCDD (Octadioxin)	1,2,3,4,6,7,8,9-OCDF (Octafuran)	Isopropylbenzene	p-Isopropyltoluene	Methylene Chloride	2-Methylnaphthalene	Napthalene	n-Propylbenzene	Tetrachloroethene	Toulene	1,1,1-Trichloroethane	Trichloroethene	1,2,4-Trimethylbenzene	1,3,5-Trimethylbenzene	Vinyl Chloride	Xylenes
MCL							0.00003					5.0				5.0	1000	200	5.0			2.0	10000
MRBCA default values										330		5.0	11.7	1.09	115	5.0	1000	200	5.0	7.06	7.05	2.0	10000
B-22	0.39	0.0061 Q J	ND	0.0029 Q J	0.0029 J	0.01 J	ND	40 B E	0.016 J	ND	ND	ND	ND	ND	ND	ND	0.053 J	ND	ND	ND	ND	ND	0.044 J
B-26	ND	ND	ND	ND	ND	ND	0.00098 Q	0.077 J	ND	ND	ND	ND	ND	ND	ND	ND	0.15 J	ND	ND	ND	ND	ND	0.078 J
B-33	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	0.062 J	ND	ND	ND	ND	ND	0.059 J
MW-01	ND	ND	ND	ND	ND	ND	ND	0.019 Q J	ND	ND	ND	ND	ND	0.15 J B	ND	ND	ND	ND	ND	ND	ND	ND	0.06 J
MW-02	0.0048 J	0.017 J	0.0022 J	ND	0.0015 Q J	ND	ND	0.26 B	0.027 J	ND	ND	ND	ND	0.19 J	ND	ND	ND	ND	ND	ND	ND	ND	0.073 J
MW-03	ND	ND	ND	ND	ND	ND	ND	0.038 J TB FB	ND	ND	ND	ND	ND	0.16 JB	ND	ND	ND	ND	ND	ND	ND	ND	0.093 J
MW-04	ND	ND	ND	ND	ND	ND	ND	0.11 TB FB	ND	ND	ND	ND	ND	0.16 JB	ND	0.061 J	ND	ND	0.22 J	ND	ND	ND	0.038 J
MW-05	ND	ND	ND	ND	ND	ND	ND	0.011 J	ND	ND	ND	ND	ND	ND	ND	0.37 J	ND	0.18J	1.9	ND	ND	ND	0.039 J TB
MW-06	ND	ND	ND	ND	ND	ND	0.0044 Q J	0.15 FB	ND	25	1.8 J	7.2 J B	15	290 B/300 D/260 E	27	ND	4.8 J FB	ND	4.2 J	180	25	3.5 J	790
MW-06 (dup)	ND	ND	ND	ND	ND	ND	0.019 Q	0.024 Q J	ND	34	2.4 J	3.9 J B	13	390 B/240 D/220 E	34	ND	4.9 J	ND	5.1 J	240	31	3.9 J	950
MW-07	ND	ND	ND	ND	ND	ND	ND	0.0066 J	ND	ND	ND	ND	ND	0.14 J B TB	ND	0.09 J	0.28 J	ND	0.5 J	ND	ND	ND	0.087 J TB

Dioxin Results in parts per trillion

J = Estimated Result. Result is less than the reporting limit.

TB = Compound detected in associates Trip Blank

FB = Compound detected in associated Field (rinsate) Blank.

E = Estimated result.

D = Result was obtained from the analysis of a dilution

Q = Estimated maximum possible concentration

B = The associated method blank contains analyte at a level above method detection limit

Table 6. Callahan Property Analytical Results - Detections

(results in mg/kg)

Sample #	Depth (feet)	Date	Pesticides	SVOCs	VOCs	Dioxin	PCBs	Metals	Acetone	Arsenic	Barium	Benzene	Benzoic Acid	2,6-Bis(1,1-dimethylethyl)-4-methylphenol	Bis-(2-Ethylhexyl)phthalate	2-Butanone (MEK)	n-Butylbenzene	Cadmium	Chromium	Cyanide	1,3,5-Cycloheptatriene	Cyclohexane	Cyclohexanol	n-Cyclohexylcyclohexanamine	11-Decyldocosane	1,2-Dichlorobenzene	1,1-Dichloroethane	1,2-Dichloroethane	cis-1,2-Dichloroethene	1,3-Diisocyanatomethylbenzene	2,4-Dimethylphenol	1,2-Dimethoxyethane	Di-n-butyl phthalate	Eicosane	Ethylbenzene	Fluorene	Fluorotrichloromethane (Freon 11)	Hexadecanoic Acid	Hexatriacontane	1,3-Isobenzofurandione	Isophorone
EPA Residential Soil Screening									61,000	0.39	15,000	1.1	240,000		35	28,000		70		1600		7000				1900	3.3	0.43	160		1200		6100		5.4	2300					
Missouri default MRBCA									4.2	3.89	2,040	0.0561	84.8		347	7.3	41.6	9.31	7,460	77.1						56.1	0.18		0.521		9.37				39.9	211					5.69
ELL-21-SS-01		12/29/82	X	X	X	X	X		ND	NA	NA	ND	ND	5.50	13.0	ND	ND	NA	NA	NA	20.0	660	ND	ND	27.0	ND	ND	ND	ND	ND	ND	ND	ND	50.0	ND	ND	ND	ND	43.0	ND	ND
ELL-24-SL-01		12/30/82	X	X	X	X	X		ND	NA	NA	ND	ND	ND	16.0	ND	ND	NA	NA	NA	0.17	ND	0.17	0.99	ND	ND	ND	ND	ND	0.2	ND	ND	ND	ND	ND	ND	0.0038	ND	ND	0.51	ND
ELL-25-SL-01		12/30/82	X	X	X	X	X		ND	NA	NA	ND	ND	ND	1.0	ND	ND	NA	NA	NA	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	0.0039	1.1	ND	ND	ND
ELL-31-SL-01		1/6/83	X	X	X	X	X		ND	NA	NA	ND	ND	ND	5.6	ND	ND	NA	NA	NA	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	8.0	ND	ND	ND	ND	ND	ND	ND	ND	ND
ELL-32-SL-01		1/6/83	X	X	X	X	X		ND	NA	NA	ND	ND	ND	4.8	ND	ND	NA	NA	NA	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	2.4
ELL-22-SS-01	5	2/15/83	X	X	X	X	X		ND	NA	NA	ND	ND	ND	1.4	ND	ND	NA	NA	NA	0.38	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
ELL-23-SS-01	15	2/16/83	X	X	X	X	X		ND	NA	NA	ND	ND	ND	ND	ND	ND	NA	NA	NA	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
NDSA (North Drum Storage Area)	Composite	12/10/99	X			X	X	X	NA	4.98	161	NA	NA	NA	NA	NA	NA	ND	14.0	ND	NA	NA	NA	NA	NA	NA	NA	NA	NA	ND	ND	ND	ND	ND	NA	NA	NA	NA	NA	NA	NA
SDSA (South Drum Storage Area)	Composite	12/10/99	X			X	X	X	NA	5.38	141	NA	NA	NA	NA	NA	NA	ND	13.9	ND	NA	NA	NA	NA	NA	NA	NA	NA	NA	ND	ND	ND	ND	ND	NA	NA	NA	NA	NA	NA	NA
CFA 1 (Callahan Fill Area)	Composite	12/10/99	X			X	X	X	NA	3.67	89.9	NA	NA	NA	NA	NA	NA	2.09	34.0	0.16	NA	NA	NA	NA	NA	NA	NA	NA	NA	ND	ND	ND	ND	ND	NA	NA	NA	NA	NA	NA	NA
GAC 1 (Test Pit Below Fill Area)	Composite	12/10/99	X			X	X	X	NA	4.17	77.9	NA	NA	NA	NA	NA	NA	1.09	43.7	0.30	NA	NA	NA	NA	NA	NA	NA	NA	NA	ND	ND	ND	ND	ND	NA	NA	NA	NA	NA	NA	NA
EU-1, SB-06 (-01)	1.5	1/31/05			X				ND	NA	NA	ND	ND	NA	NA	ND	ND	NA	NA	NA	NA	NA	NA	NA	NA	ND	ND	ND	ND	NA	NA	NA	NA	NA	ND	NA	NA	NA	NA	NA	ND
EU-1, SB-08 (-02)	2.0	1/31/05			X				ND	NA	NA	ND	ND	NA	NA	ND	ND	NA	NA	NA	NA	NA	NA	NA	NA	ND	ND	ND	ND	NA	NA	NA	NA	NA	ND	NA	NA	NA	NA	NA	ND
EU-1, all borings (-03)	Composite (1.5)	1/31/05	X	X		X	X	X	NA	3.3	63.1	NA	NA	ND	ND	NA	NA	ND	12.5	ND	ND	ND	ND	ND	ND	NA	NA	NA	NA	ND	ND	ND	ND	ND	NA	ND	ND	ND	ND	ND	NA
EU-2, SB-05 (-04)	2.0	1/31/05			X				ND	NA	NA	ND	ND	NA	NA	ND	ND	NA	NA	NA	NA	NA	NA	NA	NA	ND	ND	ND	ND	NA	NA	NA	NA	NA	ND	NA	NA	NA	NA	NA	ND
EU-2, SB-06 (-05)	1.75	1/31/05			X				ND	NA	NA	ND	ND	NA	NA	ND	ND	NA	NA	NA	NA	NA	NA	NA	NA	ND	ND	ND	ND	NA	NA	NA	NA	NA	ND	NA	NA	NA	NA	NA	ND
EU-2, all borings (-06)	Composite (1.25)	1/31/05	X	X		X	X	X	NA	3.13	12.3	NA	NA	ND	ND	NA	NA	0.122	12.6	ND	ND	ND	ND	ND	ND	NA	NA	NA	NA	ND	ND	ND	ND	ND	NA	ND	ND	ND	ND	ND	NA
EU-3, SB-03 (-07)	2.0	1/31/05			X				ND	NA	NA	ND	ND	NA	NA	ND	ND	NA	NA	NA	NA	NA	NA	NA	NA	ND	ND	ND	ND	NA	NA	NA	NA	NA	ND	NA	NA	NA	NA	NA	ND
EU-3, SB-01 (-08)	2.0	1/31/05			X				ND	NA	NA	ND	ND	NA	NA	ND	ND	NA	NA	NA	NA	NA	NA	NA	NA	ND	ND	ND	ND	NA	NA	NA	NA	NA	ND	NA	NA	NA	NA	NA	ND
EU-3, all borings (-09)	Composite (1.75)	1/31/05	X	X		X	X	X	NA	4.63	126	NA	NA	ND	ND	NA	NA	0.0251	18.3	ND	ND	ND	ND	ND	ND	NA	NA	NA	NA	ND	ND	ND	ND	ND	NA	ND	ND	ND	ND	ND	NA
SB-1, barn floor (-10)	0.6	1/31/05				X			NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
SB-1, barn floor (-11)	1	1/31/05				X			NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
SB-1, barn floor (-12)	1.5	1/31/05				X			NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Barn Floor north 1/3 (-13)	0.2	1/31/05				X			NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Barn Floor center 1/3 (-14)	0.2	1/31/05				X			NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Barn Floor south 1/3 (-15)	0.2	1/31/05				X			NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Access road east (-16)	0.2	1/31/05				X			NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Access road west (-17)	0.2	1/31/05				X			NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
W-1 barn west wall (-19)		2/1/05				X			NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
W-2 barn south wall (-20)		2/1/05				X			NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
EU-5, SB-03 (-21)	9.0	2/1/05			X				ND	NA	NA	ND	ND	NA	NA	ND	0.0278	NA	NA	NA	NA	NA	NA	NA	NA	ND	ND	ND	ND	NA	NA	NA	NA	NA	ND	NA	NA	NA	NA	NA	ND
SB-1, drainageway (-22)	1.5	2/1/05			X				ND	NA	NA	ND	ND	NA	NA	ND	ND	NA	NA	NA	NA	NA	NA	NA	NA	ND	ND	ND	ND	NA	NA	NA	NA	NA	ND	NA	NA	NA	NA	NA	ND
SB-2, drainageway (-23)	1.5	2/1/05			X				ND	NA	NA	ND	ND	NA	NA	ND	ND	NA	NA	NA	NA	NA	NA	NA	NA	ND	ND	ND	ND	NA	NA	NA	NA	NA	ND	NA	NA	NA	NA	NA	ND
DW1 drainageway (-24)	0.2	2/1/05				X			NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
EU-5, SB-06 (-25)	8	2/1/05			X				ND	NA	NA	ND	ND	NA	NA	ND	0.687	NA	NA	NA	NA	NA	NA	NA	NA	ND	ND	ND	ND	NA	NA	NA	NA	NA	2.43	NA	NA	NA	NA	NA	ND
EU-5, all borings (-26)	Composite (8.5)	2/1/05	X	X		X	X	X	NA	4.28	144	NA	0.263	ND	1.26	NA	NA	0.294	54.8	ND	ND	ND	ND	ND	ND	NA	NA	NA	NA	ND	0.177	ND	ND	ND	NA	ND	ND	ND	ND	ND	NA
Duplicate EU-5 (-27)	Composite (8.5)	2/1/05	X	X		X	X	X	NA	4.61	110	NA	0.787	ND	0.834	NA	NA	0.198	32.2	ND	ND	ND	ND	ND	ND	NA	NA	NA	NA	ND	1.31	ND	ND	ND	NA	0.138	ND	ND	ND	ND	NA
EU-4, SB-06 (-28)	1.5	2/1/05			X				ND	NA	NA	ND	ND	NA	NA	ND	ND	NA	NA	NA	NA	NA	NA	NA	NA	ND	ND	ND	ND	NA	NA	NA	NA	NA	ND	NA	NA	NA	NA	NA	ND
EU-4, SB-04 (-29)	3.5	2/1/05			X				ND	NA	NA	ND	ND	NA	NA	ND	ND	NA	NA	NA	NA	NA	NA	NA	NA	ND	ND	ND	ND	NA	NA	NA	NA	NA	ND	NA	NA	NA	NA	NA	ND
EU-4, all borings (-30)	Composite (refusal)	2/1/05	X	X		X	X	X	NA	6.55	58.3	NA	NA	ND	ND	NA	NA	0.025	212	ND	ND	ND	ND	ND	ND	NA	NA	NA	NA	ND	ND	ND	ND	ND	NA	ND	ND	ND	ND	ND	NA
DW2 drainageway (-31)	0.2	2/2/05				X			NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Pond (-32)		2/2/05	X	X	X	X	X	X	ND	4.98	105	ND	ND	ND	ND	ND	ND	0.116	16.2	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	0.288	ND	ND	ND	ND	ND	ND	ND	ND
EU-6, SB-03 (-33)	7.5	2/2/05			X				ND	NA	NA	ND	ND	NA	NA	ND	0.087	NA	NA	NA	NA	NA	NA	NA	NA	ND	ND	ND	ND	NA	NA	NA	NA	NA	3.57	NA	NA	NA	NA	NA	ND
EU-6, SB-05 (-34)	9.5	2/2/05			X				0.633	NA	NA	0.156	ND	NA	NA	0.907	6.83	NA	NA	NA	NA	NA	NA	NA	NA	ND	0.0565	0.0436	0.419	NA	NA	NA	NA	NA	20.1	NA	NA	NA	NA	NA	ND
EU-6, SB-05 (-35) Dup	9.5	2/2/05			X				0.589	NA	NA	0.124	ND	NA	NA	0.968	8.32	NA	NA	NA	NA	NA	NA	NA	NA	ND	ND	0.034	0.297	NA	NA	NA	NA	NA	29.5	NA	NA	NA	NA	NA	ND
EU-6, all borings (-36)	Composite (refusal)	2/2/05	X	X		X	X	X	NA	NA	0.017	NA	NA	ND	16.0	NA	NA	0.123	12.2	ND	ND	ND	ND	ND	ND	0.133	NA	NA	NA	ND	11.7	ND	1.48	ND	NA	0.422	ND	ND	ND	ND	NA

Table 6. Callahan Property Analytical Results - Detections (cont.)

(results in mg/kg)

Sample #	Isopropylbenzene	p-Isopropyltoluene	Lead	Mercury	2-Methoxyethanol	Methylene Chloride	Methylester Formic Acid	2-Methylnaphthalene	2-Methylphenol	4-Methylphenol	4-Methyl-2-pentanone	Methyl-t-butyl-ether	Naphthalene	Oxirane (Dimethylene Oxide)	PCB-1254	PCB-1260	Pentacosane	Phenanthrene	Phenol	2-Propenylidenecyclobutene	n-Propylbenzene	Selenium	Silver	Styrene	Tetrachloroethene	Toulene	1,1,2-Trichloroethane	Trichloroethene	1,2,4-Trimethylbenzene	1,3,5-Trimethylbenzene	Xylenes
EPA Residential Soil Screening	2100		400	5.6	180	11		310	3100	310	5300	43	3.6	0.17	0.22	0.22			18,000			390	390	6300	0.55	5000	1.1	2.8	62	780	630
Missouri default MRBCA	10.5		3.74	2.19		0.0176		7.55	11.1	0.64		0.398	0.325		2.2	2.2		.0158	25.6		13.0	6.27	16.2	11.7	0.141	29.8	0.0448	0.141	3.93	0.882	24.7
ELL-21-SS-01	ND	ND	NA	NA	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	90.0	ND	ND	ND	ND	NA	NA	ND	ND	ND	ND	ND	ND	ND	ND
ELL-24-SL-01	ND	ND	NA	NA	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	NA	NA	ND	ND	ND	ND	ND	ND	ND	ND
ELL-25-SL-01	ND	ND	NA	NA	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	NA	NA	ND	ND	ND	ND	ND	ND	ND	ND
ELL-31-SL-01	ND	ND	NA	NA	10.0	11.0	5.0	ND	ND	ND	ND	ND	ND	10.0	ND	ND	ND	ND	ND	ND	ND	NA	NA	ND	ND	0.79	ND	ND	ND	ND	0.41
ELL-32-SL-01	ND	ND	NA	NA	ND	11.4	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	NA	NA	ND	ND	ND	ND	ND	ND	ND	ND
ELL-22-SS-01	ND	ND	NA	NA	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	0.189	ND	ND	ND	ND	ND	ND	NA	NA	ND	ND	ND	ND	ND	ND	ND	0.3
ELL-23-SS-01	ND	ND	NA	NA	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	0.28	ND	NA	NA	ND	ND	ND	ND	ND	ND	ND	ND
NDSA (North Drum Storage Area)	NA	NA	7.64	ND	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	ND	ND	NA	NA	NA	NA	NA	ND	ND	NA	NA	NA	NA	NA	NA	NA	NA
SDSA (South Drum Storage Area)	NA	NA	8.29	ND	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	ND	ND	NA	NA	NA	NA	NA	ND	ND	NA	NA	NA	NA	NA	NA	NA	NA
CFA 1 (Callahan Fill Area)	NA	NA	170	ND	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	ND	ND	NA	NA	NA	NA	NA	ND	ND	NA	NA	NA	NA	NA	NA	NA	NA
GAC 1 (Test Pit Below Fill Area)	NA	NA	189	ND	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	ND	ND	NA	NA	NA	NA	NA	ND	ND	NA	NA	NA	NA	NA	NA	NA	NA
EU-1, SB-06 (-01)	ND	ND	NA	NA	ND	ND	ND	NA	NA	NA	ND	ND	ND	ND	NA	NA	NA	NA	NA	ND	ND	NA	NA	ND	ND	ND	ND	ND	ND	ND	ND
EU-1, SB-08 (-02)	ND	ND	NA	NA	ND	ND	ND	NA	NA	NA	ND	ND	ND	ND	NA	NA	NA	NA	NA	ND	ND	NA	NA	ND	ND	ND	ND	ND	ND	ND	ND
EU-1, all borings (-03)	NA	NA	9.45	0.0203	NA	NA	NA	ND	ND	ND	NA	NA	ND	NA	ND	ND	ND	ND	ND	NA	NA	ND	ND	NA	NA	NA	NA	NA	NA	NA	NA
EU-2, SB-05 (-04)	ND	ND	NA	NA	ND	ND	ND	NA	NA	NA	ND	ND	ND	ND	NA	NA	NA	NA	NA	ND	ND	NA	NA	ND	ND	ND	ND	ND	ND	ND	ND
EU-2, SB-06 (-05)	ND	ND	NA	NA	ND	ND	ND	NA	NA	NA	ND	ND	ND	ND	NA	NA	NA	NA	NA	ND	ND	NA	NA	ND	ND	ND	ND	ND	ND	ND	ND
EU-2, all borings (-06)	NA	NA	19.2	0.0188	NA	NA	NA	ND	ND	ND	NA	NA	ND	NA	ND	ND	ND	ND	ND	NA	NA	ND	0.25	NA	NA	NA	NA	NA	NA	NA	NA
EU-3, SB-03 (-07)	ND	ND	NA	NA	ND	ND	ND	NA	NA	NA	ND	ND	ND	ND	NA	NA	NA	NA	NA	ND	ND	NA	NA	ND	ND	ND	ND	ND	ND	ND	ND
EU-3, SB-01 (-08)	ND	ND	NA	NA	ND	ND	ND	NA	NA	NA	ND	ND	ND	ND	NA	NA	NA	NA	NA	ND	ND	NA	NA	ND	ND	ND	ND	ND	ND	ND	ND
EU-3, all borings (-09)	NA	NA	7.67	0.0212	NA	NA	NA	ND	ND	ND	NA	NA	ND	NA	ND	ND	ND	ND	ND	NA	NA	ND	ND	NA	NA	NA	NA	NA	NA	NA	NA
SB-1, barn floor (-10)	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
SB-1, barn floor (-11)	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
SB-1, barn floor (-12)	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Barn Floor north 1/3 (-13)	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Barn Floor center 1/3 (-14)	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Barn Floor south 1/3 (-15)	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Access road east (-16)	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Access road west (-17)	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
W-1 barn west wall (-19)	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
W-2 barn south wall (-20)	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
EU-5, SB-03 (-21)	ND	0.0139	NA	NA	ND	ND	ND	NA	NA	NA	ND	ND	ND	NA	NA	NA	NA	NA	NA	ND	ND	NA	NA	ND	ND	ND	ND	ND	0.11	0.0387	ND
SB-1, drainageway (-22)	ND	ND	NA	NA	ND	ND	ND	NA	NA	NA	ND	ND	ND	NA	NA	NA	NA	NA	NA	ND	ND	NA	NA	ND	ND	ND	ND	ND	ND	ND	ND
SB-2, drainageway (-23)	ND	ND	NA	NA	ND	ND	ND	NA	NA	NA	ND	ND	ND	NA	NA	NA	NA	NA	NA	ND	ND	NA	NA	ND	ND	ND	ND	ND	ND	ND	ND
DW1 drainageway (-24)	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	ND	ND	ND	ND	ND	ND	ND	ND
EU-5, SB-06 (-25)	0.674	0.169	NA	NA	ND	ND	ND	NA	NA	NA	ND	ND	3.03	ND	NA	NA	NA	NA	NA	ND	ND	NA	NA	ND	0.0352	32.1	ND	ND	17.2	6.44	8.52
EU-5, all borings (-26)	NA	NA	197	0.0268	NA	NA	NA	0.303	ND	ND	NA	NA	0.601	NA	ND	0.020	ND	ND	ND	NA	NA	ND	ND	NA	NA	NA	NA	NA	NA	NA	NA
Duplicate EU-5 (-27)	NA	NA	128	0.0258	NA	NA	NA	0.776	ND	0.729	NA	NA	1.69	NA	ND	ND	ND	ND	ND	NA	NA	0.5	0.25	NA	NA	NA	NA	NA	NA	NA	NA
EU-4, SB-06 (-28)	ND	ND	NA	NA	ND	ND	ND	NA	NA	NA	ND	ND	ND	ND	NA	NA	NA	NA	NA	ND	ND	NA	NA	ND	ND	ND	ND	ND	ND	ND	ND
EU-4, SB-04 (-29)	ND	ND	NA	NA	ND	ND	ND	NA	NA	NA	ND	ND	ND	ND	NA	NA	NA	NA	NA	ND	ND	NA	NA	ND	ND	ND	ND	ND	ND	ND	ND
EU-4, all borings (-30)	NA	NA	5.29	0.016	NA	NA	NA	ND	ND	ND	NA	NA	ND	NA	ND	ND	ND	ND	ND	NA	NA	ND	ND	NA	NA	NA	NA	NA	NA	NA	NA
DW2 drainageway (-31)	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Pond (-32)	ND	ND	204	0.0418	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
EU-6, SB-03 (-33)	0.141	0.0483	NA	NA	ND	ND	ND	NA	NA	NA	ND	0.0231	0.050	ND	NA	NA	NA	NA	NA	ND	0.233	NA	NA	0.0329	0.713	71.2	0.0881	ND	5.17	0.508	13.1
EU-6, SB-05 (-34)	4.29	2.78	NA	NA	ND	ND	ND	NA	NA	NA	0.508	ND	2.95	ND	NA	NA	NA	NA	NA	ND	ND	NA	NA	ND	5.72	1,180	ND	ND	85.6	28.7	58.4
EU-6, SB-05 (-35) Dup	5.45	3.51	NA	NA	ND	ND	ND	NA	NA	NA	0.467	ND	3.4	ND	NA	NA	NA	NA	NA	ND	0.013	NA	NA	ND	7.77	1,400	0.046	0.214	95.4	35.5	84.7
EU-6, all borings (-36)	NA	NA	5.1	0.0125	NA	NA	NA	0.148	0.818	4.88	NA	NA	0.461	NA	ND	ND	ND	0.126	0.146	NA	NA	ND	ND	NA	NA	NA	NA	NA	NA	NA	NA

TABLE 7

PAST SAMPLING SUMMARY - PROPOSED STRECKER FOREST SUBDIVISION
ALL INVESTIGATIONS

Sample Area	Sample No./ type	Description	Analytes	Detections above RSL/MRBCA
Former Dozier and Primm residences	B-24, B-25, MW-1, MW-2	Soil borings	Dioxins, PCBs, SVOCs, VOCs	none
		Wipe –Dozier garage rafters	Dioxins, PCBs	none
Western pond area	B-19, B-20, B-21, B-22, B-23, B-30, B-31, B-33	Soil borings	Dioxins, PCBs, SVOCs, VOCs	none
	TP1, TP2, TP3	Test pits 8 ft. bgs or refusal	Metals, pesticides, PCBs, SVOCs, VOCs	none
	SED-1	Drained pond	Dioxins, pesticides, SVOCs, VOCs	none
Central haul road	B-28, B-29	Soil borings	Dioxins, PCBs, SVOCs, VOCs	none
Solid Waste Disposal Area, interior drainageway	B-14, B-15, B-16, B-17, B-18, B-26, B-27, B-32, B-34, MW-4	Soil borings	Dioxins, PCBs, SVOCs, VOCs	none
	GP-A	Soil boring 0-3 ft. bgs	Metals, pesticides, PCBs, VOCs	1,2-dibromo-3-chloropropane (0.0029 ppm) > MRBCA (0.0011 ppm)
	GP-B, GP-E	Soil boring 0-3 ft. bgs	Metals, pesticides, PCBs, SVOCs, VOCs	none
	GP-F	Soil boring 0-3 ft. bgs	Metals, pesticides, PCBs, VOCs	Arochlor 1260 (0.36 ppm) > RSL (0.22 ppm)
	TP4, TP5, TP7, TP8	Test pits 8ft. bgs or refusal	Metals, pesticides, PCBs, SVOCs, VOCs	none
	TP-6	Test pit 8 ft. bgs or refusal	Metals, pesticides, PCBs, SVOCs, VOCs	Arochlor 1254 (1.1 ppm) > RSL (0.22 ppm)

Table 7 continued

Eastern Disturbed Area	B-11, B-11 (dup), B-12, B-13, B-35, MW-5	Soil borings	Dioxins, PCBs, SVOCs, VOCs	none
	GP-C, , GP-G	0-3 ft. bgs	Metals, pesticides, PCBs, SVOCs, VOCs	none
	A-4	Highlift-explored Geophysical anomaly	Dioxins, Metals, PCBs, VOCs	Benzo(a)pyrene (0.15 ppm) > RSL (0.015 ppm) Cadmium (28.5 ppm) > MRBCA (9.31 ppm) Ethylbenzene (17 ppm) > RSL (5.4 ppm) Naphthalene (11; 4.4 ppm) > RSL (3.6 ppm), MRBCA (0.325 ppm) Tetrachloroethene (0.67 ppm) > RSL (0.55 ppm), MRBCA (0.141 ppm) 1,2,4-trichlorobenzene (43 ppm) > RSL (22 ppm), MRBCA (18.7 ppm) 1,3,5-trimethylbenzene (53 ppm) > MRBCA (0.882 ppm) Xylenes (67.8 ppm) > MRBCA (24.7 ppm)
	EPA RI Ell-53	5-10 ft. bgs	Dioxins, pesticides, SVOCs, VOCs	none
		10-15 ft. bgs	Dioxins, pesticides, SVOCs, VOCs	none
		15-20 ft bgs	Dioxins, pesticides, SVOCs, VOCs	none
NPL Area	B-1, B-2, B-3, B-4, B-5, B-6, B-6 (dup), B-7, B-8, B-9	Soil borings	Dioxins, PCBs, SVOCs, VOCs	none
	B-10	0.5-2 ft. bgs	Dioxins, PCBs, SVOCs, VOCs	2,3,7,8-TCDD (150 ppt) > RSL (4.5 ppt)
	MW-6	7-10 ft. bgs	Dioxins, PCBs, SVOCs, VOCs	2,3,7,8-TCDD (9100E; 6,500D ppt) > RSL (4.5 ppt) Ethylbenzene (7 ppm) > RSL (5.4 ppm) 2-methylnapthalene (8.1 ppm) > MRBCA (7.55 ppm) Napthalene (14, 49D, 37E ppm) > RSL (3.6 ppm), MRBCA (0.325 ppm) Arochlor 1248 (0.24 ppm) > RSL (0.22 ppm) 1,2,4-trimethylbenzene (9.2 ppm) > MRBCA (3.93 ppm) 1,3,5-trimethylbenzend (0.95 ppm) > MRBCA (0.882 ppm)

Table 7 continued

	MW-6 (dup)	7-10 ft. bgs	Dioxins, PCBs, SVOCs, VOCs	2,3,7,8-TCDD (2,000 ppt) > RSL (4.5 ppt) Ethylbenzene (44 ppm) > RSL (5.4 ppm) Napthalene (71; 27E; 22D ppm) > RSL (3.6 ppm), MRBCA (0.325 ppm) 1,2,4-trimethylbenzene (58 ppm) > MRBCA (3.93 ppm) 1,3,5-trimethylbenzend (14 ppm) > MRBCA (0.882 ppm) Xylenes (198 ppm) > MRBCA (24.7 ppm)
	GP-D	0-3 ft. bgs, 3-6 ft. bgs	Metals, pesticides, PCBs, SVOCs,VOCs	none
	GP-H	3-6 ft. bgs	Metals, pesticides, PCBs, VOCs	none
	GP-H	9-12 ft. bgs	Metals, pesticides, PCBs, VOCs	Naphthalene (6.1; 4.5 ppm) > RSL (3.6 ppm), MRBCA (0.325 ppm) Tetrachloroethene (0.27 ppm) > MRBCA (0.141 ppm) 1,3,5-triclorobenzene (2.4 ppm) > MRBCA (0.882 ppm)
Other	MW-03, MW-07		Dioxins, PCBs, SVOCs, VOCs	none

TABLE 8

PAST SAMPLING SUMMARY – CALLAHAN PROPERTY

Sample Area	Sample No./ type	Description	Analytes	Detections above RSL/MRBCA
Former drum burial area – north portion	28 (GS-14) discrete	EU-4, SB-06 (1.5-1.75 ft bgs)	VOCs	none
	29 (GS-15) discrete	EU-4, SB-04 (3.5-3.75 ft. bgs)	VOCs	none
	30 (CS-11) composite	EU-4, Bottom of all borings (3.5-7.0 ft. bgs)	C-list	none
Former drum burial area – central portion	21 (GS-10) discrete	EU-5, SB-03 (8.5-9.0 ft. bgs)	VOCs	none
	25 (GS-13) discrete	EU-5, SB-06 (8.0-8.25 ft. bgs)	VOCs	Naphthalene (3.03 ppm) > MRBCA (0.325 ppm) Toulene (32.1 ppm) > MRBCA (29.8 ppm) 1,2,4-Trimethylbenzene (17.2 ppm) > MRBCA (3.93) 1,3,5-Trimehtylbenzene (6.44 ppm) > MRBCA (0.882)
	26 (CS-10) composite	EU-5, Only borings at 8.0-8.5 ft. bgs (SB-01, 02, 03, 06)	C-list	Naphthalene (0.601 ppm) > MRBCA (0.325 ppm)
	27(CS-10) composite	Duplicate Sample of 26	C-list	4-methylphenol (0.729 ppm) > MRBCA (0.64 ppm) Naphthalene (1.69 ppm) > MRBCA (0.325 ppm)
Former drum burial area – south portion	33 (GS-16)	EU-6, SB-03 (7.0-7.5 ft. bgs)	VOCs	1,2,4-trimethylbenzene (5.17 ppm) > MRBCA (3.93 ppm) Tetrachloroethene (0.713 ppm) > RSL (0.55 ppm) Toluene (71.2 ppm) > MRBCA (29.8 ppm) 1,1,2-tricholoroethane (0.0881 ppm) > MRBCA (0.0448 ppm)
	34 (GS-17) discrete	EU-6, SB-05 (9.0-9.5 ft. bgs)	VOCs	Benzene (0.156ppm) > MRBCA (0.0561 ppm) Ethylbenzene (20.1 ppm) > RSL (5.4 ppm) Naphthalene (2.95 ppm) > MRBCA ((0.325 ppm) Tetrachloroethene (5.72 ppm) > RSL (0.55 ppm) Toluene (1,180 ppm) > MRBCA (29.8 ppm) 1,2,4-trimethylbenzene (85.6 ppm) > RSL (62 ppm), MRBCA (3.93 ppm) 1,3,5-trimethylbenzene (28.7 ppm) > MRBCA (0.882 ppm) Xylenes (58.4 ppm) > MRBCA (24.7 ppm)

Table 8 continued

Former drum burial area – south portion (continued)	35 (GS-17) discrete	Duplicate Sample of 34	VOCs	Benzene (0.124ppm) > MRBCA (0.0561 ppm) Ethylbenzene (29.5 ppm) > RSL (5.4 ppm) Napthalene (3.4 ppm) > MRBCA (0.325 ppm) Tetrachloroethene (7.77 ppm) > RSL (0.55 ppm) Toluene (1,400 ppm) > MRBCA (29.8 ppm) 1,1,2-trichloroethane (0.046 ppm) > MRBCA (0.0448 ppm) Trichloroethene (0.214 ppm) > MRBCA (0.141 ppm) 1,2,4-trimethylbenzene (95.4 ppm) > RSL (62 ppm), MRBCA (3.93 ppm) 1,3,5-trimethylbenzene (35.5 ppm) > MRBCA (0.882 ppm) Xylenes (84.7 ppm) > MRBCA (24.7 ppm)
	36 (CS-12) composite	EU-6, Boring at refusal (5.0-15.5 ft. bgs)	C-list	2,4-dimethylphenol(11.7 ppm) > MRBCA (9.37 ppm) 4-methylphenol (4.88 ppm) > MRBCA (0.64 ppm) Napthalene (0.461 ppm) > MRBCA (0.325 ppm) Phenanthrene (0.126 ppm) > MRBCA (0.158 ppm)
Former Drum Burial area	EPA RI Ell-21 composite	2-8 ft bgs	Pesticides, SVOCs, VOCs, dioxin, PCBs	none
	EPA RI Ell-22 composite	5 ft from fill > 5 ft bgs	Pesticides, SVOCs, VOCs, dioxin, PCBs	none
	EPA RI Ell-23 composite	15 feet from fill > 5 ft bgs	Pesticides, SVOCs, VOCs, dioxin, PCBs	none
North drum staging area	01 (GS-01) discrete	EU-1, SB-06 (1.25-1.5 ft bgs)	VOCs	none
	02 (GS-02) discrete	EU-1, SB-08 (1.7-2.0 ft. bgs)	VOCs	none
	03 (CS-01) composite	EU-1, Topsoil/clay interface (approx 1.5 ft. bgs)	C-list[1]	none
	04 (GS-03) discrete	EU-2, SB-05 (1.75-2.0 ft. bgs)	VOCs	none
	05 (GS-04) discrete	EU-2, SB-06 (1.25-1.75 ft. bgs)	VOCs	none

Table 8 continued

North drum staging area (continued)	06 (CS-02) composite	EU-2, Topsoil/clay interface (< 2 ft. bgs)	C-list	none
	EPA RI Ell-32 composite	0-2 ft bgs	Pesticides, SVOCs, VOCs, dioxin, PCBs	Methylene chloride (11.4 ppm) > RSL (11), MRBCA (0.0176)
West drum staging area	07 (GS-05) discrete	EU3, SB-03 (1.75-2.0 ft bgs)	VOCs	none
	08 (GS-06) discrete	EU3, SB-01 (1.25-21.5 ft. bgs)	VOCs	none
	09 (CS-03) composite	EU3, All borings (1.5-1.75 ft. bgs)	C-list	none
	EPA RI Ell-31 composite	0-2 ft bgs	Pesticides, SVOCs, VOCs, dioxin, PCBs	Methylene Chloride (11.0 ppm) > RSL (11), MRBCA (0.0176) Oxirane (10.0 ppm) > RSL (0.17)
Barn Floor	10 (GS-07), discrete	SB-1 0-0.5 ft bgs	2,3,7,8-TCDD	none
	11 (GS-08), discrete	SB-1 0.5-1.0 ft bgs	2,3,7,8-TCDD	none
	12 (GS-09), discrete	SB-1 1.0-1.5 ft bgs	2,3,7,8-TCDD	none
	13 (CS-4), composite	Barn Floor North	2,3,7,8-TCDD	none
	14 (CS-5), composite	Barn Floor Center	2,3,7,8-TCDD	none
	15 (CS-6), composite	Barn Floor South	2,3,7,8-TCDD	none
Barn wall	19 (W-1), wipe	West Wall	2,3,7,8-TCDD	none
	20 (W-2), wipe	South Wall	2,3,7,8-TCDD	none
Driveway	16 (CS-07), composite	Road East 0-2 inches bgs	2,3,7,8-TCDD	none
	17 (CS-08), composite	Road West 0-2 inches bgs	2,3,7,8-TCDD	none
West drainageway	22 (GS-11), discrete	SB-1 12-18 inches bgs	VOCs	none
	23 (GS-12), discrete	SB-2 12-18 inches bgs	VOCs	none
	24 (CS-09), composite	DW-1 0-2 inches bgs	2,3,7,8-TCDD	none
	EPA RI Ell-24 discrete	0-1 inch bgs sediment	Pesticides, SVOCs, VOCs, dioxin, PCBs	none
	EPA RI Ell-25 discrete	0-1 inch bgs sediment	Pesticides, SVOCs, VOCs, dioxin, PCBs	none

Table 8 continued

East drainageway	31 (CS-13), composite	DW-2 0-2 inches bgs	2,3,7,8-TCDD	none
Pond Drainage Area	32		VOCs, C-list	none

1) C-list analytes include 2,3,7,8-TCDD, SVOCs, arsenic barium, cadmium, lead, mercury, selenium, silver, hexavalent chromium, cyanide, chlorinated herbicides, organochlorine pesticides, and PCBs.

TABLE 9

1999 PHASE II ENVIRONMENTAL ASSESSMENT – CALLAHAN PROPERTY

Sample Area	Sample no./type	Description	Analytes	Detections above RSL/MRBCA
Callahan Fill Area	CFA 1, Test Pits	CFA	Pesticides, PCBs, metals, dioxin	none
Area below Callahan Fill Area	GAC 1-3, Test pits	GAC	Pesticides, PCBs, metals, dioxin phenols, cyanide	none
Site-wide	NDSA, SDSA, D1	North drum staging area, south drum staging area, shallow surface soil samples	Pesticides, PCBs, metals, dioxin	none

APPENDIX C

QUALITY ASSURANCE PROJECT PLAN FORM

Region 7 Superfund Program
Addendum to the QAPP for Superfund Integrated Site Assessment and Targeted Brownfields Assessment Activities (July 2007)
for Ellisville OU #00 Site (Proposed Strecker Forest Development Property)

Project Information:

Project Name: Ellisville OU #00 Site (Proposed Strecker Forest Development Property)		**City:** Wildwood	**State:** MO
EPA Project Managers: Jim Silver and Bob Feild		**START Project Manager:** Dave Kinroth	

Approved By:			**Prepared For:** EPA Region 7 Superfund Division
Title:	START Project Manager	Date:	
Approved By:			
Title:	START Program Manager	Date:	
Approved By:			**Prepared By:** Dave Kinroth **Date:** June 2011
Title:	START QA Manager	Date:	
Approved By:			**Tetra Tech START Project Number:** X9004.11.0230.000
Title:	EPA Project Manager	Date:	
Approved By:			
Title:	EPA Project Manager	Date:	
Approved By:			
Title:	EPA Region 7 QA Manager	Date:	

1.0 PROJECT MANAGEMENT:

1.1 Distribution List

EPA—Region 7: Jim Silver, EPA Project Manager
Bob Feild, EPA Project Manager
Diane Harris, EPA Region 7 QA Manager

Tetra Tech START: Dave Kinroth, Project Manager
Kathy Homer, QA Manager

1.2 Project/Task Organization

Jim Silver and Bob Feild, of the EPA Region 7 Superfund Division, will serve as the EPA project managers for the activities described in this QAPP. Dave Kinroth, of Seagull Environmental Technologies, Inc., a subcontractor to Tetra Tech EM, Inc., (Tetra Tech), will serve as the START project manager for field activities.

1.3 Problem Definition/Background:

Description: This site-specific Quality Assurance Project Plan form is prepared as an addendum to the Generic Quality Assurance Project Plan for Superfund Integrated Assessment and Targeted Brownfields Assessment Program (updated July 2007), and contains site-specific data quality objectives for the sampling activities described herein.

☒ Description attached.
☐ Description in referenced report: ______________________ Title ______________ Date

1.4 Project/Task Description:

☐ CERCLA PA ☐ CERCLA SI ☐ Brownfields Assessment ☐ Removal Action
☒ Other (description attached): ☐ Pre-CERCLIS Screening ☐ Removal Site Evaluation

Other Description: Expanded Site Review

Schedule: Fieldwork is anticipated in summer 2011, pending approval of this QAPP by all involved parties.

☐ Description in referenced report: ______________________ Title ______________ Date

1.5 Quality Objectives and Criteria for Measurement Data:

Accuracy:	☒ Identified in attached table.
Precision:	☒ Identified in attached table.
Representativeness:	☒ Identified in attached table.
Completeness*:	☒ Identified in attached table.
Comparability:	☒ Identified in attached table.

Other Description:

*A completeness goal of 100 percent has been established for this project. However, if the completeness goal is not met, EPA may still be able to make decisions based on any or all of the remaining validated data. No ~~—c~~ritical samples” have been identified for this project.

1.6 Special Training/Certification Requirements:

☒ OSHA 1910 ☒ Special Equipment/Instrument Operator (describe below): ☐ Other (describe below):

Sampling personnel will be experienced in Geoprobe® operation (performed by a Missouri-licensed operator) and in collection of soil samples.

1.7 Documentation and Records:

☒ Field Sheets ☒ Daily Log ☐ Trip Report ☒ Area Maps ☐ Video
☒ Chain of Custody ☒ Health and Safety Plan ☒ Letter Report ☒ Photos

☒ Sample documentation will follow EPA Region 7 SOP 2420.05.
☒ Other: Analytical information will be handled according to procedures identified in Table 2.

2.0 MEASUREMENT AND DATA ACQUISITION:

2.1 Sampling Process Design:

☐ Random Sampling ☐ Transect Sampling ☒ Biased/Judgmental Sampling ☐ Stratified Random Sampling
☐ Search Sampling ☒ Systematic Grid ☐ Systematic Random Sampling ☒ Definitive Sampling
☐ Screening wo/ Definitive Confirmation ☐ Screening w/ Definitive Confirmation
☒ Sample Maps Attached

☒ Other (Provide rationale behind each sample):

The proposed sampling scheme will be judgmental, in accordance with the *Guidance for Performing Site Inspections Under CERCLA*, OSWER Directive #9345.1-05, September 1992, and *Removal Program Representative Sampling Guidance, Volume 1: Soil*, OSWER Directive 9360.4-10, November 1991. Judgmental sampling is the subjective (biased) selection of sampling locations based on historical information, visual inspection, and the best professional judgment of the sampler(s).

The proposed number of samples is a balance between cost and coverage, and represents a reasonable attempt to meet the study objectives while staying within the budget constraints of a typical investigation of this type.

Sample Summary Location	Matrix	# of Samples*	Analysis
Groundwater Monitoring Wells	Groundwater	13	Full list of analytes identified in Table 1
Decision Units	Surface Soil	41	SVOCs, PCBs, Dioxin TEQ
Geoprobe® Boring Locations	Subsurface Soil	30	VOCs, SVOCs, PCBs, Dioxin TEQ
Abandoned Residential Structures	Interior Dust, Dirt, and/or Wipes	2	Dioxin TEQ
		Total = 108	

*NOTE: Number is approximate and may change depending on site conditions. Background/QC samples are not included with these totals. See Table 1 for a complete sample summary.

2.2 Sample Methods Requirements:

Matrix	Sampling Method	EPA Region 7 SOP(s) or other Method
Groundwater from monitoring wells	Groundwater samples will be collected from monitoring wells using dedicated bailers or pumping devices with dedicated tubing after the wells have been purged and allowed to recharge. All water samples will be collected in designated containers for the analyses requested.	EPA SOPs 4334.15A & 4231.2007
Surface Soil	Composite surface soil samples will be collected from 41 decision units (DU) using an incremental core sampling tool (trier), with aliquots collected from 0-2 inch depths. The samples will be homogenized in disposable aluminum pans using the ―slab-cake or pancake procedure.” The samples will be transferred to glass jars for laboratory analysis.	EPA SOP 4231.2012, & User Guide to Accompany the Generic Dioxin Reassessment UFP-QAPP Template
Subsurface Soil	Subsurface soil samples will be collected using a Geoprobe® Direct-Push Technology (DPT) sampling device. The samples will be transferred to glass jars for laboratory analysis.	EPA SOPs 4230.07 & 4231.2012; Method 5035
Interior Dust Samples	Interior dust will be collected from surfaces inside two abandoned homes on the site property. The samples will be transferred to glass jars for laboratory analysis.	EPA SOP 4231.2011

☐ Other Description:

2.3 Sample Handling and Custody Requirements:

☒ Samples will be packaged and preserved for field screening in accordance with procedures defined in Region 7 EPA SOP 2420.06.
☒ COC will be maintained for field screening as directed by Region 7 EPA SOP 2420.04.
☒ Samples will be accepted by the EPA Region 7 laboratory according to Region 7 EPA SOP 2420.01.
☒ Other (Describe): Samples submitted to a START-contracted laboratory will be accepted in accordance with procedures established by the laboratory.

2.4 Analytical Methods Requirements:

☒ Identified in attached table.
☒ Rationale: The requested analyses have been selected based on historical information about the area and program experience with similar types of sites.
☐ Other (Describe):

2.5 Quality Control Requirements:

☐ Not Applicable
☒ Identified in attached table.
☒ In accordance with the Generic Quality Assurance Project Plan for Superfund Integrated Assessment and Targeted Brownfields Assessment Program (updated July 2007).
☒ Field QC Samples: For this investigation, field QC samples will include one water sample trip blank and one water sample field blank. The trip blank will be used to assess transportation-related contamination. The field blank will be used to evaluate contamination of sampling containers and to assess contamination potentially introduced during the sampling and laboratory procedure(s). Evaluation of blank samples depends on the levels of contamination found in environmental samples to determine whether the environmental samples are representative. Analytical results of the blank samples will be evaluated on a qualitative basis by the EPA project manager and EPA contractor(s) to determine a general indication of field-introduced and/or analysis-introduced contamination. In addition, one duplicate water, and one duplicate soil sample will be collected to assess the total precision of the analytical instruments and sampling methods. Finally, two rinsate water samples will also be collected to measure the effectiveness of decontamination procedures performed on the incremental soil sampling device (trier) and Geoprobe® sampling tools.
☐ Other (Describe):

2.6 Instrument/Equipment Testing, Inspection, and Maintenance Requirements:

☐ Not Applicable
☒ In accordance with the Generic Quality Assurance Project Plan for Superfund Integrated Assessment and Targeted Brownfields Assessment Program (updated July 2007).
☒ Testing, inspection, and maintenance of analytical instrumentation will proceed in accordance with the previously referenced SOPs and/or manufacturers' recommendations. Testing, inspection, and maintenance of field instruments (GPS units, etc.) will proceed in accordance with manufacturers' recommendations.

2.7 Instrument Calibration and Frequency:

☐ Not Applicable
☒ In accordance with the Generic Quality Assurance Project Plan for Superfund Integrated Assessment and Targeted Brownfields Assessment Program (updated July 2007).
☒ Calibration of laboratory and field equipment will be performed as described in the previously referenced SOPs and/or manufacturers' recommendations.
☐ Other (Describe):

2.8 Inspection/Acceptance Requirements for Supplies and Consumables:

☐ Not Applicable
☒ In accordance with the Generic Quality Assurance Project Plan for Superfund Integrated Assessment and Targeted Brownfields Assessment Program (updated July 2007).
☒ All sample containers will meet EPA criteria for cleaning procedures for low-level chemical analysis. Sample containers will have Level II certifications provided by the manufacturer in accordance with pre-cleaning criteria established by EPA in *Specifications and Guidelines for Obtaining Contaminant-Free Containers.*
☐ Other (Describe):

2.9 Data Acquisition Requirements:

☐ Not Applicable
☒ In accordance with the Generic Quality Assurance Project Plan for Superfund Integrated Assessment and Targeted Brownfields Assessment Program (updated July 2007).
☒ Previous data or information pertaining to the area (including other analytical data, reports, photos, maps, etc., that are referenced in this QAPP) has been compiled by EPA and/or its contractor(s) from other sources. Some of that data have not been verified by EPA and/or its contractor(s); however, that unverified information will not be used for decision-making purposes by EPA without verification by an independent professional qualified to verify such data or information.
☐ Other (Describe):

2.10 Data Management:

☒ All data acquired by the EPA Region 7 laboratory will be managed in accordance with Region 7 EPA SOP 2410.01.
☒ Other (Describe): Data acquired by the START-contracted laboratory will be managed in accordance with procedures established by the laboratory.

3.0 ASSESSMENT AND OVERSIGHT:

3.1 Assessment and Response Actions:

☒ Peer Review ☒ Management Review ☐ Field Audit ☐ Lab Audit
☒ Assessment and response actions pertaining to analytical phases of the project conducted at the EPA Region 7 laboratory are addressed in Region 7 EPA SOPs 2430.06 and 2430.12.
☒ Other (Describe): Assessment and response actions pertaining to analytical phases of the project conducted at the START-contracted laboratory will be in accordance with procedures established by the laboratory (to be determined).

3.2 Corrective Action:

☒ Corrective actions will be at the discretion of the EPA project manager whenever problems appear that could adversely affect data quality and/or resulting decisions affecting future response actions pertaining to the area.
☐ Other (Describe):

3.3 Reports to Management:

☐ Audit Report ☒ Data Validation Report ☐ Project Status Report ☐ None Required

☒ A letter report describing the sampling techniques, locations, problems encountered (with resolutions to those problems), and interpretation of analytical results will be prepared by START and submitted to the EPA.
☒ Reports will be prepared in accordance with the Generic Quality Assurance Project Plan for Superfund Integrated Assessment and Targeted Brownfields Assessment Program (updated July 2007).
☐ Other (Describe):

4.0 DATA VALIDATION AND USABILITY:

4.1 Data Review, Validation, and Verification Requirements:

☐ Identified in attached table.
☒ Data review and verification will be performed in accordance with the Generic Quality Assurance Project Plan for Superfund Integrated Assessment and Targeted Brownfields Assessment Program (updated July 2007).
☒ Review and verification of data generated by the EPA Region 7 laboratory will be performed by a qualified analyst and the laboratory's section manager as described in Region 7 EPA SOPs 2430.06, 2410.10, and 2430.12.
☒ Other (Describe): The analytical data package prepared by the START-contracted laboratory will be validated internally by the contracted laboratory in accordance with the laboratory's established SOPs. A Tetra Tech chemist will conduct an external verification and validation of the laboratory data package using a method consistent with a Stage 2B validation, as described in the EPA Contract Laboratory Program (CLP) Guidance for Labeling Externally Validated Laboratory Analytical Data for Superfund Use. A Stage 2B validation includes verification and validation based on completeness and compliance check of sample receipt conditions and sample-related and instrument-related QC results. The EPA Project Manager will be responsible for overall validation and final approval of the data, in accordance with the projected use of the results.

4.2 Validation and Verification Methods:

☐ Identified in attached table.
☒ The data will be validated in accordance with Region 7 EPA SOPs 2430.06, 2410.10, and 2430.12.
☒ The EPA project manager will inspect the data to provide a final review. The EPA project manager will review the data, if applicable, for laboratory spikes and duplicates, laboratory blanks, and the field QC samples to ensure the data are acceptable. The EPA project manager will also compare the sample descriptions with the field sheets for consistency, and will ensure appropriate documentation of any anomalies in the data.
☒ Other (Describe): If any problems with field measurements or analytical data are identified by Tetra Tech's data verification/validation, the Tetra Tech Project Manager will verbally, and in writing if requested by EPA, explain the circumstances of the failure, describe any corrective action taken, and provide an opinion on the limitations and usefulness of the data to the EPA Project Manager.

4.3 Reconciliation with User Requirements:

☐ Identified in attached table.
☒ If data quality indicators do not meet the project's requirements as outlined in this QAPP, the data may be discarded, and re-sampling or re-analysis of the subject samples may be required by the EPA project manager.
☐ Other (Describe):

Region 7 Superfund Program
Addendum to the QAPP for Superfund Integrated Site Assessment and Targeted Brownfields Assessment Activities (July 2007)
for the Ellisville OU #00 Site (Proposed Strecker Forest Development Property)

Table 1: Sample Summary

Project Name: Ellisville OU # 00 (Strecker Forest Development Property) | **Location:** Wildwood, Missouri; See Appendix B, Figure 1

START Project Manager: Dave Kinroth | **Activity/ASR #:** To be determined | **Date:** April 2011

No. of Samples	Matrix	Location	Purpose	Depth or other Descriptor	Requested Analysis	Sampling Methods	EPA SW-846 Analytical Method (or equivalent)
13	Groundwater	Network of 13 monitoring wells on and near the site	To assess potential groundwater contamination on and near the site	NA	Dioxin TEQ[g]	EPA SOPs 4334.15A & 4231.2007	1613B
					VOCs		8260B
					SVOCs		8270C
					PCBs		TBD[h]
41	Surface Soil	Decision Units established across the entire site property	To assess potential surface soil contamination on site at suspected target locations	0-2 inches bgs	Dioxin TEQ[g]	EPA SOP 4231.2012	1613B
					SVOCs		8270C
					PCBs		TBD[f]
30	Subsurface Soil	Soil core samples from selected locations on site	To assess potential subsurface soil contamination at suspected target locations	To bedrock, groundwater, or 12 feet bgs	Dioxin TEQ[g]	EPA SOPs 4230.07 & 4231.2012; Method 5035	1613B
					VOCs		8260B
					SVOCs		8270C
					PCBs		TBD[h]
2	Interior Dust	Interior surfaces of two abandoned homes on site	To assess potential interior surface contamination	NA	Dioxin TEQ	EPA SOP 4231.2011	1613B
QC Samples							
1	Water	Trip blank	To assess field/transportation-related contamination	NA	VOCs	NA	8260B
1	Water	Field Blank	To assess potential field-related contamination	NA	Dioxin TEQ	NA	1613B
					VOCs		8260B
					SVOCs		8270C
					PCBs		TBD[g]
1	Soil	Field duplicate	To assess the precision of analytical and sampling methods	NA	Dioxin TEQ	EPA SOP 4231.2012	1613B
					SVOCs		8270C
					PCBs		TBD[h]
1	Groundwater	Field duplicate	To assess the precision of analytical and sampling methods	NA	Dioxin TEQ	EPA SOPs 4334.15A & 4231.2007	1613B
					VOCs		8260B
					SVOCs		8270C
					PCBs		TBD[h]
2	Rinsate Water Samples	Decontaminated sampling tools	To assess potential for cross contamination of samples from sampling tools	NA	Dioxin TEQ	NA	1613B
					VOCs		8260B
					SVOCs		8270C
					PCBs		TBD[h]

[g] Only soil and ground water samples collected from Strecker Forest will be analyzed for dioxin TEQ. Callahan soil and ground water samples will not be analyzed for dioxin TEQ.
[h] Analytical laboratory will be contacted to verify replacement method for 8080A prior to sample shipment

Region 7 Superfund Program Addendum to the QAPP for Superfund Integrated Site Assessment and Targeted Brownfields Assessment Activities (July 2007) for the Ellisville OU #00 Site (Proposed Strecker Forest Development Property)								
Table 2: Data Quality Objective Summary								
Project Name: Ellisville OU #00 Site			**Location:** Wildwood, Missouri; See Appendix A, Figure 1					
START Project Manager: Dave Kinroth			**Activity/ASR #:** To be determined				**Date:** June 2011	
Analysis	**Analytical Method**	**Data Quality Measurements**					**Sample Handling Procedures**	**Data Management Procedures**
		Accuracy	**Precision**	**Representativeness**	**Completeness**	**Comparability**		
Soil and Groundwater								
Dioxin TEQs, VOCs, SVOCs, & PCBs	see Table 1	per analytical method	per analytical method	judgmental sampling, based on professional judgment of the sampling team	100%; no critical samples have been defined	Standardized procedures for sample collection and analysis will be used.	See Section 2.3 of QAPP form.	See Section 2.10 of QAPP form.
Interior Dust								
Dioxin TEQs	see Table 1	per analytical method	per analytical method	judgmental sampling, based on professional judgment of the sampling team	100%; no critical samples have been defined	Standardized procedures for sample collection and analysis will be used.	See Section 2.3 of QAPP form.	See Section 2.10 of QAPP form.

APPENDIX D

WATER TRACING STANDARD OPERATING PROCEDURES

Missouri Department of Natural Resources

Division of Geology and Land Survey

Geological Survey Program

Environmental Geology Section

WATER TRACING
STANDARD OPERATING PROCEDURES

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WATER TRACING STANDARD OPERATING PROCEDURE

Environmental Geology Section, Geological Survey Program

Introduction

This document has been assembled to standardize procedures used by the Division of Geology and Land Survey (DGLS), Environmental Geology Section (EGS) when conducting water traces. Traces conducted by DGLS may be academic or regulatory in nature. They may range from short and relatively simple traces to extensive studies of a large area. The amount of effort, time, and data involved for each trace can vary greatly. The guidance herein is intended to address the various types of water traces conducted by the EGS while standardizing procedures and maximizing data quality.

Definition of the Water Tracing Study Area

Limits of a water tracing study area are defined by boundaries that include recharge and discharge points needed to delineate hydrgeologic connections. The study area will be defined not only by measurable extent but also by pertinent information important to the study. Inclusion of this information is useful for concurrent and future tracer studies conducted in the area. This will incorporate the geology and hydrogeology that may affect the study. This should include the following if available and applicable:

- Watershed boundaries including any information concerning interbasin movement of groundwater in the area.

- Water level data that will help to delineate the water table and base flow in the area.

- Stratigraphy that is important to the study including a description of characteristics for each unit that are important to a water trace.

- Geologic structure including faults, fractures and folds or other features that may exert control on the movement of groundwater.

- Other data that is pertinent to a specific watershed.

A working base map with an applicable scale will be generated from this data to use during field investigations.

Research and Review of Background and Supporting Data

Extensive research of the study area will be conducted in the office before beginning field investigations. Important information about the area may have been previously documented in the following resources:

Previous Reports	Field Map Files	Dye Trace Database
Cave Files	Springs Database	Aerial Photos
Soil Surveys	Surficial Materials Maps	Geologic Maps
Losing Streams Database	USGS Gaging Stations	Water-Well Databases

Any pertinent information will be documented. This inventory of information should be used to suggest initial boundaries for the field inventory. Topographic base maps used for the water trace will include as much of this information as possible.

Field Inventory of Significant Hydrogeologic Features

A thorough field investigation of the study area will be conducted to confirm hydrogeologic features found during research, and to document new features that will be important to the trace. Features to be documented include springs, seeps, caves, sinkholes, losing streams and gaining streams. Faults, fractures and folds that are discovered should also be documented. They may become important when interpreting data after the field portion of the water trace is complete. These features will be located on the working base map and given a unique name if one does not already exist. Important physical characteristics of the features will be documented including flow characteristics, water quality, bedrock type, unconsolidated material, and vegetation.

Real time sample analysis data will be collected during this part of the trace. Measurements to be conducted include specific conductance, pH and temperature in springs, streams and seeps. Changes in these measurements may help to locate springs, gaining sections of streams and potential environmental impacts. Photographic documentation of features should be considered to preserve appearance for future comparison. Measurements or estimates of flow in streams and from springs can also be documented for later comparison and analysis.

Types of Tracers

Fluorescent tracers are used most commonly by DGLS for water tracing. They are used for detection by visual methods and/or spectrofluorometric analysis. Fluorescent tracers may be obtained in powder or liquid form, or both, depending on the type and manufacturer. They typically have an industry name and an associated color index. When analyzed spectroflourometrically, they are excited by a specific wavelength of light resulting in emission of light that peaks at a specific wavelength in the spectrum. Therefore, multiple tracers can be distinguished in a single sample with a minimum of spectral overlap. Appendix A contains a table of fluorescent tracers and some related properties. Other tracers may be used if proven viable.

Background Analysis

A study of the background data will be done to determine the location of monitoring points. All of the monitoring points will be analyzed for background fluorescence prior to tracer injection. Multiple background samples at each monitoring point are necessary to detect trends in background fluctuations. Background data will always be obtained and reviewed prior to injection (Duley 1997).

Background analysis of the study area will involve monitoring the hydrologic system prior to the introduction of tracer. This will allow the identification of masking agents. Masking agents can occur naturally. They may also reside in the hydrologic system from previous water traces or by contaminant migration. Knowing potential masking agents in the hydrologic system will help narrow the list of useable tracers and, consequently, the type(s) of tracer recovery devices to use.

It is advantageous to document all monitoring points with photographs. The photos should include some type of object for scale and a chalkboard or poster-board recording the monitoring point name and number, and date and time the photo was taken. This information should also be documented in a field notebook along with sketches of the area. All monitoring points should be located and marked on the working field map along with the monitoring point name and number. Brief notes should be recorded in the field notebook during each visit explaining the condition of the monitoring point and surrounding environment.

Selecting Tracers and Recovery Methods

Careful consideration will be given when selecting tracer(s). Masking agents in the hydrologic system may inhibit detection of some tracers. It is best to use a tracer that fluoresces at a wavelength that is different from the fluorescence wavelength of the background. One can not always depend on the concentration of the tracer being large enough to overpower the background fluorescence, although in some cases this can be accomplished. Also important are any chemical or physical properties in a hydrologic system, whether natural or not, that might jeopardize the integrity of a tracer making it more difficult to recover. Some tracers are adsorbed onto substances in the system depleting the amount that can travel to monitoring points. The chemical nature of a hydrologic system may also cause degradation effects to some tracers, which can subdue concentrations detected at the monitoring points. Subjecting fluorescent traces to drastic changes in pH will cause them to degrade.

Tracer recovery method(s) will also be given careful consideration. Appendix A describes the optimum method of passive collection for all tracers currently accepted for use by DGLS. Passive collection methods will be used to demonstrate that a tracer has intercepted a monitoring point within a known period. The exact time that tracer intercepted a monitoring point cannot be determined using this method. Passive tracer recovery includes adsorption of tracer onto activated charcoal, cotton, or polyethersulfone.

Collection of a water sample from a monitoring point will demonstrate if a tracer has passed that point at the time collected. Going a step further, a series of timed water samples can be collected at a monitoring point using a composite sampler. Observing the change in relative tracer intensities over time will yield a tracer breakthrough curve. This curve shows the time span when the greatest concentration of tracer moved past the monitoring location. A tracer recovery method will be selected to optimize the results of the trace.

Collection and Laboratory Analysis of Background Tracer Data

Passive tracer-recovery materials include activated charcoal, cotton, or polyethersulfone. Appendix A describes the type of recovery material to use with each tracer. It is sometimes necessary to use more than one type of recovery material when conducting background analysis. Water samples may also be used for background analysis. After several background samples have been analyzed, any background interference patterns should become apparent. This will help determine the type of tracer to use, and thus the type of recovery material required maximizing capture of the tracer. Once the tracer and optimum recovery material has been selected, tracer analysis will always be conducted using the optimum tracer recovery material and method selected from those used for background analysis.

When constructing tracer recovery packets it is important that they be physically similar. The size of the packet and the recovery material contained within should be consistent. Recovery material is placed inside a rectangular pocket of fiberglass screen that is enclosed by staples. It is also important when constructing and transporting tracer recovery packets to take steps to avoid contamination. This includes cleaning the equipment and workplace used to construct the packets with a bleach containing agent. Packets should be transported in a new resealing plastic storage bag and placed in a compartment separate from tracers. The bag should only be opened when retrieving a packet while wearing a new pair of polysynthetic gloves. After retrieving the needed packet(s) the bag should be immediately closed and placed back into storage.

When placing tracer recovery packets in the desired location they are attached to a weight and placed at the monitoring point so water will flow through the packet. At minimum, the packets should be replaced bi-weekly. Conductance, temperature and pH should be measured at the recovery locations and documented each time recovery packets are collected and replaced. This should be done during the entire trace including background analysis. This information may prove valuable when evaluating results of the trace. Measuring devices will be decontaminated before and after use at each monitoring point to avoid cross-contamination and maximize accuracy of measurements. Measuring devices will be recalibrated according to device-specific schedules and protocol.

When replacing tracer recovery packets in the field it is essential to avoid cross-contamination. Unused packets will be stored in a separate location from those collected. A new pair of polysynthetic gloves will be worn during each packet change. The packet can be placed in one hand and the glove turned inside out over the sample while removing the glove. The same can be done with the opposite hand. The gloves will be stored with the packets to be disposed of later in the laboratory avoiding cross-contamination. Collected packets will be stored individually in plastic bags that are marked with the sample location name, sample number, and the date and time collected. Water samples will be collected in sample or specimen cups, with lids, using the same protocol.

Laboratory analysis of tracer recovery packets will be done in the DGLS Water Tracing Laboratory using the Hitachi F-4500 spectrofluorometer. Each packet will be prepared for elutriation one at a time. The procedure is as follows:

1) Don a pair of clean polysynthetic gloves.

2) Remove the tracer recovery packet from the sealed plastic bag and properly dispose of the bag.

3) Thoroughly wash the packet under running water to remove sediment and organic material.

4) Remove the contents and place in a sealing 120-ml polysynthetic sample or specimen cup.

The samples will each be bathed in a 20-ml elutriant solution of 5% NH_4OH (Ammonium Hydroxide) in C_2H_5OH (ethanol) for a period of one hour. Background substances that have adsorbed onto the recovery material will be removed and suspended in solution in preparation for spectrofluorometric scanning. Procedures for using the Hitachi F-4500 spectrofluorometer are described in Appendix B.

Water samples will be tested using procedures as described in Appendix B.

Tracer Injection

Great care will be taken when preparing to inject a tracing agent. Most of the tracers used by DGLS are highly concentrated. Some tracers can be detected instrumentally at 50 parts per trillion (ppt). It is important to take all precautions to avoid cross-contamination. All sampling apparatus will be kept separate from personnel and equipment potentially contaminated with tracer. This is especially important when using powdered tracers, which are easily dispersed by even the slightest wind. Tracers will be loaded in a vehicle by personnel that are not involved in sampling prior to the trace. Tracer will be transported in a compartment that is separate from sampling apparatus (Duley, 1997). This compartment will be deemed contaminated from this time forward.

Injection techniques will assure a minimum of contamination of personnel and equipment with tracer. All tracer recovery packets will be replaced prior to injection by personnel that have not handled tracer. Personnel will wear disposable polysynthetic gloves while injecting. The injector will stand upwind of the injection point and pour tracer into the water just above the water level. All tracer containers, polysynthetic gloves and disposable protective suits, if worn, will be sealed in a bag and properly discarded immediately after injection (Duley, 1997). After injection, any person who has handled tracer or injection apparatus that day will not handle any samples at any time the day of the injection. Nor will that person be allowed in the DGLS Water Tracing Laboratory that day. This is done to prevent even the slightest possibility of cross-contamination.

The amount of tracer required can be estimated as follows:

Tracer Injection Amount (T_a)=T_y x F_d x D_s x I_t (Expressed in pounds for powders and gallons for liquids)

Tracer Factor (T_y)

Fluorescein=0.002, Rhodamine WT=0.001, Tinopal CBS-X=0.01, Pyranine=0.008, Amino G=0.004

Flow Dilution Factor (F_d)

Square root of the result of the following: recovery point flow divided by injection point flow

Distance Factor (D_s)

Square root of distance in feet to recovery point

Injection Point Retardation Factor (I_t)

Cave Stream=1
Rapid Losing Stream=1
Water Pooled in Obviously Leaking Sinkhole or Lagoon=2
Incremental Losing Stream=3
Open Eye of Sinkhole with Artificial Flush=4
Septic Tank=5
Backhoe Pit (open joint)=6
Pools in a Losing Watershed=7
Sinkhole (no eye and dry)=8
Dry Losing Stream=9
Backhoe Pit in Clayey Soil=10

The results of this equation will be a rough estimate of the amount of tracer required. Actual quantities of tracer to be injected will be determined using this method along with discussion of other factors that may be unique to the trace (Duley, 1997).

Tracer Recovery Packet Retrieval and Replacement

The tracer recovery packets are retrieved, replaced, handled and analyzed in the same manner as was done during the background analysis. The packets will generally be replaced on a weekly basis, and usually on the same day of the week if possible. This schedule will be followed unless special circumstances exist. After the completion of the trace all monitoring packets and equipment should be removed from the monitoring locations.

Report Preparation and Committee Review

After the investigator has established that a hydrologic connection has been established between an injection point and one or more monitoring points, or a connection is not indicated at the completion of the project, a report should be prepared that describes the trace and presents the supporting data. If a hydrologic connection has been established the report may be presented to the DGLS Water Tracing Committee for review.

The DGLS Water Tracing Committee will review any water trace that has been documented by staff of DGLS as a positive trace. The committee will review the water tracing methods and data. A Dye Trace Summary Form (Figure 1) should be completed and submitted to the Committee with the trace report and supporting data. To be approved, the trace must meet the criteria listed in Figure 2. Committee review will not be conducted on a trace that clearly shows no hydrologic connection. All committee-approved traces will be added to the DGLS Dyetrace Database.

Figure 1.
DYE TRACE SUMMARY FORM
ID#__(to be assigned by DGLS)

INJECTION **Point Name:________________________________** **County:________________**

Loc: _______¼ ____¼ ____¼ Sec: ______ T. _________ R.___ Quad:____________

Latitude:____ deg.____‘ ___" Longitude:______ deg._____‘ _____" Elevation:_______

Date:________/______/______ Time:______ Agent:____________ Amount: _______________

RECOVERY **Point name:_________________________________** **County:________________**

Loc: _______¼ _____¼ _____¼ Sec: ______ T. _______ R._____ Quad:____________

Latitude:____ deg.___‘ ___" Longitude:_______ deg._____‘ ______" Elevation:______

First recovery between:____/_____/______ and ______/____/____ Time:________________

Sampling Method:______________ Analysis Method:________ Trace Length:___________

INVESTIGATOR ________________________________ AGENCY__________________________

REMARKS ____

____

____

____

Abbreviations:

Agent:

FL	Fluorescein (uranine)
RWT	Rhodamine WT
OB	Optical Brightener 28
TIN	Tinopal CBS-X
LY	Lycopodium Spores
PYR	Pyranine
AG	Amino G
RB	Rhodamine B
DY	Direct Yellow

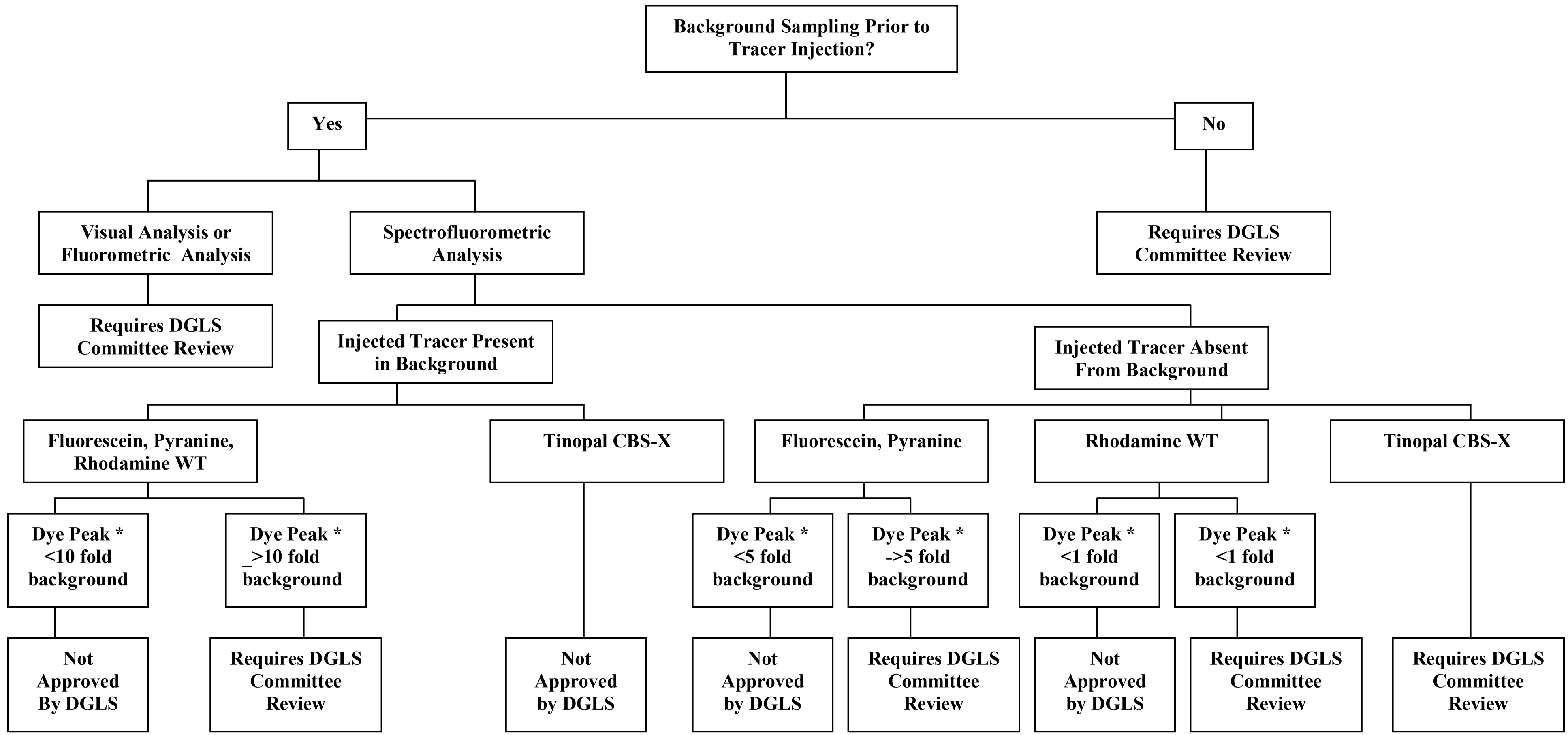
Sampling Method:

CP	Carbon Packet
GS	Grab (Water) Sample
CB	Cotton Ball

Analysis Method:

SF	Spectrofluorometer
F	Fluorometer
V	Visual

Figure 2. STANDARDS FOR DGLS APPROVED WATER TRACES



*DYE PEAK - Peak wavelength must be within 5 nm of standards below and measured in such a way as to correct for any background contribution.

Emission Peaks of Dyes in Water and 5% NH_4OH Ethyl Alcohol Mix **
Using Synchronnously Scanning Spectrofluorometer
(Scan separation shown in parentheses)

	Pyranine	Pyranine Impurity	Tinopal CBS-X	Fluorescein	Rhodamine WT
Water	510 (102 nm Sync)	381, 400 (35 nm Sync)	427 (72 nm Sync)	512 (17 nm Sync)	578 (17 nm Sync)
NH_4OH	495 (17 nm Sync)	380, 404 (35 nm Sync)	398-410 (35 nm Sync)	519 (17 nm Sync)	570 (17 nm Sync)

** Other tracers, peak wavelengths, and laboratory techniques may be approved at the discretion of the DGLS Water Tracing Committee.

APPENDIX A

PEAK CRITERIA FOR FLUORESCENT TRACERS

TRACER	COLLECTION METHOD	SOLUTION ANALYZED	SCAN NAME	PEAK RANGE (nm)	OPTIMAL PEAK(S) (nm)	DETECTION LIMIT
1. Fluorescein	Grab	Water	FL	509-514	512	50 ppt
	Carbon	NH_4OH	FL-RWT	516-522	520	
2. Rhodamine WT	Grab	Water	RWT	567-580	578	100 ppt
	Carbon	NH_4OH	FL-RWT	567-572	569	
3. Tinopal CBS-X	Grab	Water	TIN	425-429	427	1 ppb
	Carbon	NH_4OH	PYR	403-409	405	
	Cotton	-	TC	415-447	420-439	
	Cotton	NH_4OH	TE	398-410 ?	402	
4. Eosine	Grab	Water	FL-RWT	534-538	536	5 ppb
	Carbon	NH_4OH	FL-RWT	538-545	542	
5. Pyranine	Grab	Water	PYR102	507-511	509	1 ppb
	Carbon	NH_4OH	FL	493-500	495	
	Carbon	NH_4OH	PYRA	510-523	512	
6. Pyranine Impurity	Grab	Water	PYR	370-410	380 & 404	10 ppb
	Carbon	NH_4OH	PYR	370-410	380 & 400	
7. Amino G ***REQUIRES QUARTZ CULVETTES***	Grab	Water	AG190	430-450	443	1 ppb
	Carbon	NH_4OH	AG190	435-450	445	

Possible Combinations: 1, 2, and 3 (could add 4 after 1 flush, or 7); 2, 3, 4, and 5 (If desperate, could add 1 or 7 after 4 flushes).
Poor Combinations: 1 and 4; 1and 5; 2 or 4 in presence of pure gasoline.

(Revised 11/06/2008)

APPENDIX B

Procedures for Using the Hitachi F4500 Spectrophotometer to Scan Samples for the Presence of Tracers

Procedures for Starting the F4500 Spectrophotometer

1. Begin by turning on power to machine. Turn on in sequence going from left to right. Turn computer on now (computer will not operate properly without power switch farthest to left being turned on).

2. Start the constant-temperature bath by turning on the main power switch on back of control box. Next turn the power switch and cooling switch on; these are located on the front of the control box. Start air compressor located in closet.

3. Allow the spectrophotometer to warm up for approximately 30 minutes. The constant-temperature bath should be at 10 degrees Celsius.

4. Prepare to run signal-to-noise ratio. Place 4 ml of HPLC grade water in a quartz cuvette and place the cuvette in the sample chamber.

5. On the computer screen click the F4500 icon, this will bring up the main menu. The spectrophotometer will automatically initialize; if it does not, choose the **initialize** option on the **main** menu. Insert the proper disk in the proper drive and select **time scan**. Press run. This will take you to the time-scan screen.

6. In the time-scan screen the sample and comment lines remain the same. Choose the **scan** menu and then choose the **start scan** option or press the **F5 key** to start scan.

7. When the scan is complete, choose the **output** menu, then choose the **save spectrum** option. This will allow you to save data on the disk. The file name will remain the same with the exception of changing the ending number.

8. After data is saved, select the **utility** menu, then the **file convert** option. Select the **noise.ftd** file and press **run**. You will be given the error message of "overwrite," press **ok** and continue.

9. Next, go to the **start** menu – programs –command prompt this will place you at C:\> type in **cd\fl00\spectrum** and press enter, then type in **noise** and press enter.

10. The computer loads the noise program. The signal-to-noise ratio and drift are calculated and reported on the screen as shown below.

1)	The average value of signal	S
2)	The average value of noise	N
3)	S/N ration	S/N
4)	Drift level	Drift

******** Results ********

S = 18.451
N = 0.117
S / N = 158.21
Drift = 1.74%

11. Enter the calculated data from the screen into the corresponding categories on the chart provided.

12. The signal-to-noise ratio should be at least 100, and the drift should be less than 2%.

13. Type **exit** and press enter to leave the command prompt.

14. At the F4500 main menu select either **3-D scan** or **wavelength scan**. You are now ready to scan your samples.

Scanning the Sample

Samples should be placed in refrigerator or placed on ice to pre-cool them to a constant temperature and to help maintain the constant temperature bath.

When ready to scan the sample, remove it from refrigerator and place 4 ml in a quartz cuvette. Place the remaining sample back in the refrigerator. Place the cuvette in the sample chamber.

3-D Scan: To select the set of parameters for a Fluorescein / Rhodamine WT scan. Choose the **parameter** menu, then select the **load parameters** option. In this option select the set of parameters for the Fluorescein / Rhodamine WT scan.

Next select either the **output** menu then the **sample / comment** option or press the **F7** key. This will allow you to enter the sample information, which should include sample name, collection date, any dilution factor, type of scan (i.e. Fl/Rwt scan), w/ air @ 10 Deg. C. In Quartz remains the same.

1. You are now ready to start scanning. Choose the **scan** menu, then the **start scan** option (or press the **F5** key) to start the scanning process.

2. When the scan is complete you can adjust the data by choosing the **data processing** menu and the **zoom** option, then select **numeric entry**. Under **ordinate** change the **maximum** and/or **contour interval**. If a sample is above the 3000 scale range, change the maximum to an appropriate scale.

3. You can view a 2-D section of the scan by choosing **data processing** menu then the **cursor** option. Place the center of the cursor in the center of the peak.

4. When the scan is complete, choose the **output** menu and select the **save spectrum** option. This will allow you to save the data to a disk.

5. To print the data, make sure the printer in on. Choose the **output** menu, then **draw contour**.

6. ***Wavelength Scan (2-D):*** At the main menu choose the **wavelength scan** option.

7. Choose the **parameter** menu then select the **load parameters** option. In this option select the set of parameters for the Fluorescein / Rhodamine WT scan.

8. Next select either the **output** menu, then the **sample / comment** option or press the **F7** key. This will allow you to enter the sample information, which should include sample name, collection date, any dilution factor, type of scan (i.e. Fl/Rwt scan), w/ air @ 10 Deg. C. In Quartz remains the same.

9. Next choose the **parameter** menu and select the **scan parameter** option. Choose the **prescan** option, which will prescan your sample and set the ordinate scale. If a sample registers above 9999, it will have to be diluted.

10. After prescan is done, choose **ok**.

11. You are now ready to start scanning. Choose the **scan** menu, then the **start scan** option (or press the **F5** key) to start the scanning process.

12. When the scan is complete choose the **output** menu and select the **save spectrum** option. This will allow you to save the data to a disk.

13. To print the data, choose the **data processing** menu, then the **peak** option and select **run**.

Cleaning process for quartz cuvette

1. Empty sample from the cuvette.

2. Flush cuvette with distilled water (minimum of 3 full flushes).

3. Fill cuvette with 2% Micro 90 cleaner. Empty the cuvette.

4. Flush cuvette with distilled water (minimum of 3 full flushes).

5. Fill cuvette with distilled water and test with rapid scan 2-D analysis. While in the 2-D scan mode choose the **parameter,** then the **load parameters** option and select the set of parameters named **cuvette test Sy 110 scan**.

6. An increase of 10% fluorescence at any point on any cuvette’s output scan curve is unacceptable and requires complete recleaning.

7. If the cuvette cannot be air dried prior to filling with another sample, it is dried with the Vacu-wash system.

APPENDIX E

TETRA TECH HEALTH AND SAFETY MANUAL

SAFE WORK PRACTICES

EXCAVATION PRACTICES

TETRA TECH, INC.

HEALTH AND SAFETY MANUAL

VOLUME III

SAFE WORK PRACTICES (SWP)

EXCAVATION PRACTICES

SWP NO.: 6-4

ISSUE DATE: JULY 1998

REVISION NO.: 1

EXCAVATION PRACTICES

This safe work practice (SWP) outlines minimum requirements to protect employees who may be exposed to hazards during trenching and excavation activities and to provide general guidance for compliance with Title 29 of the *Code of Federal Regulations* (CFR), Part 1926, Subpart P, "Excavations."

Project managers shall ensure that all excavation, shoring, and trenching activities are conducted in accordance with the requirements outlined in this document and Subpart P of 29 CFR 1926. Project managers must also ensure that projects involving trenching and excavation are staffed by an individual capable of performing "competent person" duties as described in this procedure.

The site safety coordinator (SSC) is responsible for on-site enforcement of this SWP.

Definitions and procedures used for excavations are discussed below.

1.0 DEFINITIONS

The following definitions apply to this SWP:

Benching: Forming one or a series of horizontal levels or steps in the sides of an excavation to protect employees from cave-ins

Competent Person: One capable of identifying existing or predictable hazards in the work environment that are unsanitary or dangerous to employees and who has authorization to take prompt corrective measures to eliminate the hazards

Excavation: Any manmade cut, cavity, trench, or depression in an earth surface formed by earth removal

Shoring: Metal, hydraulic, mechanical, or timber system that supports the sides of an excavation and that is designed to prevent cave-ins

Sloping: Sloping the sides of an excavation at an incline away from the excavation to protect employees from cave-ins

Trench: A narrow excavation (in relation to its length) that is usually deeper than it is wide but less than 15 feet wide

2.0 PROCEDURES

Described below are the general safety requirements and protective system requirements for trenching and excavation activities.

2.1 GENERAL SAFETY REQUIREMENTS

General safety requirements that must be in place before work begins are as follows:

- Utility companies or a utilities locating service in the area must be notified **before excavation or trenching activities begin** to arrange for locating and protecting underground utilities.
- Access to trenching areas must be controlled and limited to authorized personnel. Prior to entering a trench or excavation, workers must notify the project manager, SSC, and nearby equipment operators whose activities could affect the trench or excavation.
- No person may enter a trench or work at the foot of the face of an excavation until a qualified, competent person has inspected the excavation and determined whether sloping or shoring is required to protect against cave-in or subsidence and the appropriate protection has subsequently been installed.
- Trenches and excavations must be assessed by a qualified, competent person, even in the absence of working personnel, whenever heavy equipment will be operating nearby in order to ensure that the trench or excavation will support the weight of the equipment without subsistence or causing the accidental overturning of machinery.
- Trenches and excavations must be inspected regularly (daily at a minimum) to ensure that changes in temperature, precipitation, shallow groundwater, overburden, nearby building weight, vibration, or nearby equipment operation have not caused weakening of the sides, faces, and floors and to ensure that personnel protection is being maintained.
- When subsidence or tension cracks are apparent anywhere in an excavation, all work should be stopped until the problem is corrected.

- The competent person must inspect trenches or excavations after any precipitation event to ensure integrity has been maintained.

- Sufficient ramps or ladders must be provided in excavations 4 or more feet deep to allow quick egress. Ramps or ladders may be placed no more than 25 feet apart, must be secured from shifting, and must extend at least 3 feet above the top of the trench or excavation. Structural ramps must be designed by a competent person.

- Material removed from an excavation or trench must be placed far enough from the edge (at least 2 feet) to prevent it from sliding into the excavation or trench or from stressing the trench or excavation walls. Worker protection must also be provided from loose rock or soil on the excavation faces.

- If trenches or excavations are near walkways or roadways, guards or warning barriers must be placed to alert pedestrians and drivers of the presence of the trench or excavation.

- If possible, trenches or excavations should be covered or filled in when unattended. Otherwise, strong barriers must be placed around the trench or excavation and lighting must be provided at night if the trench or excavation is near a walkway or roadway.

- When a hazardous atmosphere could exist, the excavation must be tested for appropriate hazardous substances and oxygen level before personnel entry. Excavation where hazardous atmospheres exist must be treated as a confined space. Entry must follow procedures outlined in "Confined Spaced Entry Program," Document Control No. 2-5.

- Entry is not allowed into excavations where water has accumulated.

2.2 PROTECTIVE SYSTEM REQUIREMENTS

Protective systems protect employees from cave-ins, material that could fall in or roll off the face of the excavation, and collapse of adjacent structures. Protective systems include shoring, shielding, sloping and benching, and other systems. Sloping and benching and shoring system requirements are described below.

2.2.1 Sloping and Benching Requirements

Sloping and benching system construction must follow the guidelines established in Appendix B to Subpart P of 29 CFR 1926. Maximum allowable slopes for excavations are summarized below. All slopes indicated are expressed as the ratio of horizontal distance (H) to vertical rise (V).

Soil or Rock Type	Maximum Allowable Slope (H:V) for Excavations Less than 20 Feet Deep
Stable Rock	Vertical (90°)
Type A	0.75:1 (53°)
Type B	1:1 (45°)
Type C	1.5:1 (34°)

Soil types are defined in Appendix A to Subpart P of 29 CFR 1926 and are summarized below.

Type A: Cohesive soils with an unconfined compression strength of 1.5 tons per square foot (ton/ft^2) or greater (such as clay, silty clay, sandy clay, or clay loam)

Type B: Cohesive soils with an unconfined compression strength of greater than 0.5 but less than 1.5 ton/ft^2 (such as angular gravel, silt, silt loam, or sandy loam)

Type C: Cohesive soils with an unconfined compression strength of less than 0.5 ton/ft^2 (such as gravel, sand, loamy sand, submerged soil, or unstable submerged rock)

Sloping and benching for excavations greater than 20 feet deep must be designed by a registered professional engineer.

Soil types must be determined by the competent person using at least one visual and one manual test. Manual tests include plasticity, dry strength, thumb penetration, and drying tests.

2.2.2 Shoring System Requirements

Appendixes C, D, and E to Subpart P of 29 CFR 1926 outline requirements for timber shoring for trenches, aluminum hydraulic shoring for trenches, and alternatives to timber shoring, respectively. Guidelines for shoring systems are listed below.

- If it is not economically feasible or there are space restrictions to prevent cutting the trench or excavation walls back to a safe angle of repose, all trenches or excavations 5 feet deep or more must be shored.
- Shoring should be erected as trenching or excavation progresses and as closely as possible to the excavation floor.

- Shoring timber dimensions must meet the minimum timber requirements specified in Tables C1.1 through C1.3 of Appendix C to Subpart P 29 CFR 1926. Aluminum hydraulic shoring must be constructed using the guidelines and dimension requirements specified in Appendix D of the same standard.

- Trench shields may be used instead of shoring or bracing. Shields must be constructed of steel flat sides welded to a heavy framework of structural pipe. Shields should be moved along by the excavator as trenching or excavation proceeds.

This document has been developed to ensure that potential hazards associated with trenching and excavation operations are identified, evaluated, and that proper hazard controls are implemented onsite. This document must be used for all trenching or excavation work lasting for more than three days in length. Regardless of project duration, a daily inspection is required of all excavations, adjacent areas and protective systems. Documentation of this inspection must be maintained in the project log. The information in this document should be reviewed with all employees prior to commencing site operations.	
Date:	Project Name:
Location:	Foreman:
Competent Person:	Competent Person Signature:
Scope of Work:	

Soil and Site Condition (respond to each item listed)			
Class	❒ A	❒ B	❒ C
Determined By	❒ Visual Test	❒ Manual Test	❒ Penetrometer
Soil Layered	❒ Yes	❒ No	❒ NA
Zones of weak soils or fractured planes in material	❒ Yes	❒ No	❒ NA
Evidence of shrinkage cracks in or on trench walls	❒ Yes	❒ No	❒ NA
Evidence of possible cave in or slide	❒ Yes	❒ No	❒ NA
Vibration	❒ Yes	❒ No	❒ NA
Previously disturbed soil	❒ Yes	❒ No	❒ NA
Previous rain/snow	❒ Yes	❒ No	❒ NA

Protection Methods (indicate protection method selected)			
Slope	❒ Yes	❒ No	❒ NA
Horizontal : Vertical			
Bench system	❒ Yes	❒ No	❒ NA
Trench shoring	❒ Yes	❒ No	❒ NA
Trench box	❒ Yes	❒ No	❒ NA
Shield system	❒ Yes	❒ No	❒ NA
Other			
Describe			

Hazard Assessment	Hazard Control			
Underground Utilities				
	Underground utilities located and marked	❒ Yes	❒ No	❒ NA
	Locate tickets onsite	❒ Yes	❒ No	❒ NA
Exposure to Falling Loads, Heavy Equipment or Loose Rock				
	Restricted access while excavating or lifting material	❒ Yes	❒ No	❒ NA
	Warning system for mobile equipment near excavation edge	❒ Yes	❒ No	❒ NA
	Barricades	❒ Yes	❒ No	❒ NA
	Cones	❒ Yes	❒ No	❒ NA
	Hand signals	❒ Yes	❒ No	❒ NA
	Stop logs	❒ Yes	❒ No	❒ NA
	Excavation scaling	❒ Yes	❒ No	❒ NA
	Material and spoils storage at least 2 feet from edge	❒ Yes	❒ No	❒ NA
Exposure to Vehicular Traffic				
	Traffic Control Plan	❒ Yes	❒ No	❒ NA
	Work Zone Protection	❒ Yes	❒ No	❒ NA
	High Visibility Clothing	❒ Yes	❒ No	❒ NA
Access and Means of Egress				
	Means of egress (ladder or other means) at no more than 25 feet of travel distance	❒ Yes	❒ No	❒ NA
	Ladder extends 3 feet beyond surface of trench	❒ Yes	❒ No	❒ NA
Hazardous Atmospheres				
Oxygen Concentration < 19.5%	Confined Space Entry Procedures Required Implement Ventilation	❒ Yes	❒ No	❒ NA
Toxic Gases approaching permissible exposure limits	Confined Space Entry Procedures Required Implement Ventilation	❒ Yes	❒ No	❒ NA
Flammable Atmosphere > 20% LEL of flammable gas	Confined Space Entry Procedures Required Implement Ventilation	❒ Yes	❒ No	❒ NA
	Respiratory Protection	❒ Yes	❒ No	❒ NA
Exposure to Water Accumulation				
	Increase frequency of competent person inspections and monitoring	❒ Yes	❒ No	❒ NA
	Water removal system in place	❒ Yes	❒ No	❒ NA
Exposure to Falls > 6 feet				
	Provide walkways with guardrails	❒ Yes	❒ No	❒ NA
Undermined Adjacent Structures i.e. buildings, pavement, walls, sidewalks				
	Competent Person inspection	❒ Yes	❒ No	❒ NA
	Bracing and support provided to protect structures from undermining the undercuts	❒ Yes	❒ No	❒ NA

This program outlines minimum requirements to protect employees who may be exposed to hazards during trenching and excavation activities and to provide general guidance for compliance with Title 29 of the *Code of Federal Regulations* (CFR), Part 1926, Subpart P, "Excavations."

1.0 SCOPE

This program and procedures applies to all sites and activities involving excavation or trenching as defined in 29 CFR 1926 Subpart P.

2.0 RESPONSIBILITIES

Project managers (PMs) shall ensure that all excavation, shoring, and trenching activities are conducted in accordance with the requirements outlined in this document and Subpart P of 29 CFR 1926. Project managers must also ensure that projects involving trenching and excavation are staffed by an individual trained and qualified to perform "competent person" duties as described in this procedure. Operating unit health and safety managers (HSMs) will provide assistance to PMs in implementing this SWP.

The site safety coordinator (SSC) is responsible for on-site enforcement of this SWP.

3.0 DEFINITIONS

The following definitions apply to this SWP:

Benching: Forming one or a series of horizontal levels or steps in the sides of an excavation to protect employees from cave-ins.

Competent Person: One capable of identifying existing or predictable hazards in the work environment that are unsanitary or dangerous to employees and who has authorization to take prompt corrective measures to eliminate the hazards.

Excavation: Any manmade cut, cavity, trench, or depression in an earth surface formed by earth removal.

Shoring: Metal, hydraulic, mechanical, or timber system that supports the sides of an excavation and that is designed to prevent cave-ins.

Sloping: Sloping the sides of an excavation at an incline away from the excavation to protect employees from cave-ins.

Trench: A narrow excavation (in relation to its length) that is usually deeper than it is wide but less than 15 feet wide.

4.0 PROCEDURES

Described below are the general safety requirements and protective system requirements for trenching and excavation activities.

4.1 General Safety Requirements

General safety requirements that must be in place before work begins are as follows:

- Utility companies or a utilities locating service in the area must be notified **before excavation or trenching activities begin** to arrange for locating and protecting underground utilities.

- Access to trenching areas must be controlled and limited to authorized personnel. Prior to entering a trench or excavation, workers must notify the project manager, SSC, and nearby equipment operators whose activities could affect the trench or excavation.

- No person may enter a trench or work at the foot of the face of an excavation until a qualified, competent person has inspected the excavation and determined whether sloping or shoring is required to protect against cave-in or subsidence and the appropriate protection has subsequently been installed.

- Trenches and excavations must be assessed by a qualified, competent person, even in the absence of working personnel, whenever heavy equipment will be operating nearby in order to ensure that the trench or excavation will support the weight of the equipment without subsistence or causing the accidental overturning of machinery.

- Trenches and excavations must be inspected regularly (daily at a minimum) to ensure that changes in temperature, precipitation, shallow groundwater, overburden, nearby building weight, vibration, or nearby equipment operation have not caused weakening of the sides, faces, and floors and to ensure that personnel protection is being maintained. Form TEC – Trenching and Excavation Checklist or its equivalent is to be used to document inspections.

- When subsidence or tension cracks are apparent anywhere in an excavation, all work should be stopped until the problem is corrected.

- The competent person must inspect trenches or excavations after any precipitation event to ensure integrity has been maintained.

- Sufficient ramps or ladders must be provided in excavations 4 or more feet deep to allow quick egress. Ramps or ladders may be placed no more than 25 feet apart, must be secured from shifting, and must extend at least 3 feet above the top of the trench or excavation. Structural ramps must be designed by a competent person.

- Material removed from an excavation or trench must be placed far enough from the edge (at least 2 feet) to prevent it from sliding into the excavation or trench or from stressing the trench or excavation walls. Worker protection must also be provided from loose rock or soil on the excavation faces.

- If trenches or excavations are near walkways or roadways, guards or warning barriers must be placed to alert pedestrians and drivers of the presence of the trench or excavation.

- If possible, trenches or excavations should be covered or filled in when unattended. Otherwise, strong barriers must be placed around the trench or excavation and lighting must be provided at night if the trench or excavation is near a walkway or roadway.

- When a hazardous atmosphere could exist, the excavation must be tested for appropriate hazardous substances and oxygen level before personnel entry. Excavation where hazardous atmospheres exist must be treated as a confined space. Entry must follow procedures outlined in "Confined Spaced Entry Program," Document Control No. 2-5.

- Entry is not allowed into excavations where water has accumulated.

4.2 Protective System Requirements

Protective systems protect employees from cave-ins, material that could fall in or roll off the face of the excavation, and collapse of adjacent structures. Protective systems include shoring, shielding, sloping and benching, and other systems. Sloping and benching and shoring system requirements are described below.

4.2.1 Sloping and Benching Requirements

Sloping and benching system construction must follow the guidelines established in Appendix B to Subpart P of 29 CFR 1926. Maximum allowable slopes for excavations are summarized below. All slopes indicated are expressed as the ratio of horizontal distance (H) to vertical rise (V).

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Type C	1.5:1 (34°)

Soil types are defined in Appendix A to Subpart P of 29 CFR 1926 and are summarized below.

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Type B: Cohesive soils with unconfined compression strength of greater than 0.5 but less than 1.5 ton/ft^2 (such as angular gravel, silt, silt loam, or sandy loam)

Type C: Cohesive soils with an unconfined compression strength of less than 0.5 ton/ft^2 (such as gravel, sand, loamy sand, submerged soil, or unstable submerged rock)

Sloping and benching for excavations greater than 20 feet deep must be designed by a registered professional engineer.

Soil types must be determined by the competent person using at least one visual and one manual test. Manual tests include plasticity, dry strength, thumb penetration, and drying tests.

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- Shoring should be erected as trenching or excavation progresses and as closely as possible to the excavation floor.
- Shoring timber dimensions must meet the minimum timber requirements specified in Tables C1.1 through C1.3 of Appendix C to Subpart P 29 CFR 1926. Aluminum hydraulic shoring must be constructed using the guidelines and dimension requirements specified in Appendix D of the same standard.
- Trench shields may be used instead of shoring or bracing. Shields must be constructed of steel flat sides welded to a heavy framework of structural pipe. Shields should be moved along by the excavator as trenching or excavation proceeds.

Revision Date	Document Authorizer		Revision Details
	Name	Approval Date	
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	Rick Lemmon		