STATE OF TENNESSEE

Residential Well and Surface Water Sampling Report
Poplar Springs Landfill
SNL531031062

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1.0 Introduction and Site Background

The Tennessee Department of Environment and Conservation (TDEC) Division of Solid Waste Management (DSWM) obtained water samples from residential groundwater supply wells and select surface water location in the vicinity of the closed Poplar Springs Landfill in Loudon County, Tennessee. The Residential Well and Surface Water Sampling Report (Report) provides background for the event, the limits of sampling scope, sampling and laboratory methods, quality control procedures and the results of the sampling.

The property consists of approximately 45 acres located near 9029/9030 Poplar Springs Road with an access road at latitude 35°43'55.8984" N, longitude 84°17'26.6424" W. An aerial view of the general locations is provided in Appendix A, Field Notes. The landfill is essentially a "ravine fill" in a small sub-watershed to the Tennessee River in the Valley and Ridge Physiographic province of East Tennessee. Geology consists of interbedded sedimentary rock types inverted and structurally deformed by thrust faulting and then weathered to form ridges where the rocks are more resistant to weathering and valleys where they are not. The Copper Ridge Dolomite, a magnesium-rich limestone also rich in granular chert composition, underlays the site. Drainage at the site is over the surface and through erosional rills and gullies and a perimeter ditch toward a sediment pond on the north of the site. All surface drainage leaving the property is through the pond discharge that is a portion of the headwaters to a "blue line" tributary which eventually discharges to the Tennessee River.

Following requests from concerned residents, the DSWM made initial site visits to determine whether or not conditions existed at the old closed landfill that could potentially pose unacceptable environmental or health risk and whether further investigative efforts were warranted. Site inspections were performed, and a water use survey was conducted on July 7 and 23, 2014. Observations and conclusions included:

- Heavy brush and wooded vegetation
- Deeply eroded landfill cover exposing waste material
- Active leachate seep areas denuded of vegetation
- An unmaintained sediment pond downgradient of leachate seeps containing sediment laden surface water
- Sediment pond discharge infrastructure and areas denuded of vegetation
- Six residents responded to the water use survey giving details about water wells or lack of wells on their property.
- It was determined that further investigation was needed, including surface and groundwater sampling to assess any impacts from the leachate.

Review of historical correspondence reveals the following about the location:

- The location was operating as an open dump prior to and after 1970.
- A solid waste permit was issued to the owner of the facility in accordance with Solid Waste Regulations of the time in approximately 1980.
- Subsequent expansions were permitted throughout the 1980s.

- Throughout its history the facility received municipal solid waste, industrial wastes, municipal waste water treatment sludge, special wastes (including asbestos containing building materials) and construction/demolition waste.
- Geologic investigation, groundwater monitoring and spring monitoring programs are inferred, suggesting the possible availability of historic water quality monitoring data.
- Final closure of the facility was approved in March 1988, and the facility has not been in a post-closure monitoring program.

2.0 Objectives

The overall objective of the DSWM activities is to evaluate the potential for human health risks associated with the landfill. The specific objective of the residential well sampling is to determine if water from residential wells contains landfill-derived chemical constituents, and in the event of their presence.

Scope of Work

The scope of activities was limited to:

- Contacting each of the residential supply well owners previously surveyed to schedule the sampling
- Coordinating with State of Tennessee Regional Laboratory in Knoxville to provide prepared sample containers and conduct the sample analysis
- Conducting an inspection of the old landfill property with the site owner, and representatives of the State of Tennessee, Loudon County and Loudon County Solid Waste Disposal Commission (LCSWDC)
- Collecting two surface water samples: a leachate sample from a selected leachate seep location and a surface water sample from the sediment pond
- Obtaining written authorization for residential supply well sampling from each property owner where sampling occurred
- Collecting groundwater samples from four (4) residential supply wells. Samples were obtained from the supply wells on the properties of Ms. Judy Hines, Mr. & Mrs. Bobby & Hazel Hembry, Mr. & Mrs. Charles & Francis Humphrey, and Mr. Jerry Johnson. A sample had been planned from the well owned by Mr. & Mrs. Guinn & Tish Shaw, but they were not present on the day of the sampling.
- Preparing a field blank with deionized water provided by the laboratory for quality control of volatile organic compounds analysis
- Collecting one duplicate water sample from a selected water supply well for laboratory and sampling quality control
- Purging each well prior to sampling by running water from the supply system
- Monitoring purge water from each well for field water quality parameters (pH, temperature, conductivity and turbidity) to ensure sampling of fresh formation water at each location

- Documenting all field data on pre-prepared field sampling forms and completing a Chain-of-Custody form to document sample handling and custody
- Packaging samples in accordance with industry standards and delivering the samples to the laboratory for analysis of DSWM Appendix I parameters and select additional metals and nutrients

3.0 Organization and Schedule

The sampling and project team and respective roles are summarized in Table 1.

Table 1
Sampling and Project Team
Poplar Spring Landfill
Residential Well and Surface Water Sampling

Name	Title	Role
Glen Pugh	Solid Waste Program Manager	Landfill advisor / oversight
James Clark, P.G.	Sr. Geologist	Sampling, geology oversight
R. Ashby Barnes	Environmental Scientist/SWAP Liaison	Project coordination and communications
Revendra Awasthi	Engineer/Field Office Manager	Field office oversight
Patrick Mulligan, P.G.	Geologist	Sampling plan and execution
Tim Hill	Environmental Scientist	Sampling Technician
Chad Norman	Property Manager	Owner's representative
Steve Field	LCSWDC	LCSWDC Chairman
Jin Lui	State of Tennessee Regional Laboratory staff	Laboratory contact

The sampling was conducted on Friday, November 21, 2014. Surface water and leachate were sampled first and the landfill's cap was inspected. Residential well sampling followed. Samples were hand delivered to the State of Tennessee Regional Laboratory in Knoxville Tennessee before close of business.

4.0 Methods

DSWM personnel used industry standard methods to collect, contain, deliver and analyze surface and groundwater samples. Several governmental and professional organizations publish standard procedures for environmental sampling including the United States Environmental Protection Agency (EPA) and the American Society for Testing Materials (ASTM). The following references were used as guidelines for developing the surface and residential well sampling contained herein.

- "Surface Water Sampling Procedure" (EPA Region 4 Science and Ecosystem Support Division, Athens, GA, 5/28/2013) was used as a reference for surface water and leachate sampling

- "Potable Water Supply Sampling Procedure" (EPA Region 4 Science and Ecosystem Support Division, Athens, GA, 5/28/2013) was used as a reference for residential well sampling.

Most published leachate sampling procedures are developed for use when leachate collection and containing infrastructure are in place. These include techniques for pumping or bailing from sumps, lysimeters, and standard monitoring wells. Because this is not the case at Poplar Springs, the leachate sample was collected directly from the leachate seep location using a shovel and stainless steel bowl.

5.1 Surface Water / Leachate Sampling

Two surface water samples were collected. Surface water and leachate samples were taken directly into laboratory prepared sampling containers. Since leachate is expected to be more heavily contaminated than other surface water samples, the leachate sample was collected last.

The following procedures were followed for surface water and leachate sampling.

- Laboratory bottles were labeled with indelible ink prior to sampling.
- The sampler donned protective eyewear and a new pair of nitrile or latex gloves for each sample location.
- The surface water sample from the sediment pond was collected by immersing a clean stainless steel bowl into the shallow water and transferring the water directly into the sample containers from the bowl.
- An active and flowing leachate seep was identified for sampling.
- A depression was dug directly into the ground surface immediately downgradient of the selected leachate seep. Leachate was allowed to drain along a shovel blade and pool into a stainless steel bowl placed in the depression until adequate volume permitted transfer from the bowl directly into the sample bottles.
- Sample bottles were filled completely so that there was no "head space" in the bottle once they were filled.
- Bottles from each sample location were wiped dry with a disposable towel and stored on ice in a cooler.
- The sampler recorded date, time, weather, sampling location, collection method and any other pertinent data.
- Samples were delivered to the Knoxville Regional Laboratory (Laboratory) under chain-of-custody procedures by close of business the day of sampling.

- The Laboratory was responsible to process the samples with appropriate preservation and within the analytical methods holding times.

5.2 Residential Supply Well Sampling

Groundwater samples were obtained from four residential supply wells. One sampling location was selected for collection of a duplicate sample (the Humphreys residence). At each location the following procedure was followed:

- Laboratory bottles were labeled with indelible ink prior to sampling.
- The sampler donned protective eyewear and a new pair of nitrile or latex gloves for each sample location.
- The owner or resident was asked to sign an authorization form granting access to sample the well.
- Samples were taken directly from spigots at outdoor locations nearest the well at each residence location. None of the residences maintained water treatment systems for their water supply, so all samples were unfiltered and untreated.
- The systems were purged at the selected sampling locations by allowing the water to run for approximately 15 minutes. Temperature, pH, conductivity, and turbidity were monitored initially and every 2-3 minutes during the purge. Once these measurements varied less than 10% between readings, the wells were considered purged sufficiently to sample representative “fresh” formation water. Purge water was allowed to run off naturally on the ground surface at each location.
- The samples were collected by placing the sample container immediately beneath the tap and allowing the water to fill the bottle. Care was taken not to allow the container to come in contact with the spigot discharge.
- Sample bottles were filled completely so that there was no “head space” in the bottles once they are filled.
- Bottles from each sample location were wiped dry with a disposable towel and stored on ice in a cooler.
- The sampler recorded date, time, weather, sampling location, collection method and any other pertinent data.

5.3 Laboratory Methods

All samples were analyzed by the State of Tennessee Central Environmental Laboratory (Laboratory) in Nashville, Tennessee for DSWM Appendix I groundwater monitoring parameters (SOLID WASTE PROCESSING AND DISPOSAL CHAPTER 0400-11-01) in accordance with Environmental Protection Agency (EPA) Methods SW-846 (or as otherwise selected by the Laboratory). These include 17 heavy metals and 47 volatile organic compounds (VOCs). The following additional metals and nutrients analyses also will be conducted: Calcium (Ca), Iron (Fe), Manganese (Mg), Magnesium (Ma), Total Organic Nitrogen (TON) and Total Hardness by Calculation (THC).

5.0 Quality Control Procedures

The following quality control procedures were observed.

6.1 Planning and Training

The Residential Well and Surface Water Sampling Plan was peer and supervisor reviewed and comments resolved prior to finalization and implementation. Comments and resolution were documented and documentation stored with file contents.

Staff performing actual sampling activities had over 10 years of experience conducting environmental sampling including solid waste and residential well sampling. Sampling staff were 40 hr OSHA Hazardous Waste Site Operator trained. Laboratory personnel were trained as required by SW 846 Methods and State laboratory certification provisions.

6.2 Prevention of Cross Contamination

The following steps were taken to prevent cross contamination.

- Dedicated laboratory-prepared bottles were used for each sampling location.
- No sampling equipment was decontaminated and re-used for multiple sampling locations.
- The sampler wore dedicated protective wear (gloves) for each sampling location.
- Sample containers for VOC analyses were bagged in ziplock plastic containers prior to storage in coolers.

6.3 Monitoring Equipment

Field water quality monitoring equipment were State supplied, in good working order, and calibrated in accordance with manufacturer specifications.

6.4 Quality Control Samples

A field blank was prepared with laboratory-provided deionized water prior to beginning sampling, and it accompanied the sampling bottles and samples during the event to monitor for sources of cross contamination. A duplicate sample was obtained from one field-selected residential supply well (Humphreys) to monitor for laboratory precision. Level II laboratory quality control procedures were performed by the laboratory to monitor for acceptable accuracy and precision in accordance with SW 846 methodologies.

6.5 Documentation and Chain-of-Custody

All activities, attendees, occurrences and work procedures were documented by field sampling staff using indelible ink. Sample location selection and preparation details and field water quality parameter monitoring data were recorded on dedicated sample acquisition forms using indelible ink. Photographs were obtained at all sampling locations prior to and during sampling. State of Tennessee laboratory analysis request forms were completed for organic, inorganic and nutrient samples submittals. A laboratory-supplied Chain-of-Custody form was completed by the sampler and submitted for signature at the time of sample delivery. Copies of laboratory request forms and the Chain-of-Custody form were retained by the sampler for the file after sample submission.

6.6 Surveillance and Corrective Action

Sampling planning and collection activities were subject to surveillance by senior DSWM management and technical personnel. No deficiencies were noted and no corrective actions were performed.

6.0 Results

Laboratory Reports of the sample analyses are provided in Appendix B. Detected VOCs are summarized in Table 2 and compared to respective DSWM Appendix III Maximum Contaminant Levels (MCLs) and USEPA Region 4 Regional Screening Levels (RSLs) for tap water (2009).

Table 2
Summary of Detected Volatile Organic Compounds
In Leachate Sample S-1
Poplar Springs Landfill, Loudon, TN
11/21/2014

Analyte	MDL/MQL	Result (µg/L)	MCL (µg/L)	RSL (µg/L)
1,2,4 Trimethylbenzene	0.10/5.0	4.64	-	15
1,3,5 Trimethylbenzene	0.16/5.0	1.73 J	-	12
1,4 Dichlorobenzene	0.54/5.0	2.04 J	75	0.43
Ethylbenzene	0.15/5.0	79.3	700	1.5
m&p Xylene	0.31/5.0	51.0	200	10,000
Napthalene	0.19/5.0	3.86 J	-	0.14
o Xylene	0.10/5.0	20.0	-	1,400
Toluene	0.11/5.0	2.24 J	1,000	2,300

Notes and acronyms:

- µg/L = micrograms per liter
  - MCL = USEPA Maximum Contaminant Level
  - RSL = Regional Screening Level for Tap Water (April 2009)
  - MDL = Method Detection Limit
  - MQL = Method Quantitation Limit
  - J = Estimated value between MDL and MQL
  - No VOCs were detected in samples from the pond and the residential wells

No VOCs were detected in the residential well samples or in the surface water sample from the pond. Eight VOCs were detected in the leachate sample in concentrations ranging from near the detection limit to 79.3 µg/L (ethylbenzene). Concentrations of all VOCs in the leachate sample were below DSWM Appendix III MCLs. Concentrations of 1,4 dichlorobenzene (2.04 µg/L), ethylbenzene (79.3 µg/L), and naphthalene (3.86 µg/L) exceeded their respective RSL values for tapwater of 0.43 µg/L, 1.5 µg/L and 0.14 µg/L.

Inorganic sample analyses results are also provided in Appendix B and a Summary of Detected Metals and Nutrients is Table 3. In the table they are compared to respective DSWM Appendix III MCLs and USEPA Region 4 RSLs for tap water (2009).

Table 3
Summary of Detected Metals and Nutrients
Poplar Springs Landfill
11/21/2014

Analyte / (units)	**S-1 (Leachate)**	**S-2 (Pond)**	**R-1 (Johnson)**	**R-2 (Hines)**	**R-3 (Hembree)**	**R-4 (Humphreys)**	**R-4 dupe (Humphreys)**	**MCL (µg/L)**	**RSL (µg/L)**
Ammonia (mg/L)	710	99.0	0.15	0.12	0.15	U	U	-	-
TON (mg/L)	120	U	U	U	0.29	U	U	-	-
THC (mg/L)	410	230	140	140	64	160	160	-	-
Arsenic (µg/L)	26 J	11 J	U	U	U	U	U	10	.045
Barium (µg/L)	470	370	7.9	6.4	61	5.1	4.6 J	2,000	7,300
Calcium (mg/L)	45	27	29	28	18	31	31	-	-
Chromium (µg/L)	10	U	U	U	U	U	U	100	-
Cobalt (µg/L)	14	16	U	U	U	U	U	-	0.27
Copper (µg/L)	220	70	6.5	0.68 J	2.4	4.1	4.9	1,300	1,500
Iron (µg/L)	7,100	230	97	60	180	33	43	-	26,000
Lead (µg/L)	U	U	U	U	U	U	1.8	15	-
Magnesium (mg/L)	72	39	18	18	4.5	19	19	-	-
Manganese (µg/L)	700	740	8.1	4.2	6.7	U	0.30 J	-	880
Nickel (µg/L)	39	29	1.1	0.98 J	1.0	0.96 J	0.93 J	-	730
Potassium (mg/L)	2,000	900	1.8	1.0	3.7	1.9	1.9	-	-
Zinc (µg/L)	19 J	U	11	13	160	110	210	-	11,000

Notes and acronyms:

- µg/L = micrograms per liter
- MCL = USEPA Maximum Contaminant Level
- RSL = Regional Screening Level for Tap Water (April 2014)
- MDL = Method Detection Limit
- MQL = Method Quantitation Limit
- J = Estimated value between MDL and MQL
- TON = Total Organic Nitrogen
- THC = Total Hardness by Calculation

A total of eight metals were detected in the samples from all residential wells. They were barium, calcium, copper, iron, magnesium, manganese, nickel, potassium and zinc. All are naturally occurring and ubiquitous to the regional geologic setting. All are below their respective MCLs and RSLs for tap water. The duplicate sample from the Humphreys well was reported to contain 1.8 µg/L lead, despite the fact that the other sample contained no detectable lead. This concentration is below the MCL for lead of 15 µg/L. Because it was not detected in the first sample, it is presumed that the occurrence in the duplicate sample is due to laboratory error. This could be verified with additional sampling.

Metals detected in the leachate and pond sample were elevated in comparison to concentrations in the residential well samples and included metals that were not present in the residential well samples. Of particular note in both the leachate and pond sample are elevated concentrations of barium (470 µg/L and 370 µg/L, respectively), copper (220µg/L and 79 µg/L), iron (7100 mg/L and 230 mg/L), magnesium (700 mg/L and 740 mg/L) and potassium (2000 mg/L and 900 mg/L). Metals concentrations in surface water samples are indicative of landfill-derived contamination.

Concentrations of total organic nitrogen and ammonia in the leachate sample and ammonia in the pond sample are indicative of landfill-derived contamination also. The Johnson, Hines, and Hembrey wells each contained low levels of ammonia (0.15 mg/L, 0.12 mg/L and 0.15 mg/L, respectively); and in addition, the sample from the Hembree well contained 0.29 mg/L total organic nitrogen. The locations of the wells are either upgradient, or beyond the limits of the drainage basin occupied by the landfill. It is common for ammonia and nitrogen to be present in groundwater in proximity to agricultural operations. It is likely that these constituents are present due to nutrient loading from septic systems, grazing and/or cultivation operations in the area. There is not an MCL for ammonia, although some European nations recognize a drinking water limit of 1.0 mg/L. There are no standards for Total Organic Nitrogen in drinking water. The USEPA MCL for nitrate is 10 mg/L.

7.0 Conclusions and Recommendations

The following conclusions are offered:

- The residential water supply wells that were sampled appear to be unaffected by the Poplar Springs Landfill.
- Residential wells that were sampled are located beyond the limits of the drainage basin the landfill occupies.
- Drainage deficiencies and ineffective erosion control at the landfill has led to deep erosional rills and gullies in the landfill cap, exposing waste materials and allowing leachate to flow out of the landfill.
- Leachate is contaminated with VOCs, nutrients and metals constituents.
- Pond water also exhibits elevated metals concentrations likely attributable to the leachate from the landfill.
- Information necessary to confirm whether contaminants from leachate are exiting the property is incomplete.

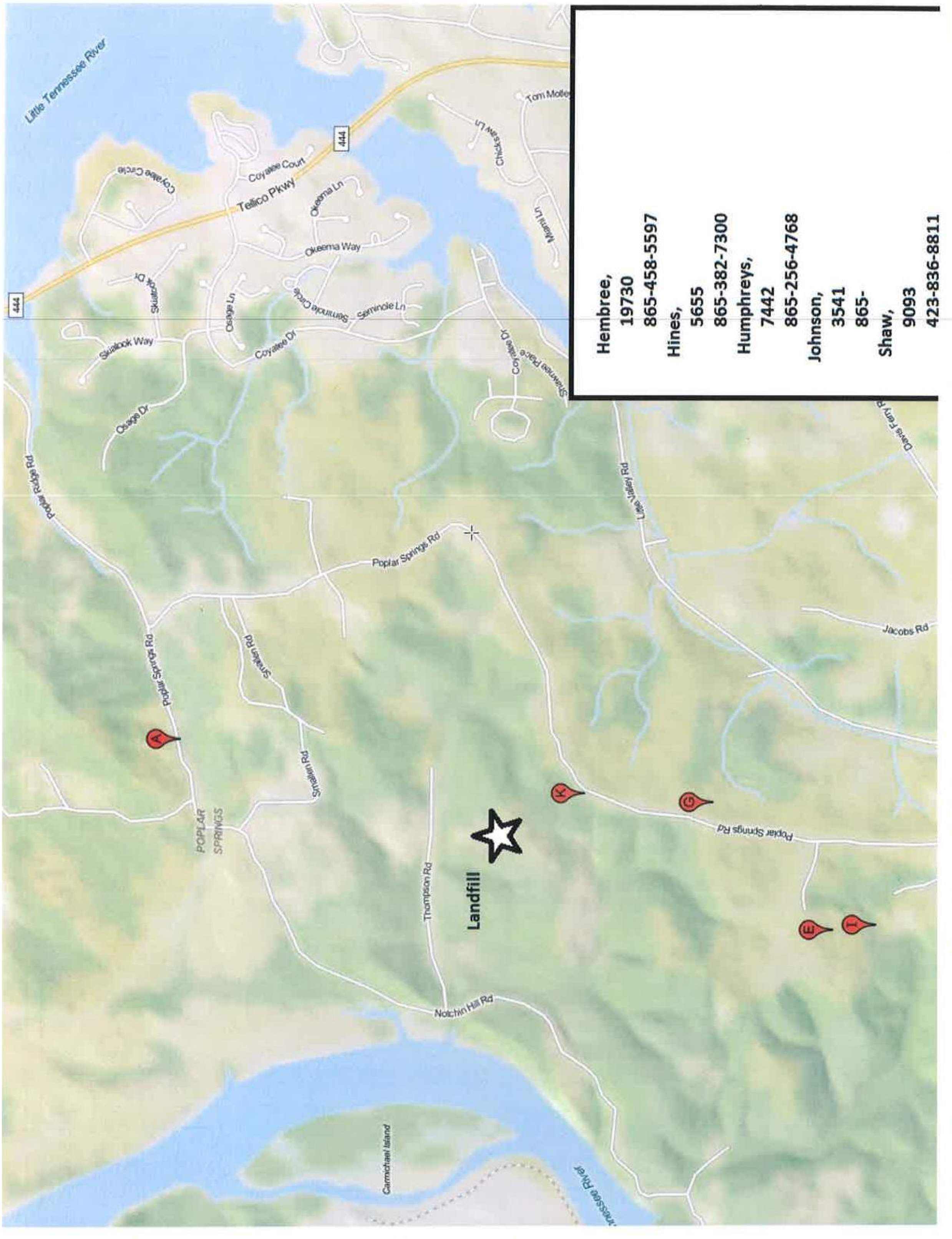
The following recommendations are offered:

- Because a variety of hazards exist on the property relative to the conditions observed, property access should be restricted.
- Additional assessment should be undertaken to verify whether leachate discharge is leaving the property. Offsite surface water sampling may be considered.
- Drainage and erosion control upgrades should be conducted to reduce infiltration of stormwater into the waste mass, leachate production and erosion. This should include maintenance and improvement of existing drainage features (perimeter ditch and sediment pond) and construction of an upgradient stormwater diversion ditch
- Rills, gullies, and other damaged areas of the cap should be repaired, including the removal of trees.
- An engineered cover/cap should be considered. At the least, the landfill cover should be upgraded to include low-permeability cover materials, topsoil and vegetative cover.

Appendix A

Field Notes

Poplar Spring Landfill aerial view. North is right. Note Poplar Springs Road in lower left corner. The landfill area is centrally located and highlighted with an arrow. Unvegetated areas without tree cover are indicative of denuded landfill areas.


Hembree,
19730
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Hines,
5655
865-382-7300
Humphreys,
7442
865-256-4768
Johnson,
3541
865-
Shaw,
9093
423-836-8811
Landfill
Little Tennessee River
Tellico Pkwy
444
Poplar Springs Rd
Poplar Ridge Rd
Little Valley Rd
Smallen Rd
Thompson Rd
Notchin Hill Rd
Jacobs Rd
POPLAR SPRINGS
Carmichael Island
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Appendix B

Laboratory Reports