SCREENING LEVEL ECOLOGICAL RISK ASSESSMENT
STEWART CREEK

EXIDE TECHNOLOGIES
FRISCO, TEXAS

Agreed Order: Docket No. 2011-1712-IHW-E

January 16, 2017

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APAR	Affected Property Assessment Report
bgs	Below Ground Surface
BHHRA	Baseline Human Health Risk Assessment
BNSF	Burlington Northern Santa Fe
BSAF	Biota Sediment Accumulation Factor
BW	Body Weight
COC	Chemicals of Concern
CSM	Conceptual Site Model
EMF	Exposure Modifying Factor
ERA	Ecological Risk Assessment
EPA	Environmental Protection Agency
EPC	Exposure Point Concentration
F.M.	Farm to Market
FOP	Former Operating Plant
FSCWWTP	Former Stewart Creek Waste Water Treatment Plant
^{SW}GW	Groundwater to Surface Water PCL
HHERA	Human Health And Ecological Risk Assessment
HQ	Hazard Quotient
LOAEL	Lowest Observed Adverse Effect Level
mg/kg	Milligrams per Kilogram
mg/L	Milligram per Liter
MW	Monitoring Well
No.	Number
NOAEL	No Observed Adverse Effect Level
NTMWD	North Texas Municipal Water District
ODEQ	Oregon Department of Environmental Quality
PBW	Pastor, Behling & Wheeler, LLC
PCL	Protective Concentration Level
RBEL	Risk Based Exposure Limit
SWG	Southwest Geoscience
SLERA	Screening-Level Ecological Risk Assessment
SSL	Soil Screening Level
TCEQ	Texas Commission on Environmental Quality
TOC	Total Organic Carbon
TPDES	Texas Pollutant Discharge Elimination System
TRV	Toxicity Reference Value
UCL	95th percentile Upper Confidence Limit
W&M	Whitehead and Mueller

1.0 INTRODUCTION

This report describes the Tier 2 screening-level ecological risk assessment (SLERA) conducted for certain sections of Stewart Creek in Frisco, Texas. Stewart Creek is a perennial creek that runs through the Exide Technologies (Exide) former operating plant (FOP) (also known as the Site) to Lake Lewisville. The location of the former plant is shown on the Site Location Map presented on Figure 1. The stretch of Stewart Creek evaluated in this SLERA is from just upstream of the FOP to 7 miles downstream of the FOP (Figures 1 and 2) although Stewart Creek and its tributaries begin several miles upstream of the FOP (Figure A-1 in Appendix A).

The FOP was a lead oxide manufacturing plant and later a lead metal recycling facility (secondary lead smelter) that was in operation in Frisco, Texas since approximately 1964, with recycling operations commencing in 1969 until operations ceased in November 2012. The facility recycled spent lead-acid batteries and other lead-bearing scrap materials. This SLERA evaluates the potential ecological risk in Stewart Creek surface water and sediment from arsenic, cadmium and lead upstream, on-Site and downstream from the FOP.

Data collection and analysis for the SLERA has been based on the Texas Commission on Environmental Quality's (TCEQ's) *Guidance for Conducting Ecological Risk Assessments at Remediation Sites in Texas RG-263 (Revised January 2014)* (TCEQ, 2014) as the primary guidance document. The SLERA is a conservative assessment that is used to evaluate the likelihood of ecological risk. The SLERA is also used to assess the need for further ecological evaluation.

A SLERA that evaluated the portions of Stewart Creek located on the FOP was submitted to the TCEQ and Environmental Protection Agency (EPA) as part of an Affected Property Assessment Report (APAR) for the FOP on July 9, 2013. On October 8, 2013, the TCEQ issued a letter conveying comments on the APAR and SLERA from the TCEQ and EPA Region 6. Responses to those comments were submitted to TCEQ and EPA on October 29, 2013. The TCEQ subsequently conditionally approved the responses on November 19, 2013 (TCEQ. 2013a). This SLERA includes revisions based on the October 29, 2013 response to comments with the modifications detailed in the TCEQ approval letter and is specific to Stewart Creek over the area from just upstream of the FOP to 7 miles downstream of the FOP. A separate SLERA, also included with the FOP APAR, evaluates the upland (i.e., terrestrial) habitat located on the FOP. The methodology for both aquatic and terrestrial SLERAs was presented in the *Screening Level Ecological Risk Assessment Work Plan for the Exide Frisco Recycling Center, Frisco, Texas* (PBW, 2012a) submitted to the TCEQ on December 21, 2012 following discussions with the TCEQ regarding data needs, sampling, and the general approach for the SLERAs. The Work Plan was approved by TCEQ on January 16, 2013.

2.0 SITE DESCRIPTION AND ENVIRONMENTAL SETTING

This section provides a summary of the history of the former operating plan (also known as the Site), current environmental setting and the anticipated future land use of the Site and Stewart Creek.

2.1 Site History

The FOP was a lead oxide manufacturing plant and later a secondary lead smelter (a lead metal recycling facility) that was in operation since approximately 1964 (lead smelting operations began in approximately 1969). The operations ceased at the end of November 2012. Spent lead-acid batteries and other lead-bearing scrap materials were recycled at the Site. The scrap lead was smelted and refined to produce lead, lead alloys and lead oxide.

Process wastewater generated when Site operations were on-going was treated in the on-Site Wastewater Treatment Facility (to remove metals) and then through the Crystallization Unit (to remove salts), producing condensate that was then discharged to the North Texas Municipal Water District (NTMWD) sanitary sewer. Prior to construction of the on-Site Wastewater Treatment Facility in approximately 1988, wastewater from the Site was treated off-site at the Former Stewart Creek Waste Water Treatment Plant (FSCWWTP) located west and adjacent to the Site (Figure 1).

Current storm water control features within the former production area include a concrete slab cover located throughout the former production area, a flood wall located between the former production area and Stewart Creek (which acts as a flood wall/retaining wall), and a French drain system located on the facility side of the flood wall that was constructed as an interim measure to address seepage of storm water and wash water to the exterior of the flood wall. These storm water control features route storm water and wash water to a conduit near the western end of the flood wall that directs the water to a storm water retention pond located on the south side of Stewart Creek. According to former Exide personnel, the storm water retention pond was constructed in approximately 1987-1988, which corresponds to the timing of the construction of the flood wall. Water within the retention pond historically was either treated and discharged to Stewart Creek or was used as make-up water in the plant’s process streams. Discharge of water to Stewart Creek is regulated by the TCEQ under Texas Pollutant Discharge Elimination System (TPDES) Permit No. WQ0002964000, but such discharge has not occurred since 2009. Runoff from areas of the Site outside of the former production area flows into either Stewart Creek or the North Tributary. These areas generally have moderate relief and are stabilized with vegetation. The ultimate storm water management plan will be designed in conjunction with the final remediation and maintenance design to be developed in the Response Action Plan for the Site. All surface water features within the City of Frisco, including Stewart Creek, are covered under the City's MS4 permit. Several studies since the 1990s, summarized below, have been performed to investigate the surface water and sediments of Stewart Creek at the Site and in downstream areas.

- JD Consulting, LLC conducted a Human Health and Ecological Risk Assessment (HHERA) for Exide in 1998 (JDC, 1998) that investigated Stewart Creek surface water and sediments. The study concluded that surface water did not pose a risk to human or ecological receptors while lead concentrations in sediment from the on-Site portion of Stewart Creek may pose a risk to human and ecological receptors. The on-Site sediments were subsequently remediated in 2000 (JDC, 2000). It was also noted in the HHERA (JDC, 1998) that cadmium and lead levels in sediment from areas downstream of the facility boundary may pose an ecological risk.
- PBW sampled sediment in October 2010 in support of a SLERA for the City of FSCWWTP, located immediately downstream of the Site (PBW, 2013a). The location of the FSCWWTP is shown on Figure 1. These data are incorporated into this SLERA and used in the evaluation of ecological risk.
- Whitehead and Mueller conducted a study for Exide in 2011 (W&M, 2011) to evaluate the presence of potential slag along the banks of the western reach of Stewart Creek on-Site. Several areas within and on the banks of the western reach of Stewart Creek were identified that contained isolated occurrences of slag. Although some slag samples were collected, no sediment or surface water samples were collected for laboratory analysis.
- Southwest Geoscience (SWG) conducted a study for the City of Frisco in 2011 to investigate potential impacts from lead and/or cadmium in sediments downstream of the FOP (SWG, 2013a). Several sediment sample locations within Stewart Creek near the Dallas North Tollway were noted as having elevated concentrations of lead or cadmium. These data are incorporated into this SLERA and used in the evaluation of ecological risk.
- SWG conducted a walking visual survey for the City of Frisco in March and April 2013 to identify the presence of visible battery chips and slag in Stewart Creek from Lake Lewisville east of F.M. 423 to the western edge of the Burlington Northern Santa Fe (BNSF) railroad bridge (minus a 1.2 mile stretch because of property access limitations) (SWG, 2013b). Battery chips and potential slag were observed in Stewart Creek. No sediment or surface water samples were collected for laboratory analysis.
- SWG completed a Supplemental Site Investigation in Stewart Creek from 4th Army Memorial Parkway to the BNSF Railroad Bridge in June 2013. Sediment and "as generated" wastes (e.g.,

chips, potential slag and slag) along Stewart Creek were sampled (SWG, 2014). Sediment data are incorporated into this SLERA and used in the evaluation of ecological risk.

2.2 Current Environmental Setting

The FOP is located within the shallow valley created by the drainages of Stewart Creek and an on-Site tributary to Stewart Creek located to the North ("North Tributary"). The on-Site portions of Stewart Creek and the North Tributary receive surface water flow from five distinct creeks that collect water from east of the Site. Appendix A shows a 2011 aerial photograph with the creeks visible and presents photographs taken from upstream locations during a Site visit on October 22, 2012. These creeks have been incorporated into parks as water features, run along roadways, through neighborhoods and other developments, and are part of the surface water features within the Frisco City limits that are contained within the City's MS4 storm water management permit. Urban runoff eventually feeds into the portion of Stewart Creek that is within the boundaries of the Site and is the primary source of water in Stewart Creek. Stewart Creek is classified as a perennial stream and the North Tributary is classified as an intermittent stream by the TCEQ (TCEQ, 2013b; TCEQ, 2013c).

Stewart Creek on-Site has banks on the east side that average 2 feet above the water line and the grasses growing along the banks are maintained and mowed. The banks along the creek on the west side of the FOP are greater than 8 feet and the vegetation consists of shrubs, small trees and grasses. Stewart Creek on-Site consists of riffles and a few pooling areas. The creek bed on-Site consists of gravel, shale, concrete, loose rip/rap, and rip/rap contained within chain link fencing. Stewart Creek downstream of the FOP contains a small number of perennial pools connected by segments of riffles and glides. The streambed is typical of a streambed that was formed by rapidly moving water. Most of the creek is dominated by long segments of exposed rock, shale and clay. During a walking survey conducted as part of the January and March 2014 habitat assessment (Appendix C), the streambed included only a few segments where a measureable amount of sediment had accumulated. Sediment was found in the small pools that were scattered along the stream course. The pooling areas were small and the water depth averaged less than 3 feet deep. The banks of Stewart Creek downstream of the FOP consist of steep eroded bluffs 4 – 6 feet high.

The ground surface in the northern portion of the FOP is relatively level and slopes gently toward either Stewart Creek or the North Tributary. In the southeastern portion of the Site, the ground surface slopes steeply downward toward the north (toward Stewart Creek) due to the natural topography. In the southwestern part of the Site, ground surface gently slopes north toward Stewart Creek.

2.3 Future Environmental Setting

For the purposes of this SLERA, it is assumed that Stewart Creek and the North Tributary will remain freshwater urban creeks that collect surface water runoff from the nearby residential areas. According to Cook-Joyce, Inc. (2014), the City of Frisco is planning to modify Stewart Creek downstream of the FOP between Cotton Gin Road, Legacy Drive, Stonebrook Parkway and the Dallas North Tollway for development of a 320 acre park. Stewart Creek west of the Dallas North Tollway will be restructured so that two lakes can be constructed on Stewart Creek (CJI, 2014). Stewart Creek will feed the lakes in the park and then will outflow into the lower downstream portions of Stewart Creek.

3.0 PROBLEM FORMULATION

Per TCEQ guidance (TCEQ, 2014), Problem Formulation is the first phase of the SLERA and establishes the goals, breadth, and focus of the assessment. Therefore, this section identifies the major factors that were considered in the assessment, such as the affected property size and ecology, distribution of chemicals of concern (COCs), and potential ecological receptors.

3.1 Stewart Creek Surface Water and Sediment COCs

A discussion of FOP COCs in surface water and sediment is presented in Sections 6 and 7 of the APAR, respectively. Consistent with that discussion, the primarily COCs evaluated in this SLERA are arsenic, cadmium, and lead.

Cadmium is considered bioaccumulative in sediment, but not water. Arsenic and lead are not considered bioaccumulative in sediment or water (Table 3-1 in TCEQ, 2014). Consistent with TCEQ guidance (TCEQ, 2014), the maximum detected concentration in a given media was used for benchmark screening in this SLERA and the 95 percent upper confidence limit on the mean (95% UCL) was used as the exposure point concentration in the food web analysis. EPA's most recent ProUCL version 5.0 software program was used to calculate the 95% UCL concentrations for the constituents in exposure areas (EPA, 2013). Appendix B provides the ProUCL output.

3.1.1 Data Summary

Multiple investigations have been conducted for Stewart Creek, as discussed and presented in greater detail in the APAR. Sediment and surface water data evaluated in this SLERA were collected from the following investigations:

Surface Water and Sediment Upstream:

- Ten surface water and ten sediment samples were collected by Golder Associates (Golder) in January 2014 from directly upstream of the FOP. Sediment samples were analyzed for arsenic, cadmium, lead, total organic carbon (TOC) and particle size. Surface water samples were analyzed for arsenic, cadmium and lead (total and dissolved).

Figure 3 shows the upstream sample locations. Analytical data are presented in Table 1 for surface water and Table 2 for sediment. Table 5 shows the sediment particle size distribution data.

Surface Water and Sediment On the Former Operating Plant:

- Sediment samples were collected in Stewart Creek and North Tributary on-Site during the 2012 PBW Site Investigation Report (PBW, 2012b) activities. Sediments were analyzed for cadmium, lead, TOC and sediment particle size.
- Surface water samples were collected in Stewart Creek on-Site during the 2012 PBW Site Investigation Report (PBW, 2012b) activities and analyzed for cadmium and lead (total and dissolved).
- Ten surface water samples were collected by PBW in the North Tributary in 2013 to support the APAR and analyzed for cadmium and lead (total and dissolved).
- Six surface water samples were taken in 2014 from Stewart Creek by Golder on-Site and analyzed for arsenic, cadmium and lead (total and dissolved).

Figure 3 shows the on-Site sample locations. Analytical data are presented in Table 1 for surface water and Table 2 for sediment. Table 5 shows the sediment particle size distribution data.

Surface Water and Sediment Downstream of the Former Operating Plant:

- Six sediment samples were collected by PBW in 2010 near the FSCWWTP and analyzed for arsenic, cadmium and lead (Figure 4 and Table 3).
- Thirty sediment samples were collected by SWG in November 2011 downstream of the FOP and analyzed for arsenic, cadmium, lead and selenium (Figure 4 and Table 3).
- In June 2013, SWG sampled sediments for arsenic, cadmium, lead, sediment TOC and sediment particle size. Additionally, there were 14 samples of sediment or “base material” co-located with battery chips, slag and potential slag (Figure 4 and Table 3). These samples included discrete and composited sediment samples taken directly beneath a chip, pieces of slag or pieces of potential slag. Samples of battery chips, slag and potential slag were not included in this SLERA per the TCEQ approved October 29, 2013 response to TCEQ and EPA comments on the APAR and SLERA (Exide, 2013; TCEQ 2013a) “battery case fragments and/or slag samples will not be included in the SLERA as an environmentally bioavailable media as they do not meet the TCEQ definition of environmentally bioavailable media”.
- Sediment samples were taken in 2014 by Golder throughout the entire downstream stretch of Stewart Creek to Lake Lewisville (Figure 5 and Tables 4 and 5). Sediments were analyzed for arsenic, cadmium, lead, TOC and particle size.

- Surface water samples were taken from eight locations by Golder in 2014 downstream of the FOP (Figure 5 and Table 1) and analyzed for arsenic, cadmium and lead (total and dissolved).
- Five surface water (Table 1) and sediment (Tables 4 and 5) samples were taken by Golder in 2014 from several tributaries of Stewart Creek not impacted by FOP activities (Figure 5).

Groundwater:

- Groundwater data presented in this SLERA are from uppermost water bearing unit monitoring wells representing the groundwater to surface water pathway (Figure 6 and Table 6). Data are presented from 2012, 2013 and 2014. The majority of the data are for cadmium and lead, although there are some data for arsenic and selenium.

Tables 1 through 4 list data used for evaluating potential ecological exposures for surface water and sediment. Table 5 shows the sediment particle size distribution. Table 6 shows the groundwater data. The sample locations are shown on Figures 3 through 6.

3.1.2 TCEQ Benchmarks/Initial Screening Comparison

Tables 1 through 6 list the TCEQ freshwater sediment and surface water (freshwater acute and chronic) screenin levels (TCEQ, 2014; 2011) that per TCEQ guidance were used in this SLERA as an initial screening step. Acute surface water quality standards were used for comparison for surface water and potential groundwater discharge to surface water in the North Tributary since the TCEQ classifies the North Tributary as an intermittent stream (TCEQ, 2013b) and, as such, the acute surface water quality criteria are the applicable standards (TCEQ, 2014, 2011). Chronic surface water quality standards were used for comparison for surface water and potential groundwater discharge to surface water in Stewart Creek since the TCEQ classifies Stewart Creek as a perennial stream (TCEQ, 2013c) and, as such, the chronic surface water quality criteria are the applicable standards (TCEQ, 2014, 2011). The dilution factor of 0.15 was applied to the chronic surface water criteria for evaluation of the groundwater to surface water pathway (refer to Section 12 of the APAR for further discussion of the groundwater to surface water dilution factor).

Required Element #1 of the TCEQ guidance is the comparison of the maximum detected concentration from an exposure area to the benchmark. Note that if a constituent is considered bioaccumulative and is detected, then it is automatically retained for further evaluation. If a constituent is not considered bioaccumultive, but is detected at a concentration in at least one sample from the ecological exposure area greater than the screening level benchmark, then the constituent is retained for further analysis. The screening comparison step for each media is presented below.

3.1.2.1 Surface Water

For surface water (Table 1) data, the preferred method of analysis is EPA Method 6020A due to lower sample detection limits than EPA Method 6010B for the analytes of interest; however, data generated using EPA Method 6010B are also presented (i.e., data were not censored). None of the samples taken in 2014 and analyzed using the more sensitive EPA Method 6020A had results that exceeded the surface water criteria. Three samples taken on the FOP in Stewart Creek in 2012 (SW-1, SW-2 and SW-11) had concentrations that exceeded the chronic criteria for cadmium and/or lead, but all samples taken in 2014 had concentrations below the chronic criteria for a perennial stream. All of the samples taken in the North Tributary in 2012 were below the acute surface water criteria for an intermittent stream. Based on the screening comparison, surface water was not carried forward for further evaluation in this SLERA.

3.1.2.2 Sediment

Table 2 shows the sediment samples taken upstream of the FOP and on the FOP in Stewart Creek and in the North Tributary. Tables 3 and 4 show the downstream sediment data. The freshwater benchmarks are also listed on these tables. Figures 3, 4 and 5 show the sampling locations.

- Arsenic data are available from the upstream samples (Table 2) and downstream of the FOP (Tables 3 and 4). Arsenic is not considered bioaccumulative. Several samples had arsenic concentrations greater than the benchmark of 9.79 mg/kg and therefore per TCEQ guidance, arsenic is carried forward for further evaluation in this SLERA.
- Cadmium is considered bioaccumulative in sediment. Because cadmium is bioaccumulative and has been detected in the sediment from Stewart Creek, per TCEQ 2014 ecological risk assessment guidance it is carried forward for risk evaluation to upper trophic level receptors. Additionally, several sediment samples had cadmium measured at concentrations greater than the benchmark.
- Lead data are available from sediment samples throughout the Stewart Creek study area. Similar to arsenic, lead is not considered bioaccumulative in sediment, but has been detected at concentrations greater than the benchmark of 35.8 mg/kg. Based on the benchmark exceedances and per TCEQ 2014 ecological risk assessment guidance, lead is carried forward for further evaluation.

- Selenium was analyzed in sediment in 2011 (Table 3), but all results are below the detection limits. TCEQ does not provide a sediment benchmark for selenium (TCEQ, 2014). The highest detection limit for a selenium sediment sample was 1.26 mg/kg. In 2013, SWG conducted a background soil study which included selenium (SWG, 2014). Lacking sediment background information, the use of area-specific background soil data can provide a reasonable understanding of the selenium concentrations in the soils that could be deposited through runoff into drainage channels. Background soil concentrations of selenium reported by SWG ranged from 0.21 mg/kg to 3.5 mg/kg (SWG, 2014). All of the detection limits from the selenium sediment data are within the background soil range. Based on the absence of selenium detections in the sediment samples, selenium was not carried forward for further evaluation in this SLERA.

3.1.2.3 Groundwater

Table 6 summarizes the groundwater data from the uppermost groundwater-bearing unit monitoring wells used to assess the groundwater to surface water pathway. Figure 6 shows the locations of the monitoring wells in relation to the North Tributary and Stewart Creek. Table 6 includes the most recent 2014 data analyzed by EPA Methods 6010B and 6020A and previous samples taken in 2012 and 2013 from relevant wells, but analyzed by EPA Method 6010B only.

There are no confirmed exceedances of the ^{SW}GW protective concentration levels (PCLs) from samples taken from the uppermost groundwater-bearing unit. The only exceedance of the ^{SW}GW PCL in these samples was from a sample taken in January 2014 from MW-46 and analyzed using EPA Method 6010B, which exceeded the ^{SW}GW PCL for both lead and cadmium; however, re-samplings of this well in February and March 2014 and analysis by EPA Method 6020A did not confirm the initial exceedance. None of the measured concentrations or detection limits in these wells near the North Tributary exceed the acute surface water criteria. Per the TCEQ guidance and Required Element # 1 (TCEQ, 2014), if the concentrations of non-bioaccumulative COCs are less than the ecological benchmarks, the COCs are not carried forward for further evaluation. As such, arsenic, cadmium and lead in groundwater were not carried forward for further evaluation in the SLERA. Selenium is considered bioaccumulative in water (Table 3.1 of TCEQ, 2014) and because there are detections of selenium in the groundwater that could enter surface water, selenium was retained for further analysis in the SLERA in accordance with TCEQ guidance.

3.1.2.4 Conclusion of Initial Screening

- **Surface Water –** Based on the screening evaluation and per TCEQ 2014 ecological risk assessment guidance, surface water as an ecological exposure medium was not carried forward in the SLERA process.
- **Sediment -** Based on the initial screening benchmark comparison and per TCEQ 2014 ecological risk assessment guidance, arsenic, lead and cadmium in sediment are carried forward for further evaluation. Selenium was not detected in sediment samples and was not carried forward.
- **Groundwater –** Based on the screening evaluation and per TCEQ 2014 ecological risk assessment guidance, the groundwater to surface water pathway is not carried forward in the SLERA process for arsenic, cadmium and lead; however, selenium in groundwater was retained because of its bioaccumulative properties.

3.1.3 Identification of Sediment Hot Spots

Following the initial screening evaluation of the data presented in Section 3.1.2 of this SLERA, the characteristics of Stewart Creek and the detected concentrations of cadmium and lead in sediment were evaluated critically for the identification of hot spots. As described in Section 3.9.2.7 of TCEQ, 2014 "a hot spot is a discrete area of substantially elevated COC concentration relative to the surrounding area. No standard approach has been developed for defining such areas. What constitutes a hot spot depends in part on the concentration, toxicity, and other properties of the COC; the medium in which it is detected; the extent of the area with elevated COC concentration; and the biological characteristics, such as receptor home range."

Two hot spot areas were identified in the downstream portion of Stewart Creek primarily based on the 2010, 2011 and 2013 data using a simple process: 1) sample locations with elevated lead (e.g., SC-Sed 5) clustered in an area; and 2) the documented presence of chip or slag material (e.g., Slag 6-24-2 base). A single location of an elevated concentration was not considered a hot spot, but a grouping of samples associated with potential source material. Sediment data associated with the hot spot areas are noted on Tables 3 and 4. Figures 4 and 5 show the general hot spot areaa in relation to the sediment sample points. The portion of Stewart Creek directly downstream of the FOP to the Dallas North Tollway is defined as Hot Spot #1. Hot Spot #1 includes the area near the FSCWWTP and several locations where slag was noted in 2013. Hot Spot #2 is tied to locations where potential slag was found in 2013 and is located east of Legacy Drive and south of Stonebrook Parkway if it extended east across Legacy Drive. These hot spots are focused on exposure to the benthic invertebrate population and not wide-ranging receptors (e.g., birds) because sufficient aquatic habitat is available within Stewart Creek and these areas do not contain any preferred habitat or unique features.

As described by TCEQ (2013d) "the initial goal of the hot-spot evaluation will be to ensure that a statistical presentation of the sampling data (e.g., 95 % UCL) will not mask or dilute areas of elevated sediment concentrations that may otherwise pose a potential risk to the benthic community or cause risk from the remaining portions of the exposure areas to be overestimated." In the next phase of the SLERA, the statistics calculated to represent the downstream sediment data set are determined with and without the data associated with the samples from the hot spots. This evaluation is described in Section 3.2.2 (Risk Management for Benthic Hot Spots) in TCEQ 2013d and states "by definition, hot spots present an unacceptable risk to the benthic community. Therefore, if hot spots are identified within the benthic expsoure area, persons should recommend appropriate risk management practices. Where hot spots are identified and will be separately addressed with a remedy (e.g., removal), these data points should be removed from the 95% UCL determiniation and the resulting 95 % UCL should be used as the exposure point concentration."

3.1.4 Arsenic, Cadmium and Lead Fate and Transport and Ecotoxicological Profiles

Potential fate and transport mechanisms are discussed below for the retained compounds as discussed in Section 3.1.2: arsenic, cadmium, and lead (TCEQ's Ecological Risk Assessment Required Element #4).

3.1.4.1 Arsenic

Arsenic is an element that occurs naturally in a variety of sulfidic ores. Most anthropogenic releases of arsenic are to land or soil, primarily in the form of pesticides or solid wastes. Arsenic released to land is relatively immobile due to binding to soil particles (ATSDR, 1993). Arsenic is both reactive and mobile and can cycle extensively through both biotic and abiotic components of local aquatic and terrestrial systems. It can undergo a variety of chemical and biochemical transformations, such as oxidation, reduction, methylation, and demethylation (Environment Canada, 1993). Arsenic can exist in four oxidation states: +5, +3, 0 and -3. In soil, arsenic is a constituent of numerous minerals and is frequently found associated with sulfur, most commonly as arsenopyrite (FeAsS). Inorganic arsenate can also be bound to iron and aluminum cations or any other cation that may be present (e.g., calcium, zinc, magnesium, lead) as well as organic matter in soils (EPA, 2005a). The two primary forms of arsenic are trivalent (+3) arsenic and pentavalent (+5) arsenic. The relative toxicity of the trivalent and pentavalent forms may also be affected by factors such as the water solubility of the compound. Soluble inorganic arsenate (pentavalent state) predominates under normal conditions since it is thermodynamically more stable in water than arsenite (trivalent state). Arsenic toxicity in water is not governed by hardness (Irwin et al., 1997a).

Over the past 100 years, arsenic compounds have had several uses including as a component of animal feed, herbicides and pesticides. Arsenic was used as a defoliant until 1992. Inorganic arsenical products were used as herbicides and insecticides in the first half of the 20th century until banned in 1988. Calcium arsenate was specifically used to fight a cotton pest, the boll weevil. Sodium arsenite was used in sheep and cattle dips. Another inorganic arsenical product, arsenic acid, was pervasively used as a cotton desiccant in Texas from approximately 1965 to 1992, when it was banned by EPA (Bureau of Economic Geology, 2005). Appendix 22 of the APAR shows historical aerial photographs of the area around the FOP and shows large tracts of land used for agriculture. Many of the agricultural tracts were likely used for cotton farming given: 1) cotton was historically identified as the main cash crop in Collin County (USDA, 1969) and 2) the development of the City of Frisco as a hub for area cotton farmers providing cotton gins and grain elevators (CCHC, 2014). Thus, it is probable that products containing arsenic were used in the general vicinity around the FOP and that the arsenic detected in the Stewart Creek sediments is sourced from agricultural products. Additionally, arsenic exceedances in sediment are not co-located with lead and cadmium exceedances suggesting that the source of the arsenic is not in association with the source of the lead and cadmium. See Sections 1.2.1.1 and 3.1.3 in the APAR for additional discussion of arsenic.

3.1.4.2 Cadmium

Cadmium is a naturally occurring element and is typically associated with other metals such as zinc and lead. Cadmium use was infrequent prior to the 20th century; however, recognition of its resistance to corrosion increased its demand, and it is now used in the manufacture of metal alloys, in nickel cadmium batteries, in pigments, metal coatings, and plastics. Cadmium emissions to the atmosphere result from combustion of fossil fuels, industrial emissions, or erosion of soils (Elinder, 1985). In nature, two oxidation states are possible (0 and +2), however, the zero or metallic state is rare. Mobility and bioavailability of cadmium in aquatic systems is enhanced under conditions of low pH, low hardness, low suspended solids, high conductivity, and low salinity (Irwin et al., 1997b). Cadmium in surface water accumulates more rapidly in the sediments than in living organisms. The toxicity of cadmium in sediments is affected by sediment content of acid volatile sulfides and total organic carbon. If released or deposited on soil, cadmium is largely retained in the surface layers of soil and is expected to convert to insoluble forms such as cadmium carbonate (EPA, 2005b).

Aquatic and terrestrial organisms bioaccumulate cadmium (Callahan et al., 1979) and TCEQ considers cadmium bioaccumulative in sediment (Table 3-1 in TCEQ, 2014). Bioaccumulation in fish is dependent on the pH and organic content of the water, which are the major determinants of water/sediment partitioning. Because cadmium accumulates in kidney and liver tissue rather than in muscle, and because intestinal absorption of cadmium is low, one would expect a low amount of biomagnification of cadmium in the food chain (ATSDR, 1991).

3.1.4.3 Lead

Lead, a naturally occurring element, is one of the most ubiquitous contaminants in the developed world because of its long history of a variety of domestic, medicinal and industrial uses. Lead is strongly sorbed in sediments and the rate is correlated with grain size and organic content. In the absence of soluble complexing species, lead is almost totally adsorbed to clay particles at pHs greater than 6 (Moore and Ramamoorthy, 1984). In surface water, lead is most soluble and bioavailable under conditions of low pH, low organic content, low levels of suspended solids, and low levels of salts of calcium, iron, manganese, zinc, and cadmium. In surface water, lead exists in three forms, dissolved labile, dissolved bound (e.g., colloids or strong complexes), or as a particulate (Benes et al,. 1985). Most lead in natural waters is precipitated to the sediment as carbonates or hydroxides (Demayo et al,. 1982). Lead in soil is relatively immobile and persistent. Lead forms complexes with organic matter and clay minerals, which limits its mobility (EPA, 2005c).

3.2 Conceptual Site Model

A conceptual site model (CSM) for the Site is presented as Figure 7 and illustrates the potential contaminant sources, release mechanisms, transport pathways, exposure media, and receptors considered for the SLERA. Development of a CSM is TCEQ’s Ecological Risk Assessment Required Element #3.

The primary release mechanism and associated route of ecological exposure is through air deposition of arsenic, cadmium and lead onto surface soil on-Site and potential surface runoff of arsenic, cadmium and lead into Stewart Creek and the North Tributary as well as direct deposition onto the Stewart Creek and the North Tributary. Other potential sources of arsenic, cadmium and lead in the sediment include the presence of battery chips and slag material in the downstream portions of Stewart Creek. As previously presented, runoff from cotton farming areas in the vicinity is also a potential off-Site source of arsenic to Stewart Creek.

3.2.1 Chemical/Physical Properties Governing Transport of Arsenic, Cadmium and Lead

Arsenic, lead and cadmium, like all compounds, have the potential to move within environmental media (e.g., soil) to some degree. The ability for a compound to be transported within a medium or between media is based on the chemical and physical characteristics of the compound(s) and the source medium as well as the receiving medium. Physical characteristics include parameters such as grain size and moisture content for surface soil particles. Chemical characteristics include parameters such as soil/water partition coefficients, adsorption potential and degradation characteristics for potential contaminants. These chemical characteristics are specific to each chemical present, and may also be affected by the physical characteristics of the media in which the chemical is present. In surface water, physical and chemical characteristics are both important because transport may occur in solution or in association with suspended sediment. Dissolved-phase transport is the dominant contaminant migration mechanism in groundwater; therefore, chemical characteristics are often important with respect to that medium as well. Arsenic, lead and cadmium generally tend to remain bound to organic matter, minerals, clays, and silts in soil and, as such, they are relatively immobile. Arsenic, lead and cadmium are not considered water soluble although their solubility will increase in acidic conditions. If present in the dissolved phase, they can migrate in groundwater, although that migration can be significantly attenuated through sorption to the groundwater matrix, particularly in clay-rich soils such as those that predominate the uppermost groundwater-bearing unit at the Site.

3.2.2 Transport of Arsenic, Cadmium and Lead in Surface Soil Via Surface Runoff

Overland surface runoff from surface soil to Stewart Creek and the North Tributary has the potential to result in arsenic, cadmium and lead bound to soil particles being transported during/after rainfall events into these surface water bodies. Overland flow during runoff events would be expected to occur in the direction of topographic slope and would more likely occur with significant rainfall events when soils are fully saturated and/or precipitation rates are greater than infiltration rates. The Site is relatively flat, with limited elevation changes over the Site, generally less than five to ten feet over the entire Site, with a gradual slope increase in the vicinity of Stewart Creek and lesser so at the North Tributary. Because of the limited topographic slope and vegetative cover, the Site is generally not conducive to high runoff velocities or high sediment loads. In addition, the soils at the Site are predominantly clay, and clay soils have a relatively low erosive potential.

There is limited physical evidence of erodible impacts on-Site other than a small area of wash-out on the south side of the railroad spur on the western-most portion of the former operations area. Additionally, there are areas of preferential surface water flow in the South Wooded Area on-Site that are stabilized by natural vegetation.

Dissolved arsenic, cadmium and lead associated with surface runoff from the Site would likewise be expected to be generally low due to the relatively low solubility of these metals. Arsenic, lead and cadmium will preferentially partition to organic matter in soil and sediment. Once bound to organic matter, these constituents may migrate as part of the sediment matrix if sediment is re-suspended during storm events and moved downstream. Stewart Creek and the North Tributary generally have a bedrock or gravel bed in the vicinity of the Site, suggesting that there is limited erosion of surface soils in this area. Table 5 shows the grain size of the sediment samples taken from Stewart Creek and the North Tributary. The grain size data indicate that the larger-sized particles (gravel and sand) are more prevalent than the smaller silt or clay particles. The relatively low measured lead and cadmium concentrations in the sediment in on-Site Stewart Creek and North Tributary also suggest that there is little evidence that overland erosion and transport of soil on-Site is a significant migration pathway. As noted in Appendix C, the creek bottom downstream of the FOP consists of mostly gravel, shale and clay and contained a few pooling areas. The streambed included only a few segments where measureable amounts of sediment had accumulated. Sediment was only found in small pools that were scattered along the stream course. The remainder of the streambed consisted of long segments of exposed rock, shale, and clay that had no accumulated sediment. On-Site, the creek bed consists of gravel, shale, concrete, loose rip/rap and rip/rap contained within chain link fencing (i.e., gabion basket). The creek bed within the pooling areas consisted of gravel, dead vegetation, and small amounts of sand or fine gravel.

3.3 Assessment Endpoints

Per TCEQ's Ecological Risk Assessment Required Element #2, ecological communities and major feeding guilds applicable to the Site were identified. Assessment endpoints are explicit expressions of the actual environmental value to be protected (EPA, 1997). If these endpoints are found to be significantly affected, they can trigger further action. The assessment endpoints for the Site are:

- Protection of aquatic life in Stewart Creek with no unacceptable effects on species diversity and abundance (and viable reproduction) due to Site-related arsenic, cadmium or lead in the surface water and sediment.
- Protection of benthic invertebrate community in Stewart Creek with no unacceptable effects on species diversity due to Site-related arsenic, cadmium or lead in the sediment.

- Protection of birds and mammals with no unacceptable effects on species diversity and abundance (and viable reproduction) due to Site-related arsenic, cadmium or lead in the surface water and sediment.

Appendix C contains the habitat evaluation conducted to evaluate the potential presence of special status species within the study area. The evaluation concludes that it is unlikely that any of these special status species would be present at the Site or associated with Stewart Creek downstream of the FOP. An evaluation of the likelihood of the presence of any of the state or federally listed species is summarized on Table 7.

3.4 Exposure Assessment

The exposure assessment phase expands the problem formulation and defines quantitative inputs for the exposures. A listing of input data available from the literature and exposure assumptions that leads to the calculation of the exposure dose for each receptor is TCEQ's Ecological Risk Assessment Required Element #5. Appendix D lists the assessment species and the input parameters that were used in this SLERA. The raccoon and snowy egret represent wildlife exposures to sediment in Stewart Creek and the North Tributary.

3.4.1 Food Web Ingestion Modeling

Food web ingestion-based modeling calculations were performed to characterize potential exposures to arsenic, cadmium and lead via the food web and to identify potential risks for upper trophic level mammals and birds. Ingestion modeling is based on species-specific exposure parameters and ingestion intake requirements using allometric equations (EPA, 1993). Species-specific ingestion models and input parameters are presented in Appendix D, but the following general equation (TCEQ, 2014) was used to estimate oral exposure for wildlife receptors:

$$\text{Dose (mg/kg - day)} = \left(\frac{(((\text{IRfood} \times \text{Cfood}) + (IRwater \times Cwater) + (IRsed \times Csed))EMF)}{\text{BW}} \right)$$

Where:

Dose	=	Estimated dose from ingestion (mg COC/kg body weight/day)
IRfood	=	Ingestion rate of food (prey) (kg/day)
Cfood	=	COC concentration in food (mg/kg)
IRwater	=	Ingestion rate of water (L/day)
Cwater	=	COC concentration in water (mg/L)
IRsoil/sed	=	Ingestion rate of sediment (kg/day)

Csoil/sed	=	COC concentration in sediment (mg/kg)
EMF	=	Exposure modifying factor (unitless)
BW	=	Body weight of the organism (kg)

The purpose of food web modeling is to characterize potential exposures to arsenic, cadmium and lead via the food web and to identify potential risks for upper trophic-level organisms. Through food web modeling, COCs are either retained for or eliminated from further steps of the SLERA. The food web modeling occurs in two phases per TCEQ Ecological Risk Assessment Required Elements #6 and #7 (TCEQ, 2014): first, a conservative no observed adverse effect level (NOAEL)- based analysis is performed followed by a less-conservative NOAEL - and lowest observed adverse effect level (LOAEL) - based analysis. As described by TCEQ (2014): "In the risk estimate generated in Required Element #6, an HQ is based on reasonably conservative exposure assumptions and representative NOAEL-based TRV." These initial or "conservative" assumptions include 100% bioavailability of the COCs and a site foraging factor of 100 % for each of the receptors. Required Element #7 of the Tier 2 SLERA provides for calculation of HQs using less conservative exposure assumptions and TRVs based on both the NOAEL and LOAEL data (TCEQ, 2014 Section 3.11). These refined or "less-conservative" assumptions can include changes to exposure modifying factors such as a site foraging factor of less than 100%.

3.4.2 Arsenic, Cadmium and Lead Uptake into Food Items

Chemicals in tissues of organisms of the food web are likely to be ingested by the species that feed on them (i.e., those occupying higher trophic levels); the result of which may be the expression of toxicological effects by the higher trophic level species. Chemical-specific uptake factors were taken from the EPA's *Screening Level Ecological Risk Assessment Protocol for Hazardous Waste Combustion Facilities* (EPA, 1999) when available as described in the TCEQ-approved SLERA Work Plan (PBW, 2012a). The sediment-to-fish uptake factors were found in the open literature. Appendix D shows all of the inputs and risk calculations.

3.4.3 Expsoure Areas

Stewart Creek can be broken down into several general exposure areas based on Site conditions and objective of this SLERA:

- Stewart Creek Upstream – Figure 1 shows the upstream exposure area. This area is located on the Undeveloped Buffer Property and is 0.2 miles in length.

- North Tributary On-Site – Figure 1 shows the North Tributary and designates the on-Site portion as 0.36 miles in length. The North Tributary is classified as intermittent and flows through the North Wooded Area which is a terrestrial exposure area evaluated as part of the terrestrial SLERA (a separate SLERA included with the FOP APAR).
- Stewart Creek On-Site – Figure 1 shows the on-Site portion of Stewart Creek which is 0.5 miles in length.
- Stewart Creek Downstream of the FOP – This exposure area is shown on Figures 4 and 5 and is 7 miles in length.
- Stewart Creek On-Site and Downstream (this exposure unit does not include upstream) - This exposure area represents the study area of Stewart Creek from the FOP to downstream (7.5 miles). This exposure unit represents the exposure area for the wide-ranging receptors. This exposure area includes two areas of elevated lead concentrations (focused on benthic invertebrates) which are discussed in Section 3.1.3 of this SLERA.

3.4.4 Exposure Point Concentrations

The basic unit of exposure is the exposure point concentration (EPC), defined as the concentration of a chemical in a specific environmental medium at the point of contact for a receptor. Both the maximum detected concentrations and the 95% UCLs for arsenic, cadmium and lead were evaluated in the SLERA. As previously discussed, the maximum detected concentrations were used for comparison to the benchmarks in the initial screening phase of the ecological risk process per TCEQ guidance. 95% UCLs were used as the EPC in the food web analysis for the exposure areas as described in Section 3.4.3.

Appendix B provides the statistical calculations for arsenic, cadmium and lead concentrations in Stewart Creek sediments. The EPA's ProUCL Version 5.0 software program (EPA, 2013) was used to test the distributions of the data for each compound and dataset and calculate parametric and distribution-free (i.e., nonparametric) 95% UCL concentrations and summary statistics from data sets. Note that the detection limits were used to represent the five nondetect cadmium values in the sediment data set (Table 3). There were no other nondetect results in the sediment data set. Table 8 summarizes the statistical evaluation of the sediment data.

4.0 TOXICITY ASSESSMENT

Mammal and bird toxicity reference values (TRVs) were taken from the EPA's Soil Screening Level (SSL) documents for arsenic, (EPA, 2005a), cadmium (EPA, 2005b), lead (EPA, 2005c), and the open literature. TRVs are the concentration of chemical exposure from an environmental media below which no significant ecological effects are anticipated. The TRVs used in this evaluation are considered screening level TRVs in that they are generally the lowest value available for that compound and endpoint based on a set of criteria and assumptions developed by EPA when estimating soil screening levels (EPA, 2005d). Because a NOAEL represents a concentration at which no adverse effects are noted, it is the preferred TRV in developing conservative soil screening values. For this SLERA, both NOAELs and LOAELs are required per TCEQ (2014). The LOAELs, or concentration at which the lowest effect was noted, were developed from the EPA SSL documents for each COC. To determine the LOAEL for each COC and receptor, the methodology employed by EPA to determine the NOAEL was replicated. For instance, if a NOAEL was based on the geometric mean of the NOAEL values for the growth endpoint, then the LOAEL was determined by calculating the geometric mean of the LOAEL values presented for the growth endpoint. When the NOAEL TRV recommended by EPA was based on a single study (as is the case for lead) the LOAEL TRV reported by this same study which determined the NOAEL was used. It is preferred to use the same study for both the NOAEL and LOAEL because the variability between study animals, study conditions and study endpoints is minimized. The mammalian and avian TRVs for each of the COCs are discussed below.

4.1 Arsenic

For birds, the TRV is the lowest NOAEL value in EPA (2005a) which is 2.24 mg/kg-day for reproduction, growth, or survival from a study by Holcman and Stibilj (1997). This study does not list a corresponding LOAEL, therefore, the geometric mean of the LOAEL values listed in EPA 2005a for reproduction, growth and survival of 4.5 mg/kg-day was determined and used as the avian LOAEL in this SLERA.

For mammals, the NOAEL TRVs (growth endpoint) listed by EPA (2005a) range from 0.0859 mg/kg-day to 10.3 mg/kg-day for growth, 0.601 mg/kg-day to 24 mg/kg-day for reproduction, and 0.533 mg/kg-day to 32 mg/kg-day for survival with a geometric mean of 2.8 mg/kg-day. The LOAELs from EPA (2005a) ranged from 0.663 mg/kg-day to 19.7 mg/kg-day for the growth endpoint, 0.0065 mg/kg-day to 48.0 mg/kg-day for the reproduction endpoint and 0.675 mg/kg-day to 43.4 mg/kg-day for the survival endpoint with a geometric mean of 6.9 mg/kg-day. The value of 2.8 mg/kg-day was used as the mammalian NOAEL TRV and 6.9 mg/kg-day was used as the LOAEL TRV for this SLERA.

4.2 Cadmium

The avian NOAEL of 1.47 mg/kg-day is a geometric mean based on growth and reproduction endpoints (EPA, 2005b). LOAELs reported in EPA 2005a ranged from 1.05 mg/kg-day to 37.6 mg/kg-day for growth and 2.37 mg/kg-day to 21.1 mg/kg-day for reproduction. A geometric mean of all of the avian LOAEL values listed in EPA 2005a based on growth and reproduction equals 6.35 mg/kg-day. The value of 6.35 mg/kg-day was used as the avian LOAEL TRV.

The mammalian NOAEL of 0.770 mg/kg-day presented in EPA (2005a) is based on a study by Yuhas et al. (1979) with a growth endpoint. Yuhas et al (1979) also defines a mammalian LOAEL of 7.70 mg/kg-day. The value of 7.70 mg/kg-day was used as the mammalian LOAEL TRV.

4.3 Lead

The avian NOAEL of 1.63 mg/kg-day was determined by EPA (2005c) and is based on a single study (Edens and Garlich, 1983) with reproduction as the endpoint. A LOAEL of 3.26 mg/kg-day was reported by Edens and Garlich (1983). The value of 3.26 mg/kg-day was used as the avian LOAEL TRV.

The mammalian NOAEL of 4.70 mg/kg-day was determined by EPA (2005c) and is based on a single study (Kimmel et al., 1980) using growth as the study endpoint. A LOAEL of 8.90 mg/kg-day was reported from Kimmel et al. (1980). The value of 8.90 mg/kg-day was used as the mammalian LOAEL TRV.

5.0 RISK CHARACTERIZATION

Predictions of the likelihood for adverse effects, if any, for the food web modeling are based on hazard quotients (HQs) (EPA, 1997). The HQs were calculated by dividing the estimated dose by the TRVs for each of the COCs for each of the upper trophic-level receptors.

NOAEL – HQ = Exposure Dose/ NOAEL-TRV

LOAEL – HQ = Exposure Dose/LOAEL-TRV

The HQ value of 1 is considered the threshold for indicating that adverse effects may occur. An HQ less than or equal to a value of 1 (to one significant figure) indicates that adverse impacts to wildlife are considered unlikely (EPA, 1997). An HQ greater than 1 is an indication that further evaluation may be necessary to evaluate the potential for adverse impacts to wildlife.

5.1 Hazard Quotient Analyses

For the initial conservative analysis as described in TCEQ (2014), HQs were calculated using no adverse effect or NOAEL-based TRVs, assumptions of 100 % bioavailability and no exposure modifying factors (Required Element #6) (TCEQ, 2014). Appendix D shows the risk calculations for the SLERA, with the HQs summarized on Table 10, for the initial conservative assessment. As outlined in the TCEQ guidance, if the HQ is greater than one in the initial conservative analysis, then the refined (less conservative) analysis is completed.

TCEQ's Ecological Risk Assessment Required Element #7 requires that the exposure parameters remain as in the initial conservative analysis (e.g., body weight, ingestion rates, and the exposure point concentration), but other factors such as the exposure modifying factor can be modified, depending on the species and site conditions. The HQ is calculated with the same NOAEL used in the initial conservative analysis, but a LOAEL-based TRV is added and the exposure is modified using the receptor's home range in relation to the exposure area size. Table 11 shows the HQs for the refined (less conservative) assessment. Each exposure area is discussed below.

5.1.1 Potential Risks to Aquatic Life Organisms in Surface Water

Risk to organisms in the water column are assessed by comparison of concentrations measured in the surface water to aquatic life criteria. The Texas surface water quality standard for arsenic, cadmium and lead are based on the dissolved portion in water (TCEQ, 2011); therefore, the dissolved samples were used for this comparison. Additionally, the criteria for cadmium and lead have been adjusted to account to the Lake Lewisville segment water hardness of 106 mg/L. Note that the surface water value for arsenic is not adjusted for hardness (TCEQ, 2012; TCEQ, 2014). Risks are discussed by ecological exposure area below. Additional discussion on selenium as it pertains to the groundwater to surface water pathway is also presented.

Stewart Creek Upstream – Table 1 shows the surface water data for arsenic, cadmium and lead in surface water samples collected directly upstream of the FOP on the Exide Undeveloped Buffer Property. Stewart Creek is classified as a perennial stream by the TCEQ (2013c) and therefore chronic criteria are applicable for this assessment. There are two detections of dissolved lead which are below the chronic aquatic life criteria. There are no detections of arsenic or cadmium (total or dissolved). Detection limits using the more sensitive EPA Method 6020A are all below the chronic screening criteria indicating acceptable data quality. Thus, per TCEQ (2014), the ecological risk assessment process of the upstream exposure area for water column receptors is complete and no further evaluation is necessary.

North Tributary - The North Tributary is classified as an intermittent stream by the TCEQ (2013b) and therefore acute criteria are used for the assessment. Table 1 shows the surface water data. There was one detection of cadmium (0.00044 mg/L) which is below the cadmium acute surface water standard of 0.00908 mg/L. There were no detections of lead in surface water from the North Tributary and the detection limit for lead of 0.0029 mg/L is below the acute criterion of 0.0688 mg/L. Arsenic data are not available for the North Tributary surface water. According to TCEQ (2014), the ecological risk assessment for water column receptors in the North Tributary for cadmium and lead exposures is complete and no further evaluation is necessary.

Stewart Creek On-Site – Surface water data collected from the FOP contains EPA Method 6010B analytical results for samples collected in 2012 and EPA Method 6020A analytical results for samples collected in 2014 (Table 1). Reviewing the more recent and more sensitive data set developed using EPA Method 6020A, there are four detections of lead, but all are below the chronic surface water criteria. There are no detections of cadmium or arsenic in the 2014 data and all of the detection limits generated using the more sensitive method are below the chronic screening criteria. Thus, per TCEQ (2014), the ecological risk assessment of Stewart Creek on-Site exposure area for water column receptors is complete and no further evaluation is necessary.

Selenium in Uppermost Groundwater-Bearing Unit - As discussed in Section 3.1.2, the groundwater to surface water pathway is potentially complete for the uppermost groundwater bearing unit. Selenium was carried forward for evaluation for this pathway because it is considered bioaccumulative. Of the uppermost groundwater bearing unit monitoring wells that represent the groundwater to surface water pathway to Stewart Creek, there are two detections of dissolved selenium in groundwater (see Table 6; MW-37 and MW-38). There are also two detections from the monitoring wells that represent groundwater that could potentially discharge to the North Tributary (LMW-8). Selenium is considered bioaccumulative in water (TCEQ, 2014) and therefore was carried forward for further analysis. One of the samples (MW-38, sample collected on January 16, 2014) was analyzed using EPA Method 6010B and when this sample was re-analyzed with EPA Method 6020A, selenium was not detected above the detection limit. In any event, the four dissolved detections and all of the detection limits are below the aquatic life criteria (unadjusted with a dilution factor). There are no selenium data for surface water or for sediment from the on-Site portion of Stewart Creek or the North Tributary. The Uncertainty Section provides additional discussion about selenium in the project data set. The only other selenium data are for sediment from Stewart Creek downstream of the FOP collected in 2011 (see Table 3). There were no detections of selenium in the sediment with a maximum detection limit of 1.26 mg/kg. As described in Section 3.1.2.2, background soil concentrations of selenium ranged from 0.21 mg/kg to 3.5 mg/kg indicating that the detection limits of the available sediment data are within the background soil range. As such, the assessment of selenium in this SLERA is considered complete given:

- The concentrations detected of selenium in the groundwater are below appropriate surface water criteria (unadjusted for dilution) indicating that the water column receptors are not at risk.
- Selenium was not detected in any sediment sample and sediment sample detection limits are within the range of background soil concentrations.
- While selenium is considered bioaccumulative, the possible exposure point concentrations for upper trophic level organisms are low (i.e., below detection limits for sediment and below chronic criterion for surface water) and therefore this pathway is not evaluated further in the SLERA.

Stewart Creek Downstream of the FOP - Surface water data collected from downstream of the FOP consisted of EPA Method 6010B and EPA Method 6020A analytical results for samples taken in 2014 for lead, cadmium and arsenic (Table 1). Reviewing the more sensitive data set developed using EPA method 6020A, all of the detections and detection limits are below the chronic surface water criteria. Thus, per TCEQ (2014), the ecological risk assessment for the Stewart Creek downstream of the FOP exposure area for water column receptors is complete and no further evaluation is necessary.

5.1.2 Potential Risks to Benthic Invertebrates in Sediment

Risks to the benthic invertebrate community were evaluated using the midpoint of the sediment benchmark and the second effects level. The use of this midpoint is considered the default sediment PCL protective of benthic organisms (TCEQ, 2014).

Stewart Creek Upstream – Table 2 shows the concentrations of arsenic, cadmium and lead in sediment taken from directly upstream of the FOP on the Exide Undeveloped Buffer Property. There are no exceedances of the conservative screening benthic benchmarks or the benthic PCLs for cadmium or lead. All of the arsenic concentration are below the benthic PCL (21.4 mg/kg), except for one (2014-SED-035 at 42.7 mg/kg) which is the most upstream sample (Figure 3). As described in Section 3.1.3.1, extensive cotton farming operations in the area are a potential off-Site source of arsenic to Stewart Creek. This single upstream exceedance of arsenic in the sediment is not co-located with elevated cadmium or lead concentrations indicating that the source of the arsenic is not associated with the source of the lead and cadmium. The 95% UCL for arsenic in the upstream exposure area is 21.71 mg/kg, which is slightly greater than the benthic PCL of 21.4 mg/kg. Appendix B contains the ProUCL output and the statistics are summarized on Table 8.

North Tributary On-Site – Similar to the Stewart Creek Upstream analsyis, there are no exceedances of the conservative screening benthic benchmarks or the benthic PCLs for cadmium or lead. Arsenic data are not available for the North Tributary sediment. Further discussion of the overall arsenic data set is provided in the Uncertainty Section of this SLERA (Section 6). The North Tributary is classified as intermittent (TCEQ, 2013b) and "conditions exist where the benthic invertebrate community may be diminished for reasons unrelated to releases of COCS from an affected property" as described in Section 3.2.1 of TCEQ's *Determining Representative Concentrations of Chemicals of Concern for Ecological Receptors* (TCEQ, 2013d). In accordance with TCEQ (2014), the ecological risk assessment process of the North Tributary on-Site exposure area for the benthic invertebrates is complete and no further evaluation is necessary.

Stewart Creek On-Site – On-Site Sediment data collected in 2012 (see Table 2) indicated no exceedances of the conservative screening benthic benchmarks or benthic PCLs for cadmium or lead. Arsenic data are not available for the on-Site sediment. Further discussion of the overall arsenic data set is provided in the Uncertainty Section of this SLERA (Section 6). In accordance with TCEQ (2014), the ecological risk assessment of the Stewart Creek on-Site exposure area for the benthic invertebrates is complete and no further evaluation is necessary.

Stewart Creek Downstream of the FOP – Table 3 summarizes the sediment data collected downstream of the FOP from 2010 to 2013. Table 4 summarizes the downstream 2014 sediment data. Exceedances of the benthic PCLs are shaded in these tables. As shown on Table 3, there are six exceedances of the lead benthic PCL of 82 mg/kg and four exceedances of the cadmium benthic PCL of 3 mg/kg. Table 4 shows the most recent 2014 sediment data and there are no exceedances of the lead benthic PCL and three exceedances of the cadmium benthic PCL. The 95 % UCL for this exposure area for lead is 58.28 mg/kg and for cadmium is 1.46 mg/kg (Table 8). Both of these 95% UCL values are below the respective benthic PCLs. There are multiple exceedances of the benthic PCL for arsenic as indicated in Tables 3 and 4. The exposure area 95 % UCL for arsenic is 32.35 mg/kg which is greater than the arsenic benthic PCL of 21.4 mg/kg. The higher detections of arsenic do not generally correspond to the elevated detections of cadmium or lead indicating that the sources of cadmium and lead are not consistent with the sources of arsenic.

5.1.3 Potential Risks to Fish from Exposure to Sediment

The fish community is a key component of the freshwater ecosystem. Fish represent an important component of aquatic food webs by processing energy from aquatic plants and benthic macroinvertebrate species. Fish also represent important prey species for piscivorous wildlife. In TCEQ's *Determining Representative Concentrations of Chemicals of Concern for Ecological Receptors* (TCEQ, 2013d), the sediment-to-fish pathway is recognized. An initial screen for evaluating the sediment-to-fish pathway is the use of the midpoint value between the primary benchmark and second effects level for benthic invertebrates. As in screening for the sediment-to-benthic invertebrate pathway, bioaccumulative compounds are retained for further evaluation whereas non-bioaccumulative compounds detected below the midpoint PCL for benthos can be removed from further consideration for the sediment-to-fish pathway. Beyond screening, the sediment-to-fish pathway is typically evaluated using estimated tissue residue concentrations based on sediment concentrations coupled with bioaccumulation factors.

For Stewart Creek, bottom-feeding fish and upper trophic level fish are evaluated for the sediment-to-fish pathway. Examples of bottom feeding fish which may be present in Stewart Creek include blue catfish (*Ictalurus furcatus*), channel catfish (*Ictalurus punctatus*) flathead catfish (*Pylodictis olivaris*), black catfish (*Ameiurus melas*) and yellow bullhead (*Ameiurus natalis*), freshwater drum (*Aplodinotus grunniens*), smallmouth buffalo (*Ictibus bubalus*), and common carp (*Cyprinus carpio*). Examples of upper trophic level fish that may be present in Stewart Creek include largemouth bass (*Micropterus salmoides*), striped bass (*Morone saxatilis*), blue catfish, longnose gar (*Lepisosteus osseus*), and alligator gar (*Aractosteus spatula*). Given the conditions of Stewart Creek, larger fish would be found in the lower portions of the creek nearer Lake Lewisville. Few large fish would be found in the isolated pools immediately downstream of the FOP.

This SLERA evaluated the sediment-to-fish pathway using biosediment accumulation factors (BSAFs) from the open literature. Rzmski et al. (2014) studied accumulation of cadmium and lead in water, sediment and three bivalve species (*Anodonta anatine, Anodonta cygnea,* and *Unio tumidus*). The geometric mean of the reported BSAFs was determined to be 0.53 for cadmium and 0.07 for lead. A BSAF value of 0.162 for arsenic was taken from EPA (2000) *Bioaccumulation Testing and Interpretation for the Purpose of Sediment Quality Assessment – Status and Trends*. The 95% UCL for each exposure area was used as the exposure point concentration to estimate tissue residue concentrations. A comparison of the estimated fish tissue concentrations with published tissue effects data was used to evaluate the potential risk to the fish population.

There are limited published studies of toxicity related to tissue burdens for freshwater fish; however, in order to evaluate the sediment to fish pathway, the most relevant available studies were chosen and presented below. Of the species/studies available, rainbow trout (*Oncorhynchusmykiss)* and brook trout (*Salvelinusfontinalis*) were chosen to assess the tissue burden from the available studies listed in Jarvinen and Ankley (1999) (recognizing that these species would not be present in Stewart Creek). Further analysis of the limitations of this assessment is presented in the Uncertainty Section (Section 6).

- **Arsenic -**Jarvinen and Ankley (1999) report a dry weight tissue concentration of 27 mg/kg (whole body) for reduced survival of rainbow trout exposed to sodium arsenate – study was lab based, flow-through but the exposure was via water.

- **Cadmium -**Jarvinen and Ankley (1999) report a dry weight tissue concentration of 4.8 mg/kg (whole body) for reduced growth of rainbow trout – study was lab based, flow-through but the exposure was via water.

- **Lead -**Jarvinen and Ankley (1999) report a dry weight tissue concentration of 20 - 44 mg/kg (whole body) for reduced growth of brook trout – study was lab based, flow-through but the exposure was via water.

Stewart Creek Upstream – There are no exceedances of the conservative screening benthic benchmarks or benthic PCLs for cadmium or lead. All of the arsenic concentrations are below the benthic PCL (21.4 mg/kg), except for one (2014-SED-035 at 42.7 mg/kg). The evaluation of the sediment-to-fish pathway for lead is complete with this comparison because “the TCEQ believes that the sediment benchmarks for non-bioaccumulative COCs are generally protective of the sediment-to-fish pathway (even sensitive life stages such as eggs and larvae)" (TCEQ, 2013d). The sediment-to-fish evaluation for arsenic is carried forward because there is a detection that exceeds the sediment benthic PCL. The evaluation of cadmium is also carried forward because cadmium is considered bioaccumulative in sediment. Fish tissue concentrations were estimated using the BSAFs and are presented in Table 9. As shown in Table 9, the estimated fish tissue concentrations are well below the literature effects concentrations for both arsenic and cadmium. In addition, the exposure of fish to sediment in the upstream exposure area would likely be limited to small forage fish because the small pools found in the upstream portion of the study area would not provide sufficient food, water temperature and dissolved oxygen for larger species, especially predator fish.

North Tributary On-Site – The North Tribuatry is classified as intermittent by the TCEQ (2013b) and therefore evaluation of the sediment-to-fish pathway is not applicable. See Section 3.4.1.1 of TCEQ's *Determining Representative Concentrations of Chemicals of Concern for Ecological Receptors* (TCEQ, 2013d).

Stewart Creek On-Site – Sediment data collected on-Site in 2012 (see Table 2) indicate no exceedances of the conservative screening benthic benchmarks or benthic PCLs for cadmium or lead. Arsenic data are not available for the on-Site sediment. Similar to the evaluation of the upstream exposure area, the evaluation of lead is complete because it is not bioaccumulative in sediment and was not detected at concentrations greater than the benchmark. The evaluation of cadmium is was carried forward because cadmium is considered bioaccumulative in sediment. Tissue concentrations were estimated using the BSAFs and are presented in Table 9. As shown in Table 9, the estimated fish tissue concentration for cadmium in on-Site sediments is well below the literature effects concentrations for cadmium.

Stewart Creek Downstream of the FOP – Arsenic, cadmium and lead were all carried forward for an evaluation of the sediment-to-fish pathway because there are detected concentrations greater than the benthic PCLs. Table 9 shows the evaluation. As shown in Table 9, the estimated fish tissue concentrations for arsenic, cadmium and lead in downstream sediments are well below the literature based tissue values.

5.1.4 Potential Risks to Upper Trophic Level Receptors

Stewart Creek Upstream – Sediment and surface water in Stewart Creek upstream of the FOP were sampled in 2014. There were two detections of lead in the surface water and neither concentration exceeded the chronic surface water criteria. For the sediment, only one sample for arsenic exceeded the benthic PCL. There were no exceedances of the benchmark for cadmium or lead; however, cadmium was retained for trophic analysis because of its bioaccumulative properties. Appendix D (Table D-6 and D-7) show the HQ calculations for arsenic and cadmium for the snowy egret and the raccoon. These upper trophic level species for this evaluation were presented in the TCEQ-approved Work Plan (PBW, 2012a). The conservative NOAEL-based HQs are summarized on Table 10. None of the HQs listed in this table are above one indicating that the trophic analysis of the upstream exposure area is complete and no adverse risk is indicated. The less-conservative evaluation was not necessary for the evaluation of arsenic and cadmium in upstream sediment.

North Tributary On-Site – The North Tribuatry is classified as intermittent by the TCEQ (2013b) and the risk to aquatic water column receptors was evaluated with acute criteria. Surface water data were collected in 2013 and there was one detection of cadmium which is well below the acute criteria. Sediment samples were collected in 2012 and there are no detections of cadmium or lead greater than their benchmarks or benthic PCLs. Sediments from the North Tributary were not analyzed for arsenic. Cadmium was retained for analysis in the trophic evaluation because of its bioaccumulative properties. Appendix D (Table D-8 and D-9) shows the HQ calculations for cadmium for the snowy egret and the raccoon. The NOAEL-based HQs are summarized on Table 10. None of the HQs listed in this table are above one indicating that the trophic analysis of the North Tributary exposure area is complete and no adverse risk is indicated. As such, a less-conservative evaluation was not necessary for the evaluation of cadmium in North Tributary sediment.

Stewart Creek On-Site – Surface water data collected in 2014 using the most sensitive analytical method (EPA Method 6020A) from Stewart Creek in the FOP showed no exceedances of the chronic surface water criteria for arsenic, cadmium or lead. Arsenic was not detected in surface water. On-Site sediment data collected in 2012 indicated no exceedances of the conservative screening benthic benchmarks or benthic PCLs for cadmium or lead. Arsenic data are not available for the on-Site sediment. Similar to the evaluation of the upstream exposure area, the evaluation of lead in on-Site sediment is complete because it is not bioaccumulative in sediment and was not detected at concentrations greater than the benchmark. The evaluation of cadmium continued because cadmium is considered bioaccumulative in sediment. Appendix D (Table D-10 and D-11) show the HQ calculations for cadmium for the snowy egret and the raccoon. The NOAEL-based HQs are summarized on Table 10. None of the HQs listed in this table are above one indicating that the trophic analysis of the On-Site Stewart Creek exposure area is complete and no adverse risk is indicated. As such, a less-conservative evaluation was not necessary for the evaluation of cadmium in on-Site sediment.

Stewart Creek Downstream of the FOP – Surface water data collected in 2014 using the most sensitive analytical method (EPA Method 6020A) from Stewart Creek downstream of the FOP showed no exceedances of the chronic surface water criteria. Arsenic, cadmium and lead in sediment were carried forward into the trophic evaluation because there were detected concentrations greater than the benthic

PCLs. Appendix D (Table D-12 and D-14) show the HQ calculations for arsenic, cadmium and lead for the snowy egret and the raccoon. The NOAEL-based HQs are summarized on Table 10. As shown in this table, the NOAEL-based HQs for the raccoon were below one. Similarly, the NOAEL-based HQs for arsenic and cadmium for the snowy egret were also less than one; however, the NOAEL-based HQ for lead was estimated to be greater than one for the snowy egret. As per the TCEQ guidance, a less-conservative assessment using LOAEL-based TRVs was completed (Table D-13). The less-conservative assessment maintains conservative assumptions such as assuming that the snowy egret forages 100% of the time from the downstream portion of Stewart Creek and 100% of the exposure point concentration is bioavailable to the snowy egret. The LOAEL-based HQs are summarized on Table 11. As shown on this table, the LOAEL-based HQ for the snowy egret exposure scenario was determined to be less than one (0.61). Based on this less-conservative evaluation for lead and the snowy egret, the trophic analysis for the downstream sediment is complete and there is no adverse risk indicated.

Stewart Creek On-Site + Downstream of the FOP – This 7.5 mile exposure unit was evaluated to address wide ranging receptors that may forage along the Stewart Creek from On-Site to Downstream. The trophic analsyis was similar to the Stewart Creek Downstream exposure area analysis with the snowy egret having a NOAEL-based HQ greater than one (Table D-15), but when a LOAEL-TRV was added to the assessment, the LOAEL-based HQ was determined to be less than one. The raccoon did not have any NOAEL-based HQs greater than one. Following the less-conservative evaluation for lead and the snowy egret, the trophic analysis was complete and no adverse risk is indicated.

Stewart Creek On-Site + Downstream of the FOP (with Hot Spots Removed) – As previously discussed, two hot spots were identified in the downstream portion of Stewart Creek primarily based on the 2010, 2011 and 2013 data. The hot spots are generally associated with samples of chips, slag and potential slag sampled in 2013. Figures 4 and 5 show the locations associated with these hot spots. If the hot spot data are removed from the On-Site + Downstream data set, the exposure point concentrations (95% UCLs) for cadmium and lead are below their screening benchmarks. Nonetheless, these metals were retained for trophic analysis because the maximum detected values are greater than the screening benchmarks. Appendix D (Table D-18 and D-19) show the HQ calculations for arsenic, cadmium and lead for the snowy egret and the raccoon. The NOAEL-based HQs are summarized on Table 10. As shown in this table, none of the HQs are above one indicating that the trophic analysis of the On-Site + Downstream (without Hot Spots) Stewart Creek exposure area is complete and no adverse risk is indicated. As such, the less-conservative evaluation was not necessary.

5.2 Risk Summary

This section evaluates the SLERA by analyte for all receptors (water column, benthic invertebrate, fish, bird or mammal). Arsenic, cadmium and lead are discussed individually.

5.2.1 Arsenic

Arsenic data are available for surface water and sediment from areas upstream and downstream of the FOP. On-Site surface water data are available for 2014 data, but there are no North Tributary arsenic surface water or on-Site arsenic surface water data and there are no sediment arsenic data from On-Site or the North Tributary.

Of the available surface water data, arsenic was detected in two samples taken on the Army Corps of Engineer property (2014-SW-026 and 2014-SW-028) and in two of the samples taken in side tributaries (2014-SW-027 amd 2014-SW-029) that feed into the Army Corps of Engineer property. Arsenic was not detected in surface water in the ten samples taken upstream of the FOP or any of the samples between the Army Corps of Engineer property and the FOP. All of the detections are well below the chronic surface water criteria of 0.15 mg/L. Arsenic was sampled for and detected in a few of uppermost water-bearing unit monitoring wells used to assess the groundwater-to-surface water pathway, but all detections and detection limits were below the chronic surface water criteria.

Sediments sampled upstream of the FOP showed one detection of arsenic (42.7 mg/kg) greater than the benthic benchmark (21.4 mg/kg) (Table 2). The location of this detection (2014-SED-035) is the most upstream location sampled (Figure 3). The 95% UCL for arsenic for the upstream data set is 21.71 mg/kg which is slightly greater than the benthic PCL of 21.4 mg/kg. Data from sediment samples taken downstream of the FOP are shown in Tables 3 and 4 with the individual concentrations which exceeded the benthic PCL shaded. The 95% UCL for the downstream arsenic sediment data was 32.35 mg/kg and 21.89 mg/kg when the hot spots were removed (Table 8). When the data from the hot spots (as defined in Section 3.1.3) are removed, the 95% UCL of 21.89 mg/kg is similar to the 95% UCL calculated for the upstream data set (21.71 mg/kg). According to TCEQ (2014) the benthic invertebrate population in areas upstream and downstream of the FOP could be at risk from exposure to arsenic based on the data comparisons to the benthic PCL.

The estimated fish tissue arsenic concentrations (Table 9) did not exceed the literature-based adverse effects tissue values indicating that the sediment-to-fish pathway does not result in unacceptable risk. Using the 95% UCLs as the exposure point concentration, there were no NOAEL-based HQs greater than one for the snowy egret or the raccoon as shown in Table 10. As such, the SLERA trophic analysis does not indicate an adverse risk to upper trophic level species from exposures to arsenic in sediment.

As discussed in Section 3.1.3.1 in this SLERA and in Sections 1.2.1.1 and 3.1.3 in the APAR, arsenic was used extensively in agricultural products. Appendix 22 of the APAR shows historical aerial photographs of the area around the FOP and shows large tracts of land used for agriculture. It is probable that products containing arsenic were used in the area around the FOP and that the arsenic detected in the Stewart Creek sediments is sourced from agricultural products. Additionally, arsenic exceedances in sediment are not always co-located with lead and cadmium exceedances suggesting that the source of the arsenic is not associated with the source of the lead and cadmium.

5.2.2 Cadmium

Cadmium data are available for surface water and sediment throughout the study area. In surface water there are no exceedances of the chronic criteria for samples analyzed using the more sensitive EPA Method 6020A data is considered. Cadmium was detected in some of the groundwater samples from the uppermost water-bearing unit monitoring wells in the vicinity of Stewart Creek and the North Tributary, but there were no exceedances of the groundwater to surface water PCL (Table 6). In sediment there were no exceedances of the benthic PCL in the Upstream Stewart Creek, On-Site Stewart Creek or North Tributary data sets. In the downstream samples there were 7 detections out of 118 samples greater than the 3 mg/kg benthic PCL (5.9%) (Tables 3 and 4). The 95% UCL for the downstream portion of the study area was 1.46 mg/kg (Table 8) which is well below the benthic PCL of 3 mg/kg. Because special status mollusk species (Louisiana pigtoe or Texas heelsplitter) or special status alligator snapping turtles were not observed and are not believed to be present in Stewart Creek (Appendix C), the use of the 95% UCL as the exposure point concentration compared to the benthic PCL based on the midpoint is consistent with TCEQ guidance.

The estimated fish tissue cadmium concentrations (Table 9) did not exceed the literature-based adverse effects tissue values found in the open literature indicating that the sediment-to-fish pathway does not result in unacceptable risk. Cadmium is considered bioaccumulative and therefore cadmium was assessed in every exposure area for trophic risk. As shown on Table 10, when the 95% UCL was used as the exposure point concentration, there were no NOAEL-based HQs greater than one for the snowy egret or the raccoon. As such, the SLERA trophic analysis does not indicate an adverse risk to the upper trophic level species from exposures to cadmium in sediment.

5.2.3 Lead

Lead data are available for surface water and sediment throughout the study area. In surface water (Table 1), there are no exceedances of the chronic criteria for samples analyzed using the more sensitive EPA Method 6020A. Lead was detected in some of the groundwater samples from the uppermost water-bearing unit monitoring wells in the vicinity of Stewart Creek and the North Tributary, but the sole exceedance of the groundwater to surface water PCL in these samples was not confirmed by re-sampling (Table 6). In sediment there were no exceedances of the benthic PCL in the Upstream Stewart Creek, On-Site Stewart Creek or North Tributary data sets. In the downstream samples collected by SWG in 2010, 2011 and 2013 (Table 3) there were 6 detections greater than the 82 mg/kg benthic PCL. There were no exceedances of the lead benthic PCL in the 2014 sediment data (Table 4). The 95% UCL using all of the data from 2010 to the present for the downstream portion of the study area was 58.28 mg/kg (Table 8) which is well below the benthic PCL of 82 mg/kg. Because special status mollusk species (Louisiana pigtoe or Texas heelsplitter) or special status alligator snapping turtles were not observed and are not believed to be present in Stewart Creek (Appendix C), the use of the 95% UCL as the exposure point concentration compared to the benthic PCL based on the midpoint is appropriate.

The estimated fish tissue lead concentrations (Table 9) did not exceed the literature-based adverse effects tissue values indicating that the sediment-to-fish pathway does not result in unacceptable risk. As shown on Table 10, when the 95% UCL was used as the exposure point concentration, there were NOAEL-based HQs greater than one for the snowy egret, but not for the raccoon. When a LOAEL-TRV was used in the trophic analysis, there were no HQs greater than one. As such, the SLERA trophic analysis does not indicate an adverse risk to upper trophic level species from exposures to lead in sediment.

6.0 UNCERTAINTY ANALYSIS

The characterization of uncertainty is a component of the ERA process (EPA, 1997) and is Required Element #8 in the TCEQ process (TCEQ, 2014). Due to the multiplicity of potential receptor species and general lack of detailed knowledge and/or variability surrounding their life cycles, feeding habits, and relative toxicological sensitivity, the uncertainty surrounding estimates of ecological hazard can be substantial. The criteria used in this assessment are intended to provide a conservative assessment of potential ecological hazards. This SLERA did not account for site-specific factors such as chemical bioavailability, adaptive tolerance, reproductive potential, or use of similar nearby ecosystems. Such factors would most likely tend to mitigate the estimated degree and ecological significance of loss or impairment of a portion of some ecological population(s) due to both chemical and physical stressors in the area. The approach used in this assessment does develop protective (conservative) estimates of exposure, which likely indicate a potential for hazard that is greater than actually encountered by organisms.

The criteria used in this assessment are all chemical-specific and as such, cannot address the additive, antagonistic, or synergistic effects of the mixtures of chemicals typically present in the environment, nor does this assessment address mechanisms of action. Furthermore, SLERAs do not typically take into account the nature and constitution of the specific ecosystem present at a Site, the potential toxicity of other constituents (naturally occurring) that were not quantified, or the pervasive influence of physical stressors associated with the disruptions caused by human activities. Uncertainties applicable to this SLERA are described below:

6.1 Hot Spot Analysis

As discussed in Section 3.1.3, two hot spots were identified in the downstream portion of Stewart Creek primarily based on the 2010, 2011 and 2013 data. The portion of Stewart Creek directly downstream of the FOP to the Dallas North Tollway is defined as Hot Spot #1. Hot Spot #1 includes the area near the FSCWWTP and several locations where slag was noted in 2013. Hot Spot #2 is tied to locations where potential slag was found in 2013 and is located east of Legacy Drive and south of Stonebrook Parkway if it extended east across Legacy Drive. Figures 4 and 5 shows the locations. Table 8 presents a revised 95% UCL for the On-Site + Downstream with the hot spot data removed. The arsenic 95 % UCL of this modified data set is 21.89 mg/kg which is slightly above the benthic PCL of 21.4 mg/kg. This arsenic concentration of 21.89 mg/kg is very similar to the upstream arsenic 95% UCL of 21.71 mg/kg. The 95% UCLs from this modified data set (i.e., the on-Site + downstream data with hot spots removed) are 1.32 mg/kg for cadmium and 23.13 mg/kg for lead which are both below their respective benthic PCLs. Note that the 95% UCLs for cadmium and lead when all the data are used (hot spot data included) are also below the benthic PCLs. The hot spot analysis in this SLERA shows that conclusions of risk are identical when the data sets (with and without hot spot data) are evaluated. As described by TCEQ (2013d) “the initial goal of the hot-spot evaluation will be to ensure that a statistical presentation of the sampling data (e.g., 95 % UCL) will not mask or dilute areas of elevated sediment concentrations that may otherwise pose a potential risk to the benthic community or cause risk from the remaining portions of the exposure areas to be overestimated.” In this SLERA, the statistics calculated to represent the downstream sediment data set were determined with and without the data associated with the samples from the hot spots. This evaluation is described in Section 3.2.2 (Risk Management for Benthic Hot Spots) in TCEQ 2013d and states “by definition, hot spots present an unacceptable risk to the benthic community. Therefore, if hot spots are identified within the benthic expsoure area, persons should recommend appropriate risk management practices. Where hot spots are identified and will be separately addressed with a remedy (e.g., removal), these data points should be removed from the 95% UCL determiniation and the resulting 95 % UCL should be used as the exposure point concentration.”

6.2 Exposure Concentrations

Risk may be overestimated in the exposure assessment because the selected EPCs are either the maximum detected (in the benchmark screening) or the 95 % UCL (in the food web modeling) concentrations. The TCEQ has selected the 95 % UCL as the preferred EPC for the benthic invertebrate community and wildlife since the goal is to protect benthic organisms and wildlife at a community level, rather than individually (TCEQ, 2013d). As described in Appendix C, there were no special status species found in Stewart Creek and therefore protection of the overall benthic and wildlife population is warranted. The 95 % UCL is a conservative estimate of the true mean and accounts for uncertainty in concentrations throughout an exposure area. The EPC term, according to EPA guidance, represents the average exposure experienced by a receptor over an exposure area during an extended period of time. Therefore, the EPC should be a conservative estimate of the true average value and not the highest observed concentration (TCEQ, 2013d). The use of the 95 % UCL as the EPC for evaluation of risk to the benthic community and wildlife receptors likely overestimates the potential risk.

6.3 Data Coverage

Arsenic, cadmium and lead are the primary constituents of interest for this SLERA, but as is common with many long term projects, data coverage for all of the project COCs is not consistent across time and exposure areas. This is especially true for antimony, arsenic and selenium as discussed below:

Antimony – Antimony was considered a project COC for the on-Site soil terrestrial evaluation, but there are no antimony data for surface water, sediment or groundwater representing the groundwater-to-surface water pathway. The terrestrial SLERA concluded that ecological exposures to antimony in soils at the FOP do not pose an adverse risk and additional evaluation was not necessary. An evaluation of the antimony soil data shows that those antimony concentrations greater than the 5 mg/kg plant benchmark were from locations where elevated lead (> 1000 mg/kg) was also detected. Remediation of these areas for lead will result in remedation of the antimony detections greater than the benchmark and thereby limit any possibility of the antimony traveling to Stewart Creek via overland flow. Because there are no data from Stewart Creek or the North Tributary for antimony, no conclusions can be made on the potential presence of antimony in the surface wate or sediments.

Arsenic - For surface water, there are no arsenic data for the North Tributary. For sediment, there are no arsenic data for the on-Site sediments in Stewart Creek or the North Tributary. Arsenic data are available for areas upstream and downstream of the FOP and in some of the groundwater samples evaluated for the groundwater-to-surface water pathway. Arsenic is considered a final COC in the SLERA and became the focus of the Site Specific Ecological Risk Assessment Work Plan attached as Appendix E.

Selenium – There are no surface water data for selenium for any of the exposure areas. There are limited sediment data for selenium. These data (all below detection limits) were collected by SWG in 2011 and only from areas downstream of the FOP (Table 3). There are data from selenium in groundwater from the wells that represent the groundwater-to-surface water pathway (Table 6) and selenium is evaluated as a groundwater COC in this SLERA because of its bioaccumulative potential. The limited data that area available for selenium indicate that selenium would not be considered a final ecological COC, howerver there are data gaps in the data set (on-Site and off-Site).

6.4 Presence of Special Status Species

A habitat evaluation with special emphasis on the potential presence of special status species was completed in January and March of 2014 (see Appendix C). No threatened or endangered species, listed by federal or state agencies, were found while conducting the surveys along Stewart Creek. There is low uncertainty that the Texas threatened freshwater mussels (Texas heelspliter or Louisiana pigtoe) would be present because the investigators waded the entire Stewart Creek study area and conducted benthic surveys finding other mussel species (pondhorn, Asian clams and giant floater), but no evidence (e.g., shells) of the Texas threatened species. There is also low uncertainty that the Texas threatened alligator snapping turtle would be present in Stewart Creek. Stewart Creek has high flow conditions and does not provide the deep muddy bottomed pools and submerged structures that attract alligator snapping turtles. The investigators did identify three species of turtle in Stewart Creek: red-eared slider, box turtle and soft shell. It is also unlikely that the special status bird species (e.g., white-faced ibis) would utilize Stewart Creek for foraging. Although the survey was completed in the winter; the white-faced ibis breed and winter along the Gulf Coast and may occur as migrants in the Panhandle and west Texas. The inland populations of white-faced ibises prefer to breed in shallow freshwater marshes with islands of emergent vegetation such as cattails or bulrushes. The Louisiana and Texas populations also breed in estuarine marshes (Farrand, 1983). In 2012, the total population size of the white-faced ibis was estimated to be 1.2 million individuals and increasing (IUCN, 2012). The investigators concluded that the white faced ibis is not a resident of the area around Stewart Creek; however, riparian habitat adjacent to the perennial pools and Lake Lewisville might be used for resting and feeding by migrating birds. Based on the habitat survey, there is low uncertainty that special status species should be represented in the SLERA.

6.5 Selection of Wildlife Species Subject to Evaluation

The snowy egret and raccoon were selected to represent all bird and mammal species that may contact arsenic, cadmium and lead in Stewart Creek sediment directly during foraging as well as indirectly via the food chain. The selection of these species to represent mammals and birds was based on site observations, their potential to contact sediment or soil directly or indirectly, and professional judgment. The snowy egret has not been observed in Stewart Creek but is likely found in the area has feeding habits that increase the likelihood that this species might contact sediment in Stewart Creek. Raccoon tracks were commonly noted during the January and March 2014 habitat evaluation of Stewart Creek (Appendix C). The myriad of factors that influence animal and bird behavior, the small size of the creek, the variable water flow in the creek, and the industrial/residential/commercial nature of the area and nearby vicinity limits the ecological productivity of the area and, therefore, the exposure to birds and mammals is likely overestimated in this SLERA. Amphibians and reptiles are present in Stewart Creek; however, assessment of amphibians and reptiles in ecological risk assessment in highly uncertain. The following sections address the assessment of amphibians and reptiles.

6.5.1 Amphibians

Research has shown that amphibians, such as frogs and salamanders, tend to be sensitive indicators of environmental stress from contaminant exposure as a result of their unique life history and physiology (Alford, 2010). Amphibians commonly travel between aquatic and terrestrial habitats and life-history requirements potentially expose this group of vertebrates to contaminants in surface water, sediments and soils at various intensities, depending on developmental stage and the life history unique to each species. In addition to their unique life history, the physiological properties of amphibians heighten their exposure to contaminants in the environment. Amphibians are exposed to contaminants through the direct uptake from water and substrate as well as the ingestion of sediments, soils and food items. The skin of amphibians is thin and highly permeable serving as part of the respiratory system. This permeability maintains the organisms balance in nature, but also creates a route for the potential for uptake and intensifies the risk of contaminant exposure to amphibians by permitting chemical transport across membranes. Amphibian toxicity is generally under-represented in the literature (ENSR, 2004) when compared to other classes of animals and as such is highly uncertain. A summary of the available amphibian aquatic toxicity data for lead and cadmium is presented below.

Endpoint	**Cadmium Concentration (μg/L)**	**Number of Studies**	**Lead Concentration (μg/L)**	**Number of Studies**
Behavioral	1 - 1.3	2	750 – 1,000	4
Biochemical/Cellular	1.1 - 4,000	5	500 – 1,000	2
Developmental	< 2 – 505	12	70 – 10,000	7
Growth	30 - 106	3	NA	NA
Mortality	9920 – 11,648	48	470 – 105,000	13
Reproductive	1.34	1	NA	NA
Other	1 – 77	27	4 – 16,000	12

Source: Table 3-4 in ENSR, 2004. No information presented for arsenic in Table 3-4 (ENSR, 2004).

All of these reported toxicity values are greater than the chronic surface water criteria used for the evaluation of Stewart Creek: cadmium = 0.256 μg/L and lead = 2.68 μg/L. As shown on Table 1, there are no detections of arsenic in any of the surface water samples. Therefore, based on the available toxicity data, the application of the surface water criteria are protective of amphibians found in Stewart Creek.

6.5.2 Reptiles

During the past decades, reptilian toxicology has made up a disproportionately small percentage of toxicological studies of vertebrates. Characteristics of some reptile species make them difficult to study, including long life span and generation time, low fecundity, and incompatibility with laboratory handling techniques. Reptile species are linked by a number of traits (e.g., ectothermia, pulmonary respiration, epidermal scales, and internal fertility), yet possess a diverse array of life history characteristics and inter-species differences (e.g., population distributions, migration patterns, diets, and metabolic processes) (Gardner and Oberdorster, 2006). Turtles such as the alligator snapping turtle (*Macrochelys temminckii*), red-eared slider (*Trachemys scripta elegans*) and soft shell turtle (*Apalone spinifera*) are of particular interest for this Stewart Creek SLERA because the alligator snapping turtle is considered a Texas threatened species in Collin County and the red-eared slider and soft shell turtle were found in Stewart

Creek in 2014; however the alligator snapping turtle was not found nor is this species expected to be present due to the high low conditions that are common in the creek and the small number of shallow pooling areas. Stewart Creek does not provide the deep muddy bottomed pools and submerged structure that attract alligator snapping turtles. The assessment of risk to these species from exposure to the arsenic, cadmium and lead is highly uncertain. The open literature was reviewed for information on toxicity to turtles from arsenic, cadmium and lead. These publications are summarized below.

- Clark et al. (2000) collected red-eared sliders in 1994 and 1995 from the Municipal Lake system in Bryan, Texas which had received **arsenic** wastes from 1940-1993. The study investigated nondestructive assay techniques by collecting and analyzing blood samples. Arsenic was not found (detection limit 0.1 ppm) in any blood samples from the red-eared sliders taken from Municipal Lake where arsenic is a known contamiant. No evidence was found in the body condition data (total body mass to carapace length) that red-eared sliders were being harmed. Red-eared sliders at Municipal Lake showed greater body weights which may have been caused by daily feeding by humans.

- Guirlet and Das (2012) studied the accumulation, path and effects of exposure to **cadmium** through diet in female red eared slider turtles In the first phase of the experiment, turtles underwent an acclimatization period during which they were fed a control diet. In the second phase, the turtles were exposed to cadmium through a $CdCl_2$ supplemented diet for 13 weeks. The three dosage turtle groups exposed to the diet Cd treatments received: 0.4 mg/kg (low dosage group), 0.58 mg/kg (medium dosage group) and 0.95 mg/kg (high dosage group). Following this, the turtles went through a third phase, a recovery phase of 3 weeks during which they were fed uncontaminated food. Blood and feces were collected during the three phases of the experiment. The turtles were euthanized at the end of the experiment and organ samples collected. The Cd-concentrations in blood remained stable over the course of the experiment while Cd-concentrations in feces increased with time and the amount of Cd ingested. In terms of burden in the organs, the Cd-burden was the highest in liver followed by kidney and pancreas. The proportional accumulation decreased as Cd ingestion increased, suggesting that a higher dose of Cd, assimilation decreased. Accumulation of Cd had no effect on survival, food consumption, growth, weight or length suggesting no effect on the female turtle body condition. The study did not identify any toxicity endpoints.

- Burger et al (1998) studied the effects of **lead** on behavioral developments of hatchling slider turtles (*Trachemys scripta*) from the Savannah River Site, near Aiken, SC. Hatchlings from 1995 showed no significant differences in growth, survival, or behavior between control and lead-injected animals at a dose of 0.05 and 0.1 mg/g. In 1996, 48 hatchlings were divided into four groups and injected with 0 (control), 0.25, 1, or 2.5 mg/g lead. Few significant differences occurred in growth or size as a function of lead treatment at 4 months of age, but survival declined markedly as a function of lead dose. Righting response was significantly impaired by lead; time to right was directly related to lead dose. Size also affected behavior; larger hatchlings turned over more quickly and reached cover sooner than did smaller hatchlings. These experiments indicate that lead affects survival and behavior in hatchling turtles at doses in the range of 0.25 to 2.5 mg/g. Thus, these researchers indicate that the no effect level is 0.1 mg/g (100 mg/kg). The survival differences were dramatic in the experiments. At control and low levels of lead, nearly all of the hatchlings survived at 4 months, whereas at medium and high levels survival was low (25% and 0%), yielding an LD_{50} of 0.5 mg/g. Although significant, the behavioral differences were not large for the righting response test, and were nonexistent for the seeking cover test. Taken together, these experiments suggest that hatchling turtles are vulnerable to lead exposure, but that the threshold for behavioral effects in on the same order of magnitude as the LD_{50}. Weight was a significant contributor to the variations in righting and seeking cover behavior observed in these experiments. Larger animals responded sooner and were able to right themselves quicker than were smaller animals. Lead dose correlated negatively with weight, carapace length, and plastron length, indicating that with increased lead, animals grew more slowly. Taken altogether, the data suggest that lead at > 1 mg/g has a major effect on survival, a lesser effect on growth and a small but significant effect on the righting response (Burger et al., 1998).

- Overmann and Krajicek (1995) investigated the common snapping turtle (*Chelydra serpentine*) as a biomonitor of **lead** in a freshwater aquatic ecosystem. Snapping turtles are omnivorous and ingest a wide variety of food items. The benthic habitats of the turtles suggest that they would frequent areas of metal-rich sediments in lead-contaminated aquatic ecosystems. The snapping turtle is mobile, but relatively sedentary which would facilitate relation of tissue contaminant levels with a relatively localized area. Thirty-seven snapping turtles were collected from three sites on the Big River, an Ozarkian stream contaminated with lead mine tailings. Morphometric measurements, tissue lead concentrations, δ-aminolevulinic acid dehydratase (δ-ALAD) activity, hematocrit, hemoglobin, plasma glucose, osmolality and chloride ion content was measured. δ-ALAD is an enzyme of the heme synthesis pathway and a sensitive indicator of lead exposure. The data showed no effects of lead contamination on capture success or morphological measurements. Tissue lead concentrations were related to capture location. Most hematological parameters were not different with respect to capture location. The δ-ALAD activity was decreased in turtles taken from contaminated sites. Lead levels in the Big River do not appear to be adversely affecting the snapping turtles of the river. The mean concentration of lead in tailings range from 1,000 to 3,000 mg/kg and the tailings vary in consistency from course sand to fine powder.

From the information available in the open literature, determination of a no effect level and low effect level via ingestion is not possible for arsenic, cadmium and lead. The following table saummarizes the available studies discussed for arsenic, cadmium and lead.

Test Species	Study Endpoint(s)	Dose	Reference
Arsenic			
Red Eared Slider Turtles	No effect on total body mass to carapace length and no arsenic detected in blood	None given	Clark, D.R, et al., 2000
Cadmium			
Red Eared Slider Turtles	No effect on survival, food consumption, growth, weight or length	0.95 mg/kg in food	Guirlet and Das, 2012
Lead			
Slider Turtles	Lowest value showing survival and behavior changes	250 mg/kg injection in leg muscle	Burger, 1998
Slider Turtles	No effects on survival or behavior	100 mg/kg injection in leg muscle	Burger, 1998
Common Snapping Turtle	Reduced δ-ALAD activity	1000 mg/kg in mine tailings in sediment	Overmann and Krajicek, 1995

The study for arsenic did not provide any dose or endpoint information. The study on cadmium recommends a no effect value of 0.95 mg/kg in food. This value could be modified as a dose but this value is similar to the benthic invertebrate sediment benchmark of 0.99 mg.kg. The applicability of a value in food when compared to a sediment value protective of benthics is unknown. The two studies for lead did not develop a no effect dose level in food.

The toxicity data are not available in the open literature for quantitative assessment of turtles in Stewart Creek. However, snapping turtles (*Chrlydra serpentine*), although primarily aquatic, are omnivorous eating vegetation, insects, crustacenas, clams, snails, fish, frogs salamanders, small turtles and algae (EPA, 1993). This diet is similar to the omnivorous diet of the raccoon assessed in this SLERA and given the uncertainties in an exposure model and in the toxicity data, the raccoon could be considered a representative speices for snapping turtles. The red-eared slider and soft shell turtle eats aquatic plants, small fish, invertebrates and decaying material (TPWD, 2014, Herps of Texas, 2014). The use of the snowy egret which is modeled to eat benthic invertebrates and fish is adequatetly representative of aquatic turtles. This SLERA assumes that the benthic invertebrate PCL, water quality criteria assessments and risk analysis of the raccoon and egret will be protective of the reptiles found or potentially found in Stewart Creek.

6.6 Fish Tissue Analysis

The studies from Jarvinen and Ankley (1999) used to evaluate the sediment to fish pathway were chosen because they were flow-through and the analysis was of the whole body and not specific organs and would therefore be more relevant to conditions in Stewart Creek. However it is recognized that the fish species (i.e., rainbow trout and brook trout) are not the same species that would be found in Stewart Creek.

Although neither rainbow nor brook trout would be present in Stewart Creek, no other species and studies that would provide an indication of toxicity that might be native in the North Texas are listed in Jarvinen and Ankley (1999). As such, these studies of trout were used in order to evaluate this pathway. It is not known how these tissue residue values used as indices of toxicity compare to native fish species that might reside in Stewart Creek. The BSAF values used to estimate the fish tissue concentations for lead and cadmium are based on bivalves and not on freshwater fish. Because bivalves would be more sedentary within the sediment and not mobile like a fish, the BSAF values are likely conservative. A BSAF of 0.162 was estimated for arsenic from EPA (2000). The geometric mean of BSAF values reported for a variety of fish species was calculated. The average and maximum measured sediment to fish accumulation factors for lead measured in the Calcasieu Estuary as part of an EPA Remedial Investigation was 0.006 to 0.02, respectively (CDM, 2002) indicating that the BSAF of 0.162 is likely conservative. Other sources of information, besides Jarvinen and Ankley (1999) on tissue concentrations are available, for instance, the Oregon Department of Environmental Quality (ODEQ) reports acceptable tissue levels for lead in fish tissue for the protection of birds ranges from 46.5 mg/kg dry weight to 230 mg/kg dry weight and for the protection of mammals ranges from 170 mg/kg dry weight to 850 mg/kg dry weight. The ODEQ lists the biota to sediment accumulation factor for lead to fish to be not applicable (ODEQ, 2007), which likely reflects the lack of accumulation potential for most metals, as well as the difficulty and variability when estimating the relationship between sediment and tissue concentrations for inorganic compounds. It is generally believed that the sediment to fish pathway is incomplete or not significant for lead because of the physio-chemical properties of inorganic lead (ATSDR, 2007). Based on the conditions of the creek, exposures to small forage fish may occur, but it is unlikely that significant populations of large predator fish will be present in Stewart Creek particularly in the area of the creek near the FOP. As such, the sediment-to-fish pathway analysis likely overestimates risk to fish in Stewart Creek.

6.7 Simultaneous Exposure to Multiple Constituents

Another source of uncertainty originated from the use of toxicity values reported in the open literature that were derived from single-species, single-constituent laboratory studies. Prediction of ecosystem effects from laboratory studies is difficult. Laboratory studies cannot take into account the effects of environmental factors that may add to the effects of chemical stress. TRVs were selected from studies using single-constituent exposure scenarios. The endpoint species selected to represent the wildlife expected to occur within the exposure area were exposed to a variety of constituents, and it is not known whether the individual constituents in this mixture are synergistic, additive, or antagonistic. Therefore, the magnitude of this uncertainty is not measurable and risk could be overestimated or underestimated. Interactive effects were also not addressed and this could increase or decrease risk.

6.8 TRVs

TRVs are designed to be conservative estimates of potential toxicity based on a variety of measurement endpoints for various ecological receptors, typically in a laboratory setting using standard species that are commercially available. In the initial phase of the SLERA, NOAEL-based TRVs are used while in the refined less conservative HQ calculation of TCEQ Ecological Risk Assessment Required Element #7, LOAEL-based TRVs are used. It is important to evaluate the adequacy and validity of the TRV during the SLERA process since sometimes the conservatism built into the TRV-derivation process limits the usefulness of the value. For example, the avian TRV for lead results in an Eco-SSL that is near background levels of lead in soil. This limitation is discussed by EPA (2005b): “The eco SSL for avian wildlife is however lower than the 50th percentile for reported background concentrations in eastern and western U.S. soils.” If the data used in the evaluation (EPA, 2005b) are inspected closer, the variability in the numerous studies and the conservative assumptions used to select the TRV result in a value that is not representative of the majority of the NOAELs for the compound. Again, using lead as an example, the range of TRVs looking at all NOAEL endpoints and species is from 0.0584 mg/kg-day to 304 mg/kg-day, which is a 10,000-fold difference. Often the geometric mean of the dataset is used to estimate the TRV but, in the case of lead, the lowest LOAEL value was lower than the geometric mean for the NOAEL (10.9 mg/kg-day) so the NOAEL-based TRV was set at a lower value which was more than 1/10th of the geometric mean. It should be noted that the range of LOAELs were highly variable as well, from 0.111 to 625 mg/kg-day, and the LOAEL-based TRV used in this risk assessment of 3.6 mg/kg-day is lower than the geometric mean of the NOAELs. Because the TRV is very influential in the calculation of HQs, it is extremely important to evaluate sources of uncertainty and variability in these values. It is likely that the conservative nature of the TRV selected for use in the SLERA will overestimate potential risk to birds and mammals.

6.9 Benthic PCLs

The benthic PCLs are the midpoint between the benchmark and the second effects levels presented in TCEQ, 2014. The benchmarks and second effects levels correspond to threshold effect concentrations and probable effects concentrations developed by MacDonald et al, (2000) and Ingersoll et al, (2000). These researchers developed a database from 92 published reports for sediment toxicity and reviewed the various studies for sediment chemistry, toxicity test used, species tested and endpoint. The threshold effect concentrations and probable effects concentrations were calculated by determining a geometeric mean of the published sediment quality guidelines for each category once the review had been completed . Although the researchers designated the toxicty thresholds for arsenic, cadmium and lead as “reliable” because there were more than 20 samples used to determine the effect concentrations, the values are not specific to Stewart

Creek and there is some uncertainty about applying these look up criteria to a specific aquatic system.

6.10 Bioavailability and Absorption

The bioavailability and absorption of arsenic, cadmium and lead was conservatively assumed to be 100 % in the SLERA. There were no adjustment factors to account for arsenic, cadmium or lead binding irreversibly onto sediment particles, for being present in a form that is not biologically available or active, or to account for the differences in the absorption between the test material that serves as the basis for the TRV for soil and Site sediment. Sediment geochemical parameters such as the quantity and type/quality of organic carbon, the presence of acid volatile sulfides, the redox state of the sediment, salinity or pH can influence whether a constituent is tightly bound within the sediment and unavailable for uptake or whether it is freely dissolved and can be absorbed into organisms (ITRC, 2011).

The TOC of the North Tributary and on-site Stewart Creek is low (< 1 % to 9 %) (Table 2) and is generally lower downstream of the FOP (Tables 3 and 4). The grain size of the sediment tends toward larger sizes such as gravel and sand and not the silt or clay (Table 5). The influence of the organic carbon, grain size and other site specific conditions in the North Tributary and Stewart Creek on arsenic, cadmium and lead availability is not known, but the presence of organic carbon in sediments suggests that Site conditions would likely result in less than 100% bioavailability of arsenic, cadmium and lead to ecological receptors. Thus the assumption of 100 % bioavailability will result in the overestimation of risk in this SLERA. The influence of organic carbon or sulfide is unknown and the presence of these factors could further reduce the bioavailability of the arsenic, cadmium and lead in Stewart Creek sediments.

6.11 Surface Water Exposure

This SLERA assumes that sediment exposure is the primary exposure pathway and does not include a surface water exposure component. The detected concentrations of the dissolved arsenic, cadmium and lead in surface water collected in 2014 and using the most sensitive analytical method were below the aquatic criteria. The raccoon diet was adjusted to 60 % benthic invertebrates, 30 % fish and 10 % plants to focus on sediment exposure and does not include an aquatic insect or amphibian exposure component (i.e., modeled tissue concentrations from surface water). Because the detections of arsenic, cadmium and in the surface water are consistently below the chronic criteria, ecological risks from exposure to surface water is believed to be within acceptable ranges.

6.12 Availablility of Nearby Aquatic Resources

Stewart Creek is one of several freshwater urban creeks in Collin and Denton Counties that provides aquatic habitat. Figure 4 in Appendix C shows where the special status mussel species the Texas healsplitter has been noted to occur in relation to Stewart Creek and Lake Lewisville. This figures shows numerous coves and channels which feed into Lake Lewisville and provide aquatic habitat for a variety of species. Based on the habitat evaluation presented in Appendix C, Stewart Creek does not provide any unique or specialized habitat. The proximity of Lake Lewisville and associated wetlands provides significant and nearby aquatic habitat to Stewart Creek.

7.0 SLERA RECOMMENDATIONS

TCEQ's Ecological Risk Assessment Required Element #9 is the calculation of medium-specific PCLs bounded by the NOAEL and LOAEL (i.e., comparative PCLs) for those COCs that are not eliminated as a result of the HQ analysis or uncertainty analysis.

In accordance with the evaluation described herein based on TCEQ guidance, this SLERA does not indicate adverse risk due to ecological exposures of cadmium and lead in sediment, groundwater or surface water at the FOP and downstream. This conclusion is based on the overall low HQs estimated for the various receptors and media at the Site. Arsenic is present at a concentration slightly greater than the benthic PCL when the 95% UCL is used to represent the exposure point concentration for upstream of the FOP and downstream of the FOP. According to TCEQ (2014) the benthic invertebrate population in areas upstream and downstream of the FOP could be at risk from exposure to arsenic based on the data comparisons to the benthic PCL. As discussed previously, it is probable that products containing arsenic were used in the area around the FOP and that the arsenic detected in the Stewart Creek sediments is sourced from agricultural products. Additionally, arsenic exceedances in sediment are not always co-located with lead and cadmium exceedances suggesting that the source of the arsenic is not associated with the source of the lead and cadmium.

TCEQ's Ecological Risk Assessment Required Element #10 is the recommendation for managing ecological risk if it is determined that there is unacceptable risk and ecological PCLs are developed in the SLERA. The only ecologically based sediment PCL based on this SLERA would be the benthic PCL of 21.4 mg/kg for arsenic for the protection of the benthic population.

To address the benthic-based arsenic PCL of 21.4 mg/kg, Exide developed a work plan to derive a site-specific arsenic PCL using a combination of sediment analytical data, toxicity testing and benthic invertebrate community analysis. This approved Work Plan is presented in Appendix E. This Work Plan outlined a study that relied on three main components:

- Collection of sediment samples with arsenic concentrations in three concentrations ranges: low (< default PCL of 21.4 mg/kg), medium (> 21.4 mg/kg – 70 mg/kg) and high (70 mg/kg – 100 mg/kg);
- Evaluation of the benthic community structures in samples from the three arsenic concentration range categories; and
- Performance of laboratory toxicity tests using the sediment from the three arsenic concentration range categories.

Sampling of the sediments in Stewart Creek and in the two reference creeks began in May 2016; however, the target range of arsenic concentrations in Stewart Creek was not found. Specifically, of the 14 samples taken from Stewart Creek only two samples exceeded the default PCL of 21.4 mg/kg (26.4 mg/kg and 32.2 mg/kg) and no samples contained arsenic at levels for the high concentration range category.

Because only relatively low concentrations of arsenic were found in the sampled sediment, analysis of the benthic community structure and the toxicity testing could not be correlated with medium and high arsenic concentration ranges as planned. This circumstance made completion of the proposed biological testing irrelevant and the planned development of a site-specific sediment benthic PCL for arsenic unachievable via this methodology.

As briefly mentioned above, reference streams that have similar flow, stream bed, and sediment characteristics to the Stewart Creek study area were identified and sampled. Analysis of arsenic in sediment from 20 samples taken in the two creeks (10 in each creek) showed arsenic concentrations ranging from 1.34 mg/kg to 42.2 mg/kg . Using the arsenic data from the reference creeks, an upper prediction limit (UPL) was estimated as the representative background (reference) arsenic concentration for Stewart Creek. The rationale for the use of the background UPL in lieu of a biologically derived PCL is presented in Appendix F.

This SLERA included evaluation of two hot spots which were associated with chip and slag material. As described in Section 3.2.2 (Risk Management for Benthic Hot Spots) in TCEQ 2013d “by definition, hot spots present an unacceptable risk to the benthic community. Therefore, if hot spots are identified within the benthic expsoure area, persons should recommend appropriate risk management practices.” The Response Action Plan for Stewart Creek will be developed considering the presence of hot spots as defined in this SLERA and the background sediment UPL for arsenic.

8.0 REFERENCES

Agency for Toxic Substances and Disease Registry (ATSDR), 1991. *Draft Toxicological Profile for Cadmium*. Prepared by Life Systems, Inc., and Clement International Assoc. U.S. Department of Health and Human Services.

Agency for Toxic Substances and Disease Registry (ATSDR), 1993. *Toxicological Profile for Arsenic*. Public Health Service, U.S. Department of Health and Human Services, Atlanta, GA.

Agency for Toxic Substances and Disease Registry (ATSDR), 2007.Toxicological Profile for Lead.Public Health Service, U.S. Department of Health and Human Services, Atlanta, GA. August.

Alford, R.A, 2010. Declines and the Global Status of Amphibians. In: Sparling, D.W., Linder, G, Bishop, C.A. and S.K. Krest (Eds). *Ecotoxicology of Amphibians and Reptiles*. Second Edition. CRC Press. Baton Raton.

Benes, P., M. Cijchanova, and B. Havlik, 1985. Migration and Speciation Of Lead In A River System Heavily Polluted From A Smelter. *Water Res.* 19:1-6.

Bureau of Economic Geology, 2005. *Evalution of Arsenic Contamination in Texas.* Report Prepared for Texas Commission on Environmental Quality. August.

Burger, J., Carruth-Hinchey, C., Ondorff, J., McMahon, M., Gibbons, J.W., and M. Gochfeld, 1998. Effects of Lead on Behavior, Growth and Survival of Hatchling Slider Turtles. *Journal of Toxicology and Environmental Health*, Part A. 55:495-502.

Callahan, M.A., Slimak, M.W., Gable, M.W., et al., 1979. *Water-Related Fate of 129 Priority Pollutants. Office of Water Planning and Standards*, U. S. Environmental Protection Agency, Washington, D.C. EPA-440/4-79-129a.

CDM, 2002.*Calcasieu Estuary Remedial Investigation/Feasibility Study: Baseline Ecological Risk Assessment. Section 11 Nature and Extent of Biota Contamination.*

Clark, D.R., Bickham, J.W., Baker, D.L. and D.F. Cowman, 2000. Environmental Contaminants in Texas, USA, Wetland Reptiles: Evaluation of Blood Samples. *Env. Tox. and Chem.* 19(9):2259-2265.

Collin County Historical Commission (CCHC), 2014. Cruising Historical Collin County by-roads to the past. Page 8. Found On-line: <http://www.collincountytx.gov/public_information/Documents/HistoricalBrochure.pdf>

Cook-Joyce Inc. (CJI), 2014. *Revised Affected Property Assessment Workplan for Grand Park, 7275 Dallas Parkway, Frisco, Texas*. VCP #2592. January.

Demayo, A., M.C. Taylor, K.W. Taylor, and P.V. Hodson, 1982. Toxic Effects Of Lead And Lead Compounds On Human Health, Aquatic Life, Wildlife Plants, And Livestock. *CRC Crit. Rev. Environ. Control* 12:257-305.

Edens, F.W and J.D. Garlich, 1983. Lead-Induced Egg Production Decrease in Leghorn and Japanese Quail Hens. *Poult. Sci.* 62(9):1757-1763.

Elinder, C.G., Edling,C., Lindberg, E. et al., 1985. Assessment Of Renal Function In Workers Previously Exposed To Cadmium: Follow-Up And Dose Response Analyses. *Am. J. Ind. Med.* 8:553-564.

ENSR, 2004. *Development of a Standardized Approach for Assessing Potential Risks to Amphibians Exposed to Sediment and Hydric Soils. Final.* Naval Facilities Engineering Service Center (NFESC) Port Hueneme, California.

Environment Canada, 1993. *Priority Substances List Assessment Report, Arsenic and its Compounds*. Chemicals Evaluation Division.

Exide Technologies, 2013*. Response to TCEQ and EPA Comments on Affected Property Assessment Report and Tier 2 Screening Level Ecological Risk Assessment for the Former Operating Plant* Exide Technologies Frisco Recycling Center, Frisco Texas. October 29.

Farrand, J. Jr. ed. 1983. *The Audubon Society Master Guide to Birding* Vol. 1. Alfred A. Knopf, Inc. New York.

Gardner, S.C. and E. Oberdorster (Eds). 2006. *New Perspectives: Toxicology and Environment. Toxicology of Reptiles*. CRC Press. Taylor & Francis Group. Boca Raton.

Guirlet, E. and K. Das, 2012. Cadmium Toxicokinetics and Bioaccumulation in Turtles: Trophic Exposure of *Trachemys scripta elegans*. *Ecotoxicology* 21:18-26.

Herps of Texas. 2014. Softshell Turtles (*Apalone mutica*) http://www.herpsoftexas.org/category/organismtype/turtles/softshell-turtles

Holcman, A. and V. Stibilj, 1997. Arsenic Residues in Eggs from Laying Hens Fed a Diet Containing Arseinc (III) oxide. *Arch. Environ. Contam. Toxicol.* 32 (4): 407-410.

Ingersoll, C.G., MacDonald, D.D., Wang, N., Crane, J.L., Field, L.J., Haverland, P.S., Kemble, N.E., Lindskoog, R.A., Severn, C. and D.E. Smorong, 2000. *Prediction of Sediment Toxicity Using Consensus-Based Freshwater Sediment Quality Guidelines*. EPA/ 905/R-00/007.

International Union for Conservation of Nature (IUCN) Bird Life International (2012). "*Plegadis chihi*" IUCN Red List of Threatened Species. Version 2013.2..

Irwin, R.J., M. VanMouwerik, L. Stevens, M.D. Seese, and W. Basham, July 1997a. *Environmental Contaminants Encyclopedia - Arsenic*. National Park Service, Water Resources Division, Fort Collins, Colorado.

Irwin, R.J., M. VanMouwerik, L. Stevens, M.D. Seese, and W. Basham, 1997b. *Environmental Contaminants Encyclopedia - Cadmium*. National Park Service, Water Resources Division, Fort Collins, CO. July.

Interstate Technology Regulatory Council (ITRC), 2011. *Incorporating Bioavailability Considerations into the Evaluation of Contaminated Sediment Sites*. February.

JD Consulting, Inc. (JDC), 1998. *Human Health and Ecological Risk Assessment and Corrective Measures Study Report*; Stewart Creek; GNB Technologies, Inc.; Frisco, Texas. August.

JD Consulting, Inc. (JDC), 2000. *Stewart Creek Corrective Measures Implementation Report*. July.

Jarvinen, A.W. and G.T. Ankley. 1999. Linkage of Effects to Tissue Residues: Development of a Comprehensive Database for Aquatic Organisms Exposed to Inorganic and Organic Chemicals. SETAC Press.

Kimmel, C.A., Grant, L.D., Sloan, C.S. and B.C. Gladen, 1980. Chronic Low Level Lead Toxicity in the Rat: Maternal Toxicology and Peri Natal Effects. *Toxicol. Appl. Pharmacol*. 56(1):28-41.

MacDonald, D.D, Ingersoll, C.G and T.A. Berger. 2000. Development and Evaluation of Consensus-Based Sediment Quality Guidelines for Freshwater Ecosystems. *Archives of Environmental Contamination and Toxicology*. 39:20-31

Moore, J. W. and S. Ramamoorthy, 1984. *Heavy Metals in Natural Waters: Applied Monitoring and Impact Assessment*. R. S. DeSanto, ed., Springer-Verlag, New York, New York.

Oregon Department of Environmental Quality (ODEQ) 2007.Guidance for Assessing Bioaccumlative Chemicals of Concern in Sediment. Final January 31, 2007, Updated April 3, 2007.

Overmann, S.R. and J.J. Krajicek, 1995. Snapping Turtles (*Chelydra serpentine*) as Biomonitors of Lead Contamination of the Big River in Missouri's Old Lead Belt. *Environmental Toxicology and Chemistry* 14(4): 689-695.

Pastor, Behling & Wheeler LLC (PBW), 2012a. *Screening Level Ecological Risk Assessment (SLERA) Work Plan*. Prepared for Exide Technologies for the Frisco Recycling Center. December.

Pastor, Behling & Wheeler LLC (PBW), 2012b. *Site Investigation Report.* Prepared for Exide Technologies for the Frisco Recycling Center. July.

Pastor, Behling & Wheeler LLC (PBW), 2013. *Screening Level Risk Assessment at the Former Stewart Creek Wastewater Treatment Plant*; Frisco, Texas. April.

Rzymski, P., Niedzielski,P., Klimaszyk, P and B. Poniedzialek, 2014. Bioaccumulation of Selected Metals in Bivalves (*Unionidae*) and *Phragmites australis* inhabiting a Municipal Water Reservoir. *Envion. Monit. Assess*. 186:3199-3212.

Southwest Geoscience (SWG), 2013a. Limited Site Investigation; Sediment Sampling of Stewart Creek; Stewart Creek; BNSF Railroad Bridge to Stonebrook Parkway. March.

Southwest Geoscience (SWG), 2013b. Visual Survey of Stewart Creek F.M. 423 to BNSF Railroad Bridge. May 14.

Southwest Geoscience (SWG), 2014. Supplemental Site Investigation Additional Sampling of Stewart Creek; Property: Stewart Creek 4th Army Memorial Parkwa to BNSF Railroad Bridge. Frisco, Texas. March. 5.

Texas Commission on Environmental Quality (TCEQ), 2011. Aquatic Life RBEL Table. Updated January 19, 2011.

Texas Commission on Environmental Quality (TCEQ), 2012. Procedures to Implement The Texas Surface Water Quality Standards. Water Quality Division. RG-194. January.

Texas Commission on Environmental Quality (TCEQ), 2013a. Conditional Approval of Response to TCEQ and EPA Comments on Affected Property Assessment Report (APAR), and Tier 2 Screening Level Ecological Risk Assessment for the Former Operating Plant, dated October 29, 2013. Exide Recycling Facility, 7471 5th St. Frisco, TX 75034-5047.

Texas Commission on Environmental Quality (TCEQ), 2013b. E-Mail Communication from Ms. Merrie Smith (TCEQ) to Mr. Eric Pastor (PBW) regarding Intermittent Classification of the North Tributary. Friday October 18, 2013.

Texas Commission on Environmental Quality (TCEQ), 2013c. Flow Status Determination of Stewart Creek. TCEQ Interoffice Memorandum, September 23.

Texas Commission on Environmental Quality (TCEQ), 2013d. *Determining Representative Concentrations of Chemicals of Concern for Ecological Receptors*. RG-366/TRRP-15eco. November.

Texas Commission on Environmental Quality (TCEQ), 2014. *Guidance for Conducting Ecological Risk Assessments at Remediation Sites in Texas*. RG-263. January.

Texas Parks and Wildlife Department (TPWD), 2009. 15 Texas Freshwater Mussels Placed on State Threatened List. November 5, 2009. http://www.texashuntfish.com/app/view/Post/27233/15-Texas-Freshwater-Mussels-Placed-on-State-Threatened-List .

Texas Parks and Wildlife Department TPWD, 2013. On Line species information on white faced ibis: http://www.tpwd.state.tx.us/huntwild/wild/species/ibis/ .

Texas Parks and Wildlife Department TPWD, 2014. On Line species information on red-eared slider (*Trachemys scripta elegans*) http://www.tpwd.state.tx.us/huntwild/wild/species/slider/

U.S. Department of Agriculture (USDA) 1969. Soil Survey Collin County, Texas. USDA Soil Conservation Service in cooperation with Texas Agricultural Experiment Station. June.

U.S. Environmental Protection Agency (EPA), 1993. *Wildlife Exposure Factors Handbook*. Office of Health and Environmental Assessment, Washington D.C., USEPA/600/R-93/187b. December 1993.

U.S. Environmental Protection Agency (EPA), 1997. *Ecological Risk Assessment Guidance for Superfund: Process for Designing and Conducting Ecological Risk Assessments, Interim Final.* Edison, NJ. USEPA/540/R-97-006. June 1997.

U.S. Environmental Protection Agency (EPA), 1999. *Screening Level Ecological Risk Assessment Protocol for Hazardous Waste Combustion Facilities*. *Peer Review Draft*. Office of Solid Waste, Washington, D.C.August 1999.

U.S. Environmental Protection Agency (EPA), 2000. *Bioaccumulation Testing and Interpretation for the Purpose of Sediment Quality Assessment. Stutus and Needs*. EPA-823-R-00-001.

U.S. Environmental Protection Agency (EPA), 2005a. *Ecological Soil Screening Levels for Arsenic. OSWER Directive 9285.7-62*. March 2005.

U.S. Environmental Protection Agency (EPA), 2005b. *Ecological Soil Screening Levels for Cadmium. OSWER Directive 9285.7-64*. March 2005.

U.S. Environmental Protection Agency (EPA), 2005c. *Ecological Soil Screening Levels for Lead*. OSWER Directive 9285.7-70. March 2005.

U.S. Environmental Protection Agency (EPA), 2005d. *Guidance for Developing Ecological Soil Screening Levels*. OSWER 9285.7-55. November 2003, Revised February 2005.

U.S. Environmental Protection Agency (EPA), 2013. PRO UCL Version 5.0 Statistical Software for Environmental Applications for Data Sets with and without Nondetect Observations available at http://www.epa.gov/osp/hstl/tsc.softwaredocs.htm and PRO UCL Version 5.0 User Guide. EPA 600/R-07/041. Office of Research and Development. September.

Whitehead and Mueller (W&M), 2011. Suspect Slag Sampling Report; Stewart Creek – West Segment; Exide Technologies; Frisco, Texas. March.

Yuhas, E.M., Schnell, R.C. and T.S. Miya, 1979. Dose-Related Alterations in Growth and Mineral Deposition by Chronic Oral Cadmium Administration in the Male Rat. Toxicology 12(1):19-29.

TABLES

Table 1. Summary of Surface Water Data for Stewart Creek and North Tributary
Screening Level Ecological Risk Assessment

Sample I.D.	Analytical Method	Sample Date	Total Metals Arsenic (mg/L)	Total Metals Cadmium (mg/L)	Total Metals Lead (mg/L)	Dissolved Metals Arsenic (mg/L)	Dissolved Metals Cadmium (mg/L)	Dissolved Metals Lead (mg/L)
Stewart Creek								
Chronic Aquatic Life RBEL[1]			**NA**	**NA**	**NA**	**0.15**	**0.000256**	**0.00268**
Upstream of the Former Operating Plant								
2014-SW-002	SW6010B	1/29/2014	< 0.00328 U	< 0.000350 U	< 0.00290 U	< 0.00328 U	< 0.000350 U	< 0.00290 U
2014-SW-002	SW6020A	1/29/2014	< 0.00130 U	< 0.0000950 U	< 0.000200 U	< 0.00130 U	< 0.0000950 U	< 0.000200 U
2014-SW-007	SW6010B	1/31/2014	< 0.00328 U	< 0.000350 U	< 0.00290 U	< 0.00328 U	< 0.000350 U	< 0.00290 U
2014-SW-007	SW6020A	1/31/2014	< 0.00130 U	< 0.0000950 U	**0.000240 J**	< 0.00130 U	< 0.0000950 U	< 0.000200 U
2014-SW-008	SW6010B	1/31/2014	< 0.00328 U	< 0.000350 U	< 0.00290 U	< 0.00328 U	< 0.000350 U	< 0.00290 U
2014-SW-008	SW6020A	1/31/2014	< 0.00130 U	< 0.0000950 U	**0.000365 J**	< 0.00130 U	< 0.0000950 U	< 0.000200 U
2014-SW-009	SW6010B	1/31/2014	< 0.00328 U	< 0.000350 U	< 0.00290 U	< 0.00328 U	< 0.000350 U	< 0.00290 U
2014-SW-009	SW6020A	1/31/2014	< 0.00130 U	< 0.0000950 U	< 0.000200 U	< 0.00130 U	< 0.0000950 U	< 0.000200 U
2014-SW-010	SW6010B	1/31/2014	< 0.00328 U	< 0.000350 U	< 0.00290 U	< 0.00328 U	< 0.000350 U	< 0.00290 U
2014-SW-010	SW6020A	1/31/2014	< 0.00130 U	< 0.0000950 U	**0.000420 J**	< 0.00130 U	< 0.0000950 U	**0.000235 J**
2014-SW-011	SW6010B	1/31/2014	< 0.00328 U	< 0.000350 U	< 0.00290 U	< 0.00328 U	< 0.000350 U	< 0.00290 U
2014-SW-011	SW6020A	1/31/2014	< 0.00130 U	< 0.0000950 U	< 0.000200 U	< 0.00130 U	< 0.0000950 U	< 0.000200 U
2014-SW-012	SW6010B	1/31/2014	< 0.00328 U	< 0.000350 U	< 0.00290 U	< 0.00328 U	< 0.000350 U	< 0.00290 U
2014-SW-012	SW6020A	1/31/2014	< 0.00130 U	< 0.0000950 U	< 0.000200 U	< 0.00130 U	< 0.0000950 U	< 0.000200 U
2014-SW-013	SW6010B	1/31/2014	< 0.00328 U	< 0.000350 U	< 0.00290 U	< 0.00328 U	< 0.000350 U	< 0.00290 U
2014-SW-013	SW6020A	1/31/2014	< 0.00130 U	< 0.0000950 U	**0.000390 J**	< 0.00130 U	< 0.0000950 U	< 0.000200 U
2014-SW-014	SW6010B	1/31/2014	< 0.00328 U	< 0.000350 U	< 0.00290 U	< 0.00328 U	< 0.000350 U	< 0.00290 U
2014-SW-014	SW6020A	1/31/2014	< 0.00130 U	< 0.0000950 U	**0.000450 J**	< 0.00130 U	< 0.0000950 U	**0.000315 J**
2014-SW-015	SW6010B	1/31/2014	< 0.00328 U	< 0.000350 U	< 0.00290 U	< 0.00328 U	< 0.000350 U	< 0.00290 U
2014-SW-015	SW6020A	1/31/2014	< 0.00130 U	< 0.0000950 U	**0.000325 J**	< 0.00130 U	< 0.0000950 U	< 0.000200 U
On-Site								
2012-SW-1	SW6010B	1/17/2012	--	**0.001J**	< 0.00290 U	--	**0.0019J**	**0.0046J**
2012-SW-2	SW6010B	1/17/2012	--	**0.0009J**	< 0.00290 U	--	**0.002J**	**0.0037J**
2012-SW-3	SW6010B	1/17/2012	--	< 0.000350 U	< 0.00290 U	--	< 0.000350 U	< 0.00290 U
2012-SW-4	SW6010B	1/17/2012	--	< 0.000350 U	< 0.00290 U	--	< 0.000350 U	< 0.00290 U
2012-SW-5	SW6010B	1/17/2012	--	< 0.000350 U	< 0.00290 U	--	< 0.000350 U	< 0.00290 U
2012-SW-6	SW6010B	1/17/2012	--	< 0.000350 U	< 0.00290 U	--	< 0.000350 U	< 0.00290 U
2012-SW-7	SW6010B	1/17/2012	--	< 0.000350 U	**0.0032J**	--	< 0.000350 U	< 0.00290 U
2012-SW-8	SW6010B	1/17/2012	--	< 0.000350 U	**0.0036J**	--	< 0.000350 U	< 0.00290 U
2012-SW-9	SW6010B	1/17/2012	--	< 0.000350 U	< 0.00290 U	--	< 0.000350 U	< 0.00290 U
2012-SW-10	SW6010B	1/17/2012	--	< 0.000350 U	< 0.00290 U	--	< 0.000350 U	< 0.00290 U
2012-SW-11	SW6010B	1/17/2012	--	< 0.000350 U	< 0.00290 U	--	**0.0006J**	< 0.00290 U
2012-SW-12	SW6010B	1/17/2012	--	< 0.000350 U	< 0.00290 U	--	< 0.000350 U	< 0.00290 U
2012-SW-13	SW6010B	1/17/2012	--	< 0.000350 U	< 0.00290 U	--	< 0.000350 U	< 0.00290 U
2014-SW-016	SW6010B	1/31/2014	< 0.00328 U	< 0.000350 U	< 0.00290 U	< 0.00328 U	< 0.000350 U	< 0.00290 U
2014-SW-016	SW6020A	1/31/2014	< 0.00130 U	< 0.0000950 U	< 0.000200 U	< 0.00130 U	< 0.0000950 U	< 0.000200 U
2014-SW-017	SW6010B	1/31/2014	< 0.00328 U	< 0.000350 U	< 0.00290 U	< 0.00328 U	< 0.000350 U	< 0.00290 U
2014-SW-017	SW6020A	1/31/2014	< 0.00130 U	< 0.0000950 U	**0.000990 J**	< 0.00130 U	< 0.0000950 U	**0.000350 J**
2014-SW-018	SW6010B	1/31/2014	< 0.00328 U	< 0.000350 U	< 0.00290 U	< 0.00328 U	< 0.000350 U	< 0.00290 U
2014-SW-018	SW6020A	1/31/2014	< 0.00130 U	< 0.0000950 U	**0.000585 J**	< 0.00130 U	< 0.0000950 U	**0.000255 J**
2014-SW-019	SW6010B	1/31/2014	< 0.00328 U	< 0.000350 U	< 0.00290 U	< 0.00328 U	< 0.000350 U	< 0.00290 U
2014-SW-019	SW6020A	1/31/2014	< 0.00130 U	< 0.0000950 U	**0.00133 J**	< 0.00130 U	< 0.0000950 U	< 0.000200 U
2014-SW-020	SW6010B	1/31/2014	< 0.00328 U	< 0.000350 U	< 0.00290 U	< 0.00328 U	< 0.000350 U	< 0.00290 U
2014-SW-020	SW6020A	1/31/2014	< 0.00130 U	< 0.0000950 U	**0.00174**	< 0.00130 U	< 0.0000950 U	**0.000310 J**
2014-SW-021	SW6010B	1/31/2014	< 0.00328 U	< 0.000350 U	< 0.00290 U	< 0.00328 U	< 0.000350 U	< 0.00290 U
2014-SW-021	SW6020A	1/31/2014	< 0.00130 U	< 0.0000950 U	**0.000635 J**	< 0.00130 U	< 0.0000950 U	**0.000850 J**
Downstream of the Former Operating Plant								
2014-SW-001	SW6010B	1/28/2014	< 0.00328 U	< 0.000350 U	< 0.00290 U	< 0.00328 U	< 0.000350 U	< 0.00290 U
2014-SW-001	SW6020A	1/28/2014	< 0.00130 U	< 0.0000950 U	**0.000310 J**	< 0.00130 U	< 0.0000950 U	**0.000205 J**
2014-SW-003	SW6010B	1/29/2014	< 0.00328 U	< 0.000350 U	< 0.00290 U	< 0.00328 U	< 0.000350 U	< 0.00290 U
2014-SW-003	SW6020A	1/29/2014	< 0.00130 U	< 0.0000950 U	**0.00142 J**	< 0.00130 U	< 0.0000950 U	**0.000250 J**
2014-SW-004	SW6010B	1/29/2014	< 0.00328 U	< 0.000350 U	< 0.00290 U	< 0.00328 U	< 0.000350 U	< 0.00290 U
2014-SW-004	SW6020A	1/29/2014	< 0.00130 U	< 0.0000950 U	**0.000655 J**	< 0.00130 U	< 0.0000950 U	< 0.000200 U
2014-SW-005	SW6010B	1/29/2014	< 0.00328 U	< 0.000350 U	< 0.00290 U	< 0.00328 U	< 0.000350 U	< 0.00290 U
2014-SW-005	SW6020A	1/29/2014	< 0.00130 U	< 0.0000950 U	**0.00103 J**	< 0.00130 U	< 0.0000950 U	**0.000205 J**
2014-SW-006	SW6010B	1/30/2014	< 0.00328 U	< 0.000350 U	< 0.00290 U	< 0.00328 U	< 0.000350 U	< 0.00290 U
2014-SW-006	SW6020A	1/30/2014	< 0.00130 U	< 0.0000950 U	**0.000440 J**	< 0.00130 U	< 0.0000950 U	**0.000240 J**
2014-SW-023	SW6020A	3/18/2014	< 0.00130 U	< 0.0004775 U *	< 0.000200 U	< 0.00130 U	**0.000204 J**	**0.000247 J**

Table 1. Summary of Surface Water Data for Stewart Creek and North Tributary
Screening Level Ecological Risk Assessment

Sample I.D.	Analytical Method	Sample Date	Total Metals			Dissolved Metals		
			Arsenic (mg/L)	Cadmium (mg/L)	Lead (mg/L)	Arsenic (mg/L)	Cadmium (mg/L)	Lead (mg/L)
2014-SW-026	SW6020A	4/15/2014	**0.00168 J**	**0.000107 J**	**0.000530 J**	**0.00171 J**	**0.0000998 J**	< 0.000200 U
2014-SW-028	SW6020A	4/16/2014	**0.00130 J**	**0.000136 J**	**0.000324 J**	**0.00151 J**	< 0.0000950 U	< 0.000200 U
Downstream Tributaries								
2014-SW-022	SW6020A	3/18/2014	< 0.00130 U	< 0.0004775 U *	**0.000812 J**	< 0.00130 U	**0.000217 J**	< 0.000200 U
2014-SW-024	SW6020A	3/19/2014	< 0.00130 U	< 0.0000950 U	**0.000286 J**	< 0.00130 U	< 0.0000950 U	< 0.000200 U
2014-SW-025	SW6020A	3/19/2014	< 0.00130 U	< 0.0000950 U	**0.000421 J**	< 0.00130 U	< 0.0000950 U	< 0.000200 U
2014-SW-027	SW6020A	4/15/2014	**0.00393**	< 0.0000950 U	**0.00105 J**	**0.00311**	< 0.0000950 U	< 0.000200 U
2014-SW-029	SW6020A	4/16/2014	**0.00185 J**	< 0.0000950 U	**0.000279 J**	**0.00194 J**	< 0.0000950 U	**0.000475 J**
North Tributary								
Acute Aquatic Life RBEL[1]			**NA**	**NA**	**NA**	**0.34**	**0.00908**	**0.0688**
SW-NT-1	SW6010B	3/20/2013	--	<0.00035	<0.0029	--	<0.00035	<0.0029
SW-NT-2	SW6010B	3/20/2013	--	<0.00035	<0.0029	--	<0.00035	<0.0029
SW-NT-3	SW6010B	3/20/2013	--	<0.00035	<0.0029	--	<0.00035	<0.0029
SW-NT-4	SW6010B	3/20/2013	--	<0.00035	<0.0029	--	<0.00035	<0.0029
SW-NT-5	SW6010B	3/20/2013	--	<0.00035	<0.0029	--	<0.00035	<0.0029
SW-NT-6	SW6010B	3/20/2013	--	<0.00035	<0.0029	--	<0.00035	<0.0029
SW-NT-7	SW6010B	3/20/2013	--	<0.00035	<0.0029	--	<0.00035	<0.0029
SW-NT-8	SW6010B	3/20/2013	--	<0.00035	<0.0029	--	<0.00035	<0.0029
SW-NT-9	SW6010B	3/20/2013	--	<0.00035	<0.0029	--	**0.00044J**	<0.0029
SW-NT-10	SW6010B	3/20/2013	--	<0.00035	<0.0029	--	<0.00035	<0.0029

Notes:

1. RBELs for cadmium and lead calculated based on a hardness value of 106 mg/L for Lake Lewisville Segment 0823 per Implementation Guidance (TCEQ, 2012).
2. RBEL - Risk Based Exposure Limit. The RBEL is used as the benchmark.
3. Acute and chronic freshwater benchmarks from TCEQ, 2011.
4. mg/L - milligrams/Liter
5. Data Qualifiers: J = estimated concentration. U = Analyte not detected. * analyte detected in field blank; sample result became non-detect at less than five times the field blank concentration.
6. < - Indicates analyte not detected above sample detection limit (SDL).
7. NA - Not Applicable
8. "--" - Not Analyzed
9. Detected analytes are bolded. No exceedances of aquatic criteria.

Table 2. Summary of Upstream and On-Site Sediment Data for Stewart Creek and North Tributary
Screening Level Ecological Risk Assessment

Sample I.D.	Sample Date	Metals (mg/Kg)			Total Organic Carbon (%)
		Arsenic	Cadmium	Lead	
Freshwater Sediment Benchmark		**9.79**	**0.99**	**35.8**	**NA**
Freshwater Sediment Benthic PCL		**21.4**	**3**	**82**	**NA**
Stewart Creek					
Upstream of the Former Operating Plant					
2014-SED-026	1/31/2014	8.55	0.358	11.5	1.07
2014-SED-027	1/31/2014	14.3	0.281 J	16.4	1.57
2014-SED-028	1/31/2014	10.3	0.392 J	13.5	4.44
2014-SED-029	1/31/2014	13.4	0.260 J	12.0	1.04
2014-SED-030	1/31/2014	20.3	0.691 J	14.0	0.834
2014-SED-031	1/31/2014	12.5	0.588	11.3	0.806
2014-SED-032	1/31/2014	15.2	0.386	8.99	0.736
2014-SED-033	1/31/2014	10.5	0.331	6.56	0.959
2014-SED-034	1/31/2014	11.7	0.488	9.35	0.986
2014-SED-035	1/31/2014	42.7	0.612	19.8	1.52
On-Site					
2012-SED-1	1/11/2012	--	0.34 J	7.09 J-	0.48
2012-SED-2	1/11/2012	--	0.79 J-	15.10 J-	0.53
2012-SED-3	1/11/2012	--	1.40 J-	17.10 J-	0.74
2012-SED-4	1/11/2012	--	2.08 J-	14.90 J-	1.32
2012-SED-5	1/11/2012	--	1.43 J-	10.90 J-	9.23
2012-SED-6	1/11/2012	--	1.03 J-	10.40 J-	7.14
2012-SED-7	1/11/2012	--	0.84 J-	10.40 J-	6.93
2012-SED-8	1/11/2012	--	0.86 J-	8.99 J-	7.15
2012-SED-9	1/11/2012	--	0.79 J-	11.50 J-	8.98
2012-SED-10	1/12/2012	--	0.90 J-	6.57 J	0.70
2012-SED-11	1/12/2012	--	0.77 J-	8.82 J	1.00
2012-SED-12	1/12/2012	--	0.72 J-	17.70 J	1.07
2012-SED-13	1/12/2012	--	1.05 J-	19.20 J	0.378 J
North Tributary					
2012-SED-16	1/12/2012	--	1.19 J-	17.80 J	0.96
2012-SED-17	1/12/2012	--	0.78 J-	28.20 J	1.39
2012-SED-18	1/12/2012	--	0.82 J-	20.10 J	--
2012-SED-19	1/12/2012	--	0.98 J-	23.40 J	1.51
2012-SED-20	1/12/2012	--	0.69 J-	12.10 J	2.21
2012-SED-21	1/12/2012	--	1.10 J-	10.40 J	3.26
2012-SED-22	1/12/2012	--	1.06 J-	10.40 J	2.65
2012-SED-23	1/12/2012	--	0.99 J-	11.10 J	4.24
2012-SED-24	1/12/2012	--	0.74 J-	19.70 J	0.87
2012-SED-25	1/12/2012	--	0.83 J-	11.90 J	3.55

Notes:

1. mg/Kg - milligrams/Kilogram
2. Data Qualifiers: J = estimated concentration; J- = estimated, biased low.
3. NA - Not Applicable
4. "--" - Not Analyzed
5. Freshwater benchmarks and midpoint benthic PCLs from TCEQ (2014).
6. Shading indicates concentration greater than benthic PCL.

Table 3. Summary of Downstream Sediment Data for Stewart Creek Collected in 2010, 2011 and 2013
Screening Level Ecological Risk Assessment

Sample I.D.	Hot Spot	Sample Date	Metals (mg/Kg)			Selenium	Total Organic Carbon (%)
			Arsenic	Cadmium	Lead		
Freshwater Sediment Benchmark			**9.79**	**0.99**	**35.80**	**NA**	**NA**
Freshwater Sediment Benthic PCL			**21.4**	**3**	**82**	**NA**	**NA**
CS-1	1	10/27/2010	25.2	6.96	34.6	--	--
CS-2	1	10/27/2010	23.2	<0.87	32.3	--	--
CS-3	1	10/27/2010	23.2	<1.03	175	--	--
CS-4	1	10/27/2010	17.8	<0.99	43.7	--	--
CS-5	1	10/27/2010	13	<1.00	14	--	--
CS-8	1	10/27/2010	26.5	2.52	--	--	--
SC-Sed 1	1	11/18/2011	11.9	0.61	38.2	<1.09	--
SC-Sed 2	1	11/18/2011	11.2	0.75	46.9	<1.15	--
SC-Sed 3	1	11/18/2011	18.6	2.01	63.8	<1.06	--
SC-Sed 4	1	11/18/2011	12.0	0.95	39.1	<1.09	--
SC-Sed 5	1	11/17/2011	14.4	0.9	397	<1.20	--
SC-Sed 6	1	11/17/2011	16.2	1.05	307	<1.08	--
SC-Sed 7	1	11/17/2011	16.1	0.54	35.6	<1.07	--
SC-Sed 8	1	11/17/2011	47.2	0.96	35.2	<1.10	--
SC-Sed 9	1	11/17/2011	20.5	4.16	162	<1.06	--
SC-Sed 10	1	11/17/2011	12.3	0.72	22.5	<1.01	--
SC-Sed 11	1	11/17/2011	29.4	1.11	46.8	<1.02	--
SC-Sed 12	NA	11/18/2011	11.3	0.79	56.7	<1.26	--
SC-Sed 13	NA	11/18/2011	31.1	0.84	33.7	<1.00	--
SC-Sed 14	NA	11/18/2011	12.7	0.79	27.7	<0.97	--
SC-Sed 15	NA	11/18/2011	12.9	1.54	35.3	<1.01	--
SC-Sed 16	NA	11/18/2011	14.6	1.49	59	<1.00	--
SC-Sed 17	NA	11/18/2011	18.3	1.19	43.1	<0.97	--
SC-Sed 18	NA	11/18/2011	8.1	0.43	20.5	<0.91	--
SC-Sed 19	NA	11/18/2011	19.5	1.47	37.6	<1.18	--
SC-Sed 20	NA	11/18/2011	17.4	1.07	38.5	<1.03	--
SC-Sed 21	NA	11/18/2011	18.0	2.19	49.5	<0.96	--
SC-Sed 22	NA	11/18/2011	19.2	2.01	53.2	<0.93	--
SC-Sed 23	NA	11/18/2011	16.1	3.69	34.2	<1.15	--
SC-Sed 24	NA	11/18/2011	32.1	2.00	49.5	<1.03	--
SC-Sed 25	NA	11/18/2011	15.1	1.03	21.6	<1.07	--
SC-Sed 26	NA	11/18/2011	16.5	0.87	30.1	<1.07	--
SC-Sed 27	NA	11/18/2011	14.3	1.09	31.8	<1.00	--
SC-Sed 28	NA	11/18/2011	14.1	1.23	29	<0.96	--
SC-Sed 29	NA	11/18/2011	18.2	1.75	35.9	<1.00	--
SC-Sed 30	NA	11/18/2011	18.5	2.41	31.3	<0.98	--
SC-Sed-31	NA	6/12/2013	19.2	0.38	12.7	--	0.0033
SC-Sed-32	NA	6/12/2013	19.3	0.64	12.3	--	0.00187
SC-Sed-33	NA	6/12/2013	18.5	0.42	14.6	--	0.00343
SC-Sed-34	NA	6/12/2013	16	0.67	14.3	--	0.00201
SC-Sed-35	NA	6/12/2013	17.8	0.45	13	--	0.00219
SC-Sed-36	NA	6/12/2013	17.7	0.61	11.5	--	0.00628
SC-Sed-37	NA	6/12/2013	16.2	0.57	12.1	--	0.00286
SC-Sed-38	NA	6/12/2013	12.7	0.33	9.7	--	0.00258
SC-Sed-39	NA	6/12/2013	11.6	0.47	10.6	--	0.00511
SC-Sed-40	NA	6/12/2013	7.0	0.16	12.9	--	0.00384
SC-Sed-41	NA	6/19/2013	24.9	0.35	13.1	--	0.00405
SC-Sed-42	NA	6/19/2013	10.8	0.35	8.6	--	0.00326
SC-Sed-43	NA	6/19/2013	20.1	1.5	14.3	--	0.00175
SC-Sed-44	2	6/19/2013	12.8	0.39	12.1	--	0.00119
SC-Sed-45	2	6/19/2013	14.0	1.7	11.4	--	0.00128
SC-Sed-46	2	6/19/2013	26.1	1.1	11.8	--	0.00196
SC-Sed-47	2	6/19/2013	16.9	1.2	19.6	--	0.00176
SC-Sed-48	2	6/19/2013	24.8	2.4	13.8	--	0.00156

Table 3. Summary of Downstream Sediment Data for Stewart Creek Collected in 2010, 2011 and 2013
Screening Level Ecological Risk Assessment

Sample I.D.	Hot Spot	Sample Date	Metals (mg/Kg)				Total Organic Carbon (%)
			Arsenic	Cadmium	Lead	Selenium	
Freshwater Sediment Benchmark			**9.79**	**0.99**	**35.80**	**NA**	**NA**
Freshwater Sediment Benthic PCL			**21.4**	**3**	**82**	**NA**	**NA**
Samples Associated with Chips, Potential Slag or Slag (see notes 9 - 12)							
Chip (6-21)-1 Base Comp	2	6/21/2013	17.7	0.87	13.3	--	--
Chip (6-21)-2 Base Comp	2	6/21/2013	12.3	0.54	9.5	--	--
PS (6-21)-1 Base Comp	2	6/21/2013	25.2	4.2	89	--	--
PS (6-21)-2 Base Comp	2	6/21/2013	44.6	0.52	9.7	--	--
Chip (6-20)-2 Base Comp	NA	6/20/2013	10.6	0.62	8.2	--	--
Chip (6-24)-3 Base Comp	NA	6/24/2013	9.2	1.1	27.7	--	--
Chip (6-24)-3 Comp	NA	6/24/2013	11.5	1.4	32.6	--	--
Chip (6-24)-3 SED	NA	6/24/2013	10.4	0.79	39.3	--	--
Chip (6-24)-3 Wall Base	NA	6/24/2013	8.1	0.92	15.7	--	--
Chip (6-24)-4 Base Comp	NA	6/24/2013	9.2	0.63	15.3	--	--
Chip (6-24)-5 Base Comp	1	6/24/2013	8.9	0.63	76.7	--	--
PS (6-24)-3 Base Comp	NA	6/24/2013	11.8	0.82	13.6	--	--
Slag (6-24)-1 Base	1	6/24/2013	16.4	0.56	17.8	--	--
Slag (6-24)-2 Base	1	6/24/2013	279	< 0.040	459	--	--

Notes:

1. Samples SC-Sed 1 through SC-Sed 11 located north of the Dallas North Tollway and are considered part of Hot Spot #1.
2. 2010 data collected by Pastor, Behling and Wheeler in support of FSCWWTP investigation.
3. 2011 data collected by Southwest Geoscience (SWG, 2013a).
4. 2013 data collected by Southwest Geoscience (SWG, 2014).
5. mg/kg - milligrams/kilogram (all values in dry weight)
6. NA = Not Applicable.
7. "--" - Not Analyzed
8. Freshwater benchmarks and midpoint benthic PCLs from TCEQ (2014).
9. Base - discrete sample collected directly beneath the Chip. Slag or Potential Slag (SWG, 2014).
10. Comp - composite sample collected from beneath Chips, Slag or Potential Slag or contained multiple chips (SWG, 2014).
11. SED - discrete sample collected from sediment beneath the base at the water interface (SWG, 2014).
12. Wall - discrete sample collected futher down the feature beneath the base but above the SED sample (SWG, 2014).
13. Two hot spots are identified in Stewart Creek and those data points included in one of the two hot spots are noted by a #1 or #2. (See Figure 4 for locations of hot spots)
14. Shading indicates concentration greater than benthic PCL.

Table 4. Summary of Downstream Sediment Data for Stewart Creek Collected in 2014
Screening Level Ecological Risk Assessment

Sample I.D.	Hot Spot	Sample Date	Metals (mg/Kg)			Total Organic Carbon (%)
			Arsenic	Cadmium	Lead	
Freshwater Sediment Benchmark			**9.79**	**0.99**	**35.8**	**NA**
Freshwater Sediment Benthic PCL			**21.4**	**3**	**82**	**NA**
Stewart Creek						
2014-SED-001	NA	1/28/2014	10.2 J	0.298 J	15.8	2.26
2014-SED-002	NA	1/28/2014	8.31 J	0.503	20.5	3.22
2014-SED-003	NA	1/28/2014	57.7 J	0.956	19.5	0.568
2014-SED-004	NA	1/28/2014	29.7 J	1.03	28.2	0.473
2014-SED-005	NA	1/28/2014	27.2 J	0.981	25.3	0.806
2014-SED-006	NA	1/28/2014	11.2 J	0.371	11.3	0.496
2014-SED-007	NA	1/28/2014	20.4 J	0.892	16.0	0.854
2014-SED-008	NA	1/28/2014	47.5 J	1.05	23.8	0.600
2014-SED-009	NA	1/28/2014	42.9 J	0.920	20.5	0.357
2014-SED-010	NA	1/28/2014	31.1 J	1.00	16.3	0.959
2014-SED-011	NA	1/28/2014	37.4 J	2.42	17.0	0.611
2014-SED-012	NA	1/28/2014	22.0 J	1.03	15.9	0.591
2014-SED-013	NA	1/28/2014	12.0 J	0.510	16.0	1.18
2014-SED-014	1	1/29/2014	12.0 J	0.439 J	25.0	0.825
2014-SED-015	1	1/29/2014	22.0	0.522	32.9	0.684
2014-SED-016	1	1/29/2014	29.6	0.458	26.2	0.406
2014-SED-017	1	1/29/2014	20.6	0.660	30.1	0.532
2014-SED-018	1	1/29/2014	20.2	0.556	59.8	1.28
2014-SED-019	NA	1/30/2014	10.0 J	1.25	47.3	1.34
2014-SED-020	NA	1/30/2014	15.0	1.77	26.0	0.355
2014-SED-021	NA	1/30/2014	25.6	4.09	40.6	0.412
2014-SED-022	NA	1/30/2014	11.6	0.301 J	11.7	0.910
2014-SED-023	NA	1/30/2014	31.2	1.64	24.6	0.269
2014-SED-024	NA	1/30/2014	25.4	1.28	15.7	0.246
2014-SED-025	NA	1/30/2014	14.8	3.03	15.1	0.874
2014-SED-036	NA	3/18/2014	42.8	0.690	34.2	3.02
2014-SED-038	NA	3/18/2014	11.6	0.378	21.4	0.894
2014-SED-039	NA	3/18/2014	25.0	1.90	18.7	0.231
2014-SED-040	NA	3/18/2014	49.2	1.01	17.5	0.401
2014-SED-041	NA	3/18/2014	41.8	1.13	19.0	0.287
2014-SED-042	NA	3/18/2014	31.4	0.870	20.7	0.193
2014-SED-043	NA	3/18/2014	28.2	0.895	28.6	0.556
2014-SED-044	NA	3/18/2014	11.3	0.501	24.8	1.79
2014-SED-045	NA	3/18/2014	19.2	1.01	19.1	0.433
2014-SED-046	NA	3/18/2014	26.6	4.47	19.6	0.273
2014-SED-048	2	3/19/2014	26.6	1.61	31.8	0.441
2014-SED-050	NA	4/15/2014	29.6	1.07	21.2 b	0.357

Table 4. Summary of Downstream Sediment Data for Stewart Creek Collected in 2014
Screening Level Ecological Risk Assessment

Sample I.D.	Hot Spot	Sample Date	Metals (mg/Kg)			Total Organic Carbon (%)
			Arsenic	Cadmium	Lead	
Freshwater Sediment Benchmark			**9.79**	**0.99**	**35.8**	**NA**
Freshwater Sediment Benthic PCL			**21.4**	**3**	**82**	**NA**
2014-SED-051	NA	4/15/2014	49.9	0.273 J	18.5 b	0.409
2014-SED-053	NA	4/15/2014	41.4	0.351	16.3 b	0.514
2014-SED-054	NA	4/15/2014	22.3	0.824	21.0 b	0.547
2014-SED-055	NA	4/15/2014	15.1	0.344 J	20.8 b	0.876
2014-SED-056	NA	4/16/2014	9.81	0.464	21.6	2.09
2014-SED-057	NA	4/16/2014	17.2	0.534	17.7	0.170
2014-SED-058	NA	4/16/2014	18.6	0.785	15.0	0.486
2014-SED-059	NA	4/16/2014	13.2	0.377	19.6	0.919
2014-SED-061	NA	4/16/2014	13.2	0.421	17.9	0.566
2014-SED-062	NA	4/16/2014	18.0	0.612	21.2	0.497
2014-SED-063	NA	4/16/2014	19.6	0.630	29.0	0.677
Downstream Tributaries						
2014-SED-037	NA	3/18/2014	10.6	0.246 J	17.3	1.86
2014-SED-047	NA	3/19/2014	15.4	0.239 J	15.4	1.39
2014-SED-049	NA	3/19/2014	12.7	0.166 J	17.2 J	2.37 J
2014-SED-052	NA	4/15/2014	8.02	0.774	22.2 b	5.19
2014-SED-060	NA	4/16/2014	9.12	0.161 J	11.6	1.26

Notes:

1. mg/Kg - milligrams/Kilogram
2. Data Qualifiers: J = estimated concentration; J- = estimated, biased low, b = detected in method blank.
3. NA - Not Applicable
4. "--" - Not Analyzed
5. Freshwater benchmarks and midpoint benthic PCLs from TCEQ (2014).
6. Two hot spots are identified in Stewart Creek and those data points included in one of the two hot spots are noted by a #1 or #2. (See Figure 4 for locations of hot spots.)
7. Blue highlighting indicates concentration greater than benthic PCL.

Table 5. Summary of Sediment Particle Size
Screening Level Ecological Risk Assessment

Sample ID	Sample Date	Gravel (%)	Sand (%)	Silt (%)	Clay (%)
Upstream					
2014-SED-026	1/31/2014	46.4	31.2	8.9	13.5
2014-SED-027	1/31/2014	1.1	16.6	28.1	54.2
2014-SED-028	1/31/2014	1.9	43.9	32.0	22.2
2014-SED-029	1/31/2014	37.7	11.2	12.8	38.3
2014-SED-030	1/31/2014	29.7	46.6	18.5	5.2
2014-SED-031	1/31/2014	49.9	38.0	7.3	4.8
2014-SED-032	1/31/2014	47.9	33.6	12.9	5.6
2014-SED-033	1/31/2014	34.1	40.7	21.4	3.8
2014-SED-034	1/31/2014	23.5	50.3	15.1	11.1
2014-SED-035	1/31/2014	21.7	46.5	19.3	12.5
On Site Stewart Creek					
2012-SED-1	1/11/2012	13.10	21.40	34.70	30.80
2012-SED-2	1/11/2012	42.60	41.40	8.00	8.10
2012-SED-3	1/11/2012	61.00	19.10	12.40	7.50
2012-SED-4	1/11/2012	35.20	35.20	19.90	9.70
2012-SED-5	1/11/2012	50.20	34.70	12.50	2.60
2012-SED-6	1/11/2012	49.10	36.30	10.20	4.40
2012-SED-7	1/11/2012	37.30	42.10	13.70	7.00
2012-SED-8	1/11/2012	52.40	28.40	14.80	4.40
2012-SED-9	1/11/2012	39.00	40.40	12.00	8.60
2012-SED-10	1/12/2012	42.20	42.70	10.70	4.40
2012-SED-11	1/12/2012	53.20	40.60	0.90	5.30
2012-SED-12	1/12/2012	35.20	19.80	21.50	23.50
2012-SED-13	1/12/2012	41.40	45.90	7.90	4.80
North Tributary					
2012-SED-16	1/12/2012	30.90	50.50	9.60	9.00
2012-SED-17	1/12/2012	38.40	44.00	6.90	10.70
2012-SED-18	1/12/2012	34.80	49.50	9.50	6.20
2012-SED-19	1/12/2012	30.80	57.40	4.80	7.00
2012-SED-20	1/12/2012	39.40	44.10	11.30	5.20
2012-SED-21	1/12/2012	67.60	24.50	5.40	2.50
2012-SED-22	1/12/2012	42.50	38.70	15.20	3.60
2012-SED-23	1/12/2012	52.40	36.10	7.90	3.60
2012-SED-24	1/12/2012	28.50	53.20	9.70	8.60
2012-SED-25	1/12/2012	34.10	46.20	15.50	4.20
Downstream of Former Operating Plant					
2014-SED-001	1/28/2014	0.0	14.5	24.2	61.3
2014-SED-002	1/28/2014	2.6	21.3	54.9	21.2
2014-SED-003	1/28/2014	25.3	57.1	12.0	5.6
2014-SED-004	1/28/2014	35.4	54.0	10.0	0.6
2014-SED-005	1/28/2014	21.3	57.1	15.0	6.6
2014-SED-006	1/28/2014	47.0	45.2	7.3	0.6
2014-SED-007	1/28/2014	40.8	48.5	8.9	1.8
2014-SED-008	1/28/2014	39.1	51.6	8.6	0.7
2014-SED-009	1/28/2014	42.6	44.2	8.1	5.1
2014-SED-010	1/28/2014	40.0	47.7	8.8	3.5

Table 5. Summary of Sediment Particle Size
Screening Level Ecological Risk Assessment

Sample ID	Sample Date	Gravel (%)	Sand (%)	Silt (%)	Clay (%)
2014-SED-011	1/28/2014	36.6	34.9	25.1	3.4
2014-SED-012	1/28/2014	37.4	34.2	18.9	9.5
2014-SED-013	1/28/2014	21.2	28.0	26.2	24.6
2014-SED-014	1/29/2014	46.9	26.0	11.8	15.3
2014-SED-015	1/29/2014	56.2	22.0	16.5	5.3
2014-SED-016	1/29/2014	25.3	42.9	19.6	12.2
2014-SED-017	1/29/2014	22.4	44.4	18.2	15.0
2014-SED-018	1/29/2014	1.5	44.0	25.3	29.2
2014-SED-019	1/30/2014	0.0	35.8	31.7	32.5
2014-SED-020	1/30/2014	38.0	46.1	5.9	10.0
2014-SED-021	1/30/2014	18.0	63.1	12.1	6.8
2014-SED-022	1/30/2014	0.0	21.7	30.0	48.3
2014-SED-023	1/30/2014	60.8	25.7	12.1	1.4
2014-SED-024	1/30/2014	48.9	38.6	7.6	4.9
2014-SED-025	1/30/2014	40.3	43.5	10.7	5.5
2014-SED-036	3/18/2014	12.8	21.0	27.7	38.5
2014-SED-037	3/18/2014	1.4	23.1	27.6	47.9
2014-SED-038	3/18/2014	11.2	28.1	35.1	25.6
2014-SED-039	3/18/2014	42.0	49.5	7.5	1.1
2014-SED-040	3/18/2014	39.5	32.3	7.6	20.6
2014-SED-041	3/18/2014	19.0	53.0	26.0	2.0
2014-SED-042	3/18/2014	46.6	42.6	9.0	1.8
2014-SED-043	3/18/2014	2.9	63.9	9.1	24.1
2014-SED-044	3/18/2014	0.6	25.2	30.8	43.4
2014-SED-045	3/18/2014	20.4	51.3	19.6	8.7
2014-SED-046	3/18/2014	37.0	32.8	25.8	4.4
2014-SED-047	3/19/2014	6.0	20.0	30.5	43.5
2014-SED-048	3/19/2014	37.4	52.5	6.2	3.9
2014-SED-049	3/19/2014	4.4	11.4	49.5	34.7
2014-SED-050	4/15/2014	56.1	39.2	3.8	0.9
2014-SED-051	4/15/2014	42.5	45.5	9.0	3.0
2014-SED-052	4/15/2014	0	15.3	61.4	23.3
2014-SED-053	4/15/2014	51.6	34.4	9.3	4.7
2014-SED-054	4/15/2014	21.0	61.0	7.3	10.7
2014-SED-055	4/15/2014	7.9	52.9	18.5	20.7
2014-SED-056	4/16/2014	0.6	9.0	42.4	48.0
2014-SED-057	4/16/2014	32.1	58.5	4.4	5.0
2014-SED-058	4/16/2014	27.7	58.2	6.3	7.8
2014-SED-059	4/16/2014	5.1	57.6	18.7	18.6
2014-SED-060	4/16/2014	0	48.1	20.6	31.3
2014-SED-061	4/16/2014	7.8	58.0	13.8	20.4
2014-SED-062	4/16/2014	19.8	64.1	7.7	8.4
2014-SED-063	4/16/2014	11.2	67.8	7.6	13.4

Table 5. Summary of Sediment Particle Size
Screening Level Ecological Risk Assessment

Sample ID	Sample Date	Gravel (%)	Sand (%)	Silt (%)	Clay (%)
		Gravel (%)	Sand (%)	Silt, Clay, Colloids (%)	
SC-Sed-31	6/12/2013	0.67	87.0	12.3	
SC-Sed-32	6/12/2013	26.8	69.4	3.8	
SC-Sed-33	6/12/2013	8.4	85.0	6.7	
SC-Sed-34	6/12/2013	2.4	88.9	8.7	
SC-Sed-35	6/12/2013	33.1	65.2	1.8	
SC-Sed-36	6/12/2013	10.4	75.4	14.2	
SC-Sed-37	6/12/2013	7.9	84.3	7.8	
SC-Sed-38	6/12/2013	9.0	79.9	11.2	
SC-Sed-39	6/12/2013	28.4	55.1	16.5	
SC-Sed-40	6/12/2013	5.4	29.9	64.8	
SC-Sed-41	6/19/2013	16.5	49.4	34.1	
SC-Sed-42	6/19/2013	23.7	57.8	18.5	
SC-Sed-43	6/19/2013	4.0	90.0	6.0	
SC-Sed-44	6/19/2013	16.4	47.4	36.2	
SC-Sed-45	6/19/2013	9.4	58.1	32.5	
SC-Sed-46	6/19/2013	21.4	67.0	11.5	
SC-Sed-47	6/19/2013	17.9	71.3	10.8	
SC-Sed-48	6/19/2013	18.2	70.2	11.7	

Table 6. Summary of Upper Groundwater Bearing Unit Data from Monitoring Wells in Vicinity of Stewart Creek and North Tributary
Screening Level Ecological Risk Assessment

				Total				Dissolved			
			Analyte	**Arsenic**	**Cadmium**	**Lead**	**Selenium**	**Arsenic**	**Cadmium**	**Lead**	**Selenium**
			^{SW}GW PCL (SW RBEL based on chronic aquatic life criteria, no dilution factor)	**NA**	**NA**	**NA**	**NA**	**0.15**	**0.000256**	**0.00268**	**0.005**
			^{SW}GW PCL (SW RBEL, with 0.15 dilution factor)	**NA**	**NA**	**NA**	**NA**	**--**	**0.0017**	**0.018**	**0.033**
			Units	**mg/L**	**mg/L**	**mg/L**	**mg/L**	**mg/L**	**mg/L**	**mg/L**	**mg/L**
Location ID	**GWBU/Location Information**	**Date Sampled**	**Method**								
Stewart Creek											
B5N	Upper GWBU/NW corner of Battery Storage Building	1/17/2012	6010	--	< 0.000350 U	< 0.00290 U	--	--	< 0.000350 U	< 0.00290 U	--
		3/22/2013	6010	--	< 0.000350 U	< 0.00290 U	--	--	< 0.000350 U	< 0.00290 U	--
MW-11	Upper GWBU/Adjacent to RR Tracks/Downstream Property Boundary	4/9/2013	6010	--	< 0.000350 U	< 0.00290 U	--	--	< 0.000350 U	< 0.00290 U	--
		3/28/2014	6020	--	--	--	--	--	< 0.0000950 U	--	--
MW-12	Upper GWBU/SE of Chrystallizer unit	1/16/2012	6010	--	< 0.000350 U	< 0.00290 U	--	--	< 0.000350 U	< 0.00290 U	--
		3/13/2013	6010	--	**0.00103 J**	**0.0029 J**	--	--	< 0.000350 U	< 0.00290 U	--
MW-13	Upper GWBU/East of Storm Water Retention Pond	1/16/2012	6010	--	< 0.000350 U	< 0.00290 U	--	--	< 0.000350 U	< 0.00290 U	--
		3/13/2013	6010	--	< 0.000350 U	< 0.00290 U	--	--	< 0.000350 U	< 0.00290 U	--
MW-14	Upper GWBU/Along Stewart Creek	1/16/2012	6010	--	< 0.000350 U	**0.00311J**	--	--	< 0.000350 U	< 0.00290 U	
		3/13/2013	6010	--	< 0.000350 U	< 0.00290 U	--	--	**0.0007J**	< 0.00290 U	
		2/17/2014	6020	--	<0.0000950 U	**0.000302 J**	--	--	**0.000120 J**	**0.00433**	--
MW-16S	Upper GWBU/Along Stewart Creek	1/17/2012	6010	--	< 0.000350 U	< 0.00290 U	--	--	< 0.000350 U	**0.00299J**	--
		4/9/2013	6010	--	**0.0012J**	**0.005J**	--	--	**0.0007J**	**0.0041J**	--
		2/14/2014	6020	--	**0.00240**	**0.00602**	--	--	< 0.0000950 U	**0.000430 J**	--
MW-17	Upper GWBU/Along Stewart Creek	1/18/2012	6010	--	< 0.000350 U	**0.00411J**	--	--	< 0.000350 U	**0.0029 UJ**	--
		3/22/2013	6010	--	**0.0004J**	< 0.00290 U	--	--	< 0.000350 U	< 0.00290 U	--
		2/17/2014	6020	--	**0.000182 J**	< 0.000200 U	--	--	**0.000130 J**	< 0.000200 U	--
MW-24	Upper GWBU/Near B5N and MW-17	3/18/2013	6010	--	< 0.000350 U	**0.0038J**	--	--	< 0.000350 U	**0.0054J**	--
MW-26	Upper GWBU/Along Stewart Creek	4/9/2013	6010	--	**0.0006J**	< 0.00290 U	--	--	**0.0004J**	< 0.00290 U	--
		2/17/2014	6020	--	**0.000311 J**	**0.000287 J**	--	--	**0.000302 J**	**0.000327 J**	--
MW-27	Upper GWBU/Along Stewart Creek	4/9/2013	6010	--	**0.001J**	**0.0029J**	--	--	**0.0009J**	**0.0035J**	--
		2/17/2014	6020	--	**0.000354 J**	**0.000718 J**	--	--	**0.000410 J**	**0.000743 J**	--
MW-29	Upper GWBU/Along Stewart Creek	4/9/2013	6010	--	**0.0015J**	< 0.00290 U	--	--	**0.0014J**	< 0.00290 U	--
		2/17/2014	6020	--	**0.000765**	**0.000433 J**	--	--	**0.000865**	**0.000937 J**	--
MW-31	Upper GWBU/Along Stewart Creek, across creek from MW-14	5/13/2013	6010	--	< 0.00035 U	< 0.0029 U	--	--	< 0.000350 U	< 0.00290 U	--
P-2	Upper GWBU/In South Wooded Area	3/19/2013	6010	--	**0.0012 J**	**0.005 J**	--	--	**0.0014 J**	**0.005 J**	--
MW-37	Upper GWBU/NW of Stormwater Pond	1/21/2014	NA	NS	NS	NS	NS	NS	NS	NS	NS
		2/13/2014	6020	< 0.00130 U	**0.000375 J**	**0.00173**	< 0.00100 U	**0.00132 J**	**0.000350 J**	**0.00132 J**	**0.00193 J**
		3/28/2014	6020	--	--	--	--	--	< 0.0000950 U	--	--
MW-38	Upper GWBU/Stormwater Pond	1/16/2014	6010	< 0.00328 U	< 0.000350 U	< 0.00290 U	**0.00603 J**	< 0.00328 U	< 0.000350 U	< 0.00290 U	**0.00470 J**
		1/16/2014	6020	--	--	--	--	**0.00165 J**	**0.000150 J**	**0.000281 J**	< 0.00100 U
MW-44	Upper GWBU/Truck Wash	1/22/2014	6010	--	R	R	--	--	**0.00100 J**	< 0.00290 U	--
		1/22/2014	6020	--	--	--	--	--	**0.000495 J**	**0.00148 J**	--
		2/17/2014	6020	--	**0.000109 J**	**0.00611**	--	--	**0.000131 J**	**0.00192**	--
MW-46	Upper GWBU/adjacent to perched well MW-32	1/22/2014	6010	--	R	R	--	--	**0.00190 J**	**0.0259**	--
		2/17/2014	6020	--	**0.000812**	**0.00185**	--	--	**0.000834**	**0.00488**	--
		3/27/2014	6020	--	**0.000794**	**0.00546**	--	-	**0.000797**	**0.00302 J**	--

				Total				Dissolved			
			Analyte	**Arsenic**	**Cadmium**	**Lead**	**Selenium**	**Arsenic**	**Cadmium**	**Lead**	**Selenium**
North Tributary											
^{SW}GW PCL (SW RBEL based on acute aquatic life criteria, no dilution factor)				**NA**	**NA**	**NA**	**NA**	**0.34**	**0.00908**	**0.0688**	**0.02**
			Units	**mg/L**	**mg/L**	**mg/L**	**mg/L**	**mg/L**	**mg/L**	**mg/L**	**mg/L**
B7N	Upper GWBU/North Wooded Area	3/18/2013	6010	--	< 0.000350 U	< 0.00290 U	--	--	< 0.000350 U	< 0.00290 U	--
B9N	Upper GWBU/North Wooded Area	4/10/2013	6010	--	< 0.000350 U	< 0.00290 U	--	--	< 0.000350 U	< 0.00290 U	--
		4/10/2013	6010	--	< 0.000350 U	< 0.00290 U	--	--	< 0.000350 U	< 0.00290 U	--
P-1	Upper GWBU/North Wooded Area	4/9/2013	6010	--	< 0.000350 U	< 0.00290 U	--	--	< 0.000350 U	< 0.00290 U	--
LMW-5	Upper GWBU/Class 2 landfill	3/13/2013	6010	< 0.00328 U	< 0.000350 U	< 0.00290 U	< 0.00417 U	< 0.00328 U	< 0.000350 U	< 0.00290 U	< 0.00417 U
LMW-8	Upper GWBU/Class 2 landfill	3/13/2013	6010	< 0.00328 U	< 0.000350 U	< 0.00290 U	**0.0104 J**	< 0.00328 U	< 0.000350 U	< 0.00290 U	**0.0057 J**
		4/12/2013	6010	--	--	--	**0.0055 J**	--	--	--	**0.0056 J**
LMW17	Upper GWBU/Class 2 landfill	3/12/2013	6010	< 0.00328 U	< 0.000350 U	< 0.00290 U	< 0.00417 U	< 0.00328 U	< 0.000350 U	< 0.00290 U	< 0.00417 U
LMW-22	Upper GWBU/Class 2 landfill	3/13/2013	6010	< 0.00328 U	< 0.000350 U	< 0.00290 U	< 0.00417 U	< 0.00328 U	< 0.000350 U	< 0.00290 U	< 0.00417 U
MW-18	Upper GWBU/W of Slag Landfill	1/17/2012	3010		< 0.000350 U	< 0.00290 U			< 0.000350 U	< 0.00290 U	
		3/18/2013	6010	--	< 0.000350 U	< 0.00290 U	--	--	< 0.000350 U	< 0.00290 U	--
MW-21	Upper GWBU/North Wooded Area	4/9/2013	6010	--	**0.0005J**	< 0.00290 U	--	--	**0.0005J**	< 0.00290 U	--
MW-22	Upper GWBU/North Wooded Area	4/9/2013	6010	--	**0.0029J**	**0.0063J**	--	--	**0.0029J**	**0.004J**	--
MW-39	Upper GWBU/Slag Landfill	1/17/2014	6010	--	< 0.000350 U	< 0.00290 U	--	--	< 0.000350 U	**0.00440 J**	--
MW-40	Upper GWBU/Slag Landfill	1/17/2014	6010	--	< 0.000350 U	< 0.00290 U	--	--	< 0.000350 U	< 0.00290 U	--
MW-41	Upper GWBU/North Tributary	1/17/2014	6010	--	< 0.000350 U	**0.00699 J**	--	NS	NS	NS	NS
		1/17/2014	6020	--	--	**0.00207**	--	--	--	--	--
		2/14/2014	6010	--	--	NA	--	< 0.00328 U	< 0.000350 U	< 0.00290 U	< 0.00417 U
MW-42	Upper GWBU/North Tributary	1/17/2014	6010	--	< 0.000350 U	**0.00369 J**	--	NS	NS	NS	NS
		1/17/2014	6020	--	--	< 0.000200 U	--	--	--	--	--
		2/14/2014	6010	--	--	--	--	< 0.00328 U	< 0.000350 U	< 0.00290 U	< 0.00417 U

Notes:
1. < - Indicates analyte not detected above method detection limit (MDL).
2. NA - Not Applicable
3. J - Analyte concentration estimated. U - Analyte not detected.
4. R - Indicates data rejection due to sample collection error (not properly filtered).
5. "--" - Not Analyzed
6. NS - Not sampled. Well was dry or there was insuffient volume available for sample collection.
7. Cadmium and lead criteria based on hardness value of 106 mg/L for Segment 0823.
8. Monitoring wells along Stewart Creek considered a potential point of exposure where the ^{SW}GW PCL (chronic) applies.
9. Monitoring wells along the North Tributary of Stewart Creek considered potential point of exposure wells where the ^{SW}GW PCL (acute) applies.
10. Dissolved samples filtered with a 0.45 micron filter.
11. Detections are bolded and the exceedance is shaded.

Table 7. Threatened and Endangered Species - Collin and Denton Counties
Screening Level Ecological Risk Assessment

Common Name[1]	Scientific Name	Status[2] Federal	Texas	Description	Signficant Presence Terrestrial	Aquatic	Comment
Birds							
American Peregrine Falcon	*Falco peregrinus anatum*	DL	T	Year-round resident and local breeder in west Texas, nests in tall cliff eyries; also, migrant across state from more northern breeding areas in US and Canada, winters along coast and farther south; occupies wide range of habitats during migration, including urban, concentrations along coast and barrier islands; low-altitude migrant, stopovers at leading landscape edges such as lake shores, coastlines, and barrier islands.	N	N	Unlikely to feed on local prey in urban area; possible rare fly-overs.
Arctic Peregrine Falcon	*Falco peregrinus tundrius*	DL		migrant throughout state from subspecies' far northern breeding range, winters along coast and farther south; occupies wide range of habitats during migration, including urban, concentrations along coast and barrier islands; low-altitude migrant, stopovers at leading landscape edges such as lake shores, coastlines, and barrier islands.	N	N	May occur as infrequent transient.
Bald Eagle	*Haliaeetus leucocephalus*	DL	T	Found primarily near rivers and large lakes; nests in tall trees or on cliffs near water; communally roosts, especially in winter; hunts live prey, scavenges, and pirates food from other birds.	N	N	May occur as infrequent transient.
Interior Least Tern	*Sterna antillarum athalassos*	LE	E	Subspecies is listed only when inland (more than 50 miles from a coastline); nests along sand and gravel bars within braided streams, rivers; also know to nest on man-made structures (inland beaches, wastewater treatment plants, gravel mines, etc); eats small fish and crustaceans, when breeding forages within a few hundred feet of colony.	N	N	May occur as infrequent transient.
Peregrine Falcon	*Falco peregrinus tundrius*	DL	T	Migrates across the state from more northern breeding areas in US and Canada to winter along coast and farther south; no longer listed in Texas, but because the subspecies are not easily distinguishable at a distance, reference is generally made only to the species level.	N	N	Unlikely to feed on local prey; possible rare fly-overs.
Piping Plover	*Charadrius melodus*	LT	T	Wintering migrant along the Texas Gulf Coast; beaches and bayside mud or salt flats.	N	N	May occur as infrequent transient.
Sprague's Pipit	*Anthus spragueii*	C		Only in Texas during migration and winter, mid September to early April; short to medium distance, diurnal migrant; strongly tied to native upland prairie, can be locally common in coastal grasslands, uncommon to rare further west; sensitive to patch size and avoids edges.	N	N	Unlikely to feed on local prey in urban area; possible rare fly-overs.
White-faced Ibis	*Plegadis chihi*		T	Prefers freshwater marshes, sloughs, and irrigated rice fields, but will attend brackish and saltwater habitats; nests in marshes, in low trees, on the ground in bulrushes or reeds, or on floating mats. The white-faced ibis seems to prefer freshwater marshes, where it can find insects, newts, leeches, earthworms, snails and especially crayfish, frogs and fish. They roost on low platforms of dead reed stems or on mud banks. In Texas, they breed and winter along the Gulf Coast and may occur as migrants in the Panhandle and West Texas (TPWD, 2013).	N	N	The white-faced ibis prefers freshwater marshes. They roost on low platforms of dead reed stems or on mud banks. In Texas, they breed and winter along the Gulf Coast and may occur as migrants in the Panhandle and West Texas (TPWD, 2013a). Prefered habitat is not found in Stewart Creek and its presence is unlikely. See Appendix C.
Whooping Crane	*Grus americana*	LE	E	Potential migrant via plains throughout most of state to coast; winters in coastal marshes of Aransas, Calhoun, and Refugio counties.	N	N	Unlikely to feed on local prey; possible rare fly-overs.
Wood Stork	*Mycteria americana*		T	Forages in prairie ponds, flooded pastures or fields, ditches, and other shallow standing water, including salt-water; usually roosts communally in tall snags, sometimes in association with other wading birds (i.e. active heronries); breeds in Mexico and birds move into Gulf States in search of mud flats and other wetlands, even those associated with forested areas; formerly nested in Texas, but no breeding records since 1960.	N	N	Unlikely to feed on local prey; possible rare fly-overs.
Mammals							
Red wolf	*Canis rufus*	LE	E	Extirpated; formerly known throughout eastern half of Texas in brushy and forested areas, as well as coastal prairies.	N	N	Considered extirpated from region.
Mollusks							
Louisiana Pigtoe	*Pleurobe mariddellii*		T	Found in streams and moderate-size rivers, usually flowing water on substrates of mud, sand, and gravel; not generally known from impoundments; Sabine, Neches, and Trinity (historic) River basins. Ranged from eastern Texas drainages into Louisiana, but has been exceptionally rare in recent decades. Since the mid-1990s, small numbers of living specimens have been found in the Neches River and some of its tributaries and the Angelina River (TPWD, 2009).	N	N	No evidence that these species are present in Stewart Creek follwing 2014 habitat assessment. See Appendix C.
Texas heelsplitter	*Potamilus amphichaenus*		T	Found in quiet waters in mud or sand and also in reservoirs. Sabine, Neches, and Trinity River basins	N	N	
Reptiles							
Alligator snapping turtle	*Macrochelys temminckii*		T	Perennial water bodies; deep water of rivers, canals, lakes, and oxbows; also swamps, bayous, and ponds near deep running water; sometimes enters brackish coastal waters; usually in water with mud bottom and abundant aquatic vegetation; may migrate several miles along rivers.	N	N	Unlikely to be present in Stewart Creek due to high flow conditions and small number of shallow pooling areas found in Stewart Creek. Deep muddy bottom pools with adequate vegetationn are not present, broad sandy flood plain preferred by females is uncommon along Stewart Creek. See Appendix C.
Timber/Canebrake rattlesnake	*Crotalus horridus*		T	Swamps, floodplains, upland pine and deciduous woodlands, riparian zones, abandoned farmland; limestone bluffs, sandy soil or black clay; prefers dense ground cover, i.e. grapevines or palmetto.	N	N	Not expected in study area due to limited and fragmented habitat. Surrounding areas are dominated by urban development and active agricultural fields. Continuous undisturbed scrub shrub and forested habitat is required. See Appendix C.
Texas horned lizard	*Phrynosoma cornutum*		T	Open, arid and semi-arid regions with sparse vegetation, including grass, cactus, scattered brush or scrubby trees; soil may vary in texture from sandy to rocky; burrows into soil, enters rodent burrows, or hides under rock when inactive.	N	N	Diet is primarily harvester ants. No harvester ant nests were noted on site. Unlikely to be present.

Notes:

1 - Taxa provided in the Texas Parks and Wildlife Departments Rare, Threatened, and Endangered Species of Texas List for Denton and Collin Counties.

http://www.tpwd.state.tx.us/gis/ris/es/ Only taxa listed as threatened or endangered on either the federal or state list are included.

2 - T = Threatened; E = Endangered; C = Candidate for Listing; LT = Listed Threatened; LE = Listed Endangered; DL = De-Listed.

TPWD 2009, 15 Texas Freshwater Mussels Placed on State Threatened List. November 5, 2009. http://www.texashuntfish.com/app/view/Post/27233/15-Texas-Freshwater-Mussels-Placed-on-State-Threatened-List

TPWD 2013, On Line Species Information on White Faced Ibis: http://www.tpwd.state.tx.us/huntwild/wild/species/ibis/

Table 8. Sediment Data Summary Statistics
Screening Level Ecological Risk Assessment

Exposure Area	Average (mg/kg)	Minimum Detection (mg/kg)	Maximum Detection (mg/kg)	95% UCL (mg/kg)	Statistic Used
Stewart Creek Upstream					
Arsenic	15.95	8.55	42.70	21.71	95% Student's-t UCL
Cadmium	0.44	0.26	0.69	0.53	95% Student's-t UCL
Lead	12.34	6.56	19.8	14.56	95% Student's-t UCL
North Tributary On-Site					
Arsenic	ND	ND	ND	ND	ND
Cadmium	0.92	0.69	1.19	1.02	95% Student's-t UCL
Lead	16.51	10.4	28.2	20.14	95% Student's-t UCL
Stewart Creek On-Site					
Arsenic	ND	ND	ND	ND	ND
Cadmium	1.00	0.34	2.08	1.21	95% Student's-t UCL
Lead	12.21	6.57	19.20	14.26	95% Student's-t UCL
Stewart Creek Downstream of FOP					
Arsenic	22.16	7	279	32.35	95% Chebyshev
Cadmium	1.09	0.04	6.96	1.46	95% Chebyshev
Lead	35.48	8.20	459	58.28	95% Chebyshev
Stewart Creek On-Site and Downstream (with Hot Spots included)					
Arsenic	22.16	7	279	32.35	95% Chebyshev
Cadmium	1.08	0.04	6.96	1.42	95% Chebyshev
Lead	33.37	6.57	459	54.24	95% Chebyshev
Stewart Creek On-Site and Downstream (without Hot Spots)					
Arsenic	19.91	7	57.7	21.89	95% Student's-t UCL
Cadmium	1.01	0.16	4.47	1.32	95% Chebyshev
Lead	21.36	6.57	59	23.13	95% Student's-t UCL

Notes:
1. UCL - upper confidence limit
2. ND - no data; arsenic data not available for on-Site Stewart Creek and the North Tributary.
3. ProUCL output presented in Appendix B.

Table 9. Sediment-To-Fish Evaluation
Screening Level Ecological Risk Assessment

Exposure Area	BSAF	95% UCL (mg/kg)	Estimated Fish Tissue Concentration (mg/kg)	Literature Based Tissue Concentration (mg/kg)	Rationale
Stewart Creek Upstream					
Arsenic	0.162	21.71	3.52	27	Evaluated because one detection > benthic PCL. Estimated tissue concentration well below literature estimate.
Cadmium	0.53	0.53	0.28	4.8	All detections less than benchmark but considered bioaccumulative in sediment. Estimated tissue concentration well below literature estimate.
Lead	NE	NE	NE	NE	All detections less than benchmark and lead is not bioaccumulative in sediment.
Stewart Creek On-Site					
Arsenic	0.162	NE	NE	NE	Arsenic sediment data not available.
Cadmium	0.53	1.02	0.54	4.8	All detections less than benchmark but considered bioaccumulative in sediment. Estimated tissue concentration well below literature estimate.
Lead	0.07	NE	NE	NE	All detections less than benchmark and lead is not bioaccumulative in sediment.
Stewart Creek Downstream of the FOP					
Arsenic	0.162	32.35	5.24	27	Evaluated because at least one detection > benthic PCL. Estimated tissue concentration well below literature estimate.
Cadmium	0.53	1.46	0.77	4.8	Evaluated because at least one detection > benthic PCL and bioaccumulative . Estimated tissue concentration well below literature estimate.
Lead	0.07	58.28	4.08	20-44	Evaluated because at least one detection > benthic PCL. Estimated tissue concentration well below literature estimate.

Notes:
NE - Not Evaluated, see text for further discussion.
North Tributary is classified as intermittent and is therefore not evaluated.

Table 10. NOAEL Based HQ Summary: Initial Conservative Assessment
Screening Level Ecological Risk Assessment

	Snowy Egret	Raccoon
	NOAEL-HQ	
Stewart Creek Upstream		
Arsenic	0.45	0.26
Cadmium	0.047	0.08
Lead	Lead removed in screening process. Max < benchmark and not bioaccumulative in sediment or water.	
North Tributary		
Arsenic	Arsenic data not available.	
Cadmium	0.09	0.15
Lead	Lead removed in screening process. Max < benchmark and not bioaccumulative in sediment or water.	
Stewart Creek On-Site		
Arsenic	Arsenic data not available.	
Cadmium	0.11	0.18
Lead	Lead removed in screening process. Max < benchmark and not bioaccumulative in sediment or water.	
Stewart Creek Downstream of the FOP		
Arsenic	0.67	0.39
Cadmium	0.13	0.22
Lead	**1.2**	0.31
Stewart Creek On-Site + Downstream of the FOP		
Arsenic	0.67	0.39
Cadmium	0.13	0.21
Lead	**1.1**	0.29
Stewart Creek On-Site + Downstream of the FOP (with Hot Spots Removed)		
Arsenic	0.45	0.27
Cadmium	0.12	0.20
Lead	0.48	0.12

Notes:

NOAEL - No Observed Adverse Effect Level

HQ - Hazard Quotient

According to Section 3.10 of TCEQ 2014; if the HQ is ≤ 1 for a given COC, then the COC is not considered further. Therefore only those COCs and receptors with HQ > 1 are carried forward to the refined or less-conservative assessment (see Table 11).

Table 11. NOAEL and LOAEL Based HQ Summary: Refined Less-Conservative Assessment
Screening Level Ecological Risk Assessment

	Snowy Egret		Raccoon	
	NOAEL-HQ	**LOAEL-HQ**	**NOAEL-HQ**	**LOAEL-HQ**
Stewart Creek Upstream				
Arsenic	--	--	--	--
Cadmium	--	--	--	--
Lead	Lead removed in screening process. Max < benchmark and not bioaccumulative in sediment or water.			
North Tributary				
Arsenic	Arsenic data not available.			
Cadmium	--	--	--	--
Lead	Lead removed in screening process. Max < benchmark and not bioaccumulative in sediment or water.			
Stewart Creek On-Site				
Arsenic	Arsenic data not available.			
Cadmium	--	--	--	--
Lead	Lead removed in screening process. Max < benchmark and not bioaccumulative in sediment or water.			
Stewart Creek Downstream of the FOP				
Arsenic	--	--	--	--
Cadmium	--	--	--	--
Lead	**1.2**	0.61	--	--
Stewart Creek On-Site + Downstream of the FOP				
Arsenic	--	--	--	--
Cadmium	--	--	--	--
Lead	**1.1**	0.57	--	--
Stewart Creek On-Site + Downstream of the FOP (with Hot Spots Removed)				
Arsenic	--	--	--	--
Cadmium	--	--	--	--
Lead	--	--	--	--

Notes:
NOAEL - No Observed Adverse Effect Level
LOAEL - Lowest Observed Adverse Effect Level
HQ - Hazard Quotient
An HQ value less than 1 indicates that risk is minimal.
NA- Not Appplicable, indicating that the HQ < 1 in the initial conservative assessment and further evaluation not necessary in the refined less-conservative assessment.
"--" indcates that the pathway in not applicable.

FIGURES

LEGEND

- Onsite Portion of Stewart Creek
- Upstream Portion of Stewart Creek (On Buffer Property)
- Stewart Creek
- Other Creek / Tributary
- Exide Site
- Undeveloped Buffer Property

NOTES

1. WWTP - WASTE WATER TREATMENT PLANT

REFERENCE

1. SITE FEATURES - GOLDER, 2014
2. AERIAL IMAGERY - SOURCE: ESRI, DIGITALGLOBE, GEOEYE, I-CUBED, USDA, USGS, AEX, GETMAPPING, AEROGRID, IGN, IGP, AND THE GIS USER COMMUNITY

DRAFT

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Feet

CLIENT
EXIDE TECHNOLOGIES

PROJECT
SCREENING LEVEL ECOLOGICAL RISK ASSESSMENT

TITLE
SITE MAP - UPSTREAM AND ON-SITE STEWART CREEK

CONSULTANT
Golder Associates

YYYY-MM-DD	2014-14-05
PREPARED	JWT
DESIGN	####
REVIEW	####
APPROVED	####

PROJECT No.	CONTROL	Rev.	FIGURE
13-02086	1302086JA006.mxd	0	1

LEGEND

- Downstream Portion of Stewart Creek
- Onsite Portion of Stewart Creek
- Other Creek / Tributary
- Exide Site
- Undeveloped Buffer Property

NOTES

1. USACE - U.S. ARMY CORPS OF ENGINEERS
2. WWTP - WASTE WATER TREATMENT PLANT

REFERENCE

1. IMAGERY - SOURCE: ESRI, DIGITALGLOBE, GEOEYE, I-CUBED, USDA, USGS, AEX, GETMAPPING, AEROGRID, IGN, IGP, AND THE GIS USER COMMUNITY

DRAFT

800 400 0 800
Feet

CLIENT
EXIDE TECHNOLOGIES
FRISCO, TX

PROJECT
SCREENING LEVEL ECOLOGICAL RISK ASSESSMENT

TITLE
SITE MAP - DOWNSTREAM STEWART CREEK

CONSULTANT

Golder Associates

YYYY-MM-DD	2014-14-12
PREPARED	JWT
DESIGN	JWT
REVIEW	AMF
APPROVED	####

PROJECT No.	CONTROL	Rev.	FIGURE
13-02086	1302086JA007.MXD	0	**2**

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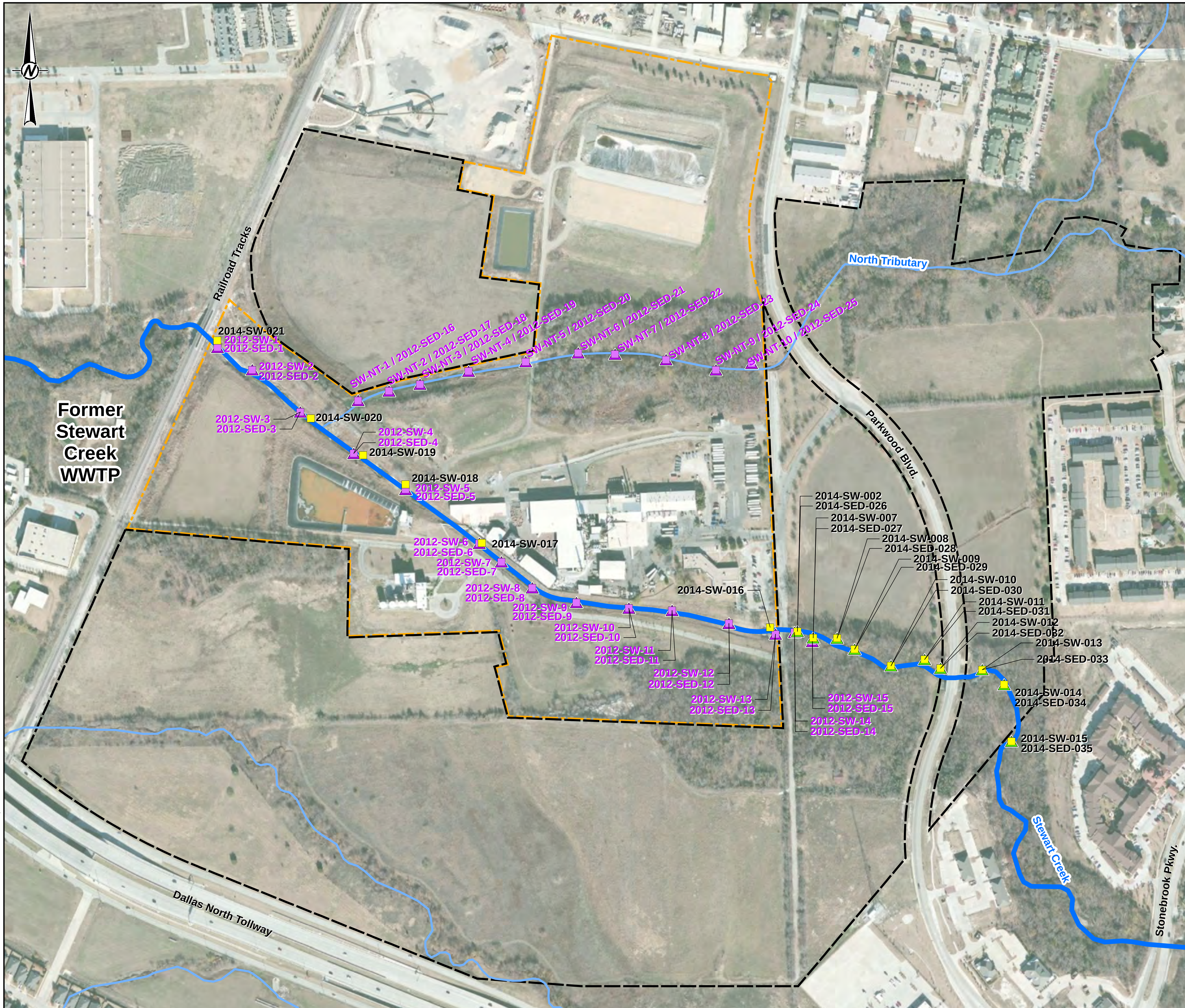

LEGEND

- 2014 Sediment Sample Location
- 2014 Surface Water Sample Location
- Sediment Sample Location
- Surface Water Sample Location
- Former Operating Plant
- Undeveloped Buffer Property

REFERENCE

1. HYDROGRAPHY - TEXAS NATURAL RESOURCES INFORMATION SYSTEM, 2014
2. LOCATIONS - PBW, SOUTHWEST GEOSCIENCES, AND GOLDER
3. AERIAL IMAGERY - SOURCE: ESRI, DIGITALGLOBE, GEOEYE, I-CUBED, USDA, USGS, AEX, GETMAPPING, AEROGRID, IGN, IGP, AND THE GIS USER COMMUNITY

DRAFT

400 200 0 400
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CLIENT
EXIDE TECHNOLOGIES

PROJECT
SCREENING LEVEL ECOLOGICAL RISK ASSESSMENT

TITLE
UPSTREAM AND ON-SITE SURFACE WATER AND SEDIMENT SAMPLE LOCATIONS

CONSULTANT

Golder Associates

YYYY-MM-DD	2014-14-09
PREPARED	JWT
DESIGN	####
REVIEW	####
APPROVED	####

PROJECT No.	CONTROL	Rev.	FIGURE
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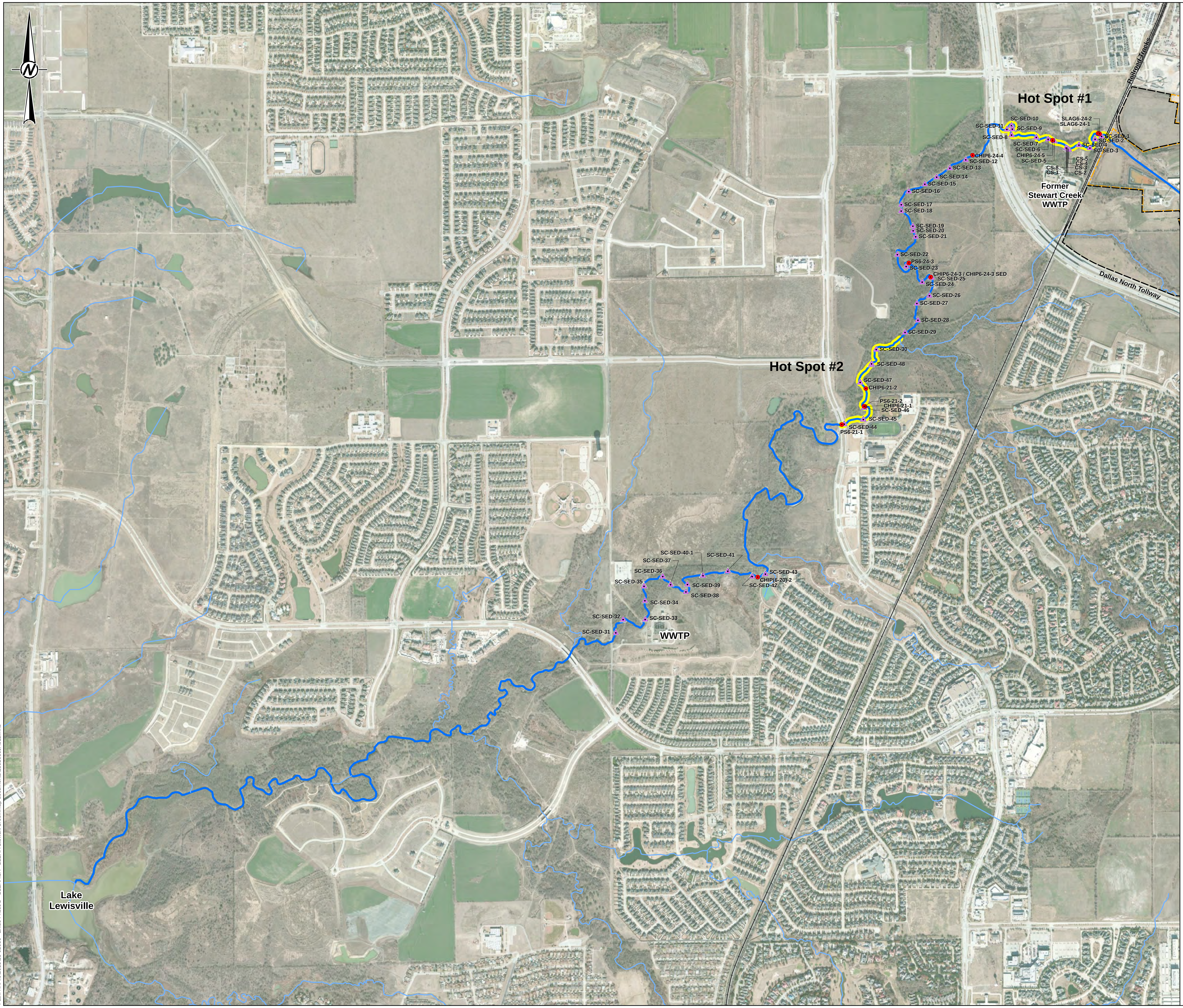


LEGEND

- Sediment Sample Location
- Chip, Slag, or Possible Slag
- Stewart Creek
- Other Creek / Tributary
- Creek Hotspot
- Exide Site
- Undeveloped Buffer Property

NOTES

1. USACE - U.S. ARMY CORPS OF ENGINEERS
2. WWTP - WASTE WATER TREATMENT PLANT

REFERENCE

1. HYDROGRAPHY - TEXAS NATURAL RESOURCES INFORMATION SYSTEM, 2014
2. LOCATIONS - PBW (2010), SOUTHWEST GEOSCIENCE (2011 AND 2013)
3. IMAGERY - SOURCE: ESRI, DIGITALGLOBE, GEOEYE, I-CUBED, USDA, USGS, AEX, GETMAPPING, AEROGRID, IGN, IGP, AND THE GIS USER COMMUNITY

DRAFT

800 400 0 800
Feet

CLIENT
EXIDE TECHNOLOGIES
FRISCO, TX

PROJECT
SCREENING LEVEL ECOLOGICAL RISK ASSESSMENT

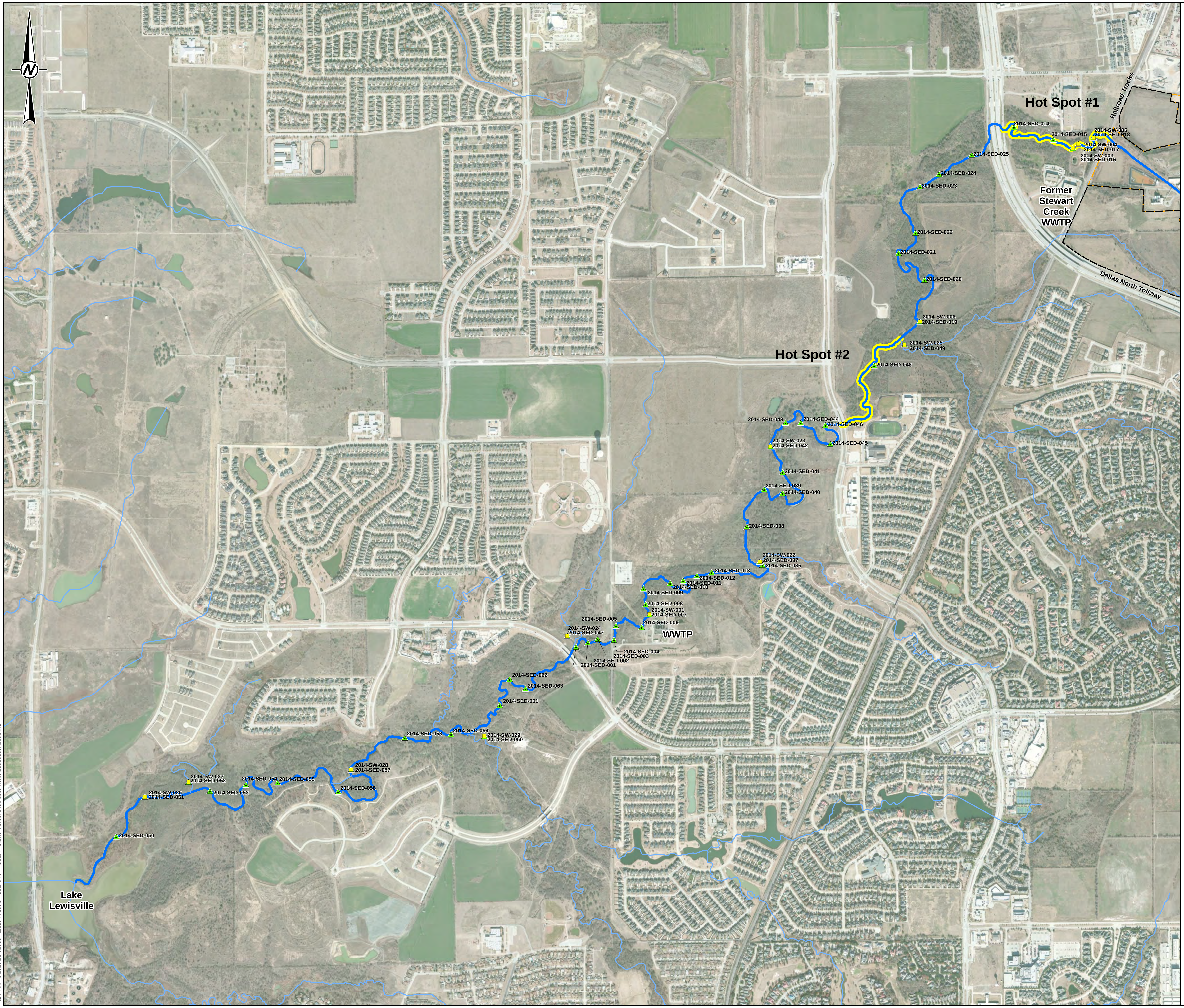
TITLE
2010, 2011, AND 2013 DOWNSTREAM SAMPLE LOCATIONS

CONSULTANT
Golder Associates

YYYY-MM-DD	2014-14-12
PREPARED	JWT
DESIGN	JWT
REVIEW	AMF
APPROVED	####

PROJECT No.	CONTROL	Rev.	FIGURE
13-02086	1302086JA011.MXD	0	4

IF THIS MEASUREMENT DOES NOT MATCH WHAT IS SHOWN, THE SHEET HAS BEEN MODIFIED FROM: ANSI D



LEGEND

- 2014 Sediment Sample Location
- 2014 Surface Water Sample Location
- Stewart Creek
- Other Creek / Tributary
- Former Operating Plant
- Undeveloped Buffer Property

NOTES

1. USACE - U.S. ARMY CORPS OF ENGINEERS
2. WWTP - WASTE WATER TREATMENT PLANT

REFERENCE

1. HYDROGRAPHY - TEXAS NATURAL RESOURCES INFORMATION SYSTEM, 2014
2. LOCATIONS - GOLDER, 2014
3. AERIAL IMAGERY - SOURCE: ESRI, DIGITALGLOBE, GEOEYE, I-CUBED, USDA, USGS, AEX, GETMAPPING, AEROGRID, IGN, IGP, AND THE GIS USER COMMUNITY

DRAFT

800 400 0 800
Feet

CLIENT
EXIDE TECHNOLOGIES
FRISCO, TX

PROJECT
SCREENING LEVEL ECOLOGICAL RISK ASSESSMENT

TITLE
2014 DOWNSTREAM SURFACE WATER AND SEDIMENT SAMPLE LOCATIONS

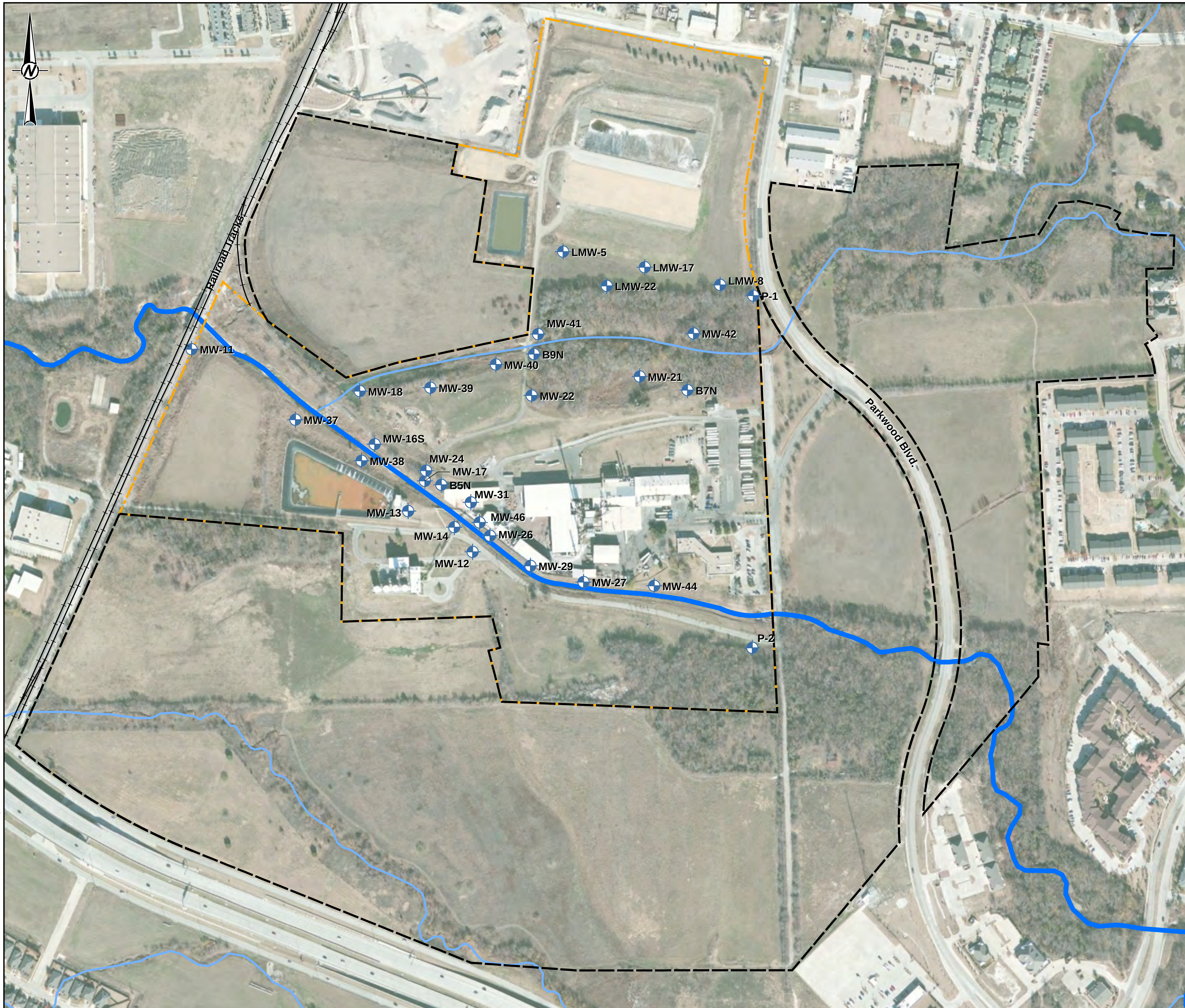
CONSULTANT

Golder Associates

YYYY-MM-DD	2014-14-12
PREPARED	JWT
DESIGN	JWT
REVIEW	AMF
APPROVED	####

PROJECT No.	CONTROL	Rev.	FIGURE
13-02086	1302086JA009.MXD	0	5

IF THIS MEASUREMENT DOES NOT MATCH WHAT IS SHOWN, THE SHEET HAS BEEN MODIFIED FROM: ANSI D



LEGEND

- MW
- Railroad
- Stewart Creek
- Other Creek / Tributary
- Former Operating Plant
- Undeveloped Buffer Property

REFERENCE

1. HYDROGRAPHY - TEXAS NATURAL RESOURCES INFORMATION SYSTEM, 2014
2. LOCATIONS - PBW, SOUTHWEST GEOSCIENCES, AND GOLDER
3. AERIAL IMAGERY - SOURCE: ESRI, DIGITALGLOBE, GEOEYE, I-CUBED, USDA, USGS, AEX, GETMAPPING, AEROGRID, IGN, IGP, AND THE GIS USER COMMUNITY

DRAFT

400 200 0 400
Feet

CLIENT
EXIDE TECHNOLOGIES

PROJECT
SCREENING LEVEL ECOLOGICAL RISK ASSESSMENT

TITLE
MONITORING WELL THAT REPRESENT THE GROUNDWATER TO SURFACE WATER PATHWAY

CONSULTANT

Golder Associates

YYYY-MM-DD	2014-14-12
PREPARED	JWT
DESIGN	####
REVIEW	####
APPROVED	####

PROJECT No.	CONTROL	Rev.	FIGURE
13-02086	1302086JA010.mxd	0	6

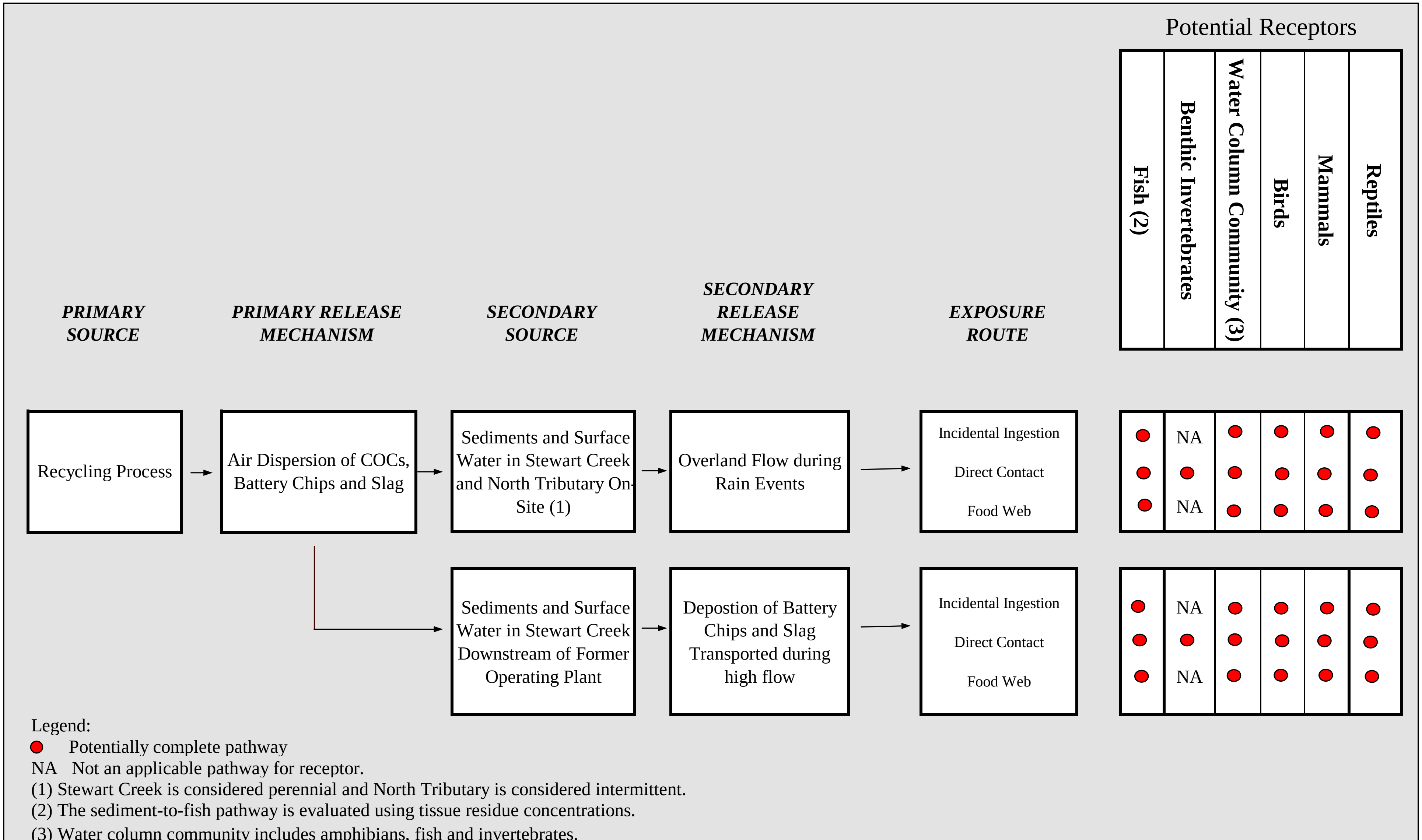
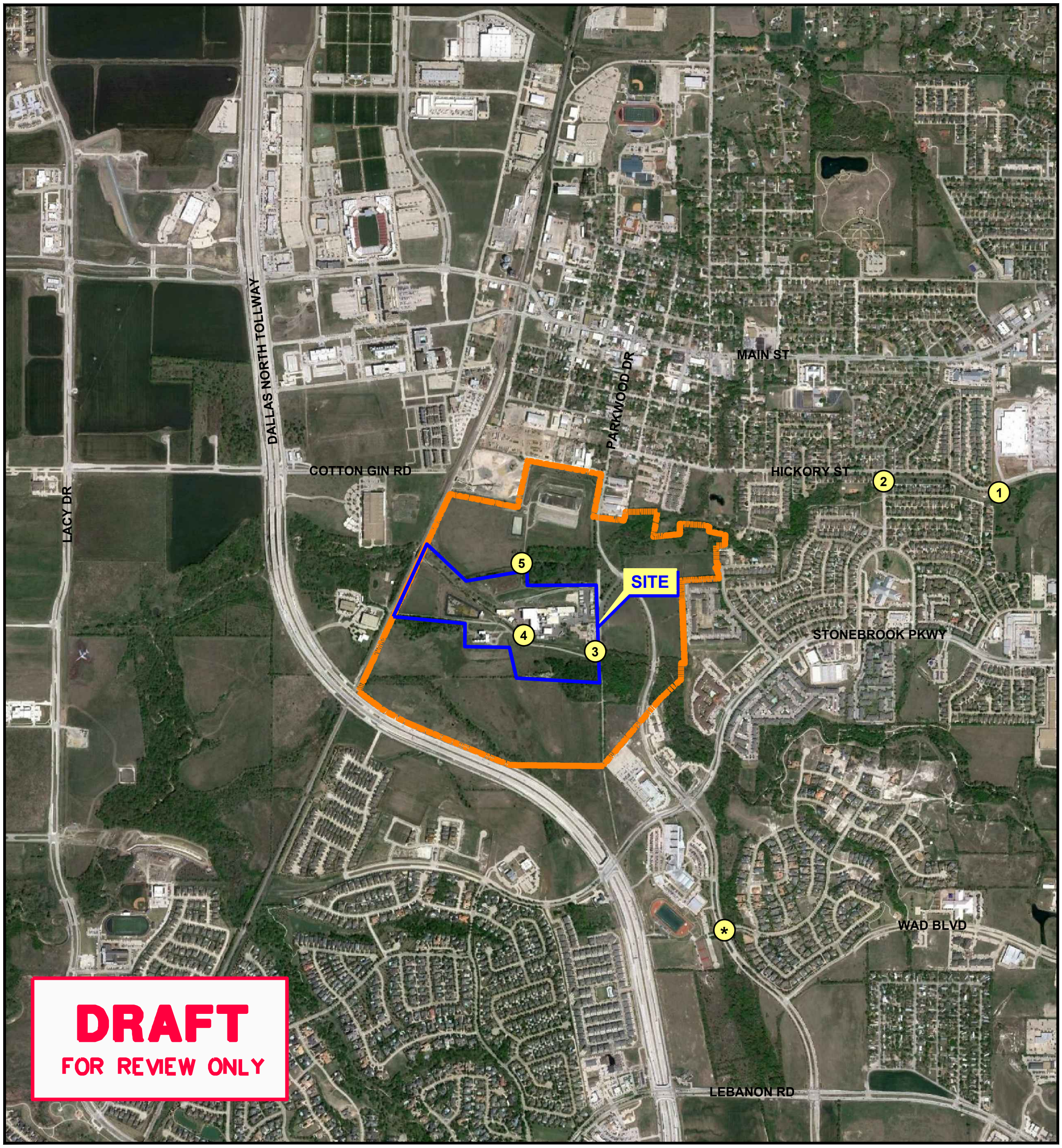


Figure 7. Ecological Conceptual Site Model
Stewart Creek

APPENDIX A

PHOTOGRAPHIC LOG

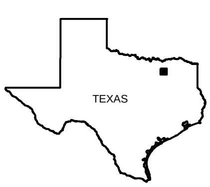


Investigation Area Boundary

Boundary of Property Owned by Exide

1 Photograph Location

* Entrance to Chapel Creek Estates with Several Fountains in Stewart Creek



N

Approx. Scale in Feet

0 1000 2000

SOURCE:
Base map from Google Earth, photography dated 3-31-2011.

EXIDE RECYCLING CENTER
FRISCO, TEXAS

Figure A-1

SITE LOCATION MAP WITH NUMBERED REFERENCES TO PICTURES

PROJECT: 1755	BY: ADJ	REVISIONS
DATE: MARCH, 2014	CHECKED: EFP	

PASTOR, BEHLING & WHEELER, LLC
CONSULTING ENGINEERS AND SCIENTISTS

Picture 1a. At apartment complex on E. Hickory, west of Preston Rd. looking toward north tributary of Stewart Creek. This landscaping feature with irrigation pipes visible drains into Stewart Creek.

Picture 1b. Looking upstream at north tributary of Stewart Creek from bridge at apartment complex on E. Hickory St. Irrigation system is visible (associated with apartment complex landscaping).

Picture 1c. Looking downstream at north tributary of Stewart Creek from bridge at apartment complex on E. Hickory St. Streambed is paved until it reaches Oak Creek Park.

Picture 2a. North tributary of Stewart Creek at Oak Creek Park at E. Hickory St. and Woodstream Drive.

Picture 2b. Standing on bridge on Woodstream Dr. looking downstream at the North Tributary of Stewart Creek.

Picture 2c. Looking downstream at the North Tributary of Stewart Creek in Oak Creek Park.

Picture 2d. Looking downstream at the North Tributary of Stewart Creek in Oak Creek Park.

Picture 3a. On-site on bridge on Eagan Dr. looking upstream at Stewart Creek.

Picture 3b. On-site on bridge on Eagan Dr. looking downstream at Stewart Creek as it enters the Site.

Picture 4. Stewart Creek directly behind the main plant at the Site.

Picture 5a. Looking upstream of the relocated North Tributary of Stewart Creek on-site on the road leading from the FRC plant to the landfill to the north of the facility.

Picture 5b. Looking downstream of the relocated North Tributary of Stewart Creek on-site on the road leading from the Site to the landfill to the north of the facility.

APPENDIX B

ProUCL STATISTICAL OUTPUT

APPENDIX B-1

SEDIMENT STEWART CREEK UPSTREAM

UCL Statistics for Uncensored Full Data Sets

User Selected Options	
Date/Time of Computation	5/6/2014 11:04
From File	working file upstream sed.xls
Full Precision	OFF
Confidence Coefficient	95%
Number of Bootstrap Operations	2000

Arsenic

General Statistics			
Total Number of Observations	10	Number of Distinct Observations	10
		Number of Missing Observations	0
Minimum	8.55	Mean	15.95
Maximum	42.7	Median	12.95
SD	9.948	Std. Error of Mean	3.146
Coefficient of Variation	0.624	Skewness	2.589
Normal GOF Test			
Shapiro Wilk Test Statistic	0.66	Shapiro Wilk GOF Test	
5% Shapiro Wilk Critical Value	0.842	Data Not Normal at 5% Significance Level	
Lilliefors Test Statistic	0.33	Lilliefors GOF Test	
5% Lilliefors Critical Value	0.28	Data Not Normal at 5% Significance Level	
Data Not Normal at 5% Significance Level			
Assuming Normal Distribution			
95% Normal UCL		95% UCLs (Adjusted for Skewness)	
95% Student's-t UCL	21.71	95% Adjusted-CLT UCL (Chen-1995)	23.87
		95% Modified-t UCL (Johnson-1978)	22.14
Gamma GOF Test			
A-D Test Statistic	0.891	Anderson-Darling Gamma GOF Test	
5% A-D Critical Value	0.729	Data Not Gamma Distributed at 5% Significance Level	
K-S Test Statistic	0.278	Kolmogrov-Smirnoff Gamma GOF Test	
5% K-S Critical Value	0.268	Data Not Gamma Distributed at 5% Significance Level	
Data Not Gamma Distributed at 5% Significance Level			
Gamma Statistics			
k hat (MLE)	4.565	k star (bias corrected MLE)	3.262
Theta hat (MLE)	3.493	Theta star (bias corrected MLE)	4.888
nu hat (MLE)	91.3	nu star (bias corrected)	65.25
MLE Mean (bias corrected)	15.95	MLE Sd (bias corrected)	8.828
		Approximate Chi Square Value (0.05)	47.66
Adjusted Level of Significance	0.0267	Adjusted Chi Square Value	45.06
Assuming Gamma Distribution			
95% Approximate Gamma UCL (use when n>=50))	21.83	95% Adjusted Gamma UCL (use when n<50)	23.09
Lognormal GOF Test			
Shapiro Wilk Test Statistic	0.847	Shapiro Wilk Lognormal GOF Test	
5% Shapiro Wilk Critical Value	0.842	Data appear Lognormal at 5% Significance Level	
Lilliefors Test Statistic	0.242	Lilliefors Lognormal GOF Test	
5% Lilliefors Critical Value	0.28	Data appear Lognormal at 5% Significance Level	
Data appear Lognormal at 5% Significance Level			
Lognormal Statistics			
Minimum of Logged Data	2.146	Mean of logged Data	2.656
Maximum of Logged Data	3.754	SD of logged Data	0.454

Assuming Lognormal Distribution

95% H-UCL	21.86	90% Chebyshev (MVUE) UCL	22.42
95% Chebyshev (MVUE) UCL	25.51	97.5% Chebyshev (MVUE) UCL	29.8
99% Chebyshev (MVUE) UCL	38.22		

Nonparametric Distribution Free UCL Statistics
Data appear to follow a Discernible Distribution at 5% Significance Level

Nonparametric Distribution Free UCLs

95% CLT UCL	21.12	95% Jackknife UCL	21.71
95% Standard Bootstrap UCL	20.71	95% Bootstrap-t UCL	35.23
95% Hall's Bootstrap UCL	45.72	95% Percentile Bootstrap UCL	21.31
95% BCA Bootstrap UCL	23.49		
90% Chebyshev(Mean, Sd) UCL	25.38	95% Chebyshev(Mean, Sd) UCL	29.66
97.5% Chebyshev(Mean, Sd) UCL	35.59	99% Chebyshev(Mean, Sd) UCL	47.24

Suggested UCL to Use

95% Student's-t UCL	**21.71**	**or 95% Modified-t UCL**	**22.14**
or 95% H-UCL	**21.86**		

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
These recommendations are based upon the results of the simulation studies summarized in Singh, Singh, and Iaci (2002)
and Singh and Singh (2003). However, simulations results will not cover all Real World data sets.
For additional insight the user may want to consult a statistician.

ProUCL computes and outputs H-statistic based UCLs for historical reasons only.
H-statistic often results in unstable (both high and low) values of UCL95 as shown in examples in the Technical Guide.
It is therefore recommended to avoid the use of H-statistic based 95% UCLs.
Use of nonparametric methods are preferred to compute UCL95 for skewed data sets which do not follow a gamma distribution.

Cadmium

General Statistics

Total Number of Observations	10	Number of Distinct Observations	10
		Number of Missing Observations	0
Minimum	0.26	Mean	0.439
Maximum	0.691	Median	0.389
SD	0.148	Std. Error of Mean	0.0469
Coefficient of Variation	0.338	Skewness	0.555

Normal GOF Test

Shapiro Wilk Test Statistic	0.922	Shapiro Wilk GOF Test
5% Shapiro Wilk Critical Value	0.842	Data appear Normal at 5% Significance Level
Lilliefors Test Statistic	0.223	Lilliefors GOF Test
5% Lilliefors Critical Value	0.28	Data appear Normal at 5% Significance Level

Data appear Normal at 5% Significance Level

Assuming Normal Distribution

95% Normal UCL		95% UCLs (Adjusted for Skewness)	
95% Student's-t UCL	0.525	95% Adjusted-CLT UCL (Chen-1995)	0.525
		95% Modified-t UCL (Johnson-1978)	0.526

Gamma GOF Test

A-D Test Statistic	0.317	Anderson-Darling Gamma GOF Test
5% A-D Critical Value	0.725	Detected data appear Gamma Distributed at 5% Significance Level
K-S Test Statistic	0.196	Kolmogrov-Smirnoff Gamma GOF Test
5% K-S Critical Value	0.267	Detected data appear Gamma Distributed at 5% Significance Level

Detected data appear Gamma Distributed at 5% Significance Level

Gamma Statistics

k hat (MLE)	10.02	k star (bias corrected MLE)	7.078
Theta hat (MLE)	0.0438	Theta star (bias corrected MLE)	0.062
nu hat (MLE)	200.3	nu star (bias corrected)	141.6
MLE Mean (bias corrected)	0.439	MLE Sd (bias corrected)	0.165
		Approximate Chi Square Value (0.05)	115.1
Adjusted Level of Significance	0.0267	Adjusted Chi Square Value	110.9

Assuming Gamma Distribution

95% Approximate Gamma UCL (use when n>=50))	0.54	95% Adjusted Gamma UCL (use when n<50)	0.56

Lognormal GOF Test

Shapiro Wilk Test Statistic	0.948	Shapiro Wilk Lognormal GOF Test	
5% Shapiro Wilk Critical Value	0.842	Data appear Lognormal at 5% Significance Level	
Lilliefors Test Statistic	0.173	Lilliefors Lognormal GOF Test	
5% Lilliefors Critical Value	0.28	Data appear Lognormal at 5% Significance Level	

Data appear Lognormal at 5% Significance Level

Lognormal Statistics

Minimum of Logged Data	-1.347	Mean of logged Data	-0.875
Maximum of Logged Data	-0.37	SD of logged Data	0.335

Assuming Lognormal Distribution

95% H-UCL	0.552	90% Chebyshev (MVUE) UCL	0.579
95% Chebyshev (MVUE) UCL	0.643	97.5% Chebyshev (MVUE) UCL	0.731
99% Chebyshev (MVUE) UCL	0.905		

Nonparametric Distribution Free UCL Statistics
Data appear to follow a Discernible Distribution at 5% Significance Level

Nonparametric Distribution Free UCLs

95% CLT UCL	0.516	95% Jackknife UCL	0.525
95% Standard Bootstrap UCL	0.512	95% Bootstrap-t UCL	0.549
95% Hall's Bootstrap UCL	0.514	95% Percentile Bootstrap UCL	0.521
95% BCA Bootstrap UCL	0.517		
90% Chebyshev(Mean, Sd) UCL	0.58	95% Chebyshev(Mean, Sd) UCL	0.643
97.5% Chebyshev(Mean, Sd) UCL	0.732	99% Chebyshev(Mean, Sd) UCL	0.906

Suggested UCL to Use

95% Student's-t UCL	**0.525**

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
These recommendations are based upon the results of the simulation studies summarized in Singh, Singh, and Iaci (2002)
and Singh and Singh (2003). However, simulations results will not cover all Real World data sets.
For additional insight the user may want to consult a statistician.

Lead

General Statistics

Total Number of Observations	10	Number of Distinct Observations	10
		Number of Missing Observations	0
Minimum	6.56	Mean	12.34
Maximum	19.8	Median	11.75
SD	3.826	Std. Error of Mean	1.21
Coefficient of Variation	0.31	Skewness	0.568

Normal GOF Test

Shapiro Wilk Test Statistic	0.973	Shapiro Wilk GOF Test	
5% Shapiro Wilk Critical Value	0.842	Data appear Normal at 5% Significance Level	
Lilliefors Test Statistic	0.135	Lilliefors GOF Test	
5% Lilliefors Critical Value	0.28	Data appear Normal at 5% Significance Level	

Data appear Normal at 5% Significance Level

Assuming Normal Distribution			
95% Normal UCL		95% UCLs (Adjusted for Skewness)	
95% Student's-t UCL	14.56	95% Adjusted-CLT UCL (Chen-1995)	14.56
		95% Modified-t UCL (Johnson-1978)	14.59
Gamma GOF Test			
A-D Test Statistic	0.151	Anderson-Darling Gamma GOF Test	
5% A-D Critical Value	0.725	Detected data appear Gamma Distributed at 5% Significance Level	
K-S Test Statistic	0.122	Kolmogrov-Smirnoff Gamma GOF Test	
5% K-S Critical Value	0.267	Detected data appear Gamma Distributed at 5% Significance Level	
Detected data appear Gamma Distributed at 5% Significance Level			
Gamma Statistics			
k hat (MLE)	11.55	k star (bias corrected MLE)	8.15
Theta hat (MLE)	1.069	Theta star (bias corrected MLE)	1.514
nu hat (MLE)	231	nu star (bias corrected)	163
MLE Mean (bias corrected)	12.34	MLE Sd (bias corrected)	4.322
		Approximate Chi Square Value (0.05)	134.5
Adjusted Level of Significance	0.0267	Adjusted Chi Square Value	130
Assuming Gamma Distribution			
95% Approximate Gamma UCL (use when n>=50))	14.96	95% Adjusted Gamma UCL (use when n<50)	15.47
Lognormal GOF Test			
Shapiro Wilk Test Statistic	0.986	Shapiro Wilk Lognormal GOF Test	
5% Shapiro Wilk Critical Value	0.842	Data appear Lognormal at 5% Significance Level	
Lilliefors Test Statistic	0.144	Lilliefors Lognormal GOF Test	
5% Lilliefors Critical Value	0.28	Data appear Lognormal at 5% Significance Level	
Data appear Lognormal at 5% Significance Level			
Lognormal Statistics			
Minimum of Logged Data	1.881	Mean of logged Data	2.469
Maximum of Logged Data	2.986	SD of logged Data	0.316
Assuming Lognormal Distribution			
95% H-UCL	15.32	90% Chebyshev (MVUE) UCL	16.08
95% Chebyshev (MVUE) UCL	17.77	97.5% Chebyshev (MVUE) UCL	20.12
99% Chebyshev (MVUE) UCL	24.73		
Nonparametric Distribution Free UCL Statistics			
Data appear to follow a Discernible Distribution at 5% Significance Level			
Nonparametric Distribution Free UCLs			
95% CLT UCL	14.33	95% Jackknife UCL	14.56
95% Standard Bootstrap UCL	14.29	95% Bootstrap-t UCL	14.86
95% Hall's Bootstrap UCL	15.58	95% Percentile Bootstrap UCL	14.26
95% BCA Bootstrap UCL	14.22		
90% Chebyshev(Mean, Sd) UCL	15.97	95% Chebyshev(Mean, Sd) UCL	17.61
97.5% Chebyshev(Mean, Sd) UCL	19.89	99% Chebyshev(Mean, Sd) UCL	24.38
Suggested UCL to Use			
95% Student's-t UCL	**14.56**		

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
These recommendations are based upon the results of the simulation studies summarized in Singh, Singh, and Iaci (2002)
and Singh and Singh (2003). However, simulations results will not cover all Real World data sets.
For additional insight the user may want to consult a statistician.

APPENDIX B-2

SEDIMENT NORTH TRIBUTARY (ON-SITE)

UCL Statistics for Uncensored Full Data Sets

User Selected Options	
Date/Time of Computation	5/6/2014 11:00
From File	working file north trib sed.xls
Full Precision	OFF
Confidence Coefficient	95%
Number of Bootstrap Operations	2000

Cadmium

General Statistics			
Total Number of Observations	10	Number of Distinct Observations	10
		Number of Missing Observations	0
Minimum	0.69	Mean	0.918
Maximum	1.19	Median	0.905
SD	0.169	Std. Error of Mean	0.0534
Coefficient of Variation	0.184	Skewness	0.228
Normal GOF Test			
Shapiro Wilk Test Statistic	0.945	Shapiro Wilk GOF Test	
5% Shapiro Wilk Critical Value	0.842	Data appear Normal at 5% Significance Level	
Lilliefors Test Statistic	0.199	Lilliefors GOF Test	
5% Lilliefors Critical Value	0.28	Data appear Normal at 5% Significance Level	
Data appear Normal at 5% Significance Level			
Assuming Normal Distribution			
95% Normal UCL		95% UCLs (Adjusted for Skewness)	
95% Student's-t UCL	1.016	95% Adjusted-CLT UCL (Chen-1995)	1.01
		95% Modified-t UCL (Johnson-1978)	1.016
Gamma GOF Test			
A-D Test Statistic	0.316	Anderson-Darling Gamma GOF Test	
5% A-D Critical Value	0.724	Detected data appear Gamma Distributed at 5% Significance Level	
K-S Test Statistic	0.195	Kolmogrov-Smirnoff Gamma GOF Test	
5% K-S Critical Value	0.266	Detected data appear Gamma Distributed at 5% Significance Level	
Detected data appear Gamma Distributed at 5% Significance Level			
Gamma Statistics			
k hat (MLE)	32.94	k star (bias corrected MLE)	23.13
Theta hat (MLE)	0.0279	Theta star (bias corrected MLE)	0.0397
nu hat (MLE)	658.8	nu star (bias corrected)	462.5
MLE Mean (bias corrected)	0.918	MLE Sd (bias corrected)	0.191
		Approximate Chi Square Value (0.05)	413.6
Adjusted Level of Significance	0.0267	Adjusted Chi Square Value	405.6
Assuming Gamma Distribution			
95% Approximate Gamma UCL (use when n>=50))	1.026	95% Adjusted Gamma UCL (use when n<50)	1.047
Lognormal GOF Test			
Shapiro Wilk Test Statistic	0.949	Shapiro Wilk Lognormal GOF Test	
5% Shapiro Wilk Critical Value	0.842	Data appear Lognormal at 5% Significance Level	
Lilliefors Test Statistic	0.179	Lilliefors Lognormal GOF Test	
5% Lilliefors Critical Value	0.28	Data appear Lognormal at 5% Significance Level	
Data appear Lognormal at 5% Significance Level			
Lognormal Statistics			
Minimum of Logged Data	-0.371	Mean of logged Data	-0.101
Maximum of Logged Data	0.174	SD of logged Data	0.184

Assuming Lognormal Distribution

95% H-UCL	1.031	90% Chebyshev (MVUE) UCL	1.079
95% Chebyshev (MVUE) UCL	1.152	97.5% Chebyshev (MVUE) UCL	1.253
99% Chebyshev (MVUE) UCL	1.452		

Nonparametric Distribution Free UCL Statistics
Data appear to follow a Discernible Distribution at 5% Significance Level

Nonparametric Distribution Free UCLs

95% CLT UCL	1.006	95% Jackknife UCL	1.016
95% Standard Bootstrap UCL	1	95% Bootstrap-t UCL	1.019
95% Hall's Bootstrap UCL	1.006	95% Percentile Bootstrap UCL	0.999
95% BCA Bootstrap UCL	1.009		
90% Chebyshev(Mean, Sd) UCL	1.078	95% Chebyshev(Mean, Sd) UCL	1.151
97.5% Chebyshev(Mean, Sd) UCL	1.251	99% Chebyshev(Mean, Sd) UCL	1.449

Suggested UCL to Use

95% Student's-t UCL	**1.016**

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
These recommendations are based upon the results of the simulation studies summarized in Singh, Singh, and Iaci (2002)
and Singh and Singh (2003). However, simulations results will not cover all Real World data sets.
For additional insight the user may want to consult a statistician.

Lead

General Statistics

Total Number of Observations	10	Number of Distinct Observations	9
		Number of Missing Observations	0
Minimum	10.4	Mean	16.51
Maximum	28.2	Median	14.95
SD	6.267	Std. Error of Mean	1.982
Coefficient of Variation	0.38	Skewness	0.681

Normal GOF Test

Shapiro Wilk Test Statistic	0.877	Shapiro Wilk GOF Test
5% Shapiro Wilk Critical Value	0.842	Data appear Normal at 5% Significance Level
Lilliefors Test Statistic	0.259	Lilliefors GOF Test
5% Lilliefors Critical Value	0.28	Data appear Normal at 5% Significance Level

Data appear Normal at 5% Significance Level

Assuming Normal Distribution

95% Normal UCL		95% UCLs (Adjusted for Skewness)	
95% Student's-t UCL	20.14	95% Adjusted-CLT UCL (Chen-1995)	20.23
		95% Modified-t UCL (Johnson-1978)	20.21

Gamma GOF Test

A-D Test Statistic	0.578	Anderson-Darling Gamma GOF Test
5% A-D Critical Value	0.727	Detected data appear Gamma Distributed at 5% Significance Level
K-S Test Statistic	0.265	Kolmogrov-Smirnoff Gamma GOF Test
5% K-S Critical Value	0.267	Detected data appear Gamma Distributed at 5% Significance Level

Detected data appear Gamma Distributed at 5% Significance Level

Gamma Statistics

k hat (MLE)	8.141	k star (bias corrected MLE)	5.765
Theta hat (MLE)	2.028	Theta star (bias corrected MLE)	2.864
nu hat (MLE)	162.8	nu star (bias corrected)	115.3
MLE Mean (bias corrected)	16.51	MLE Sd (bias corrected)	6.876
		Approximate Chi Square Value (0.05)	91.51
Adjusted Level of Significance	0.0267	Adjusted Chi Square Value	87.83

Assuming Gamma Distribution			
95% Approximate Gamma UCL (use when n>=50))	20.8	95% Adjusted Gamma UCL (use when n<50)	21.67
Lognormal GOF Test			
Shapiro Wilk Test Statistic	0.883	Shapiro Wilk Lognormal GOF Test	
5% Shapiro Wilk Critical Value	0.842	Data appear Lognormal at 5% Significance Level	
Lilliefors Test Statistic	0.249	Lilliefors Lognormal GOF Test	
5% Lilliefors Critical Value	0.28	Data appear Lognormal at 5% Significance Level	
Data appear Lognormal at 5% Significance Level			
Lognormal Statistics			
Minimum of Logged Data	2.342	Mean of logged Data	2.741
Maximum of Logged Data	3.339	SD of logged Data	0.37
Assuming Lognormal Distribution			
95% H-UCL	21.4	90% Chebyshev (MVUE) UCL	22.34
95% Chebyshev (MVUE) UCL	24.99	97.5% Chebyshev (MVUE) UCL	28.67
99% Chebyshev (MVUE) UCL	35.89		
Nonparametric Distribution Free UCL Statistics			
Data appear to follow a Discernible Distribution at 5% Significance Level			
Nonparametric Distribution Free UCLs			
95% CLT UCL	19.77	95% Jackknife UCL	20.14
95% Standard Bootstrap UCL	19.54	95% Bootstrap-t UCL	20.78
95% Hall's Bootstrap UCL	19.97	95% Percentile Bootstrap UCL	19.76
95% BCA Bootstrap UCL	20.04		
90% Chebyshev(Mean, Sd) UCL	22.46	95% Chebyshev(Mean, Sd) UCL	25.15
97.5% Chebyshev(Mean, Sd) UCL	28.89	99% Chebyshev(Mean, Sd) UCL	36.23
Suggested UCL to Use			
95% Student's-t UCL	**20.14**		

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
These recommendations are based upon the results of the simulation studies summarized in Singh, Singh, and Iaci (2002)
and Singh and Singh (2003). However, simulations results will not cover all Real World data sets.
For additional insight the user may want to consult a statistician.

APPENDIX B-3

SEDIMENT STEWART CREEK (ON-SITE)

UCL Statistics for Uncensored Full Data Sets

User Selected Options	
Date/Time of Computation	5/6/2014 11:02
From File	working file on site sed.xls
Full Precision	OFF
Confidence Coefficient	95%
Number of Bootstrap Operations	2000

Cadmium

General Statistics			
Total Number of Observations	13	Number of Distinct Observations	12
		Number of Missing Observations	0
Minimum	0.34	Mean	1
Maximum	2.08	Median	0.86
SD	0.431	Std. Error of Mean	0.119
Coefficient of Variation	0.431	Skewness	1.302

Normal GOF Test		
Shapiro Wilk Test Statistic	0.874	Shapiro Wilk GOF Test
5% Shapiro Wilk Critical Value	0.866	Data appear Normal at 5% Significance Level
Lilliefors Test Statistic	0.223	Lilliefors GOF Test
5% Lilliefors Critical Value	0.246	Data appear Normal at 5% Significance Level
Data appear Normal at 5% Significance Level		

Assuming Normal Distribution			
95% Normal UCL		95% UCLs (Adjusted for Skewness)	
95% Student's-t UCL	1.213	95% Adjusted-CLT UCL (Chen-1995)	1.243
		95% Modified-t UCL (Johnson-1978)	1.22

Gamma GOF Test		
A-D Test Statistic	0.554	Anderson-Darling Gamma GOF Test
5% A-D Critical Value	0.735	Detected data appear Gamma Distributed at 5% Significance Level
K-S Test Statistic	0.183	Kolmogrov-Smirnoff Gamma GOF Test
5% K-S Critical Value	0.237	Detected data appear Gamma Distributed at 5% Significance Level
Detected data appear Gamma Distributed at 5% Significance Level		

Gamma Statistics			
k hat (MLE)	6.261	k star (bias corrected MLE)	4.867
Theta hat (MLE)	0.16	Theta star (bias corrected MLE)	0.205
nu hat (MLE)	162.8	nu star (bias corrected)	126.5
MLE Mean (bias corrected)	1	MLE Sd (bias corrected)	0.453
		Approximate Chi Square Value (0.05)	101.6
Adjusted Level of Significance	0.0301	Adjusted Chi Square Value	98.38

Assuming Gamma Distribution			
95% Approximate Gamma UCL (use when n>=50))	1.246	95% Adjusted Gamma UCL (use when n<50)	1.286

Lognormal GOF Test		
Shapiro Wilk Test Statistic	0.919	Shapiro Wilk Lognormal GOF Test
5% Shapiro Wilk Critical Value	0.866	Data appear Lognormal at 5% Significance Level
Lilliefors Test Statistic	0.206	Lilliefors Lognormal GOF Test
5% Lilliefors Critical Value	0.246	Data appear Lognormal at 5% Significance Level
Data appear Lognormal at 5% Significance Level		

Lognormal Statistics			
Minimum of Logged Data	-1.079	Mean of logged Data	-0.082
Maximum of Logged Data	0.732	SD of logged Data	0.429

Assuming Lognormal Distribution

95% H-UCL	1.299	90% Chebyshev (MVUE) UCL	1.367
95% Chebyshev (MVUE) UCL	1.533	97.5% Chebyshev (MVUE) UCL	1.762
99% Chebyshev (MVUE) UCL	2.213		

Nonparametric Distribution Free UCL Statistics
Data appear to follow a Discernible Distribution at 5% Significance Level

Nonparametric Distribution Free UCLs

95% CLT UCL	1.196	95% Jackknife UCL	1.213
95% Standard Bootstrap UCL	1.184	95% Bootstrap-t UCL	1.274
95% Hall's Bootstrap UCL	1.485	95% Percentile Bootstrap UCL	1.202
95% BCA Bootstrap UCL	1.261		
90% Chebyshev(Mean, Sd) UCL	1.358	95% Chebyshev(Mean, Sd) UCL	1.521
97.5% Chebyshev(Mean, Sd) UCL	1.746	99% Chebyshev(Mean, Sd) UCL	2.188

Suggested UCL to Use
95% Student's-t UCL **1.213**

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
These recommendations are based upon the results of the simulation studies summarized in Singh, Singh, and Iaci (2002)
and Singh and Singh (2003). However, simulations results will not cover all Real World data sets.
For additional insight the user may want to consult a statistician.

Lead

General Statistics

Total Number of Observations	13	Number of Distinct Observations	12
		Number of Missing Observations	0
Minimum	6.57	Mean	12.21
Maximum	19.2	Median	10.9
SD	4.155	Std. Error of Mean	1.152
Coefficient of Variation	0.34	Skewness	0.371

Normal GOF Test

Shapiro Wilk Test Statistic	0.931	Shapiro Wilk GOF Test
5% Shapiro Wilk Critical Value	0.866	Data appear Normal at 5% Significance Level
Lilliefors Test Statistic	0.183	Lilliefors GOF Test
5% Lilliefors Critical Value	0.246	Data appear Normal at 5% Significance Level

Data appear Normal at 5% Significance Level

Assuming Normal Distribution

95% Normal UCL		95% UCLs (Adjusted for Skewness)	
95% Student's-t UCL	14.26	95% Adjusted-CLT UCL (Chen-1995)	14.23
		95% Modified-t UCL (Johnson-1978)	14.28

Gamma GOF Test

A-D Test Statistic	0.336	Anderson-Darling Gamma GOF Test
5% A-D Critical Value	0.734	Detected data appear Gamma Distributed at 5% Significance Level
K-S Test Statistic	0.154	Kolmogrov-Smirnoff Gamma GOF Test
5% K-S Critical Value	0.237	Detected data appear Gamma Distributed at 5% Significance Level

Detected data appear Gamma Distributed at 5% Significance Level

Gamma Statistics

k hat (MLE)	9.296	k star (bias corrected MLE)	7.202
Theta hat (MLE)	1.313	Theta star (bias corrected MLE)	1.695
nu hat (MLE)	241.7	nu star (bias corrected)	187.3
MLE Mean (bias corrected)	12.21	MLE Sd (bias corrected)	4.548
		Approximate Chi Square Value (0.05)	156.6
Adjusted Level of Significance	0.0301	Adjusted Chi Square Value	152.6

Assuming Gamma Distribution

95% Approximate Gamma UCL (use when n>=50))	14.59	95% Adjusted Gamma UCL (use when n<50)	14.98

Lognormal GOF Test

Shapiro Wilk Test Statistic	0.948	Shapiro Wilk Lognormal GOF Test	
5% Shapiro Wilk Critical Value	0.866	Data appear Lognormal at 5% Significance Level	
Lilliefors Test Statistic	0.152	Lilliefors Lognormal GOF Test	
5% Lilliefors Critical Value	0.246	Data appear Lognormal at 5% Significance Level	

Data appear Lognormal at 5% Significance Level

Lognormal Statistics

Minimum of Logged Data	1.883	Mean of logged Data	2.447
Maximum of Logged Data	2.955	SD of logged Data	0.347

Assuming Lognormal Distribution

95% H-UCL	14.93	90% Chebyshev (MVUE) UCL	15.79
95% Chebyshev (MVUE) UCL	17.41	97.5% Chebyshev (MVUE) UCL	19.66
99% Chebyshev (MVUE) UCL	24.08		

Nonparametric Distribution Free UCL Statistics

Data appear to follow a Discernible Distribution at 5% Significance Level

Nonparametric Distribution Free UCLs

95% CLT UCL	14.1	95% Jackknife UCL	14.26
95% Standard Bootstrap UCL	14.09	95% Bootstrap-t UCL	14.52
95% Hall's Bootstrap UCL	14	95% Percentile Bootstrap UCL	14.03
95% BCA Bootstrap UCL	14.08		
90% Chebyshev(Mean, Sd) UCL	15.66	95% Chebyshev(Mean, Sd) UCL	17.23
97.5% Chebyshev(Mean, Sd) UCL	19.4	99% Chebyshev(Mean, Sd) UCL	23.67

Suggested UCL to Use

95% Student's-t UCL **14.26**

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
These recommendations are based upon the results of the simulation studies summarized in Singh, Singh, and Iaci (2002)
and Singh and Singh (2003). However, simulations results will not cover all Real World data sets.
For additional insight the user may want to consult a statistician.

APPENDIX B-4

SEDIMENT STEWART CREEK FROM FOP AND DOWNSTREAM

UCL Statistics for Uncensored Full Data Sets

User Selected Options	
Date/Time of Computation	5/6/2014 10:54
From File	working file all sed.xls
Full Precision	OFF
Confidence Coefficient	95%
Number of Bootstrap Operations	2000

Arsenic

General Statistics			
Total Number of Observations	121	Number of Distinct Observations	92
		Number of Missing Observations	0
Minimum	7	Mean	22.16
Maximum	279	Median	17.7
SD	25.71	Std. Error of Mean	2.338
Coefficient of Variation	1.16	Skewness	8.497
Normal GOF Test			
Shapiro Wilk Test Statistic	0.391	Shapiro Wilk GOF Test	
5% Shapiro Wilk P Value	0	Data Not Normal at 5% Significance Level	
Lilliefors Test Statistic	0.283	Lilliefors GOF Test	
5% Lilliefors Critical Value	0.0805	Data Not Normal at 5% Significance Level	
Data Not Normal at 5% Significance Level			
Assuming Normal Distribution			
95% Normal UCL		95% UCLs (Adjusted for Skewness)	
95% Student's-t UCL	26.03	95% Adjusted-CLT UCL (Chen-1995)	27.93
		95% Modified-t UCL (Johnson-1978)	26.33
Gamma GOF Test			
A-D Test Statistic	4.091	Anderson-Darling Gamma GOF Test	
5% A-D Critical Value	0.76	Data Not Gamma Distributed at 5% Significance Level	
K-S Test Statistic	0.144	Kolmogrov-Smirnoff Gamma GOF Test	
5% K-S Critical Value	0.0847	Data Not Gamma Distributed at 5% Significance Level	
Data Not Gamma Distributed at 5% Significance Level			
Gamma Statistics			
k hat (MLE)	2.759	k star (bias corrected MLE)	2.696
Theta hat (MLE)	8.031	Theta star (bias corrected MLE)	8.218
nu hat (MLE)	667.7	nu star (bias corrected)	652.5
MLE Mean (bias corrected)	22.16	MLE Sd (bias corrected)	13.49
		Approximate Chi Square Value (0.05)	594.2
Adjusted Level of Significance	0.048	Adjusted Chi Square Value	593.5
Assuming Gamma Distribution			
95% Approximate Gamma UCL (use when n>=50))	24.33	95% Adjusted Gamma UCL (use when n<50)	24.36
Lognormal GOF Test			
Shapiro Wilk Test Statistic	0.935	Shapiro Wilk Lognormal GOF Test	
5% Shapiro Wilk P Value	6.67E-06	Data Not Lognormal at 5% Significance Level	
Lilliefors Test Statistic	0.0882	Lilliefors Lognormal GOF Test	
5% Lilliefors Critical Value	0.0805	Data Not Lognormal at 5% Significance Level	
Data Not Lognormal at 5% Significance Level			
Lognormal Statistics			
Minimum of Logged Data	1.946	Mean of logged Data	2.906
Maximum of Logged Data	5.631	SD of logged Data	0.527

Assuming Lognormal Distribution			
95% H-UCL	22.95	90% Chebyshev (MVUE) UCL	24.18
95% Chebyshev (MVUE) UCL	25.63	97.5% Chebyshev (MVUE) UCL	27.65
99% Chebyshev (MVUE) UCL	31.6		

Nonparametric Distribution Free UCL Statistics
Data do not follow a Discernible Distribution (0.05)

Nonparametric Distribution Free UCLs			
95% CLT UCL	26	95% Jackknife UCL	26.03
95% Standard Bootstrap UCL	25.98	95% Bootstrap-t UCL	30.45
95% Hall's Bootstrap UCL	41.57	95% Percentile Bootstrap UCL	26.77
95% BCA Bootstrap UCL	29.35		
90% Chebyshev(Mean, Sd) UCL	29.17	95% Chebyshev(Mean, Sd) UCL	32.35
97.5% Chebyshev(Mean, Sd) UCL	36.76	99% Chebyshev(Mean, Sd) UCL	45.42

Suggested UCL to Use
95% Chebyshev (Mean, Sd) UCL **32.35**

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
These recommendations are based upon the results of the simulation studies summarized in Singh, Singh, and Iaci (2002)
and Singh and Singh (2003). However, simulations results will not cover all Real World data sets.
For additional insight the user may want to consult a statistician.

Cadmium

General Statistics			
Total Number of Observations	144	Number of Distinct Observations	111
		Number of Missing Observations	0
Minimum	0.04	Mean	1.078
Maximum	6.96	Median	0.87
SD	0.933	Std. Error of Mean	0.0778
Coefficient of Variation	0.866	Skewness	3.11

Normal GOF Test			
Shapiro Wilk Test Statistic	0.713	Shapiro Wilk GOF Test	
5% Shapiro Wilk P Value	0	Data Not Normal at 5% Significance Level	
Lilliefors Test Statistic	0.236	Lilliefors GOF Test	
5% Lilliefors Critical Value	0.0738	Data Not Normal at 5% Significance Level	
Data Not Normal at 5% Significance Level			

Assuming Normal Distribution			
95% Normal UCL		95% UCLs (Adjusted for Skewness)	
95% Student's-t UCL	1.207	95% Adjusted-CLT UCL (Chen-1995)	1.227
		95% Modified-t UCL (Johnson-1978)	1.21

Gamma GOF Test			
A-D Test Statistic	2.532	Anderson-Darling Gamma GOF Test	
5% A-D Critical Value	0.765	Data Not Gamma Distributed at 5% Significance Level	
K-S Test Statistic	0.142	Kolmogrov-Smirnoff Gamma GOF Test	
5% K-S Critical Value	0.0791	Data Not Gamma Distributed at 5% Significance Level	
Data Not Gamma Distributed at 5% Significance Level			

Gamma Statistics			
k hat (MLE)	2.119	k star (bias corrected MLE)	2.08
Theta hat (MLE)	0.509	Theta star (bias corrected MLE)	0.518
nu hat (MLE)	610.3	nu star (bias corrected)	598.9
MLE Mean (bias corrected)	1.078	MLE Sd (bias corrected)	0.747
		Approximate Chi Square Value (0.05)	543.1

Adjusted Level of Significance	0.0483	Adjusted Chi Square Value	542.6

Assuming Gamma Distribution			
95% Approximate Gamma UCL (use when n>=50))	1.189	95% Adjusted Gamma UCL (use when n<50)	1.19

Lognormal GOF Test		
Shapiro Wilk Test Statistic	0.978	Shapiro Wilk Lognormal GOF Test
5% Shapiro Wilk P Value	0.316	Data appear Lognormal at 5% Significance Level
Lilliefors Test Statistic	0.0959	Lilliefors Lognormal GOF Test
5% Lilliefors Critical Value	0.0738	Data Not Lognormal at 5% Significance Level
Data appear Approximate Lognormal at 5% Significance Level		

Lognormal Statistics			
Minimum of Logged Data	-3.219	Mean of logged Data	-0.179
Maximum of Logged Data	1.94	SD of logged Data	0.715

Assuming Lognormal Distribution			
95% H-UCL	1.215	90% Chebyshev (MVUE) UCL	1.292
95% Chebyshev (MVUE) UCL	1.389	97.5% Chebyshev (MVUE) UCL	1.523
99% Chebyshev (MVUE) UCL	1.788		

Nonparametric Distribution Free UCL Statistics
Data appear to follow a Discernible Distribution at 5% Significance Level

Nonparametric Distribution Free UCLs			
95% CLT UCL	1.206	95% Jackknife UCL	1.207
95% Standard Bootstrap UCL	1.203	95% Bootstrap-t UCL	1.228
95% Hall's Bootstrap UCL	1.236	95% Percentile Bootstrap UCL	1.21
95% BCA Bootstrap UCL	1.227		
90% Chebyshev(Mean, Sd) UCL	1.311	95% Chebyshev(Mean, Sd) UCL	1.417
97.5% Chebyshev(Mean, Sd) UCL	1.564	99% Chebyshev(Mean, Sd) UCL	1.852

Suggested UCL to Use	
95% Chebyshev (Mean, Sd) UCL	**1.417**

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
These recommendations are based upon the results of the simulation studies summarized in Singh, Singh, and Iaci (2002)
and Singh and Singh (2003). However, simulations results will not cover all Real World data sets.
For additional insight the user may want to consult a statistician.

Lead

General Statistics			
Total Number of Observations	143	Number of Distinct Observations	116
		Number of Missing Observations	0
Minimum	6.57	Mean	33.37
Maximum	459	Median	19.6
SD	57.25	Std. Error of Mean	4.788
Coefficient of Variation	1.716	Skewness	5.724

Normal GOF Test		
Shapiro Wilk Test Statistic	0.375	Shapiro Wilk GOF Test
5% Shapiro Wilk P Value	0	Data Not Normal at 5% Significance Level
Lilliefors Test Statistic	0.32	Lilliefors GOF Test
5% Lilliefors Critical Value	0.0741	Data Not Normal at 5% Significance Level
Data Not Normal at 5% Significance Level		

Assuming Normal Distribution			
95% Normal UCL		95% UCLs (Adjusted for Skewness)	
95% Student's-t UCL	41.29	95% Adjusted-CLT UCL (Chen-1995)	43.69

		95% Modified-t UCL (Johnson-1978)	41.68
Gamma GOF Test			
A-D Test Statistic	10.58	Anderson-Darling Gamma GOF Test	
5% A-D Critical Value	0.773	Data Not Gamma Distributed at 5% Significance Level	
K-S Test Statistic	0.181	Kolmogrov-Smirnoff Gamma GOF Test	
5% K-S Critical Value	0.08	Data Not Gamma Distributed at 5% Significance Level	
Data Not Gamma Distributed at 5% Significance Level			
Gamma Statistics			
k hat (MLE)	1.4	k star (bias corrected MLE)	1.375
Theta hat (MLE)	23.83	Theta star (bias corrected MLE)	24.26
nu hat (MLE)	400.4	nu star (bias corrected)	393.4
MLE Mean (bias corrected)	33.37	MLE Sd (bias corrected)	28.45
		Approximate Chi Square Value (0.05)	348.4
Adjusted Level of Significance	0.0483	Adjusted Chi Square Value	348
Assuming Gamma Distribution			
95% Approximate Gamma UCL (use when n>=50))	37.67	95% Adjusted Gamma UCL (use when n<50)	37.72
Lognormal GOF Test			
Shapiro Wilk Test Statistic	0.885	Shapiro Wilk Lognormal GOF Test	
5% Shapiro Wilk P Value	0	Data Not Lognormal at 5% Significance Level	
Lilliefors Test Statistic	0.115	Lilliefors Lognormal GOF Test	
5% Lilliefors Critical Value	0.0741	Data Not Lognormal at 5% Significance Level	
Data Not Lognormal at 5% Significance Level			
Lognormal Statistics			
Minimum of Logged Data	1.883	Mean of logged Data	3.11
Maximum of Logged Data	6.129	SD of logged Data	0.712
Assuming Lognormal Distribution			
95% H-UCL	32.49	90% Chebyshev (MVUE) UCL	34.55
95% Chebyshev (MVUE) UCL	37.14	97.5% Chebyshev (MVUE) UCL	40.74
99% Chebyshev (MVUE) UCL	47.81		
Nonparametric Distribution Free UCL Statistics			
Data do not follow a Discernible Distribution (0.05)			
Nonparametric Distribution Free UCLs			
95% CLT UCL	41.24	95% Jackknife UCL	41.29
95% Standard Bootstrap UCL	41.13	95% Bootstrap-t UCL	46.4
95% Hall's Bootstrap UCL	45.59	95% Percentile Bootstrap UCL	42.15
95% BCA Bootstrap UCL	44.28		
90% Chebyshev(Mean, Sd) UCL	47.73	95% Chebyshev(Mean, Sd) UCL	54.24
97.5% Chebyshev(Mean, Sd) UCL	63.27	99% Chebyshev(Mean, Sd) UCL	81
Suggested UCL to Use			
95% Chebyshev (Mean, Sd) UCL	**54.24**		

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
These recommendations are based upon the results of the simulation studies summarized in Singh, Singh, and Iaci (2002) and Singh and Singh (2003). However, simulations results will not cover all Real World data sets.
For additional insight the user may want to consult a statistician.

APPENDIX B-5

SEDIMENT STEWART CREEK DOWNSTREAM OF FOP

UCL Statistics for Uncensored Full Data Sets

User Selected Options	
Date/Time of Computation	5/6/2014 13:06
From File	working file all sed past FOP.xls
Full Precision	OFF
Confidence Coefficient	95%
Number of Bootstrap Operations	2000

Arsenic

General Statistics			
Total Number of Observations	121	Number of Distinct Observations	92
		Number of Missing Observations	0
Minimum	7	Mean	22.16
Maximum	279	Median	17.7
SD	25.71	Std. Error of Mean	2.338
Coefficient of Variation	1.16	Skewness	8.497
Normal GOF Test			
Shapiro Wilk Test Statistic	0.391	Shapiro Wilk GOF Test	
5% Shapiro Wilk P Value	0	Data Not Normal at 5% Significance Level	
Lilliefors Test Statistic	0.283	Lilliefors GOF Test	
5% Lilliefors Critical Value	0.0805	Data Not Normal at 5% Significance Level	
Data Not Normal at 5% Significance Level			
Assuming Normal Distribution			
95% Normal UCL		95% UCLs (Adjusted for Skewness)	
95% Student's-t UCL	26.03	95% Adjusted-CLT UCL (Chen-1995)	27.93
		95% Modified-t UCL (Johnson-1978)	26.33
Gamma GOF Test			
A-D Test Statistic	4.091	Anderson-Darling Gamma GOF Test	
5% A-D Critical Value	0.76	Data Not Gamma Distributed at 5% Significance Level	
K-S Test Statistic	0.144	Kolmogrov-Smirnoff Gamma GOF Test	
5% K-S Critical Value	0.0847	Data Not Gamma Distributed at 5% Significance Level	
Data Not Gamma Distributed at 5% Significance Level			
Gamma Statistics			
k hat (MLE)	2.759	k star (bias corrected MLE)	2.696
Theta hat (MLE)	8.031	Theta star (bias corrected MLE)	8.218
nu hat (MLE)	667.7	nu star (bias corrected)	652.5
MLE Mean (bias corrected)	22.16	MLE Sd (bias corrected)	13.49
		Approximate Chi Square Value (0.05)	594.2
Adjusted Level of Significance	0.048	Adjusted Chi Square Value	593.5
Assuming Gamma Distribution			
95% Approximate Gamma UCL (use when n>=50))	24.33	95% Adjusted Gamma UCL (use when n<50)	24.36
Lognormal GOF Test			
Shapiro Wilk Test Statistic	0.935	Shapiro Wilk Lognormal GOF Test	
5% Shapiro Wilk P Value	6.67E-06	Data Not Lognormal at 5% Significance Level	
Lilliefors Test Statistic	0.0882	Lilliefors Lognormal GOF Test	
5% Lilliefors Critical Value	0.0805	Data Not Lognormal at 5% Significance Level	
Data Not Lognormal at 5% Significance Level			
Lognormal Statistics			
Minimum of Logged Data	1.946	Mean of logged Data	2.906
Maximum of Logged Data	5.631	SD of logged Data	0.527

Assuming Lognormal Distribution

95% H-UCL	22.95	90% Chebyshev (MVUE) UCL	24.18
95% Chebyshev (MVUE) UCL	25.63	97.5% Chebyshev (MVUE) UCL	27.65
99% Chebyshev (MVUE) UCL	31.6		

Nonparametric Distribution Free UCL Statistics
Data do not follow a Discernible Distribution (0.05)

Nonparametric Distribution Free UCLs

95% CLT UCL	26	95% Jackknife UCL	26.03
95% Standard Bootstrap UCL	25.84	95% Bootstrap-t UCL	30.86
95% Hall's Bootstrap UCL	41.74	95% Percentile Bootstrap UCL	26.52
95% BCA Bootstrap UCL	30.31		
90% Chebyshev(Mean, Sd) UCL	29.17	95% Chebyshev(Mean, Sd) UCL	32.35
97.5% Chebyshev(Mean, Sd) UCL	36.76	99% Chebyshev(Mean, Sd) UCL	45.42

Suggested UCL to Use

95% Chebyshev (Mean, Sd) UCL	**32.35**

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
These recommendations are based upon the results of the simulation studies summarized in Singh, Singh, and Iaci (2002)
and Singh and Singh (2003). However, simulations results will not cover all Real World data sets.
For additional insight the user may want to consult a statistician.

Cadmium

General Statistics

Total Number of Observations	131	Number of Distinct Observations	106
		Number of Missing Observations	0
Minimum	0.04	Mean	1.086
Maximum	6.96	Median	0.87
SD	0.97	Std. Error of Mean	0.0847
Coefficient of Variation	0.893	Skewness	3.025

Normal GOF Test

Shapiro Wilk Test Statistic	0.712	Shapiro Wilk GOF Test
5% Shapiro Wilk P Value	0	Data Not Normal at 5% Significance Level
Lilliefors Test Statistic	0.238	Lilliefors GOF Test
5% Lilliefors Critical Value	0.0774	Data Not Normal at 5% Significance Level

Data Not Normal at 5% Significance Level

Assuming Normal Distribution

95% Normal UCL		95% UCLs (Adjusted for Skewness)	
95% Student's-t UCL	1.226	95% Adjusted-CLT UCL (Chen-1995)	1.249
		95% Modified-t UCL (Johnson-1978)	1.23

Gamma GOF Test

A-D Test Statistic	2.333	Anderson-Darling Gamma GOF Test
5% A-D Critical Value	0.765	Data Not Gamma Distributed at 5% Significance Level
K-S Test Statistic	0.142	Kolmogrov-Smirnoff Gamma GOF Test
5% K-S Critical Value	0.0825	Data Not Gamma Distributed at 5% Significance Level

Data Not Gamma Distributed at 5% Significance Level

Gamma Statistics

k hat (MLE)	1.996	k star (bias corrected MLE)	1.956
Theta hat (MLE)	0.544	Theta star (bias corrected MLE)	0.555
nu hat (MLE)	523	nu star (bias corrected)	512.4
MLE Mean (bias corrected)	1.086	MLE Sd (bias corrected)	0.776

		Approximate Chi Square Value (0.05)	460.9
Adjusted Level of Significance	0.0482	Adjusted Chi Square Value	460.3

Assuming Gamma Distribution

95% Approximate Gamma UCL (use when n>=50))	1.207	95% Adjusted Gamma UCL (use when n<50)	1.208

Lognormal GOF Test

Shapiro Wilk Test Statistic	0.98	Shapiro Wilk Lognormal GOF Test
5% Shapiro Wilk P Value	0.436	Data appear Lognormal at 5% Significance Level
Lilliefors Test Statistic	0.0937	Lilliefors Lognormal GOF Test
5% Lilliefors Critical Value	0.0774	Data Not Lognormal at 5% Significance Level

Data appear Approximate Lognormal at 5% Significance Level

Lognormal Statistics

Minimum of Logged Data	-3.219	Mean of logged Data	-0.189
Maximum of Logged Data	1.94	SD of logged Data	0.738

Assuming Lognormal Distribution

95% H-UCL	1.236	90% Chebyshev (MVUE) UCL	1.319
95% Chebyshev (MVUE) UCL	1.425	97.5% Chebyshev (MVUE) UCL	1.573
99% Chebyshev (MVUE) UCL	1.862		

Nonparametric Distribution Free UCL Statistics

Data appear to follow a Discernible Distribution at 5% Significance Level

Nonparametric Distribution Free UCLs

95% CLT UCL	1.225	95% Jackknife UCL	1.226
95% Standard Bootstrap UCL	1.226	95% Bootstrap-t UCL	1.263
95% Hall's Bootstrap UCL	1.27	95% Percentile Bootstrap UCL	1.238
95% BCA Bootstrap UCL	1.259		
90% Chebyshev(Mean, Sd) UCL	1.34	95% Chebyshev(Mean, Sd) UCL	1.455
97.5% Chebyshev(Mean, Sd) UCL	1.615	99% Chebyshev(Mean, Sd) UCL	1.928

Suggested UCL to Use

95% Chebyshev (Mean, Sd) UCL	**1.455**

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
These recommendations are based upon the results of the simulation studies summarized in Singh, Singh, and Iaci (2002)
and Singh and Singh (2003). However, simulations results will not cover all Real World data sets.
For additional insight the user may want to consult a statistician.

Lead

General Statistics

Total Number of Observations	130	Number of Distinct Observations	108
		Number of Missing Observations	0
Minimum	8.2	Mean	35.48
Maximum	459	Median	20.75
SD	59.64	Std. Error of Mean	5.231
Coefficient of Variation	1.681	Skewness	5.479

Normal GOF Test

Shapiro Wilk Test Statistic	0.382	Shapiro Wilk GOF Test
5% Shapiro Wilk P Value	0	Data Not Normal at 5% Significance Level
Lilliefors Test Statistic	0.324	Lilliefors GOF Test
5% Lilliefors Critical Value	0.0777	Data Not Normal at 5% Significance Level

Data Not Normal at 5% Significance Level

Assuming Normal Distribution

95% Normal UCL		95% UCLs (Adjusted for Skewness)	
95% Student's-t UCL	44.15	95% Adjusted-CLT UCL (Chen-1995)	46.77
		95% Modified-t UCL (Johnson-1978)	44.57

Gamma GOF Test

A-D Test Statistic	10.12	Anderson-Darling Gamma GOF Test	
5% A-D Critical Value	0.772	Data Not Gamma Distributed at 5% Significance Level	
K-S Test Statistic	0.191	Kolmogrov-Smirnoff Gamma GOF Test	
5% K-S Critical Value	0.0834	Data Not Gamma Distributed at 5% Significance Level	

Data Not Gamma Distributed at 5% Significance Level

Gamma Statistics

k hat (MLE)	1.416	k star (bias corrected MLE)	1.388
Theta hat (MLE)	25.06	Theta star (bias corrected MLE)	25.56
nu hat (MLE)	368.1	nu star (bias corrected)	360.9
MLE Mean (bias corrected)	35.48	MLE Sd (bias corrected)	30.12
		Approximate Chi Square Value (0.05)	317.9
Adjusted Level of Significance	0.0482	Adjusted Chi Square Value	317.4

Assuming Gamma Distribution

95% Approximate Gamma UCL (use when n>=50))	40.29	95% Adjusted Gamma UCL (use when n<50)	40.34

Lognormal GOF Test

Shapiro Wilk Test Statistic	0.871	Shapiro Wilk Lognormal GOF Test	
5% Shapiro Wilk P Value	0	Data Not Lognormal at 5% Significance Level	
Lilliefors Test Statistic	0.112	Lilliefors Lognormal GOF Test	
5% Lilliefors Critical Value	0.0777	Data Not Lognormal at 5% Significance Level	

Data Not Lognormal at 5% Significance Level

Lognormal Statistics

Minimum of Logged Data	2.104	Mean of logged Data	3.176
Maximum of Logged Data	6.129	SD of logged Data	0.706

Assuming Lognormal Distribution

95% H-UCL	34.7	90% Chebyshev (MVUE) UCL	36.97
95% Chebyshev (MVUE) UCL	39.84	97.5% Chebyshev (MVUE) UCL	43.81
99% Chebyshev (MVUE) UCL	51.61		

Nonparametric Distribution Free UCL Statistics

Data do not follow a Discernible Distribution (0.05)

Nonparametric Distribution Free UCLs

95% CLT UCL	44.09	95% Jackknife UCL	44.15
95% Standard Bootstrap UCL	44.11	95% Bootstrap-t UCL	50.28
95% Hall's Bootstrap UCL	47.93	95% Percentile Bootstrap UCL	44.57
95% BCA Bootstrap UCL	46.84		
90% Chebyshev(Mean, Sd) UCL	51.18	95% Chebyshev(Mean, Sd) UCL	58.28
97.5% Chebyshev(Mean, Sd) UCL	68.15	99% Chebyshev(Mean, Sd) UCL	87.53

Suggested UCL to Use

95% Chebyshev (Mean, Sd) UCL	**58.28**

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
These recommendations are based upon the results of the simulation studies summarized in Singh, Singh, and Iaci (2002) and Singh and Singh (2003). However, simulations results will not cover all Real World data sets.
For additional insight the user may want to consult a statistician.

APPENDIX B-6

SEDIMENT STEWART CREEK FROM FOP AND DOWNSTREAM (without hotspots)

UCL Statistics for Uncensored Full Data Sets

User Selected Options			
Date/Time of Computation	5/6/2014 10:57		
From File	working file all sed without hotspots.xls		
Full Precision	OFF		
Confidence Coefficient	95%		
Number of Bootstrap Operations	2000		

Arsenic

General Statistics			
Total Number of Observations	86	Number of Distinct Observations	71
		Number of Missing Observations	0
Minimum	7	Mean	19.91
Maximum	57.7	Median	17.3
SD	11.02	Std. Error of Mean	1.189
Coefficient of Variation	0.554	Skewness	1.447
Normal GOF Test			
Shapiro Wilk Test Statistic	0.844	Shapiro Wilk GOF Test	
5% Shapiro Wilk P Value	8.04E-13	Data Not Normal at 5% Significance Level	
Lilliefors Test Statistic	0.197	Lilliefors GOF Test	
5% Lilliefors Critical Value	0.0955	Data Not Normal at 5% Significance Level	
Data Not Normal at 5% Significance Level			
Assuming Normal Distribution			
95% Normal UCL		95% UCLs (Adjusted for Skewness)	
95% Student's-t UCL	21.89	95% Adjusted-CLT UCL (Chen-1995)	22.07
		95% Modified-t UCL (Johnson-1978)	21.92
Gamma GOF Test			
A-D Test Statistic	1.574	Anderson-Darling Gamma GOF Test	
5% A-D Critical Value	0.756	Data Not Gamma Distributed at 5% Significance Level	
K-S Test Statistic	0.133	Kolmogrov-Smirnoff Gamma GOF Test	
5% K-S Critical Value	0.0968	Data Not Gamma Distributed at 5% Significance Level	
Data Not Gamma Distributed at 5% Significance Level			
Gamma Statistics			
k hat (MLE)	4.089	k star (bias corrected MLE)	3.954
Theta hat (MLE)	4.87	Theta star (bias corrected MLE)	5.036
nu hat (MLE)	703.3	nu star (bias corrected)	680.1
MLE Mean (bias corrected)	19.91	MLE Sd (bias corrected)	10.01
		Approximate Chi Square Value (0.05)	620.6
Adjusted Level of Significance	0.0472	Adjusted Chi Square Value	619.6
Assuming Gamma Distribution			
95% Approximate Gamma UCL (use when n>=50))	21.82	95% Adjusted Gamma UCL (use when n<50)	21.86
Lognormal GOF Test			
Shapiro Wilk Test Statistic	0.956	Shapiro Wilk Lognormal GOF Test	
5% Shapiro Wilk P Value	0.0197	Data Not Lognormal at 5% Significance Level	
Lilliefors Test Statistic	0.0967	Lilliefors Lognormal GOF Test	
5% Lilliefors Critical Value	0.0955	Data Not Lognormal at 5% Significance Level	
Data Not Lognormal at 5% Significance Level			
Lognormal Statistics			
Minimum of Logged Data	1.946	Mean of logged Data	2.864
Maximum of Logged Data	4.055	SD of logged Data	0.493
Assuming Lognormal Distribution			

95% H-UCL	21.85	90% Chebyshev (MVUE) UCL	23.09
95% Chebyshev (MVUE) UCL	24.59	97.5% Chebyshev (MVUE) UCL	26.68
99% Chebyshev (MVUE) UCL	30.78		

Nonparametric Distribution Free UCL Statistics
Data do not follow a Discernible Distribution (0.05)

Nonparametric Distribution Free UCLs

95% CLT UCL	21.87	95% Jackknife UCL	21.89
95% Standard Bootstrap UCL	21.93	95% Bootstrap-t UCL	22.14
95% Hall's Bootstrap UCL	21.95	95% Percentile Bootstrap UCL	21.91
95% BCA Bootstrap UCL	22.22		
90% Chebyshev(Mean, Sd) UCL	23.48	95% Chebyshev(Mean, Sd) UCL	25.1
97.5% Chebyshev(Mean, Sd) UCL	27.34	99% Chebyshev(Mean, Sd) UCL	31.74

Suggested UCL to Use

95% Student's-t UCL	**21.89**	**or 95% Modified-t UCL**	**21.92**

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
These recommendations are based upon the results of the simulation studies summarized in Singh, Singh, and Iaci (2002)
and Singh and Singh (2003). However, simulations results will not cover all Real World data sets.
For additional insight the user may want to consult a statistician.

Cadmium

General Statistics

Total Number of Observations	109	Number of Distinct Observations	89
		Number of Missing Observations	0
Minimum	0.16	Mean	1.006
Maximum	4.47	Median	0.84
SD	0.743	Std. Error of Mean	0.0712
Coefficient of Variation	0.739	Skewness	2.36

Normal GOF Test

Shapiro Wilk Test Statistic	0.783	Shapiro Wilk GOF Test
5% Shapiro Wilk P Value	0	Data Not Normal at 5% Significance Level
Lilliefors Test Statistic	0.202	Lilliefors GOF Test
5% Lilliefors Critical Value	0.0849	Data Not Normal at 5% Significance Level

Data Not Normal at 5% Significance Level

Assuming Normal Distribution

95% Normal UCL		95% UCLs (Adjusted for Skewness)	
95% Student's-t UCL	1.124	95% Adjusted-CLT UCL (Chen-1995)	1.141
		95% Modified-t UCL (Johnson-1978)	1.127

Gamma GOF Test

A-D Test Statistic	1.106	Anderson-Darling Gamma GOF Test
5% A-D Critical Value	0.762	Data Not Gamma Distributed at 5% Significance Level
K-S Test Statistic	0.114	Kolmogrov-Smirnoff Gamma GOF Test
5% K-S Critical Value	0.088	Data Not Gamma Distributed at 5% Significance Level

Data Not Gamma Distributed at 5% Significance Level

Gamma Statistics

k hat (MLE)	2.492	k star (bias corrected MLE)	2.43
Theta hat (MLE)	0.404	Theta star (bias corrected MLE)	0.414
nu hat (MLE)	543.3	nu star (bias corrected)	529.7
MLE Mean (bias corrected)	1.006	MLE Sd (bias corrected)	0.646
		Approximate Chi Square Value (0.05)	477.3
Adjusted Level of Significance	0.0478	Adjusted Chi Square Value	476.7

Assuming Gamma Distribution

95% Approximate Gamma UCL (use when n>=50))	1.117	95% Adjusted Gamma UCL (use when n<50)	1.118

Lognormal GOF Test

Shapiro Wilk Test Statistic	0.974	Shapiro Wilk Lognormal GOF Test
5% Shapiro Wilk P Value	0.244	Data appear Lognormal at 5% Significance Level
Lilliefors Test Statistic	0.1	Lilliefors Lognormal GOF Test
5% Lilliefors Critical Value	0.0849	Data Not Lognormal at 5% Significance Level

Data appear Approximate Lognormal at 5% Significance Level

Lognormal Statistics

Minimum of Logged Data	-1.833	Mean of logged Data	-0.208
Maximum of Logged Data	1.497	SD of logged Data	0.659

Assuming Lognormal Distribution

95% H-UCL	1.141	90% Chebyshev (MVUE) UCL	1.216
95% Chebyshev (MVUE) UCL	1.31	97.5% Chebyshev (MVUE) UCL	1.441
99% Chebyshev (MVUE) UCL	1.699		

Nonparametric Distribution Free UCL Statistics

Data appear to follow a Discernible Distribution at 5% Significance Level

Nonparametric Distribution Free UCLs

95% CLT UCL	1.123	95% Jackknife UCL	1.124
95% Standard Bootstrap UCL	1.126	95% Bootstrap-t UCL	1.149
95% Hall's Bootstrap UCL	1.155	95% Percentile Bootstrap UCL	1.123
95% BCA Bootstrap UCL	1.134		
90% Chebyshev(Mean, Sd) UCL	1.22	95% Chebyshev(Mean, Sd) UCL	1.317
97.5% Chebyshev(Mean, Sd) UCL	1.451	99% Chebyshev(Mean, Sd) UCL	1.715

Suggested UCL to Use

95% Chebyshev (Mean, Sd) UCL	**1.317**

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
These recommendations are based upon the results of the simulation studies summarized in Singh, Singh, and Iaci (2002)
and Singh and Singh (2003). However, simulations results will not cover all Real World data sets.
For additional insight the user may want to consult a statistician.

Lead

General Statistics

Total Number of Observations	109	Number of Distinct Observations	88
		Number of Missing Observations	0
Minimum	6.57	Mean	21.36
Maximum	59	Median	18.5
SD	11.12	Std. Error of Mean	1.065
Coefficient of Variation	0.521	Skewness	1.394

Normal GOF Test

Shapiro Wilk Test Statistic	0.865	Shapiro Wilk GOF Test
5% Shapiro Wilk P Value	1.11E-14	Data Not Normal at 5% Significance Level
Lilliefors Test Statistic	0.179	Lilliefors GOF Test
5% Lilliefors Critical Value	0.0849	Data Not Normal at 5% Significance Level

Data Not Normal at 5% Significance Level

Assuming Normal Distribution

95% Normal UCL		95% UCLs (Adjusted for Skewness)	
95% Student's-t UCL	23.13	95% Adjusted-CLT UCL (Chen-1995)	23.26
		95% Modified-t UCL (Johnson-1978)	23.15

Gamma GOF Test

A-D Test Statistic	1.25	Anderson-Darling Gamma GOF Test

5% A-D Critical Value	0.756	Data Not Gamma Distributed at 5% Significance Level	
K-S Test Statistic	0.116	Kolmogrov-Smirnoff Gamma GOF Test	
5% K-S Critical Value	0.0874	Data Not Gamma Distributed at 5% Significance Level	
Data Not Gamma Distributed at 5% Significance Level			

Gamma Statistics			
k hat (MLE)	4.454	k star (bias corrected MLE)	4.337
Theta hat (MLE)	4.796	Theta star (bias corrected MLE)	4.925
nu hat (MLE)	971	nu star (bias corrected)	945.6
MLE Mean (bias corrected)	21.36	MLE Sd (bias corrected)	10.26
		Approximate Chi Square Value (0.05)	875.2
Adjusted Level of Significance	0.0478	Adjusted Chi Square Value	874.3

Assuming Gamma Distribution			
95% Approximate Gamma UCL (use when n>=50))	23.08	95% Adjusted Gamma UCL (use when n<50)	23.1

Lognormal GOF Test			
Shapiro Wilk Test Statistic	0.973	Shapiro Wilk Lognormal GOF Test	
5% Shapiro Wilk P Value	0.185	Data appear Lognormal at 5% Significance Level	
Lilliefors Test Statistic	0.0825	Lilliefors Lognormal GOF Test	
5% Lilliefors Critical Value	0.0849	Data appear Lognormal at 5% Significance Level	
Data appear Lognormal at 5% Significance Level			

Lognormal Statistics			
Minimum of Logged Data	1.883	Mean of logged Data	2.945
Maximum of Logged Data	4.078	SD of logged Data	0.476

Assuming Lognormal Distribution			
95% H-UCL	23.15	90% Chebyshev (MVUE) UCL	24.33
95% Chebyshev (MVUE) UCL	25.72	97.5% Chebyshev (MVUE) UCL	27.64
99% Chebyshev (MVUE) UCL	31.42		

Nonparametric Distribution Free UCL Statistics
Data appear to follow a Discernible Distribution at 5% Significance Level

Nonparametric Distribution Free UCLs			
95% CLT UCL	23.11	95% Jackknife UCL	23.13
95% Standard Bootstrap UCL	23.12	95% Bootstrap-t UCL	23.32
95% Hall's Bootstrap UCL	23.25	95% Percentile Bootstrap UCL	23.14
95% BCA Bootstrap UCL	23.19		
90% Chebyshev(Mean, Sd) UCL	24.56	95% Chebyshev(Mean, Sd) UCL	26
97.5% Chebyshev(Mean, Sd) UCL	28.01	99% Chebyshev(Mean, Sd) UCL	31.96

Suggested UCL to Use			
95% Student's-t UCL	**23.13**	**or 95% Modified-t UCL**	**23.15**
or 95% H-UCL	**23.15**		

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
These recommendations are based upon the results of the simulation studies summarized in Singh, Singh, and Iaci (2002)
and Singh and Singh (2003). However, simulations results will not cover all Real World data sets.
For additional insight the user may want to consult a statistician.

ProUCL computes and outputs H-statistic based UCLs for historical reasons only.
H-statistic often results in unstable (both high and low) values of UCL95 as shown in examples in the Technical Guide.
It is therefore recommended to avoid the use of H-statistic based 95% UCLs.
Use of nonparametric methods are preferred to compute UCL95 for skewed data sets which do not follow a gamma distribution.

APPENDIX C

HABITAT ASSESSMENT FIELD SURVEY REPORT

HABITAT ASSESSMENT FIELD SURVEY REPORT

Exide Technologies
Frisco, Collin County, Texas

Prepared For:
Golder Associates, Inc.
St. Charles, Missouri 63301

Prepared By:
Benchmark Ecological Services, Inc.
Brookshire, Texas 77423

March 2014

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1.0 INTRODUCTION

On July 9, 2013, Exide submitted an Affected Property Assessment Report (APAR) for the former Exide operating plant to the TCEQ. A Screening Level Ecological Risk Assessment (SLERA) was conducted as a part of the APAR and submitted to the agencies with the APAR. The APAR was reviewed by the EPA and TCEQ and comments were received by Exide on October 8, 2013.

Benchmark Ecological Services, Inc. was contracted to collect the ecological information needed to address two comments provided by TCEQ concerning the Exide SLERA. This Habitat Assessment will become part of the APAR for the former Exide Operating Plant. The TCEQ comments that were addressed are presented below.

> <u>SLERA General Comment #6</u>: *Since the assessment of Stewart Creek will continue downstream, the possibility exists that sediment may accumulate in locations that could support mollusks including the threatened Louisiana pigtoe and the Texas heelsplitter. In addition, it is possible that more viable habitat downstream may exist for other protected species, including the threatened White-faced ibis. It is recommended that these species and other protected species known to occur in Collin and Denton Counties be re-evaluated for potential occurrence in downstream Stewart Creek.*

> <u>SLERA Specific Comment # 13:</u> *Figure 9 (Conceptual Site Model). Reptiles and amphibians are likely present at this site and should be reflected in the conceptual site model. In addition, risk to these receptors should be qualitatively evaluated in the SLERA. The risk to reptiles could be tied to the evaluation of the Timber/Canebrake rattlesnake discussed previously and the risk to amphibians could be related to the evaluation of site surface water quality.*

1.1 PURPOSE AND SCOPE

Benchmark was contracted to conduct a wildlife habitat assessment of approximately 7.0 miles of Stewart Creek downstream of the former Exide facility and 36 acres of undeveloped land inside the former Exide facility. The location of the study areas are shown in Figure 1. Benchmark scientists conducted a general habitat assessment with emphasis on habitat that could support the threatened and endangered species listed for Collin and Denton Counties. The habitat assessments were conducted to provide information needed to support the SLERA that is being conducted at the site.

To address General Comment #6, Benchmark mapped aquatic habitat in Stewart Creek between the former Exide facility and Lake Lewisville in two separate survey events. The initial survey event was conducted on January 15 and 16, 2014, and included all sections of the creek bordered by property owned by the city of Frisco and the United States Corp of Engineers (USACE). Access to sections bordered by private landowners was not granted until March 2014. Benchmark conducted a second survey event on March 18, 2014, in the sections of Stewart Creek not surveyed in January 2014. The creek downstream of the plant is approximately 7.0 miles long (Figure 2).

To address Specific Comment #13, Benchmark mapped wildlife habitat on approximately 36 acres of land within the former Exide facility on January 13 and 14, 2014. Risk calculations for the SLERA being conducted at the site required more information about wildlife utilization of the habitat. Benchmark delineated the habitats to determine if they are being utilized by threatened or endangered wildlife species. The former Exide facility study area is shown in Figure 3.

1.2 SITE DESCRIPTION

The former Exide Facility is located at 7471 South Fifth Street in Collin County, Frisco, Texas. The site, a secondary lead smelter, was active from 1964 through November 2012. It processed used lead-acid batteries and other lead-bearing materials into several lead products. The process produced a slag, which was processed and disposed of in a Class II landfill on-site. The process also produced battery-case chips which were disposed of off-site, and waste acid which was treated through the on-site wastewater-treatment system. The 87 acre former Exide Facility site includes approximately 36 acres of undeveloped land and modified stream channels. The on-site streams, which run east to west across the property, include a segment of Stewart Creek and an unnamed tributary of Stewart Creek (referred to as North Tributary). The streams converge west of the former Exide Facility and flow west toward Lake Lewisville.

Stewart Creek downstream of the former Exide Facility is a perennial stream that receives surface runoff from the former Exide Facility and treated wastewater from the North Texas Municipal Water District wastewater treatment plant. Immediately downstream of the former Exide facility, the stream contains a small number of perennial pools connected by segments of riffles and glides.

2.0 SAMPLING METHODS

2.1 STEWART CREEK

Benchmark conducted a habitat assessment on 7.0 miles of Stewart Creek between Lake Lewisville and the western boundary downstream of the former Exide facility as shown in Figure 2. Prior to conducting the field survey, Benchmark searched existing databases and queried resource agencies to determine if there are known threatened and endangered species occurrences within the study areas and surrounding properties. Figure 4 shows the location of endangered species occurrences identified prior to conducting the field survey. No historical endangered species occurrences were identified within the study areas.

Benchmark scientists walked, waded, and kayaked the sections of the creek shown in Figure 2 to document existing conditions and to locate habitat that could potentially support populations of benthic macro-invertebrates and other wildlife, including threatened or endangered species. Benchmark scientists conducted a general habitat survey noting the physical features of the creek, dominant plant species, and evidence of wildlife utilization.

Stream segments that exhibited favorable conditions for sediment accumulation (pools and glides) are also, in many cases, suitable habitats for benthic and aquatic wildlife. Benthic surveys were conducted within the stream segments that contained accumulated sediment using established stream assessment techniques. The benthic surveys were conducted at the stations shown in Figure 5. The surveys were conducted by first visually examining the sediment surface, and grab samples were collected using a clam rake. Within each transect, scientists waded across the stream or pool using multiple parallel paths perpendicular to the stream centerline. The results of each examination were documented in field notes and in a photographic log. Live specimens were returned to the streambed. Benchmark identified macro-invertebrates observed during the survey and documented sediment type. A photo log was compiled to document the shoreline habitat, sediment type, biological specimens, and general stream conditions. Benchmark scientists used a GPS to record the location of each transect.

During the surveys, Benchmark scientists were especially alert for listed species known to occur in Collin and Denton Counties, as listed in Attachment A. Benchmark scientists used a GPS to record the location of wildlife sightings, changes in stream conditions, and changes in dominant plant species.

2.2 FORMER EXIDE FACILITY

Benchmark Scientists conducted a habitat assessment on approximately 36 acres of undeveloped property within the former Exide Facility shown in Figure 3. The study area consists of two modified streambed areas, the North Wooded area, the South Wooded area, and the Lake Parcel. Benchmark scientists walked the transects shown in Figure 3 and documented the physical characteristics of the habitats, dominant plant species, and wildlife observations. The locations of all field observations were recorded using a sub-meter GPS unit.

Benthic surveys were conducted at the stations shown in Figure 3. The surveys were conducted by first visually examining the sediment surface and grab samples were collected using a clam rake. Within each transect, scientists waded across the stream or pool using multiple parallel paths perpendicular to the stream centerline. The results of each examination were documented in field notes and in a photographic log. A photo log was compiled to document the shoreline habitat, sediment type, and general stream conditions. Benchmark scientists used a GPS to record the location of each transect.

2.3 DATA COLLECTION

2.3.1 Field Data Log

Benchmark scientists recorded all field data on field data sheets and used a GPS to record the location of benthic invertebrate transects, wildlife sightings, stream conditions, and changes in dominant plant species. Copies of the field data sheets are included in Attachment B.

2.3.2 Photographic Log

Benchmark scientists recorded the identification numbers of all photographs taken during the field study on field data sheets. Representative photographs are shown in Attachment C.

3.0 FIELD SURVEY RESULTS

3.1 STEWART CREEK

Benchmark waded through and walked along 7.0 miles of Stewart Creek on January 15 and 16, 2014, and on March 18, 2014, in the areas shown in Figure 2. The streambed that connects the former Exide Plant and Lake Lewisville is typical of a streambed that was formed by rapidly moving water. Most of the creek bottom is dominated by long segments of exposed rock, shale and clay. The elevation of Stewart Creek at the Exide Facility is 640 ft., and the elevation of the water on Lake Lewisville is approximately 515 ft. The distance between the plant and the lake is approximately 4 miles (as the crow flies). The creek bottom downstream of the Exide facility consisted mostly of gravel, shale, and clay and contained few pooling areas. The streambed only included a few segments where measurable amounts of sediment had accumulated. Sediment was only found in the small pools that were scattered along the stream course. The pooling areas were small in size and averaged less than 3 feet deep. The remainder of the streambed consisted of long segments of exposed rock, shale, and clay that had no accumulated sediment. The banks of the creek between the former Exide Facility and Lake Lewisville primarily consisted of steep eroded bluffs 4 to 6 feet high.

Benchmark scientists collected data at 23 habitat plots, conducted 27 benthic surveys, and made over 34 wildlife observations while conducting the surveys along Stewart Creek. The location of the habitat plots, benthic surveys and wildlife observations are shown in Figure 5, and copies of field data sheets are included in Attachment B.

The dominant vegetation on the banks and immediately adjacent to the creek consisted of the following species:

- Green Ash (*Fraxinus pennsylvanica*)
- Hackberry (*Cetlis laevigata*)
- Osage Orange (*Maclura pomifera*)
- Greenbriar (*Smilax bona-nox*)
- Giant Ragweed (*Ambrosia trifida*)
- Canada Wildrye (*Elymus canadensis*)
- Inland Seaoats (*Chasmanthium latifolium*)

Benchmark found three species of mussels (listed below) while conducting the habitat surveys.

- Pondhorn *(Uniomerus tetralasmus)* - shells were found on the banks and on shallow gravel beds throughout the length of creek from the former Exide facility to Lake Lewisville. No live Pondhorn mussels were found when conducting the field surveys.

- Asian Clams (*Corbicula* spp.) – live Asian Clams were collected using a clam rake in the fine gravel of several small pooling areas along the creek downstream of the former Exide facility. Asian Clam shells were abundant on the banks and shallow gravel beds throughout the creek downstream of the former Exide facility.

- Giant Floater (*Pyganodon grandis*) – one shell was found on a shallow gravel bed near Lake Lewisville (Habitat Plot H-74 shown in Figure 5).

Representative photographs of the species listed above are included in Attachment C.

The following turtles were observed when conducting the study;

- Red-eared Slider (*Trachemys scripta elegans*) (Wildlife Plot W-45 and W-101 shown in Figure 5)
- Box Turtle *(Terrapene carolina)* (Wildlife Plots W-42 and W-48 shown in Figure 5)
- Soft Shell Turtle *(Apalone spinifera)* (Wildlife Plot W-43 shown in Figure 5)

In addition to the species listed above, the following wildlife sightings were recorded when conducting the surveys along Stewart Creek.

- Crow (*Corvus brachyrhynchos*)
- Owl (species unknown)
- Mallard (*Anas platyrhynchos*)
- Turkey Vulture (*Cathartes aura*)
- Northern Cardinal (*Cardinalis cardinalis*)
- Baird's sandpiper (*Calidris bairdii*)
- Carolina Chickadee (*Poecile carolinensis*)
- Tufted Titmouse (*Baeolophus bicolor*)
- Northern Mockingbird (*Mimus polyglottos)*
- Killdeer (*Charadrius vociferous)*
- Beaver (*Castor canadensis*)
- Raccoon (*Procyon lotor*)
- Coyote (*Canis latrans*)
- Bluegill (*Lepomis macrochirus*)
- Green Sunfish (*Lepomis cyanellus*)
- White-tailed Deer (*Odocoileus virginianus*)
- Squirrel Nest (species not identified)

- Minnows (species not identified)

3.2 FACILITY PROPERTY

Benchmark Scientists conducted a habitat assessment on approximately 36 acres of undeveloped property within the former Exide Facility shown in Figure 3. The study area consisted of two modified streambed areas, two wooded areas, and the lake parcel. Copies of the field notes recorded when conducting the habitat surveys area included in Attachment B.

3.2.1 Streams

Benchmark scientists conducted habitat surveys on Stewart Creek and the North Tributary located within the former Exide Facility on January 13 and 14, 2014.

3.2.1.1 Stewart Creek

Stewart Creek runs east to west across the former Exide Facility as shown in Figure 3. The banks on the east end of Stewart Creek averaged approximately 2 feet above the water line. The grasses growing along the banks were maintained and had recently been mowed. The banks along the creek on the west side of the former Exide Facility were greater than 8 ft. tall, and vegetation consisted of shrubs, small trees, and grasses.

Benchmark scientists collected data at 10 habitat plots, conducted 4 benthic surveys, and made over 16 wildlife observations when conducting the surveys along Stewart Creek within the former Exide Facility.

The dominant vegetation along the banks of Stewart Creek consisted of;

- Johnsongrass (*Sorghum halepense*)
- Canada Goldenrod (*Solidago canadensis*)
- Winged Elm (*Ulmus alata*)
- Bermudagrass (*Cynodon dactylon*)
- Giant Ragweed (*Ambrosia trifida*)
- Black Willow (*Salix nigra*)

Wildlife sightings recorded when conducting surveys adjacent to Stewart Creek included the following species;

- European Starling (*Sturnus vulgaris*)
- Crow (*Corvus brachyrhynchos*)

- Turkey Vulture (*Cathartes aura*)
- Pigeon (*Columba livia*)
- Red Tail Hawk (*Buteo jamaicensis*)
- Raccoon (*Procyon lotor*)
- Beaver (*Castor canadensis*)
- Pondhorn (*Uniomerus tetralasmus*)
- Feral hog (*Sus scrofa*)
- Mallard (*Anas platyrhynchos*)

Stewart Creek within the former Exide facility consisted of riffles and a few pooling areas just upstream of small dams located along the creek (one beaver dam and 1 small concrete dam). The creek bed in the riffle areas consisted of gravel, shale, concrete, loose rip/rap, and rip/rap contained within chain link fencing. The creek bed within the pooling areas consisted of gravel, dead vegetation, and small amounts of sand or fine gravel. The gravel sizes vary along the length of the creek bed.

Benchmark conducted benthic surveys in the two pooling areas and in 2 riffle areas within the facility. Benthic survey locations are shown in Figure 3. Several attempts to collect benthic organisms using a clam rake were made at each of the 4 benthic survey stations. No live mussels and no mussel shells were observed when conducting the benthic surveys in Stewart Creek within the former Exide facility.

Benchmark scientists found Pondhorn mussel shells along the bank of the creek just upstream of the Railroad tracks located on the West boundary of the former Exide facility. The weathered condition of the mussel valves indicated that deposition of the shell was not recent. The shells were found approximately 7 feet above the water line on a relatively steep slope.

3.2.1.2 North Tributary

The North Tributary of Stewart Creek runs from east to west. The east end of the North Tributary is located within the North Wooded Area discussed in Section 3.2.2.1. The west end of the North Tributary is bounded by a lake parcel on the north and the former Exide Facility on the south. The North Tributary ends near the west end of the study area where it converges with Stewart Creek. A smaller volume of water flows through the North Tributary compared to Stewart Creek. Small pooling areas less than 5 to 10 square feet were observed when conducting the surveys. The bottom of the creek bed within the riffle areas and pooling areas consisted of gravel, clay and shale.

Along the section of the North Tributary located outside of the North Wooded Area, Benchmark scientists collected data at 8 habitat plots and made over 4 wildlife observations. The dominant vegetation along the stream banks and wildlife observations made in the section of the North Tributary located within the North Wooded Area are listed in Section 3.2.2.1.

The dominant vegetation along the North Tributary outside of the North Wooded Area consisted of:

- Canada Goldenrod (*Solidago canadensis*)
- Bermudagrass (*Cynodon dactylon*)
- Johnsongrass (*Sorghum halepense*)
- Giant Ragweed (*Ambrosia trifida*)

Wildlife sightings recorded when conducting surveys along the North Tributary (outside of the wooded area) included the following species:

- Red Tail Hawk (*Buteo jamaicensis*)
- Raccoon (*Procyon lotor*)
- Active Burrows (unknown species)

3.2.2 Wooded Areas

Benchmark conducted habitat surveys in two wooded areas located within the former Exide Facility. The two wooded areas are labeled North Wooded Area and South Wooded Area in Figure 3.

3.2.2.1 North Wooded Area

Benchmark scientists walked 5 north/south transects within the North Wooded Area as shown in Figure 3. Field data were collected at 16 habitat plots and 13 wildlife observations were made during the surveys in the North Wooded Area. The North Wooded Area was separated into two different habitat types. The north and east sections of the study area consisted of relatively level ground with a higher elevation than the southwest section. The southwest section of the study area was at a lower elevation and exhibited hydrologic features such as drift lines and buttressing at the base of numerous trees. The drift lines and buttressing indicates the area contains standing water part of the year. The approximate boundaries of the two habitat areas listed above are shown in Figure 6.

The dominant vegetation within the wooded area with the higher elevation in the north and east consisted of:

- Greenbrair (*Smilax bona-nox*)
- Osage Orange (*Maclura pomifera*)
- Canada Wildrye (*Elymus canadensis*)
- Hackberry (*Cetlis laevigata*)
- Cedar Elm (*Ulmus crassifolia*)
- American Elm (*Ulmus americana*)
- Honeysuckle (*Lonicera japonica*)

Dominant vegetation within the area at a lower elevation in the southwest consisted of:

- Hackberry (*Cetlis laevigata*)
- Black Willow (*Salix nigra*)
- Mustang Grape (*Vitis mustangensis*)

Wildlife sightings recorded when conducting surveys in the North Wooded area included the following species:

- Robin (*Turdus migratorius*)
- Northern Cardinal (*Cardinalis cardinalis*)
- Mourning Dove (*Zenaida macroura*)
- Raccoon (*Procyon lotor*)
- Tufted Titmouse (*Baeolophus bicolor*)
- Loggerhead Shrike (*Lanius ludovicianus*)

3.2.2.2 South Wooded Area

Benchmark scientists walked 4 north/south transects within the South Wooded Area as shown in Figure 3. Benchmark scientists collected data at 9 habitat plots and made 14 wildlife observations while conducting the surveys in the South Wooded Area. The elevation along the south edge of the wooded area is approximately 680 ft., and the elevation at the north edge of the wooded area is approximately 640 ft. The angle of the slope starting at the south edge and sloping down to north edge is approximately 20 degrees.

The dominant vegetation in the South Wooded Area consisted of:

- Bermudagrass (*Cynodon dactylon*)
- Greenbrair (*Smilax bona-nox*)

- Osage Orange (*Maclura pomifera*)
- Canada Wildrye (*Elymus canadensis*)
- Hackberry (*Cetlis laevigata*)
- Cedar Elm (*Ulmus crassifolia*)

Wildlife sightings recorded when conducting surveys in the South Wooded Area included the following species:

- White-tailed Deer (*Odocoileus virginanus)*
- Tufted Titmouse (*Baeolophus bicolor*)
- Mockingbird (*Mimus polyglottos*)
- Carolina Chickadee (*Poecile carolinensis*)
- Bird nest (unknown species)
- Burrows (unknown species)
- Nest (unknown species)
- Northern Cardinal (*Cardinalis cardinalis*)
- Robin (*Turdrus migratorius*)
- Woodpecker (unknown species)
- Cottontail Rabbit (*Sylvilagus floridanus*)
- Packrat (unknown spieces)
- Cedar Waxwing (*Bombycilla cedrorum*)
- Blue Jay (Cyanocitta cristata)

3.2.3 Lake Parcel

Benchmark scientists walked 1 north/south transect and collected data on 1 habitat plot when conducting the surveys in the Lake Parcel located in the Southwest corner of the former Exide facility (Figure 3). The Lake Parcel was relatively flat and had recently been mowed.

Dominant vegetation in the parcel consisted of;

- Canada Goldenrod (*Solidago canadensis*)
- Bermudagrass (*Cynodon dactylon*)
- Johnsongrass (*Sorghum halepense*)

No wildlife sightings were recorded while conducting surveys in the Lake Parcel.

4.0 DISCUSSION

4.1 STEWART CREEK

No threatened or endangered species, listed by federal or state agencies, were found while conducting the surveys along Stewart Creek.

Benchmark scientists found the following three species of mussels while conducting habitat surveys.

- Pondhorn *(Uniomerus tetralasmus)* - shells were found on the banks and on shallow gravel beds throughout the length of creek from the former Exide Facility to Lake Lewisville. No live Pondhorn mussels were found when conducting the field surveys.
- Asian Clams (*Corbicula spp.*) – live Asian Clams were collected using a clam rake in the fine gravel of several small pooling areas along the creek downstream of the former Exide facility. Asian Clam shells were abundant on the banks and shallow gravel beds throughout the creek downstream of the facility.
- Giant Floater (*Anodonta grandis*) – one shell was found on a shallow gravel bed near Lake Lewisville (Habitat Plot H-74 shown in Figure 5).

Benchmark waded the creek bed and conducted benthic surveys at 20 sample stations. The water was clear along most of the creek, and there were no visible signs of live mussels other than the Asian Clams. The creek bed was comprised of gravel, shale and clay and there were few pooling areas identified during the field study. Based on the results of the visual observations, benthic surveys and the small number of pooling areas with sandy and muddy bottoms, it is unlikely that the Texas Heelsplitter or Louisiana Pigtoe inhabit the sections of Stewart Creek that were surveyed. Three species of turtles were observed when conducting the surveys (Red-eared Slider, Box Turtle, and Soft Shell).

4.1.1 Threatened and Endangered Species

No threatened or endangered species, listed by federal or state agencies, were found while conducting the surveys along Stewart Creek. A list of the threatened and endangered species listed for Collin and Denton Counties is presented in Attachment A. Additional information concerning the habitat requirements of state listed species mentioned in SLERA Comment #6 or by TCEQ Ecological Risk Assessment Program Manager (Alligator snapping turtle and White-faced ibis), are provided below.

<u>Alligator Snapping Turtle</u> (*Macrochelys temminckii*) - No Alligator snapping turtles, which are listed as threatened by the state of Texas, were observed in the creek during the survey. Alligator snapping turtles live in freshwater habitats in the southeastern United States, and are found in most of the river systems that drain into the Gulf of Mexico. They are almost exclusively aquatic and generally live in the deepest water within their habitat. Only females venture on land to build nests and lay their eggs. Alligator snapping turtles prefer the habitat found in large rivers, deep sloughs, oxbow lakes and deep pools connected to large rivers (Ernst, et al., 1994). They prefer areas with submerged cover, fallen logs, overhanging shrubs, and dense overhead canopies. Adult turtles may thermoregulate using differing stream depths seasonally. Adult turtles choose deeper water during midwinter and shallower water in early summer (Riedle, et al., 2006). Hatchlings and juveniles may also inhabit smaller rivers and streams. All stable populations of alligator snapping turtles are found around larger bodies of water (i.e., large rivers and lakes) (Minton Jr., 2001; Conant, et al., 1992; Ernst, et al., 1994).

Alligator snapping turtles are both scavengers and active hunters. They are nocturnal feeders that will eat fish, frogs, snakes, snails, worms, clams, crayfish, aquatic plants, small mammals, and other turtles. During the day, they will lay motionless on the bottom of a pool and use a worm-like lure attached to the back of the mouth to attract fish into their open jaws. The turtles feed year round by taking advantage of warm winter days to search for food along the shoreline (Elsey, 2006; Ernst, et al., 1994; Pritchard, 1979).

Alligator snapping turtles mate in late spring in the western part of their range (i.e., Texas), and the females lay their eggs in a nest about two months later approximately 50 m from a body of water. Nesting success is dependent upon the quality and availability of the adjoining riparian habitat and the abundance of nest predators like raccoons, dogs, cats, and skunks.
It is unlikely that the Alligator snapping turtle would spend time within the survey area due to high flow conditions that are common in the creek and the small number of shallow pooling areas found in the creek. Stewart Creek does not provide the deep muddy bottomed pools and submerged structure that attract alligator snapping turtles. The broad sandy flood plain that is preferred by female snapping turtles for nesting is also uncommon along Stewart Creek. Adult snapping turtles would find it difficult to live and reproduce in the Stewart Creek habitat.

<u>White-Faced Ibis (*Plegadis chihi*)</u> - No White-faced Ibis, which is listed as threatened by the state of Texas, were observed in the creek during the survey. The White-faced Ibis is a medium sized dark brown or maroon wading bird (46-56 cm tall, 450-525 grams) with a long, down-curved bill. It is a member of

the family Threskiornithidae and is similar in appearance and habits to the Glossy Ibis. The White-faced Ibis is distinguished from the Glossy Ibis by the narrow border of white feathers around its bare reddish facial skin (breeding adult). Adult birds have a grey bill, reddish legs, and red eyes year-round (Ryder and Manry, 1994).

The White-faced Ibis prefers freshwater marshes, where it can find insects, newts, leeches, earthworms, snails and especially crayfish, frogs and fish. They roost on low platforms of dead reed stems or on mud banks. Ibises will feed in large flocks of up to 1,000 birds. They utilize both natural wetlands and irrigated and flooded agricultural fields.

The White-faced Ibis is a colonially breeder and usually constructs nests on top of emergent aquatic vegetation or in low shrubs or tree over the water. Locating the nests over water helps protect the eggs and nestlings from mammalian predators such as skunks, raccoons, and cats. Nests are also preyed on by gulls, magpies, ravens, crows, owls, and grackles.. The White-faced Ibis nests in isolated colonies from Oregon to Kansas, but its center of greatest abundance in the US is in Utah, Texas, and Louisiana. In Texas, they breed and winter along the Gulf Coast and may occur as migrants in the Panhandle and West Texas.The inland populations of White-faced Ibises prefer to breed in shallow freshwater marshes with islands of emergent vegetation such as cattails or bulrushes. The Louisiana and Texas populations also breed in estuarine marshes (Farrand, 1983).

Its breeding range extends from the western US south through Mexico to Brazil, Bolivia, Argentina, and Chile (IUCN 2012). Its winter range extends from southern California and Louisiana south to include the rest of its breeding range. In 2012, the total population size was estimated to be 1.2 million individuals, and increasing. The IUCN rates it as a species of "Least Concern" (IUCN 2012).

They migrate from the northern portions of their range in the colder months to winter as far south as northern South America. The breeding populations on the Texas and Louisiana coasts are year round residents.The White-faced Ibis is not a resident of the area around Stewart Creek, but riparian habitat adjacent to the perennial pools and lake shore might be used for resting and feeding by migrating birds. No White-faced Ibis were observed during the habitat survey for this study.

4.2 FACILITY PROPERTY

Benchmark conducted a habitat survey within the former Exide facility on January 13 and 14, 2014, using the methods described in Section 2.2. Benchmark scientists did not find any reptiles or amphibians while conducting the study. It is likely that reptiles and amphibians live within the study area, but were dormant at the time the habitat surveys were conducted.

4.2.1 Threatened and Endangered Species

No threatened or endangered species, listed by federal or state agencies, were found while conducting the surveys on the facility property. A list of the threatened and endangered species listed for Collin and Denton Counties is presented in Attachment A. Additional information concerning the habitat requirements of state listed species mentioned in SLERA Comment #13 or by TCEQ Ecological Risk Assessment Program Manager (Timber/Canebrake Rattlesnake and Texas Horned Lizard), are provided below.

Timber/Canebrake Rattlesnake (*Crotalus horridus*) - While it is likely that some reptiles do inhabit the study area, it is unlikely that the Timber/Canebrake rattlesnake, which is listed as endangered by the state of Texas, would thrive within the study area. Timber and canebrake rattlesnakes are considered a single species but they may have different habitat preferences and may exhibit different seasonal activity patterns. No subspecies is currently recognized (ITIS, 2014). Timber rattlesnake will be used in the following discussion in reference to both groups. Timber rattlesnakes are found in upland woods and rocky ridges in the eastern United States and the eastern third of Texas.

In Texas, timber rattlesnakes occupy bottomland hardwood forest dominated by oaks, hickories, and sweetgum, and upland forests dominated by oaks, loblolly pine, and shortleaf pine (Rudolph, *et al.*, 2004). They prefer woodlands or thickets near permanent water sources such as rivers, lakes, ponds, streams and swamps where tree stumps, logs and branches provide cover. Timber rattlesnake populations require undisturbed den sites and large contiguous wooded areas to be used during the foraging season (Brown, 1993). This species occurs in a wide variety of terrestrial habitats but their abundance typically declines sharply when urbanization encroaches (Waldron *et al*., 2006).

Timber rattlesnakes usually congregate in dens in rocky areas during cold weather to hibernate. After emergence from the den in spring, males and non-gravid females migrate to lowlands, pasture edges, the banks of streams and rivers, and brushy or wooded sites (Petersen and Fritsch, 1986). Timber rattlesnakes migrate back to the same dens in the fall for hibernation and may retrace the same route used for spring migration (Brown, *et al*., 1982). After migrating to summer habitat, timber rattlesnakes move short distances within summer ranges to forage and breed. Home range size increases for males during the breeding season compared to the foraging season (Rudolph and Burgdorf, 1997; Waldron *et al*., 2006).

Habitat selection by timber rattlesnakes differs based on gender, reproductive status, and season (Brown, 1993; Reinert and Zappalorti, 1988.). Timber rattlesnakes need 3 types of habitat (e.g., denning, transient, and summer habitats). Denning habitat is used by all timber rattlesnakes for hibernation. Transient habitat is located close to the den and is used by males and non-gravid females for basking before migration to summer habitat. It is also used by gravid females for gestation and parturition. Summer habitat is used by males and nongravid females for foraging, mating, and basking (Brown, 1993).

Timber rattlesnakes feed on rabbits, squirrels, rats, mice, birds, other snakes, lizards, and frogs. Young timber rattlers are eaten by coyotes, bobcats, skunks, foxes, hawks, owls, and snake-eating snakes such as king snakes, indigo snakes and cottonmouths. Timber rattlers are diurnal (active during the day) during spring and fall but become nocturnal (active at night) during summer. Timber rattlesnakes are sometimes slow to defend themselves and rely on their ability to blend into their surroundings to avoid confrontation. They prefer to hide from predators and avoid confrontation.

Mating season is in early spring, only once every two to three years for females. The live young are born in late summer or early fall. After birth, young snakes remain near their mother for seven to ten days, but no parental care is provided. Causes of mortality for newborns include predation, lack of suitable small-sized prey items, and lack of suitable dens (Galligan and Dunson, 1979). Most adult mortality is due to human impacts including hunting, collecting for commercial purposes, habitat loss, and habitat fragmentation (Rudolph and Burgdorf, 1997; Waldron *et al*., 2006).

Timber rattlesnakes would not live in the study area due to the limited and fragmented habitat adjacent to and within the property. An aerial photograph of the property (Figure 7) shows that the surrounding areas are dominated by urban development and active agricultural fields. The continuous undisturbed scrub shrub and wooded habitat that is required to support a population of Timber rattlesnakes was not found at the site.

<u>Texas Horned Lizard</u> (*Phrynosoma cornutum)* - The Texas horned lizard ranges from the south-central United States to northern Mexico (including Texas, Oklahoma, Kansas and New Mexico) and the former Exide Facility is within the range of the species. Texas horned lizards can be found in arid and semiarid habitats in open areas with sparse plant cover. Because horned lizards dig for hibernation, nesting and

insulation purposes, they commonly are found in loose sand or loamy soils (Munger, 1984). The Texas horned lizard currently is listed as a threatened species in Texas (federal category C2).

Texas Horned lizards are most often found near harvester ant mounds. About 70% of the horned lizard's diet is made up of harvester ants and the remainder is composed of termites, beetles, and grasshoppers. The horned lizard requires bright sunlight to produce vitamin D and they are often found in open un-vegetated areas where full sunlight reaches the ground. Without sunlight the lizards are unable to produce vitamin D and will suffer from vitamin deficiency. At night, the lizard buries itself in sand.

Horned lizards can move rapidly if they feel there is a predator in the area, and will dart into thick grass and foliage to escape. Horned lizards are excellent diggers, and can quickly burrow in sandy soil to escape threats (Munger, 1986).

It is unlikely that the Texas Horned lizard is common in the study area due to the lack of suitable habitat. The Texas horned lizard prefers open sandy areas where herbaceous vegetation is scarce. This habitat was not common at the former Exide Facility. The forested areas found at the site are not preferred habitat for the lizards. In addition, Benchmark did not find harvester ants or ant mounds (the preferred prey item of the horned lizard) within the study area.

5.0 REFERENCES

Brown, William S. 1993. Biology, status, and management of the timber rattlesnake (*Crotalus horridus*): a guide for conservation. In: Collins, Joseph T., ed. Herpetological Circular No. 22. Lawrence, KS: Society for the Study of Amphibians and Reptiles. 79 p.

Brown, William S.; Pyle, Donald W.; Greene, Kimberly R.; Friedlaender, Jeffrey B. 1982. Movements and temperature relationships of timber rattlesnakes (*Crotalus horridus*) in northeastern New York. Journal of Herpetology. 16(2): 151-161.

Conant, R., R. Stebbins, J. Collins. 1992. Peterson First Guide to Reptiles and Amphibians. New York, New York: Houghton Mifflin Company.

Elsey, R. 2006. Food Habits of *Macrochelys temminckii* (Alligator Snapping Turtle) From Arkansas and Louisiana. Southeastern Naturalist, 5: 443-452.

Ernst, C., R. Barbour, J. Lovich. 1994. Turtles of the United States and Canada. Washington, D.C.: Smithsonian Institution Press.

Farrand, J. Jr. ed. 1983. *The Audubon Society Master Guide to Birding Vol. 1.* Alfred A. Knopf, Inc. New York.

Galligan, John H.; Dunson, William A. 1979. Biology and status of timber rattlesnake (*Crotalus horridus*) populations in Pennsylvania. Biological Conservation. 15(1): 13-58.

Harrel, J., N. Douglas, M. Haraway, R. Thomas. 1996. Mating Behavior In Captive Alligator Snapping Turtles (*Macroclemys temminckii*). Chelonian Conservation and Biology, 2: 101-105.

ITIS. 2014. "*Crotalus horridus*". Integrated Taxonomic Information System. Retrieved 20 February 2014.

IUCN BirdLife International (2012). "*Plegadis chihi*". *IUCN Red List of Threatened Species. Version 2013.2*. International Union for Conservation of Nature.

Minton Jr., S. 2001. Amphibians & Reptiles of Indiana. Indianapolis: Indiana Academy of Science.

Munger, James C. (1984). Home ranges of horned lizards (*Phrynosoma*): circumscribed and exclusive. *Oecologia* 62 (3): 351–360.

Munger, James C. (1986). Rate of Death Due to Predation for two Species of Horned Lizard, *Phrynosoma cornutum* and *Phrynosoma modestum*. *Copeia* (American Society of Ichthyologists and Herpetologists) **3** (3): 820–824.

Petersen, Richard C.; Fritsch, Robert W., II. 1986. Connecticut's venomous snakes: The timber rattlesnake and northern copperhead. Bulletin 111. 2nd ed. Hartford, CT: Department of Environmental Protection, State Geological and Natural History Survey. 48 p.

Pritchard, P. 1979. Encyclopedia of Turtles. Neptune, New Jersey: T.F.H. Publications, Inc.

Reinert, Howard K.; Zappalorti, Robert T. 1988. Timber rattlesnakes (*Crotalus horridus*) of the Pine Barrens: their movement patterns and habitat preference. Copeia. 1988(4): 964-978.

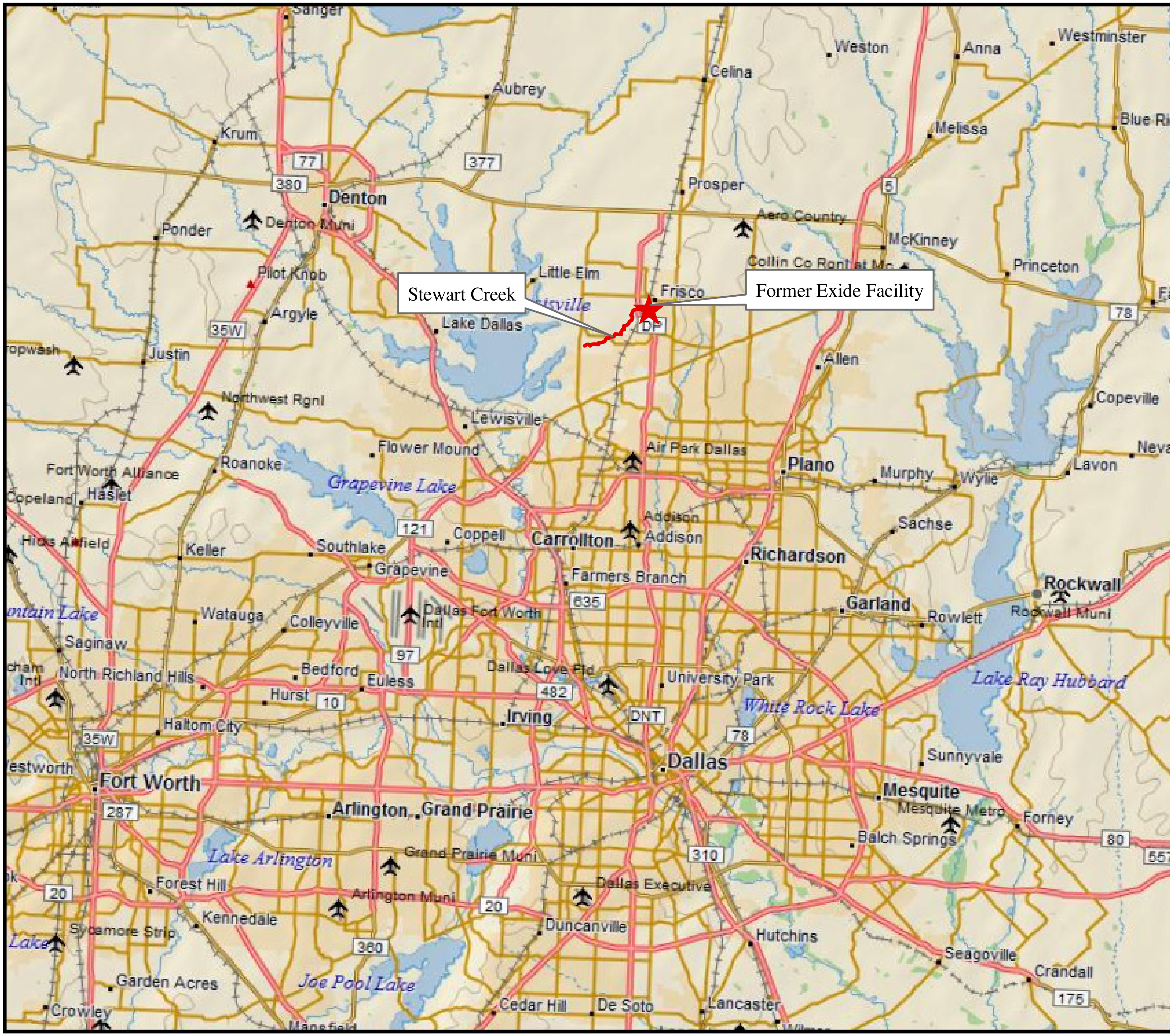
Rudolph, D. Craig; Burgdorf, Shirley J. 1997. Timber rattlesnakes and Louisiana pine snakes of the West Gulf Coastal Plain: hypotheses of decline. Texas Journal of Science. 49(3) Supplement: 111-122.

Rudolph, D. Craig; Schaefer, R. R.; Saenz, D.; Conner, R. N. 2004. Arboreal behavior in the timber rattlesnake, Crotalus horridus, in eastern Texas. Texas Journal of Science. 56(4): 395-404.

Ryder, R.A., and D.E. Manry. 1994. White-faced Ibis (Plegadus chihi) *In The Birds of North America, No. 130* (A. Poole and F. Gill, Eds.) Philadelphia, PA. The Academy of Natural Sciences; Washington, D.C.: The American Ornithologist's Union.

Waldron, J. L.; Bennett, S. H.; Welch, S. M.; Dorcas, M. E.; Lanham, J. D.; Kalinowsky, W. 2006. Habitat specificity and home-range size as attributes of species vulnerability to extinction: a case study using sympatric rattlesnakes. Animal Conservation. 9(4): 414-420.

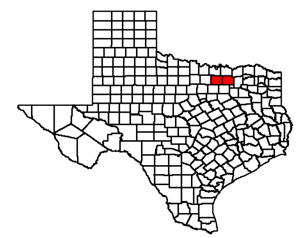
Waldron, Jayme L.; Lanham, Joseph D.; Bennett, Stephen H. 2006. Using behaviorally-based seasons to investigate canebrake rattlesnake (*Crotalus horridus*) movement patterns and habitat selection. Herpetologica. 62(4): 389-398.



Legend

Notes

Delorme World Base Map
Collin and Denton Counties



Site Location Map

Exide Technologies
Habitat Assessment

Golder Associates, Inc.

BESI Benchmark Ecological Services, Inc.

Project: 13009-001
Date: 01/02/2014

Figure 1

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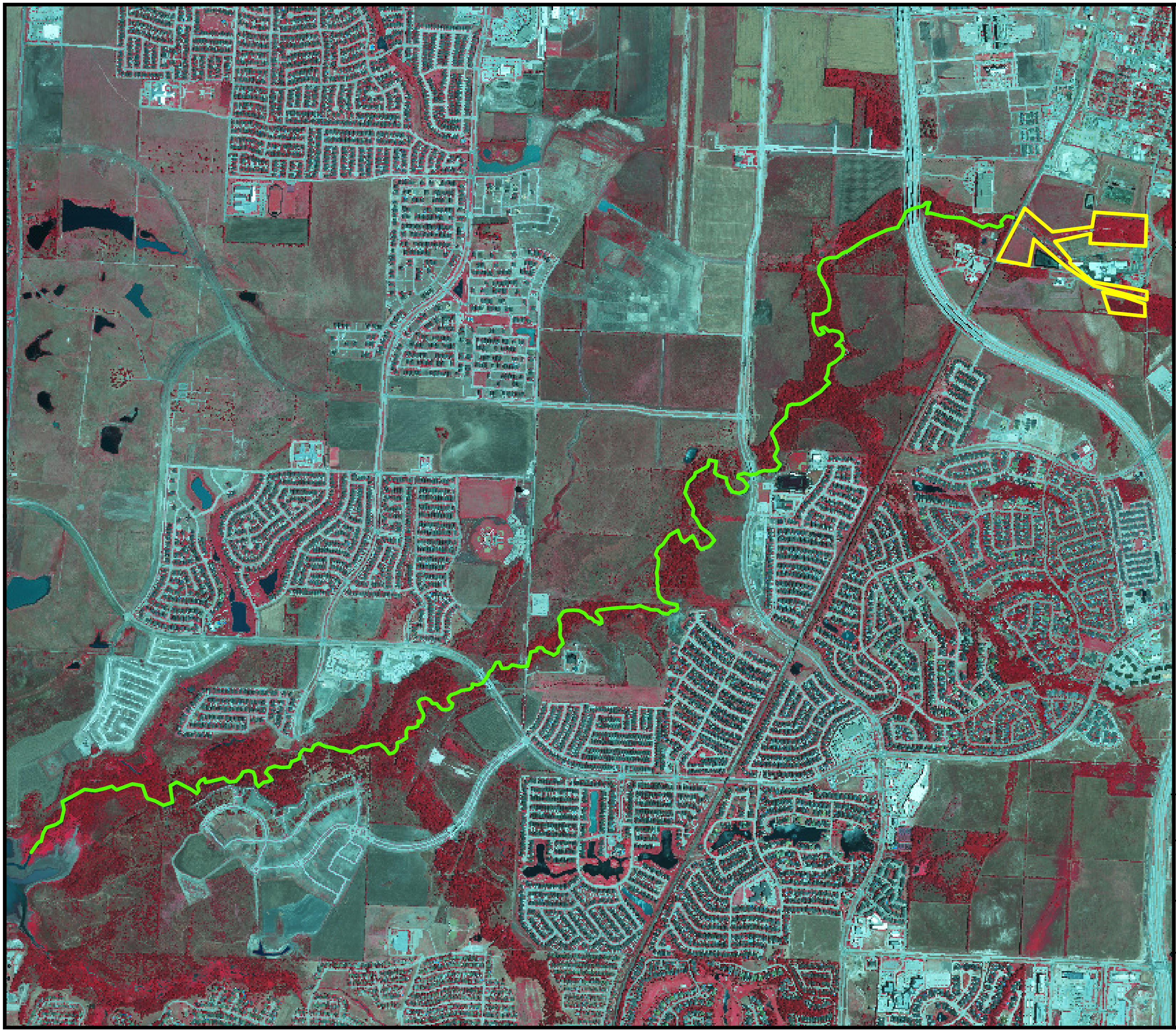


N

0 1,450 2,900
Feet

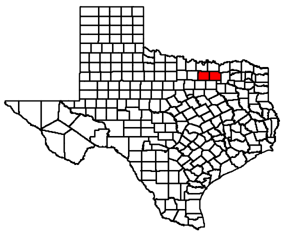
Legend

Stewart Creek
(Surveyed)

Former Exide Facility

Notes

2008 DOQQ (Heburn and Frisco) Quad
Collin and Denton County



Stewart Creek
Areas Assessment

Exide Technologies
Habitat Assessments

Golder Associates, Inc.

BESI
Benchmark
Ecological Services, Inc.

Project: 13009-001

Date: 03/19/2014

Figure 2

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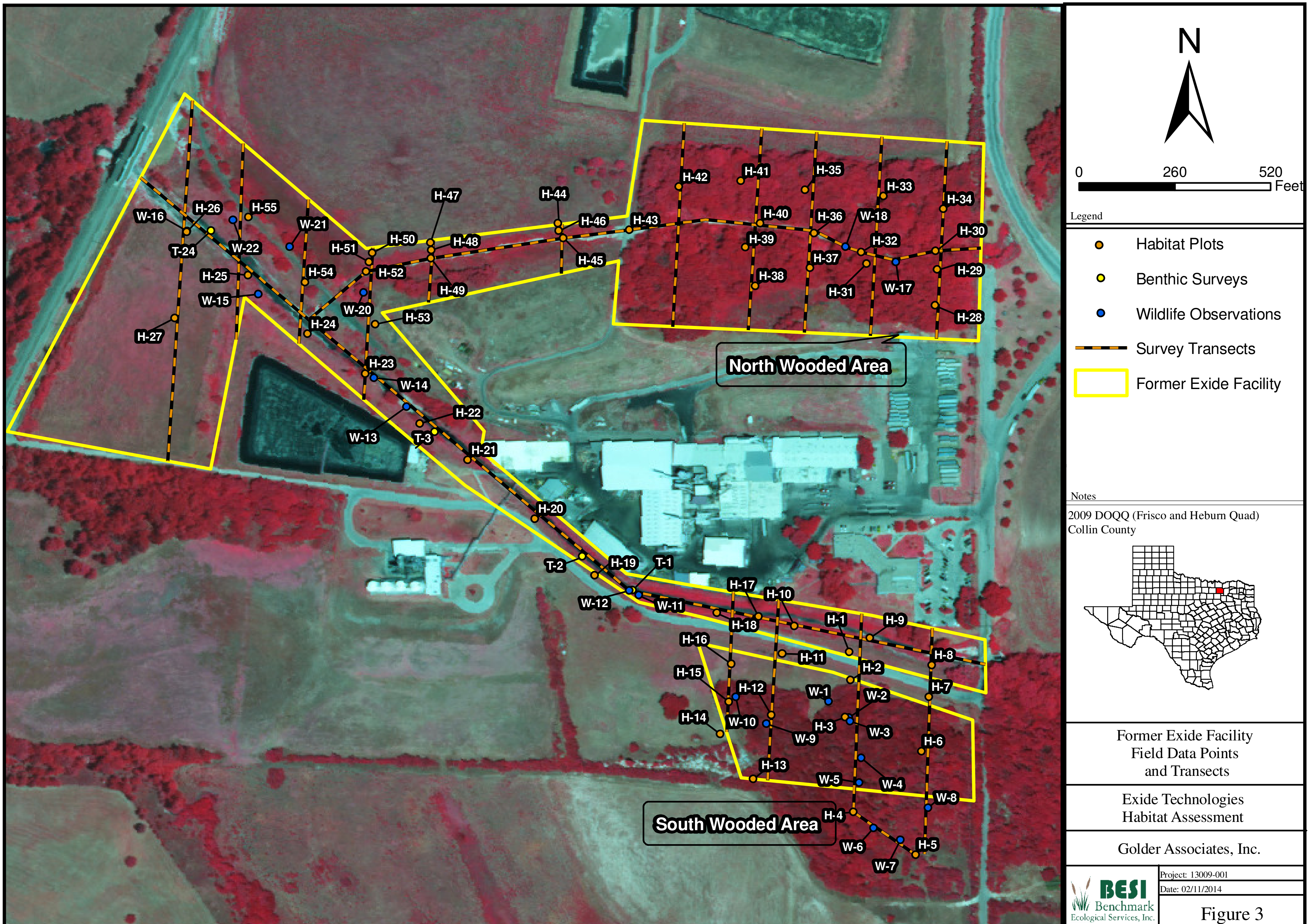

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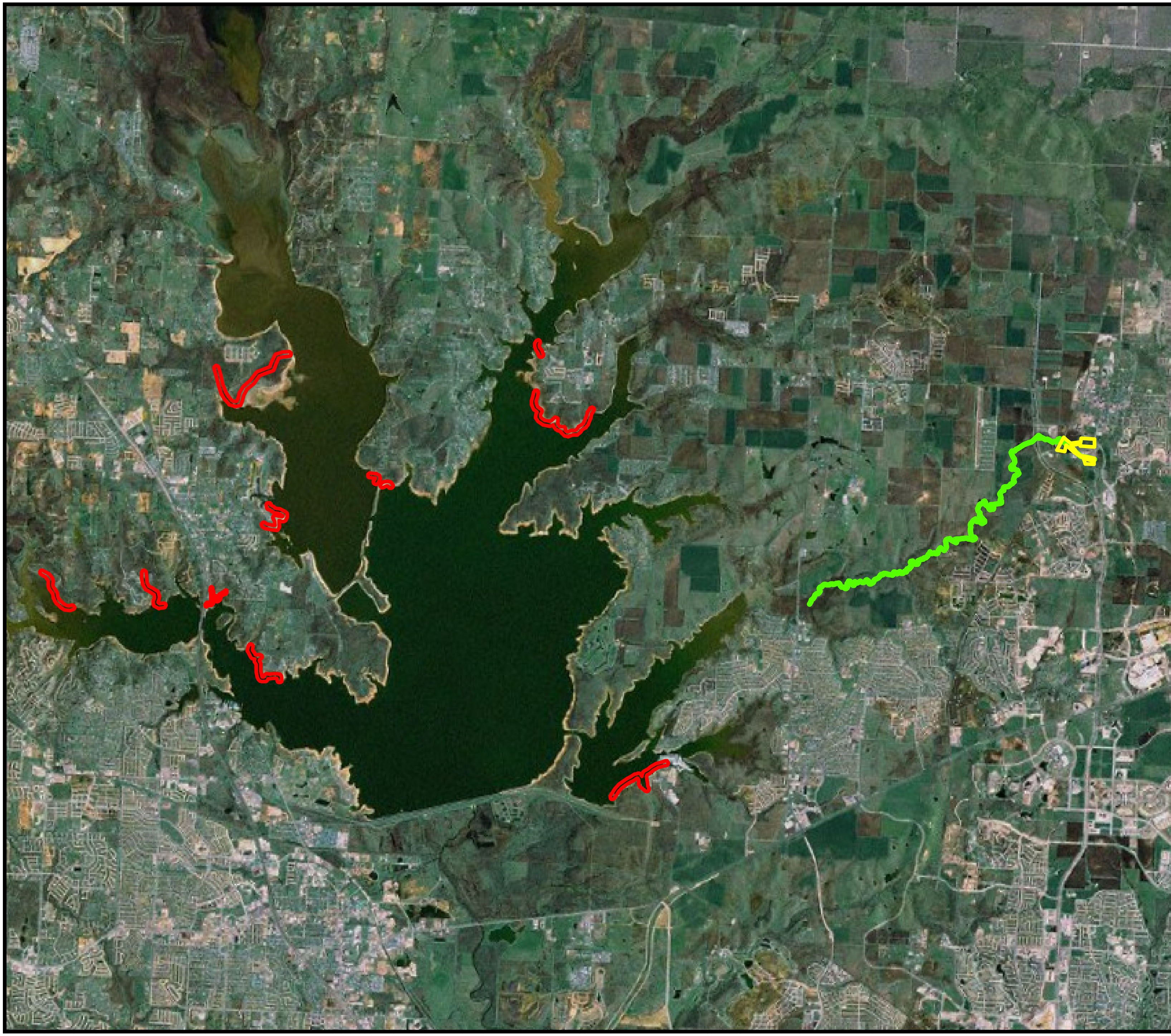


N

0 1 2 Miles

Legend

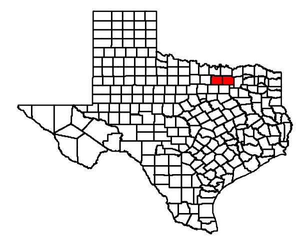
Former Exide Facility

Stewart Creek

Texas Heelsplitter

Notes

ESRI World Imagery, TPWD EO data
Collin and Denton Counties



Threatened and Endanged Species
Documented Occurrences

Exide Technologies
Habitat Surveys

Golder Associates, Inc.

BESI
Benchmark
Ecological Services, Inc.

Project: 13009-001

Date: 02/11/2014

Figure 4

M:\13009\001\arc\Figure 4 T and E sightings.mxd

N

0 435 870 Feet

Legend

Habitat Plots

Benthic Surveys

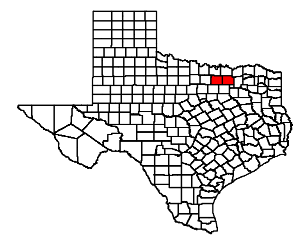
Wildlife Observations

Former Exide Facility

Stewart Creek (Surveyed)

Notes

2008 DOQQ (Frisco, Lewisville East and Heburn Quad) Collin and Denton Counties



Stewart Creek Habitat Plots, Benthic Surveys, and Wildlife Observations.

Exide Technologies
Habitat Assessments

Golder Associates, Inc.

BESI Benchmark Ecological Services, Inc.

Project: 13009-001

Date: 03/19/2014

Figure 5
(Map 1 of 5)

M:\13009\001\arc\working\Figure 5 mapbook of stream_2.mxd

N

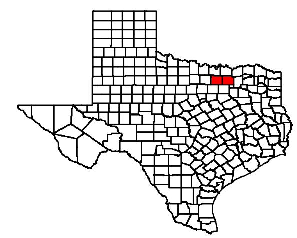
0 437.5 875 Feet

Legend

- Habitat Plots
- Benthic Surveys
- Wildlife Observations
- Former Exide Facility
- Stewart Creek (Surveyed)

Notes

2008 DOQQ (Frisco, Lewisville East and Heburn Quad) Collin and Denton Counties



Stewart Creek Habitat Plots, Benthic Surveys, and Wildlife Observations.

Exide Technologies
Habitat Assessments

Golder Associates, Inc.

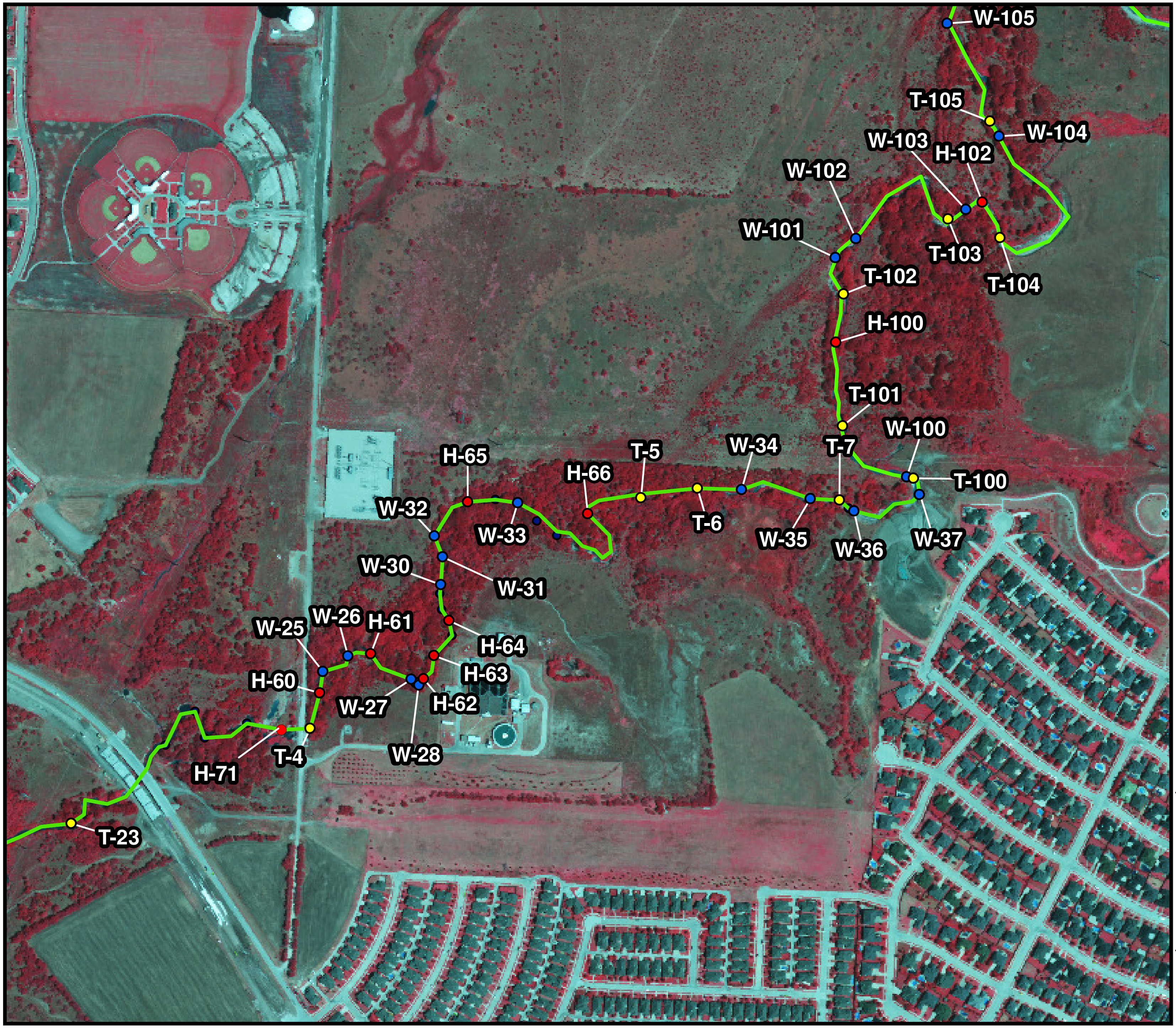
BESI Benchmark Ecological Services, Inc.

Project: 13009-001

Date: 03/19/2014

Figure 5
(Map 2 of 5)

M:\13009\001\arc\working\Figure 5 mapbook of stream_2.mxd



N

0 437.5 875 Feet

Legend

Habitat Plots

Benthic Surveys

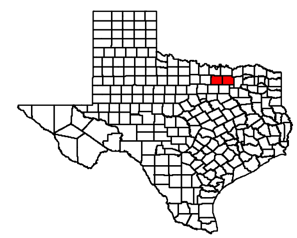
Wildlife Observations

Former Exide Facility

Stewart Creek (Surveyed)

Notes

2008 DOQQ (Frisco, Lewisville East and Heburn Quad) Collin and Denton Counties



Stewart Creek Habitat Plots, Benthic Surveys, and Wildlife Observations.

Exide Technologies
Habitat Assessments

Golder Associates, Inc.

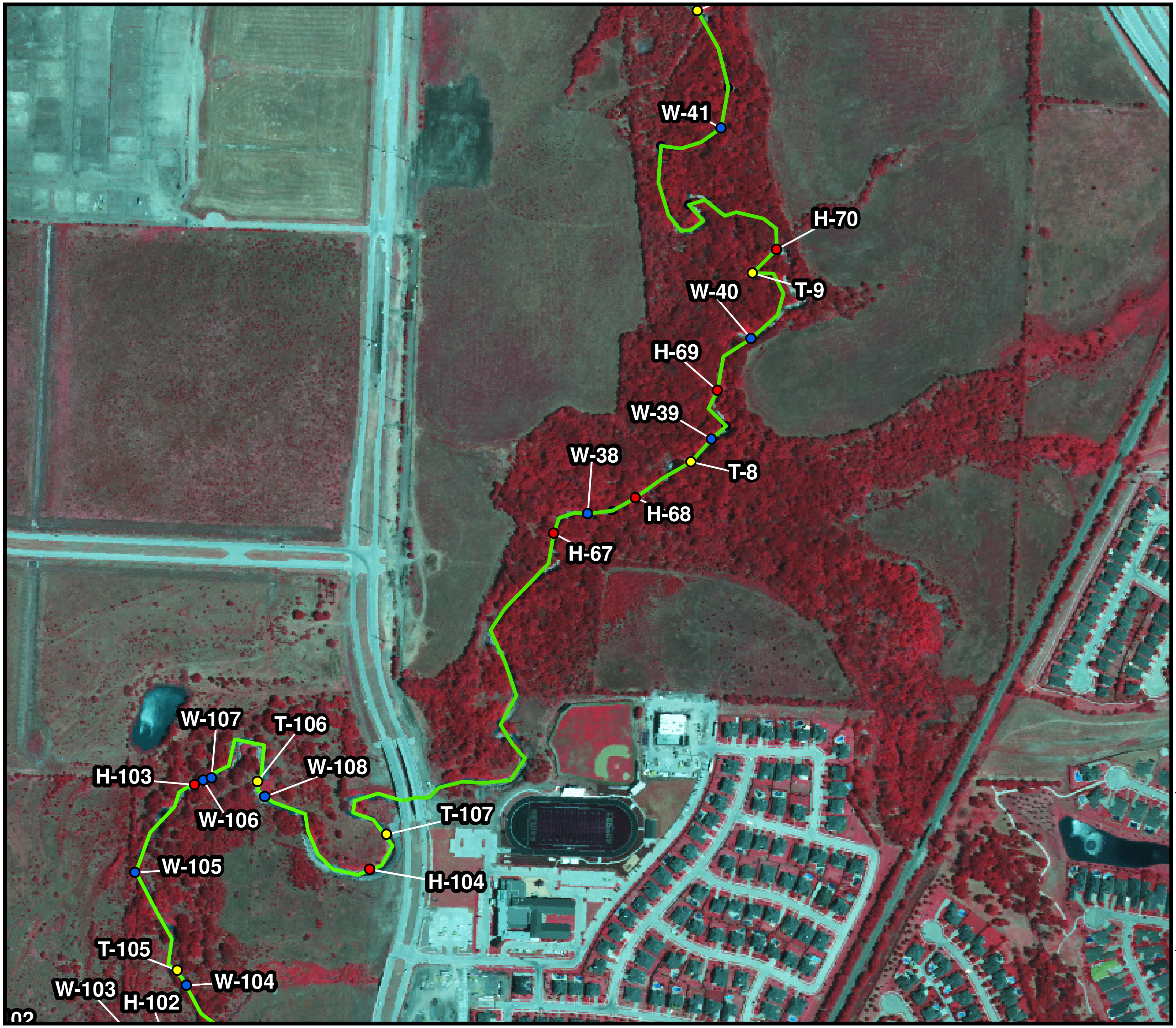
BESI Benchmark Ecological Services, Inc.

Project: 13009-001

Date: 03/19/2014

Figure 5
(Map 3 of 5)

M:\13009\001\arc\working\Figure 5 mapbook of stream_2.mxd



Legend

- Habitat Plots
- Benthic Surveys
- Wildlife Observations
- Former Exide Facility
- Stewart Creek (Surveyed)

Notes

2008 DOQQ (Frisco, Lewisville East and Heburn Quad) Collin and Denton Counties

Stewart Creek Habitat Plots, Benthic Surveys, and Wildlife Observations.

Exide Technologies
Habitat Assessments

Golder Associates, Inc.

BESI Benchmark Ecological Services, Inc.

Project: 13009-001

Date: 03/19/2014

Figure 5
(Map 4 of 5)

M:\13009\001\arc\working\Figure 5 mapbook of stream_2.mxd

N

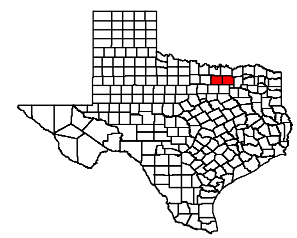
0 437.5 875 Feet

Legend

- Habitat Plots
- Benthic Surveys
- Wildlife Observations
- Former Exide Facility
- Stewart Creek (Surveyed)

Notes

2008 DOQQ (Frisco, Lewisville East and Heburn Quad) Collin and Denton Counties



Stewart Creek Habitat Plots, Benthic Surveys, and Wildlife Observations.

Exide Technologies
Habitat Assessments

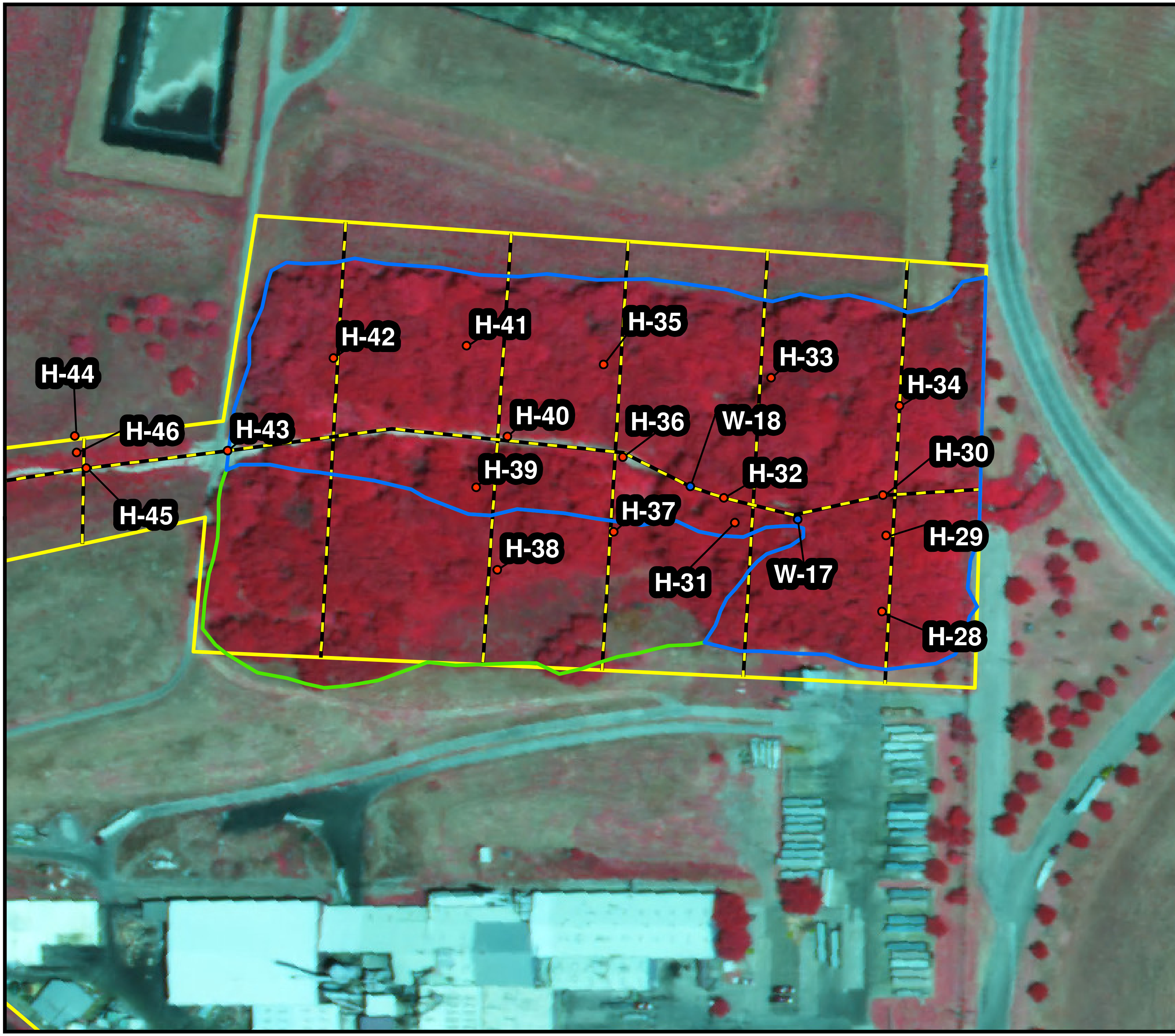
Golder Associates, Inc.

BESI Benchmark Ecological Services, Inc.

Project: 13009-001
Date: 03/19/2014

Figure 5
(Map 5 of 5)

M:\13009\001\arc\working\Figure 5 mapbook of stream_2.mxd

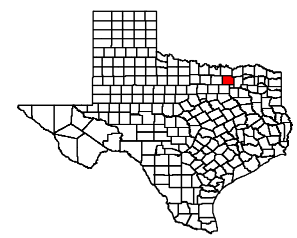


Legend

- Habitat Plot
- Wildlife Observations
- Wooded Area (Higher Elevation)
- Wooded Area (Lower Elevation)
- Former Exide Facility
- Survey Transects

Notes

2008 DOQQ (Frisco Quad)
Collin County



North Wooded Area

Exide Technologies
Habitat Assessment

Golder and Associates, Inc.

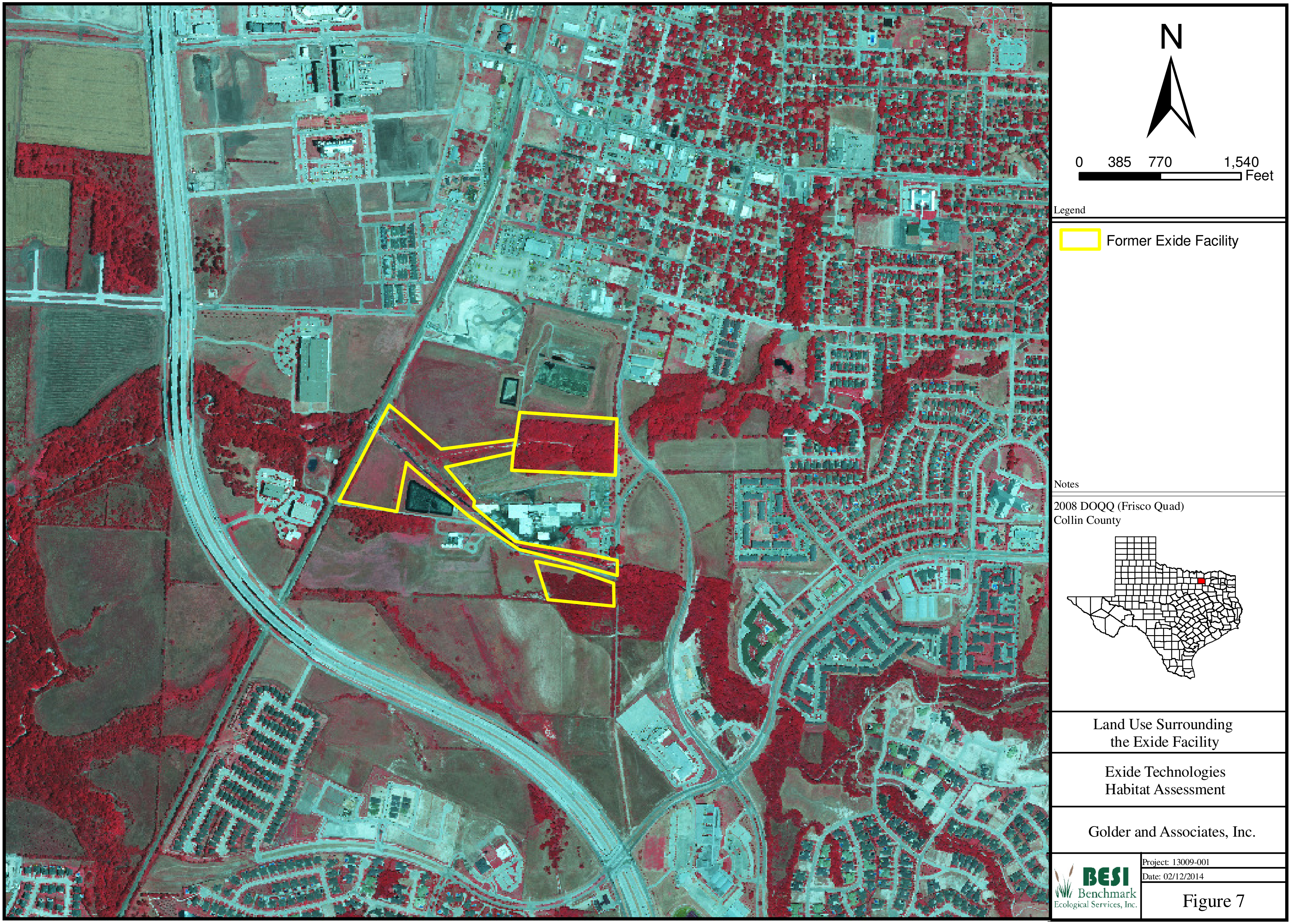
BESI Benchmark Ecological Services, Inc.

Project: 13009-001

Date: 02/11/2014

Figure 6

M:\13009\001\arc\Figure 6.mxd



Land Use Surrounding the Exide Facility

Exide Technologies Habitat Assessment

Golder and Associates, Inc.

BESI Benchmark Ecological Services, Inc.

Project: 13009-001

Date: 02/12/2014

Figure 7

M:\13009\001\arc\Figure 7 forested areas.mxd

Attachment A

Revised
2/28/2011

COLLIN COUNTY

BIRDS

		Federal Status	State Status
American Peregrine Falcon	*Falco peregrinusanatum*	DL	T

year-round resident and local breeder in west Texas, nests in tall cliff eyries; also, migrant across state from more northern breeding areas in US and Canada, winters along coast and farther south; occupies wide range of habitats during migration, including urban, concentrations along coast and barrier islands; low-altitude migrant, stopovers at leading landscape edges such as lake shores, coastlines, and barrier islands.

Arctic Peregrine Falcon	*Falco peregrinustundrius*	DL	

migrant throughout state from subspecies' far northern breeding range, winters along coast and farther south; occupies wide range of habitats during migration, including urban, concentrations along coast and barrier islands; low-altitude migrant, stopovers at leading landscape edges such as lake shores, coastlines, and barrier islands.

Bald Eagle	*Haliaeetusleucocephalus*	DL	T

found primarily near rivers and large lakes; nests in tall trees or on cliffs near water; communally roosts, especially in winter; hunts live prey, scavenges, and pirates food from other birds

Henslow's Sparrow	*Ammodramushenslowii*		

wintering individuals (not flocks) found in weedy fields or cut-over areas where lots of bunch grasses occur along with vines and brambles; a key component is bare ground for running/walking

Interior Least Tern	*Sterna antillarumathalassos*	LE	E

subspecies is listed only when inland (more than 50 miles from a coastline); nests along sand and gravel bars within braided streams, rivers; also know to nest on man-made structures (inland beaches, wastewater treatment plants, gravel mines, etc); eats small fish and crustaceans, when breeding forages within a few hundred feet of colony

Peregrine Falcon	*Falco peregrinus*	DL	T

both subspecies migrate across the state from more northern breeding areas in US and Canada to winter along coast and farther south; subspecies (F. p. anatum) is also a resident breeder in west Texas; the two subspecies' listing statuses differ, F.p. tundrius is no longer listed in Texas; but because the subspecies are not easily distinguishable at a distance, reference is generally made only to the species level; see subspecies for habitat.

Piping Plover	*Charadriusmelodus*	LT	T

wintering migrant along the Texas Gulf Coast; beaches and bayside mud or salt flats

Sprague's Pipit	*Anthusspragueii*	C	

only in Texas during migration and winter, mid September to early April; short to medium distance, diurnal migrant; strongly tied to native upland prairie, can be locally common in coastal grasslands, uncommon to rare further west; sensitive to patch size and avoids edges.

Western Burrowing Owl	*Athenecuniculariahypugaea*		

open grasslands, especially prairie, plains, and savanna, sometimes in open areas such as vacant lots near human habitation or airports; nests and roosts in abandoned burrows

White-faced Ibis	*Plegadischihi*		T

prefers freshwater marshes, sloughs, and irrigated rice fields, but will attend brackish and saltwater habitats; nests in marshes, in low trees, on the ground in bulrushes or reeds, or on floating mats

Whooping Crane	*Grus Americana*	LE	E

potential migrant via plains throughout most of state to coast; winters in coastal marshes of Aransas, Calhoun, and Refugio counties

Wood Stork	*Mycteriaamericana*		T

forages in prairie ponds, flooded pastures or fields, ditches, and other shallow standing water, including salt-water; usually roosts communally in tall snags, sometimes in association with other wading birds (i.e. active heronries); breeds in Mexico and birds move into Gulf States in search of mud flats and other wetlands, even those associated with forested areas; formerly nested in Texas, but no breeding records since 1960

	CRUSTACEANS	Federal Status	State Status
A crayfish	*Procambarussteigmani*		

burrower in long-grass prairie; all animals were collected with traps, thus there is no knowledge of depths of burrows; herbivore; crepuscular, nocturnal

MAMMALS Federal Status State Status

Plains spotted skunk *Spilogaleputoriusinterrupta*

catholic; open fields, prairies, croplands, fence rows, farmyards, forest edges, and woodlands; prefers wooded, brushy areas and tallgrass prairie

Red wolf *Canisrufus* LE E

extirpated; formerly known throughout eastern half of Texas in brushy and forested areas, as well as coastal prairies

MOLLUSKS Federal Status State Status

Fawnsfoot *Truncilladonaciformis*

small and large rivers especially on sand, mud, rocky mud, and sand and gravel, also silt and cobble bottoms in still to swiftly flowing waters; Red (historic), Cypress (historic), Sabine (historic), Neches, Trinity, and San Jacinto River basins.

Little spectaclecase *Villosalienosa*

creeks, rivers, and reservoirs, sandy substrates in slight to moderate current, usually along the banks in slower currents; east Texas, Cypress through San Jacinto River basins

Louisiana pigtoe *Pleurobemariddellii* T

streams and moderate-size rivers, usually flowing water on substrates of mud, sand, and gravel; not generally known from impoundments; Sabine, Neches, and Trinity (historic) River basins

Texas heelsplitter *Potamilusamphichaenus* T

quiet waters in mud or sand and also in reservoirs. Sabine, Neches, and Trinity River basins

Wabash pigtoe *Fusconaiaflava*

creeks to large rivers on mud, sand, and gravel from all habitats except deep shifting sands; found in moderate to swift current velocities; east Texas River basins, Red through San Jacinto River basins; elsewhere occurs in reservoirs and lakes with no flow

REPTILES		Federal Status	State Status
Alligator snapping turtle	*Macrochelystemminckii*		T

perennial water bodies; deep water of rivers, canals, lakes, and oxbows; also swamps, bayous, and ponds near deep running water; sometimes enters brackish coastal waters; usually in water with mud bottom and abundant aquatic vegetation; may migrate several miles along rivers; active March-October; breeds April-October

Texas garter snake	*Thamnophissirtalisannectens*		

wet or moist microhabitats are conducive to the species occurrence, but is not necessarily restricted to them; hibernates underground or in or under surface cover; breeds March-August

Texas horned lizard	*Phrynosomacornutum*		T

open, arid and semi-arid regions with sparse vegetation, including grass, cactus, scattered brush or scrubby trees; soil may vary in texture from sandy to rocky; burrows into soil, enters rodent burrows, or hides under rock when inactive; breeds March-September

Timber/Canebrake rattlesnake	*Crotalushorridus*		T

swamps, floodplains, upland pine and deciduous woodlands, riparian zones, abandoned farmland; limestone bluffs, sandy soil or black clay; prefers dense ground cover, i.e. grapevines or palmetto

Last Updated 2/28/2011

DENTON COUNTY

BIRDS

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year-round resident and local breeder in west Texas, nests in tall cliff eyries; also, migrant across state from more northern breeding areas in US and Canada, winters along coast and farther south; occupies wide range of habitats during migration, including urban, concentrations along coast and barrier islands; low-altitude migrant, stopovers at leading landscape edges such as lake shores, coastlines, and barrier islands.

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	MOLLUSKS	Federal Status	State Status
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swamps, floodplains, upland pine and deciduous woodlands, riparian zones, abandoned farmland; limestone bluffs, sandy soil or black clay; prefers dense ground cover, i.e. grapevines or palmetto

PLANTS

		Federal Status	State Status
Glen Rose yucca	*Yucca necopina*		

Texas endemic; grasslands on sandy soils and limestone outcrops; flowering April-June

Attachment B

Exide Technologies Benthic Survey

Date: 1/14/2014

Transect: T-1

Personnel: NH, KH, BS

Camera: Nikon

GPS: B

Time: 8:00

General Location: Stewart Creek, just upstream of beaver dam

Photo IDs	Description
2342	Benthic rake
2343	Contents of the rake

GPS Waypoints	Description
T-1	Stream

Sediment Description

Clay, solid, gravel and small amounts of dead vegetation (leaves), no overlying sediment.

Number of Rakes 6

Benthic Observations

None

Exide Technologies Benthic Survey

Date: 1/14/2014

Transect: T-2

Personnel: NH, KH, BS

Camera: Nikon

GPS: B

Time: 8:15

General Location: Stewart Creek downstream of beaver dam

Photo IDs	Description
2344	Benthic Rake
2345	Benthic Rake
2346	Contents of rake

GPS Waypoints	Description
T-2	Stream

Sediment Description

Clay, solid, areas with low soft sediment over clay large amounts of gravel

Number of Rakes: 6

Benthic Observations

None

Exide Technologies Benthic Survey

Date: 1/13/2014

Transect: T-3

Personnel: NH, KH, BS

Camera: Nikon

GPS: B

Time: 8:30

General Location: Stewart Creek

Photo IDs	Description
2347	Benthic rake
2348	Contents of rake

GPS Waypoints	Description
T-3	Stream

Sediment Description

Hard clay and gravel, no overlying sediment, dead leaves and vegetation.

Number of Rakes: 8

Benthic Observations

None

Exide Technologies Benthic Survey

Date: 1/15/2014

Transect: T-4

Personnel: (BESI) NH, KH, BS (Golder) AM, MR (Frisco) Tommy

Camera: Nikon

GPS: B

Time: 8:00

General Location: Stewart Creek up upstream of 4th Army Rd.

Photo IDs	Description
2349	Upstream
2350	Downstream
2351	Contents of rake

GPS Waypoints	Description
T-4	Stream

Sediment Description

Gravel, just upstream of culvert under road.

Number of Rakes: 6

Benthic Observations

None

Exide Technologies Benthic Survey

Date: 1/15/2014

Transect: T-5

Personnel: (BESI) NH, KH, BS (Golder) AM, MR (Frisco) Tommy

Camera: Nikon

GPS: B

Time: 10:10

General Location: Stewart Creek upstream of wastewater treatment plant

Photo IDs	Description
2407	Benthic rake
2408	Benthic rake
2409	Contents of rake
2410	Site
2411	Contents of rake

GPS Waypoints	Description
T-5	Stream

Sediment Description

Sand, gravel, and rocks

Number of Rakes: 6

Benthic Observations

None

Exide Technologies Benthic Survey

Date: 1/15/2014 Transect: T-6

Personnel: (BESI) NH, KH, BS (Golder) AM, MR (Frisco) Tommy Camera: Nikon GPS: B

Time: 10:20

General Location: Stewart Creek upstream of wastewater treatment facility

Photo IDs	Description
2412-2414	Benthic rake
2415	Benthic rake
2416	Contents of rake
2417	Northern Cardinal
	(Cardinalis cardinalis)

GPS Waypoints	Description
T-6	Stream

Sediment Description

Sand, gravel, and rocks

Number of Rakes: 6

Benthic Observations

Prior to using the benthic rake, Benchmark scientists observed signs of mussel/ clam activity on the surface of the sediment.

Collected live Asian Clams *(Corbicula spp .)* in rake.

Exide Technologies Benthic Survey

Date: 1/15/2014

Transect: T-7

Personnel: (BESI) NH, KH, BS (Golder) AM, MR (Frisco) Tommy

Camera: Nikon

GPS: B

Time: 11:00

General Location: Stewart Creek upstream of wastewater treatment facility

Photo IDs	Description
2434	Contents of rake
2435	Downstream
2436	Benthic rake
2437	Contents of rake

GPS Waypoints	Description
T-7	Stream

Sediment Description
Sand, gravel, and rocks

Number of Rakes: 6

Benthic Observations :

None

General Observations:

Raccoon (*Procyon lotor*) and canine tracks spotted on bank nearby.

Exide Technologies Benthic Survey

Date: 1/15/2014

Transect: T-8

Personnel: (BESI) NH, KH, BS (Golder) AM, MR (Frisco) Jason

Camera: Nikon

GPS: B

Time: 14:15

General Location: Stewart Creek upstream of Stonebrook Pkwy

Photo IDs	Description
2465	Contents of rake
2466	Creek
2467	Pondhorn (*Uniomerus tetralasmus*)
	shells found on the surface

GPS Waypoints	Description
T-8	Stream

Sediment Description
Small gravel and sand

Number of Rakes: 6

Benthic Observations

Area has a lot of exposed beds, spotted several of the Pondhorn *(Uniomerus tetralasmus*) shells on the exposed gravel beds.

Exide Technologies Benthic Survey

Date: 1/15/2014

Transect: T-9

Personnel: (BESI) NH, KH, BS (Golder) AM, MR (Frisco) Jason

Camera: Nikon

GPS: B

Time: 15:09

General Location: Stewart Creek upstream of Stonebrook Pkwy.

Photo IDs	Description
2478	Contents of rake
2479	Creek
2480	Gravel bank

GPS Waypoints	Description
T-9	Stream

Sediment Description

Gravel, shall, and clay. Small area of fine gravel in 1 foot deep pool.

Number of Rakes: 6

Benthic Observations

None

Exide Technologies Benthic Survey

Date: 1/15/2014

Transect: T-10

Personnel: (BESI) NH, KH, BS (Golder) AM, MR (Frisco) Jason

Camera: Nikon

GPS: B

Time: 15:45

General Location: Stewart Creek downstream of Dallas Pkwy.

Photo IDs	Description
2490	Worm
2491	Worm
2492	Creek
2493	Worms
2494	Worms

GPS Waypoints	Description
T-10	Stream

Sediment Description

Gravel and sand

Number of Rakes: 5

Benthic Observations

Worms, observed signs of worms on the sediment surface. Captured several worms in rake.

Exide Technologies Benthic Survey

Date: 1/16/2014 Transect: T-11

Personnel: (BESI) BS, KH, (Golder) AM, MR (Frisco) Tommy Camera: Nikon GPS: B

Time: 9:01

General Location: Stewart Creek downstream of former Exide Facility

Photo IDs	Description
2522	Contents of rake
2523	Contents of rake
2524	Downstream
2525	Creek
2526	Upstream

GPS Waypoints	Description
T-11	Soft area

Sediment Description
Small gravel, sand, and silt.

Number of Rakes: 6

Benthic Observations

None

General Observations

Nest in nearby tree, and small animal tracks on the bank.

Exide Technologies Benthic Survey

Date: 1/16/2014

Transect: T-12

Personnel: (BESI) BS, KH (Golder) AM, MR (Frisco) Tommy

Camera: Nikon

GPS: B

Time: 10:51

General Location: Stewart Creek upstream of Lake Lewisville

Photo IDs	Description
2527	Contents of rake
2528	Upstream
2529	Creek
2530	Downstream
2531	Asian Clam (*Corbicula spp.*) shells

	Description
T-12	Start transect
T-12b	End transect

Sediment Description

Mix of gravel and silt (1-2" of silt)

Number of Rakes: 7

Benthic Observations

Small rocks, Asian Clams (*Corbicula spp.*) shells.

Exide Technologies Benthic Survey

Date: 1/16/2014

Transect: T-13

Personnel: (BESI) BS, KH (Golder) AM, MR (Frisco) Tommy

Camera: Nikon

GPS: B

Time: 11:08

General Location: Stewart Creek upstream of Lake Lewisville

Photo IDs	Description
2534	Upstream
2535	Downstream
2536	Creek
2537	Content of raking
2538	Asian Clams (*Corbicula spp.*)
2539	Asian Clams (*Corbicula spp.*)

GPS Waypoints	Description
T-13	Start transect
T-13b	End transect

Sediment Description

Sand and silt in middle of channel, clay on sides, steep bank.

Number of Rakes: 6

Benthic Observations

Small rocks, Asian Clams (*Corbicula spp.*), shell pieces and one live clam.

Date: 1/16/2014

Transect: T-14

Personnel: (BESI) BS, KH (Golder) AM, MR (Frisco) Tommy

Camera: Nikon

GPS: B

Time: 11:35

General Location: Stewart Creek upstream of Lake Lewisville

Photo IDs	Description
2541	Upstream
2542	Downstream
2543	Contents of rake
2544	Asian Clams (*Corbicula spp.*)
2545	Asian Clams (*Corbicula spp.*)

GPS Waypoints	Description
T-14	Start transect
T-14b	End transect

Sediment Description

Soft silt and gravel mix.

Number of Rakes: 8

Benthic Observations

4 Asian Clams (*Corbicula spp.*) (live), 1 Asian Clam (*Corbicula spp* .) shell.

Exide Technologies Benthic Survey

Date: 1/16/2014

Transect: T-15

Personnel: (BESI) BS, KH (Golder) AM, MR (Frisco) Tommy

Camera: Nikon

GPS: B

Time: 11:46

General Location: Stewart Creek upstream of Lake Lewisville

Photo IDs	Description
2546	Contents of rake
2547, 2548	Asian Clams (*Corbicula spp.*), shell, and possibly Pondhorn Mussel shell pieces
2549-2551	Downstream, Creek, Upstream
2552	Asian Clams (*Corbicula spp.*), shell, and Pondhorn (Uniomerus Tetralasmus) shells

GPS Waypoints	Description
T-15	Start transect
T-15b	End transect

Sediment Description
Soft silt and gravel mix

Number of Rakes: 8

Benthic Observations
Asian Clams (*Corbicula spp.*) (live), shell, and Pondhorn (*Uniomerus tetralasmus*) shells.

Exide Technologies Benthic Survey

Date: 1/16/2014

Transect: T-16

Personnel: (BESI) BS, KH (Golder) AM, MR (Frisco) Tommy

Camera: Nikon

GPS: B

Time: 12:11

General Location: Stewart Creek upstream of Lake Lewisville

Photo IDs	Description
2558-2559	Asian Clam (*Corbicula spp*.) shells and Pondhorn (*Uniomerus tetralasmus*) shells
2560	Downstream
2561	Upstream

GPS Waypoints	Description
T-16	Start transect
T-16b	End transect

Sediment Description

Sandy silt and gravel mix, with rocks.

Number of Rakes: 8

Benthic Observations

Asian Clam (*Corbicula spp.*) shells and Pondhorn (*Uniomerus tetralasmus*) shells.

Exide Technologies Benthic Survey

Date: 1/16/2014

Transect: T-17

Personnel: (BESI) BS, KH (Golder) AM, MR (Frisco) Tommy

Camera: Nikon

GPS: B

Time: 12:33

General Location: Stewart Creek upstream of Lake Lewisville

Photo IDs	Description
2564	Downstream
2565	Upstream
2566	Creek
2567	Asian Clams (*Corbicula spp* .), shells and unidentified snail

GPS Waypoints	Description
T-17	Start transect
T-17b	End transect

Sediment Description
Silt and gravel, small rocks on sides of channel, hard clay in middle of channel.

Number of Rakes: 7

Benthic Observations
Asian Clams (*Corbicula spp.*), shells and unidentified snail.

Exide Technologies Benthic Survey

Date: 1/16/2014 Transect: T-18

Personnel: (BESI) BS, KH (Golder) AM, MR (Frisco) Tommy Camera: Nikon GPS: B

Time: 12:50

General Location: Stewart Creek upstream of Lake Lewisville

Photo IDs	Description
2568	Upstream
2569	Creek
2570	Downstream
2571	Contents of rake
2572	Pondhorn (*Uniomerus tetralasmus*) and Asian Clam (*Corbicula spp* .)

GPS Waypoints	Description
T-18	Start transect
T-18b	End transect

Sediment Description
Soft silt.

Number of Rakes: 5

Benthic Observations
Pondhorn (*Uniomerus tetralasmus*) shells and Asian Clam (*Corbicula spp.*) shells.

Exide Technologies Benthic Survey

Date: 1/16/2014

Transect: T-19

Personnel: (BESI) BS, KH (Golder) AM (Frisco) Jason

Camera: Nikon

GPS: B

Time: 14:58

General Location: Stewart Creek upstream of Lake Lewisville

Photo IDs	Description
2580	Downstream
2581	Upstream
2582	Creek
2583	Benthic rake
2584	Contents of rake
2585	Asian Clams (*Corbicula spp.*)

GPS Waypoints	Description
T-19	Stream

Sediment Description

Sand, silt, and gravel.

Number of Rakes : 6

Benthic Observations

Asian Clams (*Corbicula spp.*)

Exide Technologies Benthic Survey

Date: 1/16/2014

Transect: T-20

Personnel: (BESI) BS, KH (Golder) AM (Frisco) Jason

Camera: Nikon

GPS: B

Time: 15:40

General Location: Stewart Creek upstream of Lake Lewisville

Photo IDs	Description
2599	Contents of raking
2600	Asian clams (*Corbicula spp.*)
2601	Upstream
2602	Downstream

GPS Waypoints	Description
T-20	Stream

Sediment Description

Sand and silt with gravel.

Number of Rakes: 6

Benthic Observations

Asian Clams (*Corbicula spp.*) on nearby streambed. Collected live clams and clam shells in rake.

Exide Technologies Benthic Survey

Date: 1/16/2014

Transect: T-22

Personnel: (BESI) BS, KH (Golder) AM (Frisco) Jason

Camera: Nikon

GPS: B

Time: 16:29

General Location: Stewart Creek upstream of Lake Lewisville

Photo IDs	Description
2619	Upstream
2620	Creek
2621	Downstream

GPS Waypoints	Description
T-22	Stream

Sediment Description

Light silt and rocks.

Number of Rakes: 6

Benthic Observations

None

Exide Technologies Benthic Survey

Date: 1/16/2014

Transect: T-23

Personnel: (BESI) BS, KH (Golder) AM, MR (Frisco) Jason

Camera: Nikon

GPS: B

Time: 16:50

General Location Stewart Creek downstream of Lebanon Rd.

Photo IDs	Description
2622	Upstream
2623	Downstream
2624	Site and contents of rake
2625	Contents of rake
2626	Asian Clam (*Corbicula spp.*)

GPS Waypoints	Description
T-23	Stream

Sediment Description
Gravel and sandy silt mix, soft layer approximately 2 inches.

Number of Rakes: 6

Benthic Observations

1 Asian Clam (*Corbicula spp.*) shell found in rake.

Exide Technologies Benthic Survey

Date: 1/13/2014 Transect: T-24

Personnel: NH, KH, BS, BD Camera: Sony GPS: B

Time: 15:30

General Locatio Stewart Creek in Former Exide Facili

Photo IDs	Description
389-391	Benthic rake
392	Bottom of creek
393	Benthic rake near railroad bridge
394-395	Bank where Pondhorn Mussel shells were found
396	Wading bird tracks
397-398	Area where Pondhorn Mussel shells were found
399	Beaver sign on old tree

GPS Waypoints	Description
Mussel rake site	Stream

Sediment Description

Gravel & bedrock/ consolidated clay.

Number of Rakes: 12

Benthic Observations

None

Exide Technologies Benthic Survey

Date: 3/18/2014

Transect: T-100

Personnel: (BESI) KH, RM (Golder) AM, Chris (Frisco) Jason

Camera: Nikon

GPS: A

Time: 9:15

General Location: Stewart Creek downstream of Legacy Dr.

Photo IDs	Description
2767	Upstream
2769	Downstream
2770	Site/ Contents of rake
2771	Contents of rake
2772	Asian Clam (*Corbicula spp.*)

GPS Waypoints	Description
T-100	Stream

Sediment Description

Gravel and silt with shale bottom.

Number of Rakes: 3

Benthic Observations

Multiple Asian Clams (*Corbicula spp.*) collected in rake.

Exide Technologies Benthic Survey

Date: 3/18/2014

Transect: T-101

Personnel: KH,RM (BESI) AM,Chris (Golder) Jason (Frisco)

Camera: Nikon

GPS: A

Time: 10:42

General Location Stewart Creek downstream of Legacy Dr.

Photo IDs	Description
2777	Upstream
2775	Downstream
2774	Site/ Contents of rake
2773	Contents of rake
2778	Asian Clam (*Corbicula spp.*)
2776	Bank of creek

GPS Waypoints	Description
T-101	Stream

Sediment Description

Mostly gravel with trace of sand and silt.

Number of Rakes: 5

Benthic Observations

Multiple Asian Clams (*Corbicula spp.*) collected in rake.

Exide Technologies Benthic Survey

Date: 3/18/2014

Transect: T-102

Personnel: KH,RM (BESI) AM, Chris (Golder) Jason (Frisc

Camera: Nikon

GPS: A

Time: 11:19

General Location Stewart Creek downstream of Legacy Dr.

Photo IDs	Description
2784	Upstream
2785	Downstream
2783	Site/ Contents of rake
2786	Mid Stream
2787/8	Asian Clam (*Corbicula spp.*)

GPS Waypoints	Description
T-102	Stream

Sediment Description

Soft. Silty sand with gravel.

Number of Rakes: 6

Benthic Observations

Asian Clams (*Corbicula spp.*) and various snail species unidentified. Pondhorn (*Uniomerus tetralasmus*) shells observed nearby.

Exide Technologies Benthic Survey

Date: 3/18/2014

Transect: T-103

Personnel: KH,RM (BESI) ; Amy, Chris (Golder), Jason (Frisco)

Camera: Nikon

GPS: A

Time: 12:22

General Location Stewart Creek downstream of Legacy Dr.

Photo IDs	Description
2795	Upstream
2794	Downstream
2793	Contents of rake
2796	Mid Stream
2798/9	Asian Clam (*Corbicula spp.*)
2797	Creek bank

GPS Waypoints	Description
T-103	Stream

Sediment Description

Large and small gravel with silt layer on top.

Number of Rakes: 6

Benthic Observations

Multiple Asian Clams (*Corbicula spp.*) collected in rake.

General Observations

Wading bird print in exposed sediment.

Exide Technologies Benthic Survey

Date: 3/18/2014

Transect: T-104

Personnel: (BESI) KH, RM (Golder) AM, Chris (Frisco) Jason

Camera: Nikon

GPS: A

Time: 13:00

General Location: Stewart Creek downstream of Legacy Dr.

Photo IDs	Description
2809	Upstream
2807	Downstream
2805	Contents of rake
2806	Mid Stream
2808	Mid Stream

GPS Waypoints	Description
T-104	Stream

Sediment Description

Soft. Course sand and small amount of silt and gravel - leaves and twigs intermixed.

Number of Rakes: 6

Benthic Observations

None

Exide Technologies Benthic Survey

Date: 3/18/2014

Transect: T-105

Personnel: KH,RM (BESI)AM, Chris (Golder) Jason (Frisco)

Camera: Nikon

GPS: A

Time: 13:34

General Location Stewart Creek downstream of Legacy Dr.

Photo IDs	Description
2815	Upstream
2813	Downstream
2814	Creek
2816	Contents of rake
2817	Asian Clam (*Corbicula spp.*) and snails

GPS Waypoints	Description
T-105	Stream

Sediment Description

Gravel with silt.

Number of Rakes: 6

Benthic Observations

Multiple Asian Clams (*Corbicula spp.*) and snails (class Gastropoda) collected in rake.

Exide Technologies Benthic Survey

Date: 3/18/2014

Transect: T-106

Personnel: KH,RM (BESI) AM Chris (Golder) Jason (Frisco)

Camera: Nikon

GPS: A

Time: 15:34

General Location Stewart Creek downstream of Legacy Dr.

Photo IDs	Description
2827	Upstream
2829	Downstream
2828	Contents of rake
2830	Contents of rake
2831	Asian Clam (*Corbicula spp.*)

GPS Waypoints	Description
T-106	Stream

Sediment Description

Sand with gravel with small trace amounts of silt.

Number of Rakes: 6

Benthic Observations

Multiple Asian Clams (*Corbicula spp.*) collected in rake.

Exide Technologies Benthic Survey

Date: 3/18/2014

Transect: T-107

Personnel: KH,RM (BESI) AM, Chris (Golder) Jason (Frisco)

Camera: Nikon

GPS: A

Time: 16:00

General Location Stewart Creek downstream of Legacy Dr.

Photo IDs	Description
2846	Upstream
2843	Downstream
2841/2	Stream Banks
2839	Contents of rake
2844	Asian Clam (*Corbicula spp.*)
2845	Benthic worm
2840	*Corbicula* siphon holes

GPS Waypoints	Description
T-107	Stream

Sediment Description

Sand with fine gravel. Burrows and siphon holes identified throughout exposed bank on downstream end of inside stream bar.

Number of Rakes: 6

Benthic Observations

Multiple Asian Clams (*Corbicula spp.*) and 1 benthic worm collected in rake.

Exide Technologies Habitat Surveys

Date: 1/13/2014

Plot: H-1

Personnel: NH, KH, BS, BD

Camera: Nikon

GPS: B

Time: 8:30

General Location: Adjacent to Stewart creek

Dominant Vegetation
Cynodon dactylon
Ambrosia trifida

GPS Waypoint	Description
Plot 1	Plot H-1

Photo IDs	Description
2106	North
2107	East
2108	South
2109	West

Comments

None

Exide Technologies Habitat Surveys

Date: 1/13/2014

Plot: H-2

Personnel: NH, KH, BS, BD

Camera: Nikon

GPS: B

Time: 8:35

General Location: Adjacent to south forested area

GPS Waypoints	Description
Plot 2	Plot H-2

Dominant Vegetation

Cynodon dactylon

Photo IDs	Description
2110	North
2111	East
2112	South
2113	West

Comments

None

Exide Technologies Habitat Surveys

Date: 1/13/2014

Plot: H-3

Personnel: NH, KH, BS, BD

Camera: Nikon

GPS: B

Time: 8:50

General Locatior South forested area

Dominant Vegetation
Ulmus crassifolia
Ulmus alata
Maclura pomifera
Elymus canadensis
Quercus spp.
Elymus canadensis

GPS Waypoints	Description
Plot 3	On plot H-3
Drainage feature	East of plot

Photo IDs	Description
2224	North
2225	East
2226	South
2227	West
2228	Dry creek

Comments

Dry creek bed running adjacent to Plot H-3.

Exide Technologies Habitat Surveys

Date: 1/13/2014

Plot: H-4

Personnel: NH, KH, BS, BD

Camera: Nikon

GPS: B

Time: 9:00

General Location: South forested area

GPS Waypoints	Description
Plot 4	Plot H-4

Dominant Vegetation
Ulmus crassifolia
Ulmus alata
Maclura pomifera
Elymus canadensis
Quercus spp.
Elymus canadensis
Smilax bona-nox

Photo IDs	Description
2131	North
2132	East
2133	South
2134	West

Comments

Woodpecker, call heard at site.

Northern Cardinal (*Cardinalis cardinalis)* spotted.

Plot at toe of small earthern dam.

American Robins (*Turdus migratorius*) heard near plot.

Date: 1/13/2014

Plot: H-5

Personnel: NH, KH, BS, BD

Camera: Nikon

GPS: B

Time: 9:07

General Location: South forested area

GPS Waypoints	Description
Plot H-5	Plot H-5

Dominant Vegetation

Celtis occidentalis

Amphiachyris dracunculoides

Gleditsia triacanthos

Cynodon dactylon

Ambrosia psilostachya

Ulmus crassifolia

Comments

None

Photo IDs	Description
2136	North
2137	East
2138	South
2139	West

Exide Technologies Habitat Surveys

Date: 1/13/2014

Plot: H-6

Personnel: NH, KH, BS, BD

Camera: Nikon

GPS: B

Time: 9:20

General Location: South forested area

GPS Waypoints	Description
Plot 6	Plot H-6

Dominant Vegetation
Ulmus crassifolia
Ulmus alata
Maclura pomifera
Elymus canadensis
Quercus spp.

Photo IDs	Description
2145	North
2146	East
2147	South
2148	West

Comments

Cottontail rabbit (*Sylvilagus floridanus)* seen near site

Exide Technologies Habitat Surveys

Date: 1/13/2014

Plot: H-7

Personnel: NH, KH, BS, BD

Camera: Nikon

GPS: B

Time: 9:40

General Location: South forested area

GPS Waypoints	Description
Plot 7	Plot H-7

Dominant Vegetation

Cynodon dactylon

Photo IDs	Description
2149	North
2150	East
2151	South
2152	West

Comments

None

Exide Technologies Habitat Surveys

Date: 1/13/2014

Plot: H-8

Personnel: NH, KH, BS, BD

Camera: Nikon

GPS: B

Time: 9:20

General Location: Adjacent to creek

GPS Waypoints	Description
Plot 8	Plot H-8

Dominant Vegetation

Cynodon dactylon

Ambrosia trifida

Photo IDs	Description
2153	North
2154	East
2155	South
2156	West

Comments

None

Exide Technologies Habitat Surveys

Date: 1/13/2014

Plot: H-9

Personnel: NH, KH, BS, BD

Camera: Nikon

GPS: B

Time: 9:46

General Location: Adjacent to creek

GPS Waypoints	Description
Plot 9	Plot H-9

Dominant Vegetation
Sorghum halepense
Ambrosia psilostachya
Ambrosia trifida

Photo IDs	Description
2153	North/creek
2154	East
2155	South
2156	West
2158	Creekbed
2159	Creekbed

Comments

Steep bank, rocky bottom clear water high flow area.

Exide Technologies Habitat Surveys

Date: 1/13/2014

Plot: H-10

Personnel: NH, KH, BS, BD

Camera: Nikon

GPS: B

Time: 9:42

General Location: Adjacent to creek

GPS Waypoints	Description
Plot 10	Plot H-10

Dominant Vegetation
Cynodon dactylon
Ambrosia trifida

Photo IDs	Description
2159	European Starling (S*turnus vulgaris*)
2161	North
2162	East
2163	South
2164	West

Comments

None

Exide Technologies Habitat Surveys

Date: 1/13/2014

Plot: H-11

Personnel: NH, KH, BS, BD

Camera: Nikon

GPS: B

Time: 9:45

General Location: Clearing north of south forested area

GPS Waypoints	Description
Plot 11	Plot H-11

Dominant Vegetation
Cynodon dactylon
Setaria geniculata

Photo IDs	Description
2164	North
2165	East
2166	South
2167	West

Comments

Cottontail Rabbit (*Sylvilagus floridanus*) spotted adjacent to site.

Exide Technologies Habitat Surveys

Date: 1/13/2014

Plot: H-12

Personnel: NH, KH, BS, BD

Camera: Nikon

GPS: B

Time: 9:50

General Location: South forested area

GPS Waypoints	Description
Plot 12	Plot H-12

Dominant Vegetation
Ulmus crassifolia
Ulmus alata
Maclura pomifera
Elymus canadensis
Quercus spp.

Photo IDs	Description
2168	North
2169	East
2170	South
2171	West

Comments

Steep slope.

Exide Technologies Habitat Surveys

Date: 1/13/2014

Plot: H-13

Personnel: NH, KH, BS, BD

Camera: Nikon

GPS: B

Time: 10:00

General Location: South forested area

GPS Waypoints	Description
Plot 13	Plot H-13

Dominant Vegetation

Celtis laevigata

Smilax bona-nox

Melia azederach

Photo IDs	Description
2174	North
2175	East
2176	South
2177	West
2178	Rock outcrop

Comments

Rock and concrete at plot.

Exide Technologies Habitat Surveys

Date: 1/13/2014

Plot: H-14

Personnel: NH, KH, BS, BD

Camera: Nikon

GPS: B

Time: 10:01

General Location: South forested area

GPS Waypoints	Description
Plot 14	Plot H-14

Dominant Vegetation

Cynodon dactylon

Photo IDs	Description
2179	North
2180	East
2181	South
2182	West

Comments

None

Exide Technologies Habitat Surveys

Date: 1/13/2014

Plot: H-15

Personnel: NH, KH, BS, BD

Camera: Nikon

GPS: B

Time: 10:07

General Location: South forested area

GPS Waypoints	Description
Plot 15	Plot H-15

Dominant Vegetation

- *Ulmus crassifolia*
- *Ulmus alata*
- *Maclura pomifera*
- *Elymus canadensis*
- *Quercus spp.*

Photo IDs	Description
2186	North
2187	East
2188	South
2189	West
2190	Packrat burrows

Comments

Cedar Waxwing (*Bombycilla cedrorum*) heard over at site.

Packrat burrows observed.

Exide Technologies Habitat Surveys

Date: 1/13/2014

Plot: H-16

Personnel: NH, KH, BS, BD

Camera: Nikon

GPS: B

Time: 10:09

General Location: Clearing north of south forested area

GPS Waypoints	Description
Plot 16	Plot H-16

Dominant Vegetation

Cynodon dactylon

Photo IDs	Description
2191	North
2192	East
2193	South
2194	West

Comments

None

Exide Technologies Habitat Surveys

Date: 1/13/2014

Plot: H-17

Personnel: NH, KH, BS, BD

Camera: Nikon

GPS: B

Time: 10:11

General Location: Adjacent to Stewart Creek

GPS Waypoints	Description
Plot 17	Plot H-17

Dominant Vegetation
Cynodon dactylon
Ambrosia trifida

Photo IDs	Description
2195	North
2196	East
2197	South
2198	West
2199	Creek
2200	Creek
2201	Redtailed Hawks (*Buteo jamaicensis*)

Comments

Spotted American Kestrel (*Falco sparverius*) and 2 Redtailed Hawks (*Buteo jamaicensis*).

Exide Technologies Habitat Surveys

Date: 1/13/2014

Plot: H-18

Personnel: NH, KH, BS, BD

Camera: Nikon

GPS: B

Time: 10:11

General Location: Adjacent to Stewart Creek

GPS Waypoints	Description
Plot 18	Plot H-18

Dominant Vegetation

Cynodon dactylon

Ambrosia trifida

Photo IDs	Description
2202	Footprint
2203	Slide
2204	Slide
2205	North
2206	East
2207	South
2208	West

Comments

Beaver footprints

Potential benthic rake site.

Exide Technologies Habitat Surveys

Date: 1/13/2014

Plot: H-19

Personnel: NH, KH, BS, BD

Camera: Nikon

GPS: B

Time: 10:32

General Location: Adjacent to Stewart Creek

GPS Waypoints	Description
Plot 19	Plot H-19

Dominant Vegetation

Ulmus alata

Solidago canadensis

Photo IDs	Description
2212	North
2213	East
2214	South
2215	West
2216	Turkey vulture (*Cathartes aura*)

Comments

Spotted 2 Crows *(Corvus brachyrhynchos*) and a Turkey Vulture (*Cathartes aura*).

Exide Technologies Habitat Surveys

Date: 1/13/2014

Plot: H-20

Personnel: NH, KH, BS, BD

Camera: Nikon

GPS: B

Time: 10:35

General Location: Adjacent to Stewart Creek

GPS Waypoints	Description
Plot 20	Plot H-20
Man made dam	Man made dam located next to plot

Dominant Vegetation

Ulmus alata

Solidago canadensis

Rubus trivialis

Ambrosia trifida

Photo IDs	Description
2217	North
2218	East
2219	South
2220	West
2221	Dam

Comments

Spotted 3 Rock Doves (*Columba livia*).

Exide Technologies Habitat Surveys

Date: 1/13/2014

Plot: H-21

Personnel: NH, KH, BS, BD

Camera: Nikon

GPS: B

Time: 10:41

General Location: Adjacent to Stewart Creek

GPS Waypoints	Description
Plot 21	Plot H-21
Dam	Man made dam next to plot

Dominant Vegetation
Helianthus annuus
Ulmus alata
Solidago canadensis

Photo IDs	Description
2222	North
2223	East
2224	South
2225	West
2226	Creek

Comments

Rip Rap for creekbed.

2 Red-tailed Hawks (*Buteo jamaicensis)* flew over the site.

Exide Technologies Habitat Surveys

Date: 1/13/2014

Plot: H-22

Personnel: NH, KH, BS, BD

Camera: Nikon

GPS: B

Time: 10:45

General Location: Adjacent to Stewart Creek

GPS Waypoints	Description
Plot 22	Plot H-22

Dominant Vegetation

Sorghum halepense

Salix nigra

Solidago canadensis

Photo IDs	Description
2227	North
2228	East
2229	South
2230	West
2231	Culverts
2232	Creek
2234	Creek
2235	Creek
2236	Dam just downstream of Plot H-22

Comments

4 large culverts on oppsite side of creek.

Concrete dam and large rip rap creek bottom.

Riffle area downstream of dam and concrete.

Exide Technologies Habitat Surveys

Date: 1/13/2014

Plot: H-23

Personnel: NH, KH, BS, BD

Camera: Nikon

GPS: B

Time: 10:55

General Location: Adjacent to Stewart Creek

GPS Waypoints	Description
Plot 23	Plot H-23

Dominant Vegetation

Sorghum halepense

Salix nigra

Photo IDs	Description
2238	North
2239	East
2240	South
2241	West
2242	Canine Tracks

Comments

Tracks in creekbed, canine and raccoon (*Procyon lotor).*

Riffle area in creek.

Exide Technologies Habitat Surveys

Date: 1/13/2014

Plot: H-24

Personnel: NH, KH, BS, BD

Camera: Nikon

GPS: B

Time: 11:00

GPS Waypoints	Description
Plot 24	Plot H-24

General Location: Adjacent to Stewart Creek

Dominant Vegetation
Sorghum halepense
Salix nigra
Solidago canadensis

Photo IDs	Description
2243	North
2244	East
2245	South
2246	West
2247	Culvert
2248	Rock creek bottom
2249	Beaver (*Castor canadensis*) sign
2250	Creek bottom

Comments

Raccoon (*Procyon lotor)* tracks and beaver (*Castor canadensis*) sign along creek.

Rock-clay-shale bottom very hard.

Exide Technologies Habitat Surveys

Date: 1/13/2014

Plot: H-25

Personnel: NH, KH, BS, BD

Camera: KH phone

GPS: B

Time: 11:00

General Location: Adjacent to Stewart Creek

GPS Waypoints	Description
Plot 25	Plot H-25

Dominant Vegetation
Sorghum halepense
Salix nigra
Ambrosia trifida

Photo IDs	Description
111053	North
111057	East
111101	South
111105	West
111417	Creek bottom

Comments

Hard creek bottom, no sediment.

Riffle area.

Exide Technologies Habitat Surveys

Date: 1/13/2014

Plot: H-26

Personnel: NH, KH, BS, BD

Camera: Nikon

GPS: B

Time: 11:20

General Location: Adjacent to Stewart Creek

GPS Waypoints	Description
Plot 26	Plot H-26

Dominant Vegetation

Solidago canadensis

Photo IDs	Description
2258	North
2259	East
2260	South
2261	West
2262	Downstream
2263	Site
2264	Upstream

Comments

None

Exide Technologies Habitat Surveys

Date: 1/13/2014

Plot: H-27

Personnel: NH, KH, BS, BD

Camera: Nikon

GPS: B

Time: 11:27

General Location: Lake Parcel

GPS Waypoints	Description
Plot 27	Plot H-27

Dominant Vegetation

Solidago canadensis

Cynodon dactylon

Sorghum halepense

Photo IDs	Description
2254	North
2255	East
2256	South
2257	West

Comments

Plot was located in a hayfield.

Exide Technologies Habitat Surveys

Date: 1/13/2014

Plot: H-28

Personnel: NH, KH, BS, BD

Camera: Nikon

GPS: B

Time: 12:00

General Location: North of forested area

Dominant Vegetation
Ulmus americana
Smilax bona-nox
Celtis laevigata

GPS Waypoints	Description
Plot 28	Plot H-28

Photo IDs	Description
2265	North
2266	East
2267	South
2268	West

Comments

Exide Technologies Habitat Surveys

Date: 1/13/2014

Plot: H-29

Personnel: NH, KH, BS, BD

Camera: Nikon

GPS: B

Time: 12:00

General Location: North forested area

GPS Waypoints	Description
Plot 29	Plot H-29

Dominant Vegetation
Populus deltoides
Lonicera japonica
Diospyros texana
Celtis laevigata

Photo IDs	Description
2269	North
2270	East
2271	South
2272	West

Comments

American Robin (*Turdus migratorius*) heard in area.

Exide Technologies Habitat Surveys

Date: 1/13/2014

Plot: H-30

Personnel: NH, KH, BS, BD

Camera: Nikon

GPS: B

Time: 12:05

General Location: North tributary in forested area

GPS Waypoints	Description
Plot 30	Plot H-30

Dominant Vegetation

Populus deltoides

Lonicera japonica

Diospyros texana

Celtis laevigata

Photo IDs	Description
2273	Upstream
2274	Site
2275	Downstream
2276	Creek bottom

Comments

Creek bottom consists of gravel.

Spotted Cardinal (*Cardinalis carlinalis)* in area.

Exide Technologies Habitat Surveys

Date: 1/13/2014

Plot: H-31

Personnel: NH, KH, BS, BD

Camera: Nikon

GPS: B

Time: 12:20

General Location: North forested area

GPS Waypoints	Description
Plot 31	Plot H-31

Dominant Vegetation
Forestiera acuminata
Maclura pomifera
Juniperus virginana
Celtis laevigata
Smilax bona-nox
Ulmus americana

Comments

None

Photo IDs	Description
2278	North
2279	East
2280	South
2281	West

Exide Technologies Habitat Surveys

Date: 1/13/2014

Plot: H-32

Personnel: NH, KH, BS, BD

Camera: Nikon

GPS: B

Time: 12:21

General Location: North tributary in north forested area

GPS Waypoints	Description
Plot 32	Plot H-32, middle of creek.

Dominant Vegetation

Forestiera acuminata

Maclura pomifera

Celtis laevigata

Simlax bona-nox

Ulmus americana

Photo IDs	Description
2282	Downstream
2283	Site
2284	Upstream
2285	Creek bed
2286	Creek bed
2287	Creek bed

Comments

Rocky creek bottom.

Riffle area.

Exide Technologies Habitat Surveys

Date: 1/13/2014

Plot: H-33

Personnel: NH, KH, BS, BD

Camera: Nikon

GPS: B

Time: 12:25

General Location: North tributary in north forested area

GPS Waypoints	Description
Plot 33	Plot H-33, middle of creek.

Dominant Vegetation

Lonicera japonica

Maclura pomifera

Celtis laevigata

Smilax bona-nox

Ulmus americana

Vitis mustangensis

Photo IDs	Description
2289	squirrel nest
2290	North
2291	East
2292	South
2293	West

Comments

Rocky creek bottom.

Riffle area.

Exide Technologies Habitat Surveys

Date: 1/13/2014

Plot: H-34

Personnel: NH, KH, BS, BD

Camera: Nikon

GPS: B

Time: 12:30

General Location: North forested area

GPS Waypoints	Description
Plot 34	Plot H-34

Dominant Vegetation
Smilax bona-nox
Ulmus americana
Elymus canadensis

Photo IDs	Description
2294	North
2295	East
2296	South
2297	West

Comments

None

Exide Technologies Habitat Surveys

Date: 1/13/2014

Plot: H-35

Personnel: NH, KH, BS, BD

Camera: Nikon

GPS: B

Time: 12:37

General Location: North forested area

GPS Waypoints	Description
Plot 35	Plot H-35

Dominant Vegetation
Smilax bona-nox
Ulmus americana
Elymus canadensis

Photo IDs	Description
2298	North
2299	East
2300	South
2301	West
2302	Squirrel nest

Comments

American Robin (*Turdus migratorius*) sighted near plot.

Squirrel nest near site.

Mourning Doves (*Zenaida macroura*) spotted near site.

Exide Technologies Habitat Surveys

Date: 1/13/2014

Plot: H-36

Personnel: NH, KH, BS, BD

Camera: Nikon

GPS: B

Time: 12:40

General Location: Center of creek, North tributary

GPS Waypoints	Description
Plot 36	Plot H-36

Dominant Vegetation

Smilax bona-nox

Celtis laevigata

Elymus canadensis

Photo IDs	Description
2303	Upstream
2304	Site
2305	Downstream

Comments

Rocky creek bottom, and riffles.

Exide Technologies Habitat Surveys

Date: 1/13/2014

Plot: H-37

Personnel: NH, KH, BS, BD

Camera: Nikon

GPS: B

Time: 12:40

General Location: North forested area

GPS Waypoints	Description
Plot 37	Plot H-37

Dominant Vegetation
Salix nigra
Celtis laevigata
Vitis mustangensis

Photo IDs	Description
2306	North
2307	East
2308	South
2309	West

Comments

None

Exide Technologies Habitat Surveys

Date: 1/13/2014

Plot: H-38

Personnel: NH, KH, BS, BD

Camera: Nikon

GPS: B

Time: 12:50

General Location: North forested area

GPS Waypoints	Description
Plot 38	Plot H-38

Dominant Vegetation

Salix nigra

Photo IDs	Description
2310	North
2311	East
2312	South
2313	West

Comments

Spotted Northern Mockingbird (*Mimus polyglottos*) near plot

Blue Jay (*Cyanocitta cristata*) heard near site.

Exide Technologies Habitat Surveys

Date: 1/13/2014

Plot: H-39

Personnel: NH, KH, BS, BD

Camera: Nikon

GPS: B

Time: 12:53

General Location: North forested area

GPS Waypoints	Description
Plot 39	Plot H-39

Dominant Vegetation

Ulmus americana

Smilax bona-nox

Elymus canadensis

Ambrosia trifida

Comments

Mourning Dove (*Zenaida macroura*) spotted at site.

Photo IDs	Description
2314	North
2315	East
2316	South
2317	West

Exide Technologies Habitat Surveys

Date: 1/13/2014

Plot: H-40

Personnel: NH, KH, BS, BD

Camera: Nikon GPS: B

Time: 13:00

General Location: North tributary of north forested area

GPS Waypoints	Description
Plot 40	Plot H-40

Dominant Vegetation

Ulmus americana

Smilax bona-nox

Elymus canadensis

Ambrosia trifida

Photo IDs	Description
2318	Upstream
2319	Site
2320	Downstream

Comments

Riffle area, small amount (less than 1 cm) of sediment over gravel;

Heard Mourning Dove (*Zenaida macroura*) at the site.

Raccoon (*Procyon lotor*) tracks thoughout creek.

Exide Technologies Habitat Surveys

Date: 1/13/2014

Plot: H-42

Personnel: NH, KH, BS, BD

Camera: Nikon

GPS: B

Time: 13:00

General Location: North forested area

Dominant Vegetation
Celtis laevigata
Maclura pomifera
Smilax bona-nox
Lonicera japonica
Ulmus americana

GPS Waypoints	Description
Plot 42	Plot H-42

Photo IDs	Description
2325	North
2326	East
2327	South
2328	West

Comments

None

Exide Technologies Habitat Surveys

Date: 1/13/2014

Plot: H-41

Personnel: NH, KH, BS, BD

Camera: Nikon

GPS: B

Time: 12:55

General Location: North forested area

GPS Waypoints	Description
Plot 41	Plot H-41

Dominant Vegetation

Ulmus americana

Smilax bona-nox

Maclura pomifera

Photo IDs	Description
2321	North
2322	East
2323	South
2324	West

Comments

None

Exide Technologies Habitat Surveys

Date: 1/13/2014

Plot: H-43

Personnel: NH, KH, BS, BD

Camera: Nikon

GPS: B

Time: 13:05

General Location: North tributary

GPS Waypoints	Description
Plot 43	Plot H-43

Dominant Vegetation

Celtis laevigata

Smilax bona-nox

Lonicera japonica

Ulmus americana

Photo IDs	Description
2329	Upstream
2330	Site
2331	Downstream
2332	Predator scat
2333	Predator scat

Comments

Northern Shrike (*Lanius ludovicianus*) spotted near site.

High flow area, no sediment.

Rocky creek bottom.

Exide Technologies Habitat Surveys

Date: 1/13/2014

Plot: H-44

Personnel: NH, KH, BS, BD

Camera: Nikon

GPS: B

Time: 14:58

General Location: Hayfield adjacent to north tributary

GPS Waypoints	Description
Plot 44	Plot H-44

Dominant Vegetation
Solidago canadensis
Cynodon dactylon
Sorghum halepense
Engelmannia peristenia

Photo IDs	Description
2334	North
2335	East
2336	South
2337	West

Comments

Plot was located in a hayfield that was recently mowed.

Red-tailed Hawk (*Buteo jamaicensis*) sighted.

Exide Technologies Habitat Surveys

Date: 1/13/2014

Plot: H-45

Personnel: NH, KH, BS, BD

Camera: Sony

GPS: B

Time: 15:07

General Location: North tributary

GPS Waypoints	Description
Plot 45	Plot H-45

Dominant Vegetation
Solidago canadensis
Cynodon dactylon
Ambrosia trifida

Photo IDs	Description
353	Upstream
354	Site
355	Downstream

Comments

Gravel bottom, no sediment, and a high flow area.

Exide Technologies Habitat Surveys

Date: 1/13/2014

Plot: H-46

Personnel: NH, KH, BS, BD

Camera: Sony

GPS: B

Time: 15:03

General Location: Adjacent to north tributary

GPS Waypoints	Description
Plot 46	Plot H-46

Dominant Vegetation
Solidago canadensis
Salix nigra
Sorghum halepense
Desmanthus illinoensis
Ulmus alata

Photo IDs	Description
347	North
348	East
349	South
350	West

Comments

None

Exide Technologies Habitat Surveys

Date: 1/13/2014

Plot: H-47

Personnel: NH, KH, BS, BD

Camera: Sony

GPS: B

Time: 16:14

General Location: Hayfield adjacent to north tributary

GPS Waypoints	Description
Plot 47	Plot H-47

Dominant Vegetation
Solidago canadensis
Cynodon dactylon
Sorghum halepense
Engelmannia peristenia

Photo IDs	Description
360	Upstream
361	Site
362	Downstream
363	Raccoon (*Procyon lotor*) skull.

Comments

Raccoon (*Procyon lotor*) skull.

Exide Technologies Habitat Surveys

Date: 1/13/2014

Plot: H-48

Personnel: NH, KH, BS, BD

Camera: Sony

GPS: B

Time: 15:14

General Location: Adjacent to north tributary

GPS Waypoints	Description
Plot 48	Plot H-48

Dominant Vegetation
Solidago canadensis
Salix nigra
Sorghum halepense
Desmanthus illinoensis
Ulmus alata
Ambrosia trifida

Comments

None

Photo IDs	Description
356	North
357	East
358	South
359	West

Exide Technologies Habitat Surveys

Date: 1/13/2014

Plot: H-49

Personnel: NH, KH, BS, BD

Camera: Sony

GPS: B

Time: 15:20

General Location: North tributary

GPS Waypoints	Description
Plot 49	Plot H-49

Dominant Vegetation
Solidago canadensis
Cynodon dactylon
Ambrosia trifida

Photo IDs	Description
360	Upstream
361	Site
362	Downstream

Comments

Gravel creek bottom, no sediment, and a high flow area.

Exide Technologies Habitat Surveys

Date: 1/13/2014

Plot: H-50

Personnel: NH, KH, BS, BD

Camera: Nikon

GPS: B

Time: 14:58

General Location: Hayfield adjacent to north tributary

GPS Waypoints	Description
Plot 50	Plot H-50

Dominant Vegetation

Solidago canadensis

Cynodon dactylon

Sorghum halepense

Engelmannia peristenia

Photo IDs	Description
2334	North
2335	East
2336	South
2337	West

Comments

Plot was located in a hayfield that was recently mowed.

Exide Technologies Habitat Surveys

Date: 1/13/2014

Plot: H-51

Personnel: NH, KH, BS, BD

Camera: Sony

GPS: B

Time: 15:20

General Location: North tributary

GPS Waypoints	Description
Plot 51	Plot H-51

Dominant Vegetation
Solidago canadensis
Salix nigra
Sorghum halepense
Desmanthus illinoensis
Ulmus alata

Photo IDs	Description
364	North
365	East
366	South
367	West

Comments

None

Exide Technologies Habitat Surveys

Date: 1/13/2014

Plot: H-52

Personnel: NH, KH, BS, BD

Camera: Sony

GPS: B

Time: 15:07

General Location: North tributary

GPS Waypoints	Description
Plot 52	Plot H-52

Dominant Vegetation
Solidago canadensis
Cynodon dactylon
Ambrosia trifida

Photo IDs	Description
368	Upstream
369	Site
370	Downstream

Comments

Raccoon (*Procyon lotor*) tracks near site.

Exide Technologies Habitat Surveys

Date: 1/13/2014

Plot: H-53

Personnel: NH, KH, BS, BD

Camera: Sony

GPS: B

Time: 15:40

General Location: Between Stewart Creek and north tributary

GPS Waypoints	Description
Plot 53	Plot H-53

Dominant Vegetation
Solidago canadensis
Cynodon dactylon
Sorghum halepense
Engelmannia peristenia

Photo IDs	Description
367	North
368	East
369	South
370	West

Comments

None

Exide Technologies Habitat Surveys

Date: 1/13/2014

Plot: H-54

Personnel: NH, KH, BS, BD

Camera: Sony

GPS: B

Time: 15:40

General Location: Railroad tracks

GPS Waypoints	Description
Plot 54	Plot H-54

Dominant Vegetation
Gleditsia triacanthos
Melia azedarach
Sorghum halepense
Helianthus annuus
Ambrosia trifida
Malus ioensis
Solidago canadensis

Photo IDs	Description
380	North
381	East
382	South
383	West

Comments

Red-tailed Hawk (*Buteo jamaicensis*) sighted.

Exide Technologies Habitat Surveys

Date: 1/13/2014

Plot: H-55

Personnel: NH, KH, BS, BD

Camera: Sony

GPS: B

Time: 15:43

General Location: Railroad tracks

GPS Waypoints	Description
Plot 55	Plot H-55

Dominant Vegetation
Gleditsia triacanthos
Melia azedarach
Sorghum halepense
Helianthus annuus
Ambrosia trifida
Malus ioensis
Solidago canadensis

Comments

Photos taken of an old railroad bed.

Photo IDs	Description
385	Northwest down tracks
386	Southeast down tracks
387	West, big creek
388	East toward field

Exide Technologies Habitat Surveys

Date: 1/15/2014

Plot: H-60

Personnel: (BESI) NH, KH, BS (Golder) AM, MR, (Frisco) Tommy

Camera: Nikon

GPS: B

Time: 8:15

General Location: Stewart Creek

GPS Waypoints	Description
Plot 60	Plot H-60

Dominant Vegetation

Fraxinus pennsylvanica

Smilax bona-nox

Photo IDs	Description
2352	Pondhorn mussel (*Uniomerus tetralasmus*)
2353	Pondhorn mussel (*Uniomerus tetralasmus*)
2354	Shell fragment
2355	Downstream
2356	Upstream

Comments

Bottom of creek consists of gravel rocks.

2 Pondhorn mussel (*Uniomerus tetralasmus*) shells found.

Located downstream of wastewater treatment facility

Exide Technologies Habitat Surveys

Date: 1/15/2014

Plot: H-61

Personnel: (BESI) NH, KH, BS (Golder) AM, MR, (Frisco) Tommy

Camera: Nikon

GPS: B

Time: 8:35

General Location: Streambed near outfall of water treatment plant.

GPS Waypoints	Description
Plot 61	Plot H-61

Dominant Vegetation

Celtis laevigata

Ambrosia trifida

Photo IDs	Description
2363	Downstream
2364	Upstream
2365	Asian clam (*Corbicula spp.*)
2366	Asian clam (*Corbicula spp.*)
2367	Canine and raccoon (*Procyon lotor*) tracks
2368	Canine and raccoon (*Procyon lotor*) tracks

Comments

Bottom of creek changed to gravel.

Canine and raccoon (*Procyon lotor*) tracks on bank.

2 Asian clam (*Corbicula spp.*) shells.

Exide Technologies Habitat Surveys

Date: 1/15/2014

Plot: H-62

Personnel: (BESI) NH, KH, BS (Golder) AM, MR, (Frisco) Tommy

Camera: Nikon

GPS: B

Time: 8:50

General Location: Stewart Creek near outfall

GPS Waypoints	Description
Plot 62	Plot H-62

Dominant Vegetation

Celtis occidentalis

Ambrosia trifida

Photo IDs	Description
2373	Upstream
2374	Downstream
2375	Outfall

Comments

Creek bed transition to sediment and finer gravel.

Exide Technologies Habitat Surveys

Date: 1/15/2014

Plot: H-63

Personnel: (BESI) NH, KH, BS (Golder) AM, MR, (Frisco) Tommy

Camera: Nikon

GPS: B

Time: 8:57

General Location: Near outfall of wastewater treatment facility

GPS Waypoints	Description
Plot 63	Plot H-63

Dominant Vegetation
Celtis laevigata
Ambrosia trifida
Fraxinus pennsylvanica

Photo IDs	Description

Comments

Creek bottom transitioned to all gravel with no sediment.

Exide Technologies Habitat Surveys

Date: 1/15/2014

Plot: H-64

Personnel: (BESI) NH, KH, BS (Golder) AM, MR, (Frisco) Tommy

Camera: Nikon

GPS: B

Time: 9:00

General Location: Upstream of waste water treatment outfall

Dominant Vegetation
Celtis laevigata
Ambrosia trifida
Fraxinus pennsylvanica

GPS Waypoints	Description
Plot 64	Plot H-64

Photo IDs	Description
2377	Gravel bank with mussel shells
2378	Upstream
2379	Asian clams (*Corbicula spp.*)
2380	Bank of site
2381	Dead Green Sunfish (*Lepomis cyanellus*)

Comments

Large amount of mussel shell on gravel bank.

Just upstream from the outfall of wastewater treatment facility

Sediment, all small gravel.

Green sunfish (*Lepomis cyanellus*), dead.

Exide Technologies Habitat Surveys

Date: 1/15/2014

Plot: H-65

Personnel: (BESI) NH, KH, BS (Golder) AM, MR, (Frisco) Tommy

Camera: Nikon

GPS: B

Time: 9:20

General Location: Upstream of wastewater treatment outfall

GPS Waypoints	Description
Plot 65	Plot H-65

Dominant Vegetation
Celtis laevigata
Fraxinus pennsylvanica
Elymus canadensis

Photo IDs	Description
2393	Downstream
2394	Gravel bank
2395	Asian Clam (*Corbicula spp.*)

Comments

Small round Asian Clam (*Corbicula spp.*) collected.

Snail shells found in area, dead.

Exide Technologies Habitat Surveys

Date: 1/15/2014 Plot: H-66

Personnel: (BESI) NH, KH, BS (Golder) AM, MR, (Frisco) Tommy Camera: Nikon GPS: B

Time: 9:50

General Location: Stewart Creek, upstream of wastewater treatment outfall

GPS Waypoints	Description
Plot 66	Plot H-66

Dominant Vegetation
Celtis laevigata
Fraxinus pennsylvanica
Elymus canadensis

Photo IDs	Description
2403	Upstream
2404	Site
2405	Downstream
2406	Asian Clams (*Corbicula spp.*)

Comments

Small pools in bends of creek with riffles in the straight aways.

Small amounts of sedimentation in bends.

Asian Clam (*Corbicula spp.*) shells found all along creek on high surfaces next to water.

Nest spotted over creek.

Exide Technologies Habitat Surveys

Date: 1/15/2014

Plot: H-67

Personnel: (BESI) NH, KH, BS (Golder) AM, MR, (Frisco) Jason

Camera: Nikon

GPS: B

Time: 13:50

General Location: Near bridge at Stonebrook Pkwy

GPS Waypoints	Description
Plot 67	Plot H-67

Dominant Vegetation
Fraxinus pennsylvanica
Celtis laevigata
Ambrosia trifida
Smilax bona-nox

Photo IDs	Description
2450	Upstream
2451	Downstream
2452	Pondhorn mussel (*Uniomerus tetralasmus*) weathered.
2453	Pondhorn mussel (*Uniomerus tetralasmus*) weathered.
2454	Snail
2455	Pondhorn mussel (*Uniomerus tetralasmus*) intact.

Comments

Gravel, sand, and rocks

Exide Technologies Habitat Surveys

Date: 1/15/2014 Plot: H-68

Personnel: (BESI) NH, KH, BS (Golder) AM, MR, (Frisco) Jason Camera: Nikon GPS: B

Time: 14:28

General Location: Stewart Creek, upstream of Stonebrook Pkwy.

GPS Waypoints	Description
Plot 68	Plot H-68

Dominant Vegetation
Fraxinus pennsylvanica
Smilax bona-nox
Sorghum halepense

Photo IDs	Description
2460	Upstream
2461	Downstream
2462	Pondhorn (*Uniomerus tetralasmus*)
2463	Upstream
2464	Downstream

Comments

Area has a lot of exposed rock beds.

Spotted several pondhorn mussel shells on the exposed gravel bed

Exide Technologies Habitat Surveys

Date: 1/15/2014 Plot: H-69

Personnel: (BESI) NH, KH, BS (Golder) AM, MR, (Frisco) Jason Camera: Nikon GPS: B

Time: 14:35

General Location: Stewart Creek upstream of Stonebrook Pkwy.

GPS Waypoints	Description
Plot 69	Plot H-69

Dominant Vegetation
Fraxinus pennsylvanica
Smilax bona-nox
Sorghum halepense

Photo IDs	Description
2469	Pondhorn mussel (*Uniomerus tetralasmus*)
2470	Downstream
2471	Upstream

Comments

Spotted several pondhorn mussel shells on exposed rock beds.

Stream flow is relatively high to elevation changes.

Spotted small minnows near plot.

Exide Technologies Habitat Surveys

Date: 1/15/2014

Plot: H-70

Personnel: (BESI) NH, KH, BS (Golder) AM, MR, (Frisco) Jason

Camera: Nikon

GPS: B

Time: 15:04

General Location: Stewart Creek, upstream of Stonebrook Pkwy.

GPS Waypoints	Description
Plot 70G15	Plot H-70

Dominant Vegetation
Fraxinus pennsylvanica
Smilax bona-nox
Sorghum halepense

Photo IDs	Description
2475	Upstream
2476	Downstream
2477	Site

Comments

Streambed consists of gravel over clay and shale.

Strong currents compared to lower part of the stream surveyed this morning.

Exide Technologies Habitat Surveys

Date: 1/15/2014

Plot: H-71

Personnel: (BESI) NH, KH, BS (Golder) AM, MR, (Frisco) Jason

Camera: Nikon

GPS: B

Time: 11:00

General Location: Stewart Creek between Lebanon Rd. and 4th Army Dr.

GPS Waypoints	Description
Photo 001	Outfall near road.
G-10	Soft spot
G-11	Soft spot
G-12	Soft spot
G-13	Soft spot

Dominant Vegetation
Fraxinus pennsylvanica
Smilax bona-nox
Ambrosia trifida
Celtis laevigata

Photo IDs	Description
2438-2440	Outfall near road, rocky.
2441-2443	Pool area, soft.
2444-2445	Pool area, soft.
2446-2447	Pool area, soft.
2448-2449	Pool area, soft, tributary nearby.

Comments

None

Exide Technologies Habitat Surveys

Date: 1/16/2014

Plot: H-72

Personnel: (BESI) KH, BS (Golder) AM, MR, (Frisco)Tommy

Camera: Nikon

GPS: B

Time: 8:31

General Location: Stewart Creek directly downstream of Exide Facility

GPS Waypoints	Description
Plot 72	Plot H-72, stream bed

Dominant Vegetation

Fraxinus pennsylvanica

Sorghum halepense

Ambrosia trifida

Celtis laevigata

Photo IDs	Description
2469	Pondhorn mussel (*Uniomerus tetralasmus*)
2470	Downstream
2471	Upstream

Comments

Creek bed composed of rocks, no sediment.

Nest in tree nearby.

Small animal tracks on bank.

Exide Technologies Habitat Surveys

Date: 1/16/2014

Plot: H-73

Personnel: (BESI) KH, BS (Golder) AM, MR, (Frisco) Tommy

Camera: Nikon

GPS: B

Time: 10:55

General Location: Stewart Creek upstream of Lake Lewisville

GPS Waypoints	Description
Plot 73	Plot H-73, stream bed

Dominant Vegetation

Fraxinus pennsylvanica

Sorghum halepense

Ambrosia trifida

Celtis laevigata

Photo IDs	Description
2528	Downstream
2529	Site
2530	Upstream

Comments

Asian clam (*Corbicula spp.*) shell found in rake nearby.

Six Mallard (*Anas platyrhynchos*) ducks sighted.

Turkey Vulture (*Cathartes aura*) sighted.

Numerous animal tracks on the bank.

Exide Technologies Habitat Surveys

Date: 1/16/2014

Plot: H-74

Personnel: (BESI) KH, BS (Golder) AM, MR, (Frisco) Tommy

Camera: Nikon

GPS: B

Time: 12:17

General Location: Stewart Creek upstream of Lake Lewisville

GPS Waypoints	Description
Plot 74	Plot H-74, stream bed

Dominant Vegetation

Fraxinus pennsylvanica

Chasmanthium latifolium

Photo IDs	Description
2560	Downstream
2561	Upstream
2562	Gaint Floater (*Anodonta grandis*) and Pondhorn (*Uniomerus tetralasmus*)
2563	Gaint Floater (*Anodonta grandis*) and Pondhorn (*Uniomerus tetralasmus*)

Comments

Beaver (*Castor canadensis*) signs, cut tree.

Five Mallard (*Anas platyrhynchos*) ducks sighted.

Squrriel (*Sciurus*) sighted.

Numerous animal tracks on the bank.

Exide Technologies Habitat Surveys

Date: 1/16/2014

Plot: H-75

Personnel: (BESI) KH, BS (Golder) AM, MR, (Frisco) Jason

Camera: Nikon

GPS: B

Time: 13:15

General Location: Stewart Creek upstream of Lake Lewisville

GPS Waypoints	Description
Plot 75	Plot H-75, stream bed

Dominant Vegetation
Chasmanthium latifolium
Maclura pomifera
Fraxinus pennsylvanica

Photo IDs	Description
2575	Upstream
2576	Site
2577	Downstream

Comments

Bend in stream.

Exide Technologies Habitat Surveys

Date: 1/16/2014

Plot: H-76

Personnel: (BESI) KH, BS (Golder) AM, MR, (Frisco) Tommy

Camera: Nikon

GPS: B

Time: 13:26

General Location: Stewart Creek upstream of Lake Lewisville

GPS Waypoints	Description
Plot 76	Plot H-76, stream bed

Dominant Vegetation
Sorghum halepense
Maclura pomifera
Ulmus crassifolia
Fraxinus pennsylvanica

Photo IDs	Description
2578	Upsteam
2579	Downstream

Comments

Gravel and sand mix.

2 Mallard (*Anas platyrhynchos*) ducks sighted.

Nest in tree.

Exide Technologies Habitat Surveys

Date: 1/16/2014

Plot: H-77

Personnel: (BESI) KH, BS (Golder) AM, MR, (Frisco) Jason

Camera: Nikon

GPS: B

Time: 15:14

General Location: Stewart Creek downstream of Lebanon Rd.

GPS Waypoints	Description
Plot 77	Plot H-77, stream bed

Dominant Vegetation
Fraxinus pennsylvanica
Maclura pomifera
Panicum virgatum
Chasmanthium latifolium

Photo IDs	Description
2586	Upstream
2587	Site
2588	Downstream

Comments

Asian Clam (*Corbicula spp.*) shells on streambed.

Gravel and silt mix, hard bottom.

Heard owl hooting.

Animal tracks on the bank.

Exide Technologies Habitat Surveys

Date: 1/16/2014

Plot: H-78

Personnel: (BESI) KH, BS (Golder) AM, MR, (Frisco) Jason

Camera: Nikon

GPS: B

Time: 15:24

General Location: Stewart Creek downstream of Lebanon Rd.

GPS Waypoints	Description
Plot 78	Plot H-78, stream bed

Dominant Vegetation

Fraxinus pennsylvanica

Ulmus crassifoila

Ambrosia trifida

Photo IDs	Description
2592	Upstream
2593	Site
2594	Downstream
2595	Streambed
2596	Streambed
2597	Asian Clam (*Corbicula spp.*) shells
2598	Asian Clam (*Corbicula spp.*) shells

Comments

Stream bed with large amounts of Asian Clam (*Corbicula spp.*)shells.

Rocky streambed.

Exide Technologies Habitat Surveys

Date: 3/18/2014

Plot: H-100

Personnel: (BESI) KH, RM (Golder) AM, Chris (Frisco) Jason

Camera: Nikon

GPS: A

Time: 11:00

General Location: Stewart Creek downstream of Legacy Dr.

GPS Waypoints	Description
Plot H100	Plot H-100, stream bed

Dominant Vegetation
Ulmus alata
Celtis occidentalis
Gleditsia triacanthos

Photo IDs	Description
2779	North
2780	East
2781	South
2782	West

Comments

Unknown frog species heard.

Exide Technologies Habitat Surveys

Date: 3/18/2014

Plot: H-102

Personnel: (BESI) KH, RM (Golder) AM, Chris (Frisco) Jason

Camera: Nikon

GPS: A

Time: 12:42

General Location: Stewart Creek downstream of Legacy Dr.

GPS Waypoints	Description
Plot 102	Plot H-102, stream bed

Dominant Vegetation
Ulmus alata
Ambrosia Trifida
Sorghum halepense
Rumex crispus

Photo IDs	Description
2801	North
2802	East
2803	South
2804	West

Comments

4 Spring Peepers (*Pseudacris crucifer*) heard.

Exide Technologies Habitat Surveys

Date: 3/18/2014 Plot: H-103

Personnel: (BESI) KH, RM (Golder) AM, Chris (Frisco) Jason Camera: Nikon GPS: A

Time: 14:34

General Location: Stewart Creek downstream of Legacy Dr.

Dominant Vegetation
Fraxinus pennsylvanica
Ulmus alata
Gleditsia triacanthos
Ambrosia trifida
Smilax bona-nox

GPS Waypoints	Description
Plot H103	Plot H-103, stream bed

Photo IDs	Description
2819	North
2820	South
2821	West
2822	East

Comments

None

Exide Technologies Habitat Surveys

Date: 3/18/2014

Plot: H-104

Personnel: (BESI) KH, RM (Golder) AM, Chris (Frisco) Jason

Camera: Nikon

GPS: A

Time: 15:50

General Location: Stewart Creek downstream of Legacy Dr.

GPS Waypoints	Description
Plot H104	Plot H-104, stream bed

Dominant Vegetation
Ambrosia trifida
Ulmus alata
Panicum virgatum

Comments

Open with very few woody species.

Photo IDs	Description
2834	West
2835	North
2836	East
2837	South
2838	Stream bottom

Exide Technologies Wildlife Observations

Initials	Date	Time	ID	Observation	Photo ID
NH	1/13/2014	8:45	W-1	Deer (*Odocoileus virginianus*) rubs	2114-2118
NH	1/13/2014	8:50	W-2	Burrow, unknown species, and active	2119-2121
NH	1/13/2014	8:50	W-3	Burrow and Deer (*Odocoileus virginianus*) tracks	2122-2123
NH	1/13/2014	9:00	W-4	Nests, possibly used by a squirrel.	2129
NH	1/13/2014	9:00	W-5	Nest, large possibly used by a raptor or owl.	2130
NH	1/13/2014	9:05	W-6	Burrow, Tufted Titmouse (*Baeolophus bicolor*) and Carolina Chickadee heard.	2135
NH	1/13/2014	9:06	W-7	Mockingbird (*Minus polyglottos*) sighting	
NH	1/13/2014	9:10	W-8	Burrows, multiple, next to old structure, possibly used by Packrats.	2140-2144
NH	1/13/2014	9:46	W-9	Burrows, multiple in the area.	2172-2173
NH	1/13/2014	9:51	W-10	Blue Jay (*Cyanocitta cristata*) heard.	
NH	1/13/2014	10:21	W-11	Beaver (*Castor canadensis*) slide, Burr oak acorns next to the slide.	2209
NH	1/13/2014	10:22	W-12	Beaver (*Castor canadensis*) dam, pooling behind dam.	2210-2211
NH	1/13/2014	10:46	W-13	Beaver (*Castor canadensis*) sign on log.	2233
NH	1/13/2014	10:50	W-14	Raccoon (*Procyon lotor*) tracks	2237
NH	1/13/2014	11:07	W-15	Hog sign	2251
NH	1/13/2014	11:18	W-16	Dead Pondhorn (*Uniomerus tetralasmus*) shell found approximately 7 feet above the waterline.	
NH	1/13/2014	12:15	W-17	Scat, most likely a Raccoon (*Procyon lotor*) on log over creek and Tufted Titmouse (*Baeolophus bicolor*) was spotted.	2277

Exide Technologies Wildlife Observations

Initials	Date	Time	ID	Observation	Photo ID
NH	1/13/2014	12:20	W-18	Raccoon (Procyon lotor) tracks in creek.	2288
NH	1/13/2014	14:42	W-19	Coyote (*Canis latrans*) spotted from van on the south side of creek.	
NH	1/13/2014	15:30	W-20	Burrows	371-373
NH	1/13/2014	15:40	W-21	Nest	384
NH	1/13/2014	16:10	W-22	Burrows	400
NH	1/14/2014	8:00	W-23	Pair of Mallard Ducks (*Anas platyrhynchos*) spotted below the dam.	2338-2341
NH	1/14/2014	8:00	W-24	Mourning Doves (*Zenaida marcoura*) spotted.	
NH	1/15/2014	8:20	W-25	2 Asian Clams (*Corbicula spp.*) and a pair of Mallard Ducks (*Anas platyrhynchos*) spotted.	2357-2358
NH	1/15/2014	8:21	W-26	2 Asian Clams (*Corbicula spp.*) and Great Blue Heron (*Ardea herodias*) feather.	2359-2362
NH	1/15/2014	8:45	W-27	Asian Clams (*Corbicula spp.*) , Raccoon (*Procyon lotor*) and canine tracks	2369-2370
NH	1/15/2014	8:50	W-28	Mussel shell fragment possibly a Pondhorn (*Uniomerus tetralasmus*)	2371-2372
NH	1/15/2014	8:55	W-29	Mussel shell fragment possibly a Pondhorn (*Uniomerus tetralasmus*)	2376
NH	1/15/2014	9:05	W-30	2 dead Bluegill (*Lepomis macrochirus*) and 1 dead Green Sunfish (*Lepomis cyanellus*) found. Also a Carolina Chickadee (*Poecile carolinensis*) was heard.	2381-2384
NH	1/15/2014	9:15	W-31	Deer (Odocoileus virginianus) tracks and rubings on the south bank. A Pondhorn (*Uniomerus tetralasmus*) shell.	2385-2388
NH	1/15/2014	9:17	W-32	Intact Pondhorn (*Uniomerus tetralasmus*) shell	2389-2398
NH	1/15/2014	9:25	W-33	Pondhorn (*Uniomerus tetralasmus*) shell	2396-2399
NH	1/15/2014	10:30	W-34	Wading bird tracks and fish nests on sediment surface.	2418-2420

Exide Technologies Wildlife Observations

Initials	Date	Time	ID	Observation	Photo ID
NH	1/15/2014	10:40	W-35	Larger Pondhorn (*Uniomerus tetralasmus*) shell, on riffle area, older shell.	2421-2424
NH	1/15/2014	10:50	W-36	Larger Pondhorn (*Uniomerus tetralasmus*) shell, shale bottom, on riffle area, older shell.	2425-2428
NH	1/15/2014	11:00	W-37	Bairds Sandpiper (*Calidris bairdii*) spotted, shale bottom no sediment.	2429-2433
NH	1/15/2014	14:20	W-38	Pondhorn (*Uniomerus tetralasmus*) shell, large, bottom rocky.	2456-2459
NH	1/15/2014	14:30	W-39	Wading bird foot prints in sand.	2468
NH	1/15/2014	14:40	W-40	Large Pondhorn (*Uniomerus tetralasmus*) shell.	2472-2473
NH	1/15/2014	15:38	W-41	Large Pondhorn (*Uniomerus tetralasmus*) shell.	2483-2488
NH	1/15/2014	15:50	W-42	Turtle, recently dead.	2496-2503
NH	1/15/2014	16:05	W-43	Juvenile Soft-shell turtle (*Apalone spinifera*) found live, gravel bottom.	2504-2505
BS	1/16/2014	8:23	W-44	Pondhorn (*Uniomerus tetralasmus*) shell out of water on gravel bank.	2510-2513
BS	1/16/2014	8:44	W-45	Red-eared slider (*Trachemys scripta elegans*), multiple sightings. Northern Cardinal (*Cardinalis cardinalis*) sighted. Pondhorn (*Uniomerus tetralasmus*) shell found.	2517-2519
BS	1/16/2014	11:06	W-46	Two (dead), only shells, possibly Red-eared sliders (*Trachemys scripta elegans*)	2533-2534
BS	1/16/2014	11:34	W-47	Animal tracks on bank possibly Raccoon (*Procyon lotor*) and Coyote (*Canis latrans*)	2540
BS	1/16/2014	12:02	W-48	Small owl, fresh dead, found floating in creek. Large trutle also found in creek.	2553-2557
BS	1/16/2014	13:00	W-49	Dead bird, half decomposed, possibly a raptor or owl.	2573-2574
BS	1/16/2014	15:19	W-50	Mallard Ducks(*Anas platyrhynchos*) spotted in streambed.	2589-2591
BS	1/16/2014	16:28	W-51	Beaver (*Castor canadensis*) dam	2616-2617

Exide Technologies Wildlife Observations

Initials	Date	Time	ID	Observation	Photo ID
KH	3/18/2014	9:10	W100	2 Mallards (*Anas platyrhynchos*), 1 mockingbird (*Mimus polyglottos*) sighted.	2766
KH	3/18/2014	11:30	W101	Red-eared slider (*Trachemys scripta elegans*)	2789-2791
KH	3/18/2014	11:40	W102	2 Mallards (*Anas platyrhynchos*) sighted in creek. Beaver (*Castor canadensis*) sign evident on banks.	2792
KH	3/18/2014	12:30	W103	Beaver (*Castor canadensis*) evidenced.	2800
KH	3/18/2014	13:15	W104	White tailed deer (*Odocoileus virginianus*) tracks and Asian clam (*Corbicula spp.*) shells on bank.	2811
KH	3/18/2014	14:00	W105	Auditory observation of Mockingbird (*Mimus polyglottos*) and Hawk (species unknown).	N/A
KH	3/18/2014	14:43	W106	North American Raccoon (*Procyon lotor*) tracks on sediment bar.	2823
KH	3/18/2014	14:45	W107	Pondhorn (*Uniomerus tetralasmus*) shell out of water on gravel bank.	2825
KH	3/18/2014	15:37	W108	2 Mallard ducks (*Anas platyrhynchos*) on stream. North American Raccoon (*Procyon lotor*) tracks on sediment bar.	2832-2733

Attachment C

Stewart Creek (H-64)

Stewart Creek (H-65)

Stewart Creek (T-6)

Stewart Creek (W-35)

Stewart Creek (W-35)

Stewart Creek (H-72)

Stewart Creek (H-73)

Stewart Creek (T-15)

Stewart Creek (T-10)

Stewart Creek (H-77)

Stewart Creek (H-78)

Clam Rake (T-21)

Clam Rake (T-6)

Clam Rake (T-7)

Clam Rake (T-8)

Clam Rake (T-9)

Clam Rake (T-11)

Clam Rake (T-18)

Asian Clams (H-78)

Asian Clams (T-13)

Clam Rake (T-14)

Asian Clams and Pondhorn (T-15)

Asian Clams and Pondhorns (T-15)

Pondhorn (W-41)

Pondhorn (W-44)

Pondhorn (W-45)

Soft-shell Turtle (W-43)

Green Sunfish (W-32)

Box Turtle (W-42)

Stewart Creek in Exide Facility (H-18)

Stewart Creek in Exide Facility (H-17)

Stewart Creek in Exide Facility (H-26)

Stewart Creek in Exide Facility (T-24)

Rip-rap in Stewart Creek (W-13)

Concrete Dam in Stewart Creek (H-22)

Stewart Creek in Exide Facility (H-3)

Rip-rap in Stewart Creek (H-22)

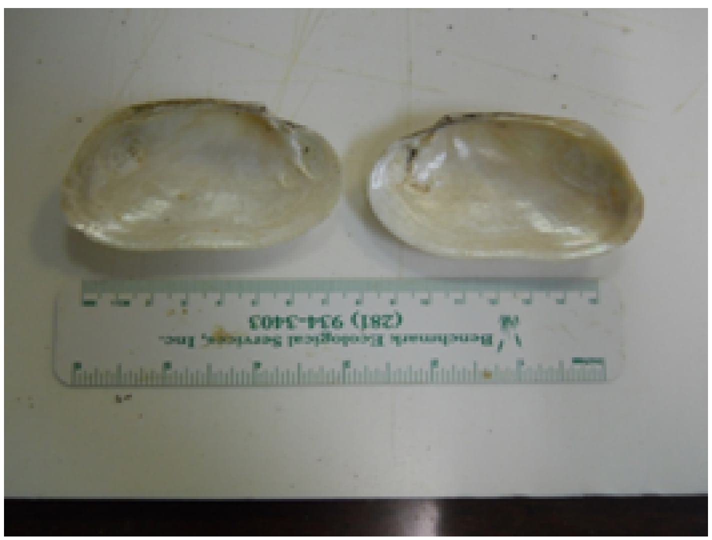
Clam Rakes within the Exide Facility (T-2)

Sediment in the Exide Facility (H-24)

Clam Rakes within the Exide Facility (T-1)

Stewart Creek in the Exide Facility (H-26)

Stewart Creek in the Exide Facility (H-26)



Pondhorn found within the Exide Facility (W-16)

Pondhorn found within the Exide Facility (W-16)

Mallards (W-23)

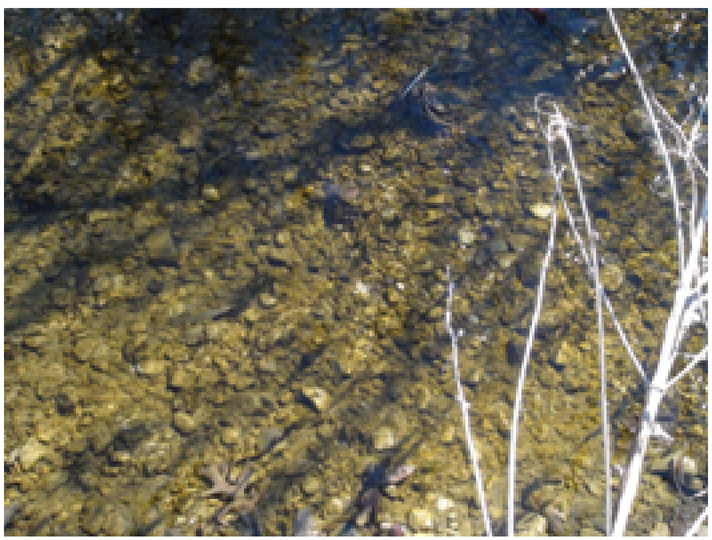
Northern tributary in NE forested area (H-40)

Northern tributary in NE forested area (H-28)

Northern tributary in NE forested area (H-32)

Northern tributary in NE forested area (H-32)

Northern tributary outside NE forested area (H-49)



Northern tributary outside NE forested area (H-47)

Northern tributary outside NE forested area (H-47)

Northeast Forested Area (H-38)

Northeast Forested Area (H-41)

Northeast Forested Area (H-34)

Northeast Forested Area (H-37)

Southeast Forested Area (H-5)

Southeast Forested Area (H-3)

Southeast Forested Area (H-4)

Southeast Forested Area (H-5)

Deer rub (W-1)

Burrow (W-2)

Packrat burrow (W-8)

Nest (H-33)

Hayfield (H-27)

Hayfield (H-27)

APPENDIX D

ECOLOGICAL RISK ASSESSMENT CALCULATIONS

Calculation Input Parameters for Wildlife Receptors
Stewart Creek SLERA

Screening Level Ecological Risk Assessment
Former Operating Plant
Stewart Creek
Frisco, Texas
May, 2014

Table D-1
Uptake Factors

Analyte	Sediment to Aquatic Plant UF		Sediment to Benthic Invertebrate UF		Sediment to Fish UF	
Arsenic	0.036	a	0.90	a	0.162	b
Cadmium	0.364	a	3.40	a	0.53	c
Lead	0.045	a	0.63	a	0.07	c

Notes:

a. EPA. August 1999. Screening Level Ecological Risk Assessment Protocol for Hazardous Waste Combustion Facilities. Office of Solid Waste and Emergency Response. EPA530-D-99-001.

b. EPA, 2000. Bioaccumulation Testing and Interpretation for the Purpose of Sediment Quality Assessment. Status and Needs. EPA-823-R-00-001.

c. Geometric mean of sediment to fish BSAF values from Rzymski, P., Niedzielski, P., Klimaszyk, P and B. Poniedzialek, 2014. Bioaccumulation of Selected Metals in Bivalves (*Unionidae*) and *Phragmites australis* inhabiting a Municipal Water Reservoir. *Envion. Monit. Assess*. 186:3199-3212.

Screening Level Ecological Risk Assessment
Former Operating Plant
Stewart Creek
Frisco, Texas
May, 2014

Table D-2
NOAEL and LOAEL Toxicity Data

	Avian NOAEL TRV (mg/kg-day)	Avian LOAEL TRV (mg/kg-day)	Mammal NOAEL TRV (mg/kg-day)	Mammal LOAEL TRV (mg/kg-day)
Arsenic	2.24	4.5	2.8	6.9
Cadmium	1.47	6.35	0.77	7.70
Lead	1.63	3.26	4.70	8.90

Notes:

1. Arsenic NOAELs and LOAELs from EPA 2005. Ecological Soil Screening Levels for Arsenic.
2. Cadmium NOAELs and LOAELs from EPA 2005. Ecological Soil Screening Levels for Cadmium.
3. Lead NOAELs and LOAELs from EPA 2005. Ecological Soil Screening Levels for Lead.

Screening Level Ecological Risk Assessment
Former Operating Plant
Stewart Creek
Frisco, Texas
May, 2014

Table D-3
Ingestion-Pathway Exposure Assumptions for Aquatic Wildlife Measurement Receptors

Common Name	Scientific Name	Body Weight (kg)		Food Ingestion Rate (kg/day)		Sediment Ingestion (% of diet)		Sediment Ingestion Rate (kg/day)	Exposure Modifying Factor (EMF)
Bird									
Snowy Egret	*Egretta thula*	0.371	a	0.031	b	17	c	0.0053	1
Mammal									
Raccoon	*Procyon lotor*	5.63	a	0.280	b	9.4	c	0.0263	1

Notes:

a. Geometric mean of raccoon body weights for both sexes from EPA (1993) *Wildlife Exposure Factors Handbook*. Office of Research and Development. EPA/600/R-93/187. December.
To be conservative, the lower of the average male or female body weight was used if available (Dunning, 1993).
Dunning, J.B., Jr., 1993. *CRC Handbook of Avian Body Masses*. CRC Press, Boca Raton, FL. 371 pp.

b. Food ingestion rates for mammals determined using FI (kg/day) = 0.0687 $Wt^{0.822}$ (kg) from EPA 1993 (equation 3-7). Food ingestion rate for all mammals.
Food ingestion rates for birds determined using FI (kg/day) = 0.0582 $Wt^{0.651}$ (g) from EPA 1993 (equation 3-5). Food ingestion rate for all birds.

c. Sediment ingestion taken from Beyer (1994). Beyer, W.N., E. Conner and S. Gould, 1994. Estimates of Soil Ingestion by Wildlife. *J. Wildl Manage*. 58:375-382.

Screening Level Ecological Risk Assessment
Former Operating Plant
Stewart Creek
Frisco, Texas
May, 2014

Table D-4
Fraction of Components in Receptor Diet

Common Name	Aquatic Vascular Plants	Benthic Invertebrates	Fish	Reference
Bird				
Snowy Egret		0.3	0.7	Terres, 1980
Mammal				
Raccoon	0.1	0.6	0.3	EPA 1993

Notes:

1. Terres, J.K. 1980. *The Audubon Society Encyclopedia of North American Birds* . Wing Books. NY.
2. EPA 1993 *Wildlife Exposure Factors Handbook.*

Screening Level Ecological Risk Assessment
Former Operating Plant
Stewart Creek
Frisco, Texas
May, 2014
Table D-5
Sediment Data Summary Statistics

Exposure Area	Minimum Detection (mg/kg)	Maximum Detection (mg/kg)	95% UCL (mg/kg)	Notes for Trophic Analysis
Stewart Creek Upstream				
Arsenic	8.55	42.70	21.71	Arsenic retained for trophic analysis. Max > benchmark.
Cadmium	0.26	0.69	0.53	Cadmium retained for trophic analysis. Max < benchmark, but considered bioaccumulative.
Lead	6.56	19.8	14.56	Lead removed in screening. Max < benchmark and not bioaccumulative.
North Tributary On-Site				
Arsenic	ND	ND	ND	No arsenic data available.
Cadmium	0.69	1.19	1.02	Cadmium retained for trophic analysis. Max < benchmark, but considered bioaccumulative.
Lead	10.4	28.2	20.14	Lead removed in screening. Max < benchmark and not bioaccumulative.
Stewart Creek On-Site				
Arsenic	ND	ND	ND	No arsenic data available.
Cadmium	0.34	2.08	1.21	Cadmium retained for trophic analysis. Max < benchmark, but considered bioaccumulative.
Lead	6.57	19.20	14.26	Lead removed in screening. Max < benchmark and not bioaccumulative.
Stewart Creek Downstream of FOP				
Arsenic	7	279	32.35	Arsenic retained for trophic analysis. Max > benchmark.
Cadmium	0.04	6.96	1.46	Cadmium retained for trophic analysis. Max > benchmark.
Lead	8.20	459	58.28	Lead retained for trophic analysis. Max > benchmark.
Stewart Creek On-Site and Downstream				
Arsenic	7	279	32.35	Arsenic retained for trophic analysis. Max > benchmark.
Cadmium	0.04	6.96	1.42	Cadmium retained for trophic analysis. Max > benchmark.
Lead	6.57	459	54.24	Lead retained for trophic analysis. Max > benchmark.
Stewart Creek On-Site and Downstream (without hotspots)				
Arsenic	7	57.7	21.89	Arsenic retained for trophic analysis. Max > benchmark.
Cadmium	0.16	4.47	1.32	Cadmium retained for trophic analysis. Max > benchmark.
Lead	6.57	59	23.13	Lead retained for trophic analysis. Max > benchmark.

Notes:
1. UCL - upper confidence limit
2. ProUCL output presented in Appendix B.
3. ND - No Data

Hazard Quotient Calculations
Stewart Creek Upstream Exposure Unit

Screening Level Ecological Risk Assessment
Former Operating Plant
Stewart Creek Upstream Exposure Unit
Frisco, Texas
May, 2014

Table D-6
Hazard Quotient Calculations for the Snowy Egret - Initial Conservative Exposure Parameters

Snowy Egret	95% UCL Sediment Conc (mg/kg)	Benthic Invertebrate UF (unitless)	Benthic Invertebrate Conc (mg/kg)	Fish UF (unitless)	Fish Conc (mg/kg)	Total Daily Dose Rate (mg/kg BW-day)	NOAEL Toxicity Reference Value (mg/kg BW-day)	Based on Conservative Exposure Parameters NOAEL Hazard Quotient (unitless)
Arsenic	21.71	9.0E-01	2.0E+01	1.6E-01	3.5E+00	1.0E+00	2.2E+00	4.5E-01
Cadmium	0.53	3.4E+00	1.8E+00	5.3E-01	2.8E-01	6.8E-02	1.5E+00	4.7E-02
Lead	NA	Lead removed in screening						

$$\text{Dose} = [(\text{Conc}_{\text{benthics}} \times \text{IR}_{\text{food}})0.3 + (\text{IR}_{\text{food}} \times \text{Conc}_{\text{fish}})0.7 + (\text{IR}_{\text{sed}} \times \text{Conc}_{\text{Sediment}})]/\text{Body Weight}_{\text{Egret}}$$

Screening Level Ecological Risk Assessment
Former Operating Plant
Stewart Creek Upstream Exposure Unit
Frisco, Texas
May, 2014
Table D-7
Hazard Quotient Calculations for the Raccoon - Initial Conservative Exposure Parameters

Raccoon	95% UCL Sediment Conc (mg/kg)	Aquatic Plant UF (unitless)	Aquatic Plant Conc (mg/kg)	Benthic Invertebrate UF (unitless)	Benthic Invertebrate Conc (mg/kg)	Fish UF (unitless)	Fish Conc (mg/kg)	Total Daily Dose Rate (mg/kg BW-day)	NOAEL Toxicity Reference Value (mg/kg BW-day)	Based on Conservative Exposure Parameters NOAEL Hazard Quotient (unitless)
Arsenic	21.71	3.6E-02	7.8E-01	9.0E-01	2.0E+01	1.6E-01	3.5E+00	7.4E-01	2.8E+00	2.6E-01
Cadmium	0.53	3.6E-01	1.9E-01	3.4E+00	1.8E+00	5.3E-01	2.8E-01	6.1E-02	7.7E-01	7.9E-02
Lead	NA	Lead removed in screening.								

$$\text{Dose} = [(\text{Conc}_{\text{benthics}} \times \text{IR}_{\text{food}})0.6 + (\text{IR}_{\text{food}} \times \text{Conc}_{\text{fish}})0.3 + (\text{IR}_{\text{food}} \times \text{Conc}_{\text{plant}})0.1 + (\text{IR}_{\text{sed}} \times \text{Conc}_{\text{Sediment}})]/\text{Body Weight}_{\text{raccoon}}$$

Hazard Quotient Calculations
North Tributary Exposure Unit

Screening Level Ecological Risk Assessment
Former Operating Plant
North Tributary Exposure Unit
Frisco, Texas
May, 2014
Table D-8
Hazard Quotient Calculations for the Snowy Egret - Initial Conservative Exposure Parameters

Snowy Egret	95% UCL Sediment Conc (mg/kg)	Benthic Invertebrate UF (unitless)	Benthic Invertebrate Conc (mg/kg)	Fish UF (unitless)	Fish Conc (mg/kg)	Total Daily Dose Rate (mg/kg BW-day)	NOAEL Toxicity Reference Value (mg/kg BW-day)	Based on Conservative Exposure Parameters NOAEL Hazard Quotient (unitless)
Arsenic	NA	Arsenic data not available from North Tributary Exposure Unit						
Cadmium	1.02	3.4E+00	3.5E+00	5.3E-01	5.4E-01	1.3E-01	1.5E+00	9.0E-02
Lead	NA	Lead removed in screening						

$$\text{Dose} = [(\text{Conc}_{benthics} \times \text{IR}_{food})0.3 + (\text{IR}_{food} \times \text{Conc}_{fish})0.7 + (\text{IR}_{sed} \times \text{Conc}_{Sediment})]/\text{Body Weight}_{Egret}$$

Screening Level Ecological Risk Assessment
Former Operating Plant
North Tributary Exposure Unit
Frisco, Texas
May, 2014

Table D-9
Hazard Quotient Calculations for the Raccoon - Initial Conservative Exposure Parameters

Raccoon	95% UCL Sediment Conc (mg/kg)	Aquatic Plant UF (unitless)	Aquatic Plant Conc (mg/kg)	Benthic Invertebrate UF (unitless)	Benthic Invertebrate Conc (mg/kg)	Fish UF (unitless)	Fish Conc (mg/kg)	Total Daily Dose Rate (mg/kg BW-day)	NOAEL Toxicity Reference Value (mg/kg BW-day)	Based on Conservative Exposure Parameters NOAEL Hazard Quotient (unitless)
Arsenic	NA	Arsenic data not available from North Tributary Exposure Unit								
Cadmium	1.02	3.6E-01	3.7E-01	3.4E+00	3.5E+00	5.3E-01	5.4E-01	1.2E-01	7.7E-01	1.5E-01
Lead	NA	Lead removed in screening.								

$$\text{Dose} = [(\text{Conc}_{benthics} \times \text{IR}_{food})0.6 + (\text{IR}_{food} \times \text{Conc}_{fish})0.3 + (\text{IR}_{food} \times \text{Conc}_{plant})0.1 + (\text{IR}_{sed} \times \text{Conc}_{Sediment})]/\text{Body Weight}_{raccoon}$$

Hazard Quotient Calculations
Stewart Creek On-Site Exposure Area

Screening Level Ecological Risk Assessment
Former Operating Plant
Stewart Creek On-Site Exposure Unit
Frisco, Texas
May, 2014
Table D-10
Hazard Quotient Calculations for the Snowy Egret - Initial Conservative Exposure Parameters

Snowy Egret	95% UCL Sediment Conc (mg/kg)	Benthic Invertebrate UF (unitless)	Benthic Invertebrate Conc (mg/kg)	Fish UF (unitless)	Fish Conc (mg/kg)	Total Daily Dose Rate (mg/kg BW-day)	NOAEL Toxicity Reference Value (mg/kg BW-day)	Based on Conservative Exposure Parameters NOAEL Hazard Quotient (unitless)
Arsenic	NA	Arsenic data not available from Stewart Creek On-Site Exposure Unit						
Cadmium	1.21	3.4E+00	4.1E+00	5.3E-01	6.4E-01	1.6E-01	1.5E+00	1.1E-01
Lead	NA	Lead removed in screening						

$$Dose = [(Conc_{benthics} \times IR_{food})0.3 + (IR_{food} \times Conc_{fish})0.7 + (IR_{sed} \times Conc_{Sediment})]/Body\ Weight_{Egret}$$

Screening Level Ecological Risk Assessment
Former Operating Plant
Stewart Creek On-Site Exposure Unit
Frisco, Texas
May, 2014

Table D-11
Hazard Quotient Calculations for the Raccoon - Initial Conservative Exposure Parameters

Raccoon	95% UCL Sediment Conc (mg/kg)	Aquatic Plant UF (unitless)	Aquatic Plant Conc (mg/kg)	Benthic Invertebrate UF (unitless)	Benthic Invertebrate Conc (mg/kg)	Fish UF (unitless)	Fish Conc (mg/kg)	Total Daily Dose Rate (mg/kg BW-day)	NOAEL Toxicity Reference Value (mg/kg BW-day)	Based on Conservative Exposure Parameters NOAEL Hazard Quotient (unitless)
Arsenic	NA	Arsenic data not available from Stewart Creek On-Site Exposure Unit								
Cadmium	1.21	3.6E-01	4.4E-01	3.4E+00	4.1E+00	5.3E-01	6.4E-01	1.4E-01	7.7E-01	1.8E-01
Lead	NA	Lead removed in screening.								

$$\text{Dose} = [(\text{Conc}_{benthics} \times \text{IR}_{food})0.6 + (\text{IR}_{food} \times \text{Conc}_{fish})0.3 + (\text{IR}_{food} \times \text{Conc}_{plant})0.1 + (\text{IR}_{sed} \times \text{Conc}_{Sediment})]/\text{Body Weight}_{raccoon}$$

Hazard Quotient Calculations
Stewart Creek Downstream of the FOP Exposure Area

Screening Level Ecological Risk Assessment
Former Operating Plant
Stewart Creek Downstream of the FOP Exposure Unit
Frisco, Texas
May, 2014

Table D-12
Hazard Quotient Calculations for the Snowy Egret - Initial Conservative Exposure Parameters

Snowy Egret	95% UCL Sediment Conc (mg/kg)	Benthic Invertebrate UF (unitless)	Benthic Invertebrate Conc (mg/kg)	Fish UF (unitless)	Fish Conc (mg/kg)	Total Daily Dose Rate (mg/kg BW-day)	NOAEL Toxicity Reference Value (mg/kg BW-day)	Based on Conservative Exposure Parameters NOAEL Hazard Quotient (unitless)
Arsenic	32.35	9.0E-01	2.9E+01	1.6E-01	5.2E+00	1.5E+00	2.2E+00	6.7E-01
Cadmium	1.46	3.4E+00	4.9E+00	5.3E-01	7.7E-01	1.9E-01	1.5E+00	1.3E-01
Lead	58.28	6.3E-01	3.7E+01	7.0E-02	4.1E+00	2.0E+00	1.6E+00	**1.2E+00**

$$\text{Dose} = [(\text{Conc}_{\text{benthics}} \times \text{IR}_{\text{food}})0.3 + (\text{IR}_{\text{food}} \times \text{Conc}_{\text{fish}})0.7 + (\text{IR}_{\text{sed}} \times \text{Conc}_{\text{Sediment}})]/\text{Body Weight}_{\text{Egret}}$$

Screening Level Ecological Risk Assessment
Former Operating Plant
Stewart Creek Downstream of the FOP Exposure Unit
Frisco, Texas
May, 2014
Table D-13
Hazard Quotient Calculations for the Snowy Egret - Less Conservative Exposure Parameters

Snowy Egret									Based on Less-Conservative Exposure Parameters	
COC	95% UCL Sediment Conc (mg/kg)	Benthic Invertebrate UF (unitless)	Benthic Invertebrate Conc (mg/kg)	Fish UF (unitless)	Fish Conc (mg/kg)	Total Daily Dose Rate (mg/kg BW-day)	NOAEL Toxicity Reference Value (mg/kg BW-day)	LOAEL Toxicity Reference Value (mg/kg BW-day)	NOAEL Hazard Quotient (unitless)	LOAEL Hazard Quotient (unitless)
Arsenic	32.35	9.0E-01	2.9E+01	1.6E-01	5.2E+00	1.5E+00	2.2E+00	4.5E+00	6.7E-01	3.3E-01
Cadmium	1.46	3.4E+00	4.9E+00	5.3E-01	7.7E-01	1.9E-01	1.5E+00	6.4E+00	1.3E-01	3.0E-02
Lead	58.28	6.3E-01	3.7E+01	7.0E-02	4.1E+00	2.0E+00	1.6E+00	3.3E+00	**1.2E+00**	6.1E-01

Intake = [(Conc benthics x IRfood)0.3 + (IRfood x Conc fish)0.7 + (IRsed x Conc Sediment)]*EMF/Body Weight

Screening Level Ecological Risk Assessment
Former Operating Plant
Stewart Creek Downstream of the FOP Exposure Unit
Frisco, Texas
May, 2014
Table D-14
Hazard Quotient Calculations for the Raccoon - Initial Conservative Exposure Parameters

Raccoon	95% UCL Sediment Conc (mg/kg)	Aquatic Plant UF (unitless)	Aquatic Plant Conc (mg/kg)	Benthic Invertebrate UF (unitless)	Benthic Invertebrate Conc (mg/kg)	Fish UF (unitless)	Fish Conc (mg/kg)	Total Daily Dose Rate (mg/kg BW-day)	NOAEL Toxicity Reference Value (mg/kg BW-day)	Based on Conservative Exposure Parameters NOAEL Hazard Quotient (unitless)
Arsenic	32.35	3.6E-02	1.2E+00	9.0E-01	2.9E+01	1.6E-01	5.2E+00	1.1E+00	2.8E+00	3.9E-01
Cadmium	1.46	3.6E-01	5.3E-01	3.4E+00	4.9E+00	5.3E-01	7.7E-01	1.7E-01	7.7E-01	2.2E-01
Lead	58.28	4.5E-02	2.6E+00	6.3E-01	3.7E+01	7.0E-02	4.1E+00	1.4E+00	4.7E+00	3.1E-01

$$\text{Dose} = [(\text{Conc}_{\text{benthics}} \times \text{IR}_{\text{food}})0.6 + (\text{IR}_{\text{food}} \times \text{Conc}_{\text{fish}})0.3 + (\text{IR}_{\text{food}} \times \text{Conc}_{\text{plant}})0.1 + (\text{IR}_{\text{sed}} \times \text{Conc}_{\text{Sediment}})]/\text{Body Weight}_{\text{raccoon}}$$

Hazard Quotient Calculations
Stewart Creek On-Site and Downstream of the FOP

Screening Level Ecological Risk Assessment
Former Operating Plant
Stewart Creek On-Site and Downstream Exposure Unit
Frisco, Texas
May, 2014

Table D-15
Hazard Quotient Calculations for the Snowy Egret - Initial Conservative Exposure Parameters

Snowy Egret	95% UCL Sediment Conc (mg/kg)	Benthic Invertebrate UF (unitless)	Benthic Invertebrate Conc (mg/kg)	Fish UF (unitless)	Fish Conc (mg/kg)	Total Daily Dose Rate (mg/kg BW-day)	NOAEL Toxicity Reference Value (mg/kg BW-day)	Based on Conservative Exposure Parameters NOAEL Hazard Quotient (unitless)
Arsenic	32.35	9.0E-01	2.9E+01	1.6E-01	5.2E+00	1.5E+00	2.2E+00	6.7E-01
Cadmium	1.42	3.4E+00	4.8E+00	5.3E-01	7.5E-01	1.8E-01	1.5E+00	1.3E-01
Lead	54.24	6.3E-01	3.4E+01	7.0E-02	3.8E+00	1.8E+00	1.6E+00	**1.1E+00**

$$\text{Dose} = [(\text{Conc}_{benthics} \times \text{IR}_{food})0.3 + (\text{IR}_{food} \times \text{Conc}_{fish})0.7 + (\text{IR}_{sed} \times \text{Conc}_{Sediment})]/\text{Body Weight}_{Egret}$$

Screening Level Ecological Risk Assessment
Former Operating Plant
Stewart Creek On-Site and Downstream Exposure Unit
Frisco, Texas
May, 2014

Table D-16
Hazard Quotient Calculations for the Snowy Egret - Less Conservative Exposure Parameters

Snowy Egret									Based on Less-Conservative Exposure Parameters	
COC	95% UCL Sediment Conc (mg/kg)	Benthic Invertebrate UF (unitless)	Benthic Invertebrate Conc (mg/kg)	Fish UF (unitless)	Fish Conc (mg/kg)	Total Daily Dose Rate (mg/kg BW-day)	NOAEL Toxicity Reference Value (mg/kg BW-day)	LOAEL Toxicity Reference Value (mg/kg BW-day)	NOAEL Hazard Quotient (unitless)	LOAEL Hazard Quotient (unitless)
Arsenic	32.35	9.0E-01	2.9E+01	1.6E-01	5.2E+00	1.5E+00	2.2E+00	4.5E+00	6.7E-01	3.3E-01
Cadmium	1.42	3.4E+00	4.8E+00	5.3E-01	7.5E-01	1.8E-01	1.5E+00	6.4E+00	1.3E-01	2.9E-02
Lead	54.24	6.3E-01	3.4E+01	7.0E-02	3.8E+00	1.8E+00	1.6E+00	3.3E+00	**1.1E+00**	5.7E-01

Intake = [(Conc benthics x IRfood)0.3 + (IRfood x Conc fish)0.7 + (IRsed x Conc Sediment)]*EMF/Body Weight

Screening Level Ecological Risk Assessment
Former Operating Plant
Stewart Creek On-Site and Downstream Exposure Unit
Frisco, Texas
May, 2014

Table D-17

Hazard Quotient Calculations for the Raccoon - Initial Conservative Exposure Parameters

Raccoon	95% UCL Sediment Conc (mg/kg)	Aquatic Plant UF (unitless)	Aquatic Plant Conc (mg/kg)	Benthic Invertebrate UF (unitless)	Benthic Invertebrate Conc (mg/kg)	Fish UF (unitless)	Fish Conc (mg/kg)	Total Daily Dose Rate (mg/kg BW-day)	NOAEL Toxicity Reference Value (mg/kg BW-day)	Based on Conservative Exposure Parameters NOAEL Hazard Quotient (unitless)
Arsenic	32.35	3.6E-02	1.2E+00	9.0E-01	2.9E+01	1.6E-01	5.2E+00	1.1E+00	2.8E+00	3.9E-01
Cadmium	1.42	3.6E-01	5.2E-01	3.4E+00	4.8E+00	5.3E-01	7.5E-01	1.6E-01	7.7E-01	2.1E-01
Lead	54.24	4.5E-02	2.4E+00	6.3E-01	3.4E+01	7.0E-02	3.8E+00	1.3E+00	4.7E+00	2.9E-01

$$\text{Dose} = [(\text{Conc}_{\text{benthics}} \times \text{IR}_{\text{food}})0.6 + (\text{IR}_{\text{food}} \times \text{Conc}_{\text{fish}})0.3 + (\text{IR}_{\text{food}} \times \text{Conc}_{\text{plant}})0.1 + (\text{IR}_{\text{sed}} \times \text{Conc}_{\text{Sediment}})]/\text{Body Weight}_{\text{raccoon}}$$

Hazard Quotient Calculations
Stewart Creek On-Site and Downstream of the FOP
Hot Spots Removed from Data Set

Screening Level Ecological Risk Assessment
Former Operating Plant
Stewart Creek On-Site and Downstream Exposure Unit
Data from Hot Spots Removed
Frisco, Texas
May, 2014

Table D-18
Hazard Quotient Calculations for the Snowy Egret - Initial Conservative Exposure Parameters

Snowy Egret	95% UCL Sediment Conc (mg/kg)	Benthic Invertebrate UF (unitless)	Benthic Invertebrate Conc (mg/kg)	Fish UF (unitless)	Fish Conc (mg/kg)	Total Daily Dose Rate (mg/kg BW-day)	NOAEL Toxicity Reference Value (mg/kg BW-day)	Based on Conservative Exposure Parameters NOAEL Hazard Quotient (unitless)
Arsenic	21.89	9.0E-01	2.0E+01	1.6E-01	3.5E+00	1.0E+00	2.2E+00	4.5E-01
Cadmium	1.32	3.4E+00	4.5E+00	5.3E-01	7.0E-01	1.7E-01	1.5E+00	1.2E-01
Lead	23.13	6.3E-01	1.5E+01	7.0E-02	1.6E+00	7.9E-01	1.6E+00	4.8E-01

$$Dose = [(Conc_{benthics} \times IR_{food})0.3 + (IR_{food} \times Conc_{fish})0.7 + (IR_{sed} \times Conc_{Sediment})]/Body\ Weight_{Egret}$$

Screening Level Ecological Risk Assessment
Former Operating Plant
Stewart Creek On-Site and Downstream Exposure Unit
Data from Hot Spots Removed
Frisco, Texas
May, 2014
Table D-19
Hazard Quotient Calculations for the Raccoon - Initial Conservative Exposure Parameters

Raccoon	95% UCL Sediment Conc (mg/kg)	Aquatic Plant UF (unitless)	Aquatic Plant Conc (mg/kg)	Benthic Invertebrate UF (unitless)	Benthic Invertebrate Conc (mg/kg)	Fish UF (unitless)	Fish Conc (mg/kg)	Total Daily Dose Rate (mg/kg BW-day)	NOAEL Toxicity Reference Value (mg/kg BW-day)	Based on Conservative Exposure Parameters NOAEL Hazard Quotient (unitless)
Arsenic	21.89	3.6E-02	7.9E-01	9.0E-01	2.0E+01	1.6E-01	3.5E+00	7.5E-01	2.8E+00	2.7E-01
Cadmium	1.32	3.6E-01	4.8E-01	3.4E+00	4.5E+00	5.3E-01	7.0E-01	1.5E-01	7.7E-01	2.0E-01
Lead	23.13	4.5E-02	1.0E+00	6.3E-01	1.5E+01	7.0E-02	1.6E+00	5.7E-01	4.7E+00	1.2E-01

$$\text{Dose} = [(\text{Conc}_{benthics} \times \text{IR}_{food})0.6 + (\text{IR}_{food} \times \text{Conc}_{fish})0.3 + (\text{IR}_{food} \times \text{Conc}_{plant})0.1 + (\text{IR}_{sed} \times \text{Conc}_{Sediment})]/\text{Body Weight}_{raccoon}$$

APPENDIX E

SITE-SPECIFIC ECOLGOICAL RISK ASSESSMENT WORK PLAN-ARSENIC IN SEDIMENT STEWART CREEK

SITE-SPECIFIC ECOLOGICAL
RISK ASSESSMENT WORK PLAN– ARSENIC IN SEDIMENT
STEWART CREEK

EXIDE TECHNOLOGIES
FRISCO, TEXAS

Agreed Order: Docket No. 2011-1712-IHW-E

February 1, 2016

Prepared for:

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LIST OF ACRONYMS

APAR	Affected Property Assessment Report
ASTM	American Society of Testing and Materials
COC	Chemicals of Concern
C-O-C	Chain of Custody
ERA	Ecological Risk Assessment
EPA	Environmental Protection Agency
FOP	Former Operating Plant
LOEC	Lowest Observed Effect Concentration
mg/kg	Milligrams per Kilogram
mg/L	Milligram per Liter
NOEC	No Observed Effect Concentration
PBW	Pastor, Behling & Wheeler, LLC
PCL	Protective Concentration Level
SLERA	Screening-Level Ecological Risk Assessment
SSERA	Site-Specific Ecological Risk Assessment
SQT	Sediment Quality Triad
SVOC	Semivolatile organic compound
TCEQ	Texas Commission on Environmental Quality
TOC	Total Organic Carbon
TRRP	Texas Risk Reduction Program
YCT	Yeast Cerophyll Trout Chow

1.0 INTRODUCTION

The results of the Screening Level Ecological Risk Assessment (SLERA) (PBW, 2014) for Stewart Creek suggest that potential risks to higher trophic level organisms were within acceptable regulatory thresholds (Hazard Quotient ≤ 1). The SLERA is presented in the Affected Property Assessment Report (APAR) for the Former Operating Plant (FOP) submitted May 2014 (Golder, 2014) with updates pending to address TCEQ review comments provided in a letter dated May 5th 2015. Potential risks to benthic organisms that dwell in Stewart Creek sediment within the study area may be unacceptable when compared to the conservative default freshwater benthic protective concentration level (PCL) for arsenic of 21.4 milligrams/kilogram (mg/kg) despite the absence of observable ecological impacts during sample collection in 2014. Figure 1 shows the generalized arsenic concentrations (e.g., < 21.4 mg/kg, > 21.4 mg/kg, > 50 mg/kg and > 100 mg/kg) in Stewart Creek based on samples collected in 2014. Arsenic concentrations in sediment exceed the conservative default PCL in multiple samples downstream of the FOP to Lake Lewisville. As such, a focused assessment of potential benthic impacts related to arsenic in sediment is proposed in this Site Specific Ecological Risk Assessment (SSERA) Work Plan.

The objective of this SSERA is to determine if the benthic community in the Stewart Creek study area is being impacted by the presence of arsenic in the sediment and if so, to determine a site-specific benthic PCL for arsenic. This determination will be made using several lines of evidence which make up the sediment quality triad (SQT): 1) presence of arsenic in the sediment, 2) whole sediment toxicity testing, and 3) benthic community analysis.

1.1 Default Arsenic PCL and Regulatory Framework

TCEQ specifies the midpoint between the initial "low effect" benchmark and the second "median effect" level as the default benthic PCL (TCEQ, 2014a). The default freshwater benthic PCL of 21.4 mg/kg for arsenic is based on a geometric mean of five published toxicity studies. These studies were performed in the early 1990s under a variety of conditions from freshwater locations across the United States. The studies toxicity values ranged from 5.9 mg/kg to 33 mg/kg for the low effect benchmark level and 17 mg/kg to 85 mg/kg for the median effect or second effect level. The TCEQ default freshwater benthic PCL is designed to be protective of all freshwater benthic communities in Texas and does not account for any site-specific conditions such as bioavailability. Although this default PCL is used as the benthic PCL in the Texas Risk Reduction Program (TRRP) Tier 2 Screening Level Ecological Risk Assessment process, TRRP regulations provide for refinement of the PCL based on site-specific conditions. Note that the human health contact recreation PCL for arsenic in sediment is 110 mg/kg (TCEQ, 2006 or most recent update) and will serve as the ceiling default PCL.

A Tier 3 SSERA is described in Section 4 of the TCEQ's *Conducting Ecological Risk Assessment at Remediation Sites in Texas* (2014a) Section 4.2.2, which states "Toxicity tests can be used to demonstrate whether COCs are bioavailable, can evaluate the aggregate toxic effects of all COCs in a medium and the toxicity of substances whose toxicity is not well characterized or known, can characterize the nature of the toxic effect (lethal or sublethal), can characterize the distribution of toxicity at an affected property, and can be used to develop PCLs and facilitate remediation decisions."

In addition, Section 4.2.3 of the TCEQ guidance (2014a) describes how field studies are incorporated into a SSERA. The guidance states "Field studies generally focus on populations and communities and the associated habitats rather than individual organisms. Community metrics include measurements of species composition, richness, diversity, dominance, abundance, community structure, trophic dynamics, seasonal patterns, and age classes. These measurements are typically compared to those of a reference area or are evaluated for changes along a concentration gradient."

A SSERA is proposed to evaluate potential impacts to the benthic community in the Stewart Creek study area as a result of arsenic in sediment. As part of this SSERA, a site-specific ecological benthic PCL will be developed using sediment analytical results from Stewart Creek (see Section 4.2), standard freshwater whole sediment toxicity tests and benthic community structure analysis. Both the toxicity test results and the community structure results will be compared to the results from two reference locations, to arrive at overall risk conclusions for the benthic community in the Stewart Creek study area.

1.2 Study Objectives

The overarching goal of the SSERA for arsenic in sediment in Stewart Creek is to assess whether there is evidence of biological degradation of the sediment community structure and if exposure to arsenic in sediment results in an impact to the benthic community. To achieve these objectives, the following will be performed:

1. Identify a concentration gradient of arsenic in the Stewart Creek sediment. Concentrations of arsenic should range from low (< the default PCL of 21.4 mg/kg) to medium (> 21.4 mg/kg – 70 mg/kg) and high (70 mg/kg – 100 mg/kg or greater). As stated previously, the human health total sediment combined for contact recreation PCL is 110 mg/kg (TCEQ, 2006). In order to minimize potential cofounding effects, the lead and cadmium concentrations in the samples selected for toxicity testing should be below the benthic PCLs for those chemicals of concern

(COCs) of 81.9 mg/kg and 2.98 mg/kg, respectively.

2. Conduct standard 10-day toxicity tests for two species of freshwater benthic organisms (*Hyalella azteca* and *Chironomus dilutis*). Endpoints will include survival and growth. Since arsenic is not considered bioaccumulative in sediment by the TCEQ (TCEQ, 2014a), a 10-day study is adequate.

3. Compare the benthic community structure between Stewart Creek and reference location(s). Endpoints will include abundance, richness, tolerance, diversity, functional feeding groups and community similarities.

Combining several approaches, such as the studies described above, and using a weight of evidence approach is the most desirable for assessing effects of contaminants associated with sediment (ASTM, 2010). This is often called a sediment quality triad (SQT), which relies on chemical concentration, sediment toxicity and benthic infaunal community condition data. It is recommended that these data are used together since sediments are complex mixtures and evaluating any one part of the triad without the other pieces of information can provide an incomplete or uncertain evaluation of potential risks.

For Tier 3 SSERAs that entail more than one type of study (or line of evidence), a weight-of-evidence approach is used to integrate multiple types of data to support a conclusion. Generally, confidence in the risk assessment conclusions will be increased using several lines of evidence. Balancing and interpreting the different types of data can be major tasks requiring professional judgment, as not all data are of equal value (TCEQ, 2014a).

A systematic evaluation of the analytical chemistry, toxicity, and benthic community data will be conducted using the methodology described by EPA (2002) and Bay and Weisberg (2012) as detailed in Section 4.1 of this SSERA work plan. Additionally, an examination may be made of the most appropriate regional index of biotic integrity (IBI) assessment for comparison purposes only (TCEQ, 2014b). The IBI will not be considered an additional line of evidence but included in the overall analysis of benthic invertebrates. The primary objective will be development of a site-specific PCL for arsenic in sediment. The PCL will be estimated using the quantitative toxicity test data while qualitatively considering the benthic community evaluation data if the data indicate that the benthic population is impacted by arsenic (i.e., toxicity and community structure impacts are correlated with arsenic concentrations in sediment).

2.0 ENVIRONMENTAL SETTING

2.1 Stewart Creek Study Area Description

Stewart Creek is classified as a perennial stream that receives surface runoff from the FOP, urban development and treated wastewater from the North Texas Municipal Water District wastewater treatment plant. Immediately downstream of the FOP, the stream contains a small number of perennial pools connected by segments of riffles and glides. A habitat assessment of Stewart Creek was completed in 2014 which consisted of walking, wading and kayaking the 7 miles of Stewart Creek between Lake Lewisville and the western boundary of the FOP. Benthic surveys were conducted within the stream segments that contained accumulated sediment using established stream assessment techniques. Documentation of the habitat survey is presented in the *Habitat Assessment Field Survey Report* (Benchmark Ecological Services, Inc., 2014) as an attachment to the Stewart Creek SLERA found in the 2014 FOP APAR. Relevant findings of the survey area to this SSERA Work Plan are presented below.

The Stewart Creek streambed between the FOP and Lake Lewisville is typical of a streambed formed by rapidly moving water. Today the creek receives flash flood volumes of water, but in general is a low to medium flow urban stream. Most of the creek bottom is dominated by long segments of exposed rock, shale and clay. Sediment was found in the small pools that were scattered along the stream course. The pooling areas were small in size and averaged less than 3 feet deep. The banks of the creek between the FOP and Lake Lewisville primarily consist of steep eroded bluffs 4 to 6 feet high.

The ecology of Stewart Creek was found to be typical of an urban stream in north Texas. Three species of mussels were found during the habitat survey:

- Pondhorn (*Uniomerus tetralasmus*) – shells were found on the banks and on shallow gravel beds throughout the length of the creek. No live Pondhorn mussels were found.
- Asian Clams (*Corbicula* spp.) – live Asian clams were collected using a rake in the fine gravel of several small pooling areas along the creek. Asian clams were abundant on the banks and shallow gravel beds throughout the creek.
- Giant Floater (*Pyganodon grandis*) – one shell was found on the shallow gravel bed near Lake Lewisville.

In addition to these mussels, the ecologists observed two different species of turtles: red-eared slider (*Trachemys scripta elegans*), and soft shell turtle (*Apalone spinifera*). Wildlife sighting included mallard (*Anas platyrhynchos*), Baird's sandpiper (*Calidris bairdii*), killdeer (*Charadrius vociferous*), beaver

(*Castor canadensis*), raccoon (*Procyon lotor*), bluegill (*Lepomis macrochirus*) and green sunfish (*Lepomis cyanellus*).

2.2 Reference Creeks

According to the TCEQ (2014a) "a reference site or area is defined as an area that is outside the COC influence of the affected property, but possesses similar characteristics such as habitat and substrate type, allowing for comparison of data between areas with and without impacts. This applies whether the reference area is used for a community evaluation or to collect reference samples for toxicity tests on media from the affected property. Reference areas give valuable information about naturally occurring compounds or ubiquitous COCs. The area selected must be of similar habitat type and species composition to those of the affected property, and should lie outside the area of influence of the affected property, preferably in an area of minimal impact or disturbance. Sampling and surveying of reference areas should use the same techniques and the same level of detail employed at the affected property to ensure a valid comparison."

For this SSERA, two reference locations were chosen that have similar flow, stream bed, and sediment characteristics to the Stewart Creek study area so that an adequate comparison to toxicity and benthic health and diversity can be made with minimal uncertainty. One of the reference areas is a tributary to Stewart Creek (Figure 2A) and the other is a creek located north of Stewart Creek – Cottonwood Branch (Figure 2B). Cottonwood Branch is a perennial stream located north of Stewart Creek that flows into Lake Lewisville.

Both of the reference creeks and Stewart Creek have similar characteristics, which include:

- Low to medium velocity flow under normal conditions, although they all receive urban runoff and are subject to flash flooding;
- Bed material including areas of gravel, bedrock/shale, and/or sand (loose, fine grain sediment);
- Areas of riffles and deep pools. Water depths vary but generally no more than 3 feet in depth;
- Creek widths range from 5 to 16 feet across;
- Land use surrounding the creeks is urban; and
- Based on preliminary reconnaissance, it appears that there is a sufficient amount of fine grain, loose sediment in both reference areas for sample collection.

Analytical data collected from the reference creeks will be reviewed prior to conducting the toxicity and benthic invertebrate community analysis.

3.0 PROJECT DESIGN

This section describes the study that is designed to meet the project objectives described above.

3.1 Sediment Chemical Analysis and Sample Screening

Sediment sample locations were generally chosen by evaluating the existing analytical data that corresponded to three general arsenic concentration ranges, high (70 mg/kg - 100 mg/kg), medium (21.4 mg/kg - 70 mg/kg) and low (< 21.4 mg/kg). It should be noted that sample locations were not chosen if corresponding lead and cadmium were elevated (i.e., above their respective PCLs) in a given sample. Fourteen samples in Stewart Creek and ten samples from the reference creeks(s) (five from each reference creek) will be obtained and shipped to the toxicity and benthic laboratories for storage while the chemistry samples are analyzed for concentrations of arsenic, lead and cadmium, total organic carbon (TOC) and grain size on a rapid turn-around-time. Samples from the reference creeks will also be analyzed for an expanded list of metals (arsenic, barium, cadmium, chromium, copper, lead, nickel, mercury, selenium, silver and zinc), semivolatile organic compounds (SVOCs), pesticides and herbicides. From these samples, a subgroup of samples will be chosen for the toxicity testing and benthic community analysis. The sample numbers were determined based on the need for at least 9 samples (three from each concentration gradient) from Stewart Creek and three samples from each reference creek. Proposed sample locations are shown on Figure 3; however, final collection sites will be determined by sediment availability at a given location. Figure 3 also presents the available data for arsenic, lead and cadmium from Stewart Creek samples (2013 and 2014) used to guide the sampling design. Note that each location will have to have sufficient biologically active sediment (top 4 inches) for collection of approximately 3 gallons of sediment as described below:

Stewart Creek:

- One - two gallon bucket of sediment for the toxicity testing using ASTM Method E-1706-05;
- Three - 500 ml wide mouth jars filled at least half full for the benthic community testing (see Appendix A for the Standard Operating Procedures);
- One - 8 oz jar for analysis of arsenic, lead and cadmium using EPA Method 6010B (U.S. EPA, 1996) and TOC analysis using Walkey Black Method (Walkley and Black, 1934); and;
- One - 16 oz jar for grain size analysis using ASTM Method D422.

Reference Creeks:

- One - two gallon bucket of sediment for the toxicity testing using ASTM Method E-1706-05;
- Three - 500 ml wide mouth jars filled at least half full for the benthic community testing (see Appendix A for the Standard Operating Procedures);
- One - 8 oz jar for analysis of metals using EPA Method 6010B (U.S. EPA, 1996), TOC analysis using Walkey Black Method (Walkley and Black, 1934) and for analysis of SVOCs using EPA Method 8270 (U.S. EPA, 1996);
- One – 8 oz jar for pesticides using EPA Method 8081A (U.S. EPA, 1996) and herbicides using EPA Method 8151 (U.S. EPA, 1996); and
- One - 16 oz jar for grain size analysis using ASTM Method D422.

Sampling procedures are taken from TCEQ's *Surface Water Quality Monitoring Procedures, Volume 1: Physical and Chemical Monitoring Methods* (2012).

- "In streams, choose a sampling site with lower hydrologic energy, such as the inner (depositional) side of a bend or eddy where the water movement may be slower. Quiescent areas are conducive to the settling of finer materials. Sediment is often difficult to collect in streams with sandy, hard clay and bedrock bottoms," as is the case with Stewart Creek. The field crew will determine the final sampling locations using the previously identified sample locations as a guide, but the most important attribute for each sampling location will be sufficient sediment volume that is depositional in nature.
- "More often than not a dredge does not function very well in smaller streams." In these cases, sediment may be collected using a stainless steel spoon, shovel, ponar dredge, sampling jar or bucket or with Nitrile gloved hands. "In streams with excessive bottom debris (e.g., rocks, sticks, leaves) where the use of an Ekman or Ponar dredge is ineffective (the dredge does not close, causing loss of sediment), samples may be collected by hand." After choosing an appropriate sampling location, the field team will determine a sampling technique that will minimize the loss of sediment and maintain consistency of sediment types between the three creeks.
- Each sample will be described in the field log book for depth of sediment collected, depth of aerobic zone, odor, observation of sheen, color, description of sediment (e.g., fine, course) and texture. Debris such as sticks and rocks will be removed from the sample.
- If a larger area is required for sampling to achieve sufficient sediment volume, sediment can be composited for the analytical and toxicity testing; however, the benthic invertebrate samples will be discrete samples with minimum manipulation.

- According to TCEQ (2012), sampling equipment (e.g., Ponar dredge, spoons) can be cleaned with native water between sampling locations.

Using the chemistry analytical data, a subset of samples will be chosen by the project team, including TCEQ, for toxicity testing and benthic community analysis. The exact number of samples will be determined when the analytical data are received but it is anticipated that nine samples from the Stewart Creek study area (three from each of the high, medium, and low concentration groups) will be used for the toxicity and benthic community analysis. Three samples from each of the two reference creeks will be used for the toxicity and benthic community testing.

Each location will be documented using the following parameters and descriptions:

- Photographic documentation;
- Bottom substrate description;
- Description of water depth and flow such as riffles and pools;
- Bank description – evidence of erosion, approximate bank angle and height;
- Riparian buffer description;
- General aesthetics of sampling area;
- Size of area sampled (e.g., the sample represents a 1 square foot area for benthic analysis);
- Sampling technique description (e.g., ponar grab sample); and
- Sediment description (odor, color, size of sediment particles and depth of sediment sampled). Note that if sufficient sediment is not available in a discrete area within the 4 inch depth, the sample will be taken from a larger lateral area, but the sample depth will not extend into the anaerobic zone (note that there is field decision discretion). For the benthic invertebrate sampling, circumstances will dictate the sampling device used; however, the surface area of the benthic evaluation sample must be recorded in the field notes. For example, a Surber sampling device may be used for the more shallow areas with adequate surface water flow and a Ponar would be used in deeper water. If a Ponar, or other type of dredge is used, then the dredge material should be emptied into a 500 micro sieve for draining the water from the sample. Sticks or rocks should be inspected for attached benthic invertebrates. These invertebrates should be removed and placed in the sample using tweezers or a vegetable brush.

3.2 Toxicity Testing

Because benthic communities contain a diversity of organisms, it is desirable to conduct toxicity testing with more than one organism, especially if they have potentially different exposure pathways or endpoints monitored (e.g., infaunal vs epifaunal). Two toxicity test organisms, the amphipod *Hyalella azteca* and the midge *Chironomus dilutus* (formerly known as *C. tentans*) will be used to measure the site-specific toxicity of the sediments from Stewart Creek. The toxicity tests will be conducted for 10 days according to ASTM method E 1706-05 in 300 mL chambers containing 100 mL of sediment. Both organisms were chosen for this study because they are established sediment toxicity testing organisms (U.S. EPA, 2000) and are relatively sensitive to contaminants associated with sediment. Endpoints for the 10-day toxicity tests are survival and growth for both organisms. The environmental toxicology laboratory, Atkins North America, Inc. Environmental Toxicology Laboratory in Houston Texas (Atkins), will conduct the toxicity tests. Appendix B shows Atkins' accreditation for these tests.

Hyalella azteca is a freshwater amphipod species that inhabits lakes, ponds, and steams throughout North and South America. These amphipods are detritivores (i.e., detritus feeders) that burrow into the surficial sediment surface (upper 2 centimeters). Studies with this species have demonstrated that they are tolerant of a wide range of sediment physico-chemical characteristics (e.g., various grain size, TOC and conductivity), but are sensitive to chemical contaminants (Cal/EPA, 2004).

The midge, *Chironomus dilutis,* is a fly species whole larval and pupal stages are found in streams, ponds and lakes. The life cycle of *C. dilutis* can be divided into four stages: 1) egg stage, approximately 3 days, 2) larval stage consisting of four instars, approximately 18 days, 3) a pupal stage, approximately 3 days and 4) an adult stage (emergent approximately 3 to 5 days). The larval stages of *C. dilutis* occur in the upper few centimeters of the sediment, are tolerant of a number of sediment physico-chemical properties, and are relatively sensitive to COCs. The 10-day test is started with 10 second-to third-instar larvae (approximately 10 days old). During the test the larvae burrow into the sediment and construct tubes (cases). They feed on particulate matter drawn into the tube or in the vicinity of either end of the open-ended tubes (Cal/EPA, 2004).

3.2.1 Toxicity Testing Endpoints and Analysis

Test measures are the average of the surviving organisms at the end of the 10-day test to address the survival endpoint and ash-free dry weight to evaluate the growth endpoint. Dry weight is defined as the difference between dry weight of the surviving organisms (total weight - tare weight) divided by the number of surviving organisms (pan count) exposed to the test, control or reference sediment. A laboratory control will be used to verify the acceptability of the test and not for comparison to the site samples for determining levels of toxicity. Site sample toxicity will be compared against the reference locations toxicity, and not to the laboratory control toxicity, for decision making. All acclimation and testing will be conducted at 23°C.

Statistical analysis will be performed on the growth (ash-free dry weight) and survival data to determine if results for the Stewart Creek locations are significantly different from the results of the reference sediment groups. Statistical analyses will be conducted at a 95% confidence level ($\alpha = 0.05$) using CETIS™ v 1.8.0.4 (Tidepool Scientific Software, McKinleyville, CA). Following distribution tests, mean survival and mean dry weight will be examined using the Student-Newman-Kuels test (Kuels, 1952) or Dunnett's Multiple Comparison test (Dunnett, 1964).

The results of the two toxicity tests (i.e., survival and growth) will be used to determine the magnitude of sediment toxicity at each sample location. Thresholds based on percentage survival and growth and statistical significance will be applied to classify the test results into one of four potential toxicity categories: nontoxic (minimal potential), low, moderate, and high. These categories will be used in the line of evidence analysis described in Section 4.1.

3.2.2 Toxicity Testing Protocol Deviation and Interferences

At this time, it is anticipated that one deviation from the ASTM standard method will be used: decrease food given to the test chambers from 1.5 mL Yeast-Cerophyll-Trout Chow (YCT) /day/chamber to 1 mL YCT/day/chamber for *H. azteca* [the feeding level was revised to 1 ml YCT/day/chamber in ASTM E1706-05 (2010) to be consistent with the feeding levels in long-term tests with *H. azteca*].Interferences are characteristics of a sediment aside from those related to the sediment-associated COCs that can potentially affect test organism survival or growth. These interferences can potentially confound interpretation of test results in two ways: 1) false-positive response, i.e., toxicity is observed in the test when COCs are not present at concentrations known to elicit a response, or there is more toxicity than expected; and 2) false-negative response, i.e., no toxicity is observed when COCs are present at concentrations known to elicit a response or there is less toxicity than expected. There are three categories of interfering factors that can cause false-negative or false-positive responses: 1) those characteristics of sediments affecting survival independent of COC concentration (i.e., non-COC factors such as grain size or TOC), 2) changes in chemical bioavailability as a function of sediment manipulation or storage, and 3) presence of indigenous organisms (EPA, 2000). Impact of these potential interferences will be minimized by selection of samples with similar sediment grain size and minimal handling of the sediment. Both test species are documented to be tolerant of a wide range of sediment particle sizes and content of organic matter. The testing laboratory will remove any indigenous organisms found during sample preparation.

3.2.3 Toxicity Testing Sampling, Preservation and Shipping

For the toxicity testing, two gallons of sediment will be collected from the biologically active zone (i.e., top 4 inches) of the sediment column. The preferred sediment will be fine grained with rocks and organic debris removed. Two gallon buckets will be provided by the laboratory. Once the sample has been collected, it will be placed in a cooler. The samples do not have to be maintained at a specific temperature, but will be maintained out of the summer heat. Chain of custody (C-O-C) paper work will accompany the samples during shipment to the laboratory.

The two gallon buckets will be provided by Atkins. Sediment should be collected from the biologically active zone within the top 4 inches. No preservation is required for these samples. Each sediment sample will be identified with a unique field sample location on the buckets and the C-O-C. Samples will be shipped via overnight delivery to:

Atkins – Environmental Toxicology Laboratory
Mr. Jim Horne
888 W. Sam Houston Pkwy, South - Ste. 110
Houston, TX, 77042-1917
Direct: (713) 292- 9020 | Cell: (713) 582 7297
jim.horne@atkinsglobal.com

3.3 Benthic Community Analysis

Benthic community analysis and data interpretation will be conducted by EcoAnalysts, Inc. of Moscow Idaho, who will be using standard procedures for evaluating the health and diversity of sediment ecosystems by taxanomic sorting and analysis of benthic macroinvertebrates. After the sediment samples are processed according to the standard operating procedures contained in Appendix A, a taxonomist will identify benthic macroinvertebrates using a unique taxonomic code. The number of individuals of each taxon will be counted and entered into the database. This process will be used for site and reference samples, and verified by a second taxonomist. This evaluation provides, for all samples, information on abundance (total number of invertebrates present in a sample), dominance (the rank order of most abundant taxon in the sample), species richness (total number of identifiably distinct taxa in a sample), community composition, functional group composition (e.g., filter feeder, gatherer, predator, piercer-herbivore, shredders, and scrapers), diversity, and stressor identification indices. Comparisons, using population statistical comparisons, will be made with reference locations to evaluate the potential impacts related to the health and diversity of the various site samples. These community metrics will be used in combination with sediment toxicity data to determine the magnitude of disturbance to the benthos at each sample site. EcoAnalysts will provide interpretation of the benthic infaunal community data as compared to the reference samples to be used in the sediment quality triad evaluation described in Section 4.1.

3.3.1 Benthic Community Analysis Sampling, Preservation and Shipping

Benthic community samples will be collected prior to any other samples (e.g., toxicity or analytical). See Section 3.1 for a description of sampling for benthic invertebrates. Sample containers will be 500 ml heavy duty wide mouth plastic jars such as Nalgene® HDPE or equivalent with screw on lids. There will be three sediment subsamples taken from each sample location. Each container will be filled approximately half way with sediment.

Ethanol (90% - 95%) will be used for sample preservation. Field preservation method include:

- Fill each 500 ml jar approximately half full directly from the sampling device (e.g., Ponar). Do not decant the water. Document the area samples (e.g., 6 inches x 6 inches). The sediment from the area sampled may be placed in more than one jar per replicate but note on the sample container (e.g., 1 of 2 and 2 of 2 for replicate #1). There will be 3 replicates per sampling location;
- Immediately, add 90% - 95% ethanol to the sample container to the top of the container. A good rule of thumb is a 1:1 ratio of preservative to sample material. If the sample is large and just barely fits in the jar, split the sample into separate containers to allow adequate preservation;
- Place the preserved samples into a cooler, out of direct sunlight. Ice will be placed in the cooler to maintain a cool temperature; and
- Samples must remain in the ethanol for 24 hours prior to preparation for shipment.

Prior to shipping, decant the ethanol from each sample, pack and ship the samples using the following procedure:

- Place a knee high hose over the jar and decant <u>all of the free liquid</u> from the jar;
- Put the knee high hose into the jar (benthic invertebrates will be attached to the hose);
- Place the lid on the jar and seal the lip with electrical tape (minimum of 2 1/2 times around).
- Line a cooler with a garbage bag before you begin filling it, and once filled seal the bag either by tying, a zip tie, or other means;
- Each sample container must be placed upright in the package;
- Place enough padding on the bottom, top, and each side of the package to protect the sample containers from breaking due to impacts;

- Put enough absorbent material in the package to absorb any spillage or leakage of samples;
- Some jars have very poor fitting lids and are prone to leakage even when taped, if after taping the jars they still leak double bag each sample in Ziploc or similar type bags;
- Fill each package completely: do not leave any empty space or your samples can shift around during shipping the package is much more likely to be damaged, and samples more likely to be lost; and
- Include a C-O-C (Appendix C) in the shipment in a Ziploc bag and email an electronic version to Shandra McGraw that lists the samples as well as states what type of preservative was used for the samples.

Ship the samples overnight to:

EcoAnalysts, Inc
Shanda McGraw
1420 S. Blaine Suite 14
Moscow, ID 83843
208-882-2588 Ext 30
smcgraw@ecoanalysts.com

4.0 EVALUATION OF RESULTS

Possible ecological impacts to the benthic community from arsenic exposure will be assessed using multiple lines of evidence as described in this section and, if necessary, a site-specific sediment PCL for arsenic will be developed.

4.1 Sediment Quality Triad Data Evaluation

The process outlined by EPA (2002) and the resulting framework described by Bay and Weisberg (2012) will be used to assess the sediment quality triad data collected as part of this study. This framework is proposed as it reduces the need to rely on best professional judgment and because it has been reliably used to standardize triad-based sediment quality assessments. The sediment quality triad (SQT) approach uses multiple lines of evidence based on the results of benthic community assessments, sediment toxicity and sediment chemistry to evaluate the relationship between sediment-associated chemicals and biological community quality. The combination of potential cause (chemistry) and effect (toxicology and ecology) measurements makes the SQT one of them most effective tools available to establish the extent and significance of pollution-induced degradation (Sorensen et al., 2007). The SQT process is based on a foundation that there must be some evidence of biological effect and some evidence of elevated chemical exposure to identify a sample (or site) as chemically-impacted. The framework consists of a three-step process, which includes the following for each sample:

1) The response for each line of evidence (i.e., chemistry, toxicity, benthic community) will be assigned into one of four response categories: a) no difference from reference conditions, b) a small response that might not be statistically distinguishable from reference conditions, c) a response that is clearly distinguishable from reference, and d) a large response indicative of extreme conditions. Tables 1a, 1b and 1c show examples of how the information will be organized.
2) The individual lines of evidence will be combined to assess the level of biological effects (using benthic community and toxicity data) and to evaluate the potential for chemically induced effects (using toxicity and chemistry data). Tables 2 and 3 show how the lines of evidence will be organized for determining the severity of effect classification.
3) The severity of the effect and the potential for chemically-induced effects will be combined for each sample to assign each sample to one of six impact categories: unimpacted, likely unimpacted, possibly impacted, likely impacted, clearly impacted, and inconclusive (Table 4).

The decision process for determining the site assessment category is based on a foundation that there must be data indicating biological effect in order to classify the severity of impact (minimal, low, moderate and high). Additionally, there must be some evidence of elevated chemical exposure in order to classify a sample location as chemically-impacted.

If there are unexplained differences in toxicity (survival and growth) between replicates of the same sample for a test species evaluated in this study, the impact of the uncertainty will be considered in the overall results to describe potential risks to the benthic community of Stewart Creek as a result of arsenic concentrations.

In addition, the risk characterization may include multiple linear regressions to explore potential associations or dependencies between the various physical and chemical parameters, which are the independent variables, and the toxicity test endpoints (i.e., survival and growth), which are the dependent variables.

4.2 Determination of Site-Specific Freshwater Sediment Arsenic Benthic PCL

If it is determined that biological degradation is potentially occurring at the Site, and that arsenic exposure in sediment in the study area is causing the biological response (relative to the reference location data), a site-specific arsenic PCL will be derived using the data analysis presented in Tables 1-4. For example, the highest concentration of arsenic corresponding to the samples that are identified as “unaffected” in Table 4 will be associated with the no observed effects concentration (NOEC) and the lowest concentration from samples identified as “low effect” would be associated with the lowest observed effects concentration (LOEC). The final arsenic PCL would be the midpoint between the NOEC and LOEC.

4.3 SSERA Reporting and Conclusions

As described by TCEQ (2014a), a SSERA which includes recommendations for managing ecological risk must be submitted to the TCEQ as part of an APAR. This SSERA will be submitted as part of an APAR addendum to the 2014 FOP APAR and will focus on arsenic in sediment (i.e., the previous SLERA used to evaluate other COCs and other media will not be repeated). The SSERA will provide the information to support the recommended decision for risk management of arsenic in the sediments of Stewart Creek.

5.0 UNCERTAINTY ANALYSIS

Uncertainties are associated with each step in the risk assessment process. According to USEPA (1997), "Uncertainty should be distinguished from variability, which arises from true heterogeneity or variation in characteristics of the environment and receptors." The interpretation of the SSERA will be aided by recognition and understanding of the source and nature of the known or predicted uncertainties that can influence the risk characterization results. A few of the anticipated uncertainties particular to this project are described below.

5.1 COCs

Arsenic in sediment is the focus of the SSERA; however, other COCs could be influencing the stability and diversity of the benthic community and the sediment toxicity. To address this uncertainty, the samples will be analyzed for the other project COCs: lead and cadmium. It is possible that some organic constituents could be present in the sediment that are unrelated to the FOP operations. This information will be evaluated in the multiple linear regression analysis if other COCs appear to be impacting the overall toxicity and benthic community analysis results.

5.2 COC Gradient

The sample locations were chosen based upon existing arsenic, lead and cadmium data obtained in 2014. Stewart Creek is a dynamic urban creek which has received periodic rainfall events since the samples were taken in 2014. In May of 2015, the area received 19.15 inches of rain (more than 8 inches in one day) resulting in significant flooding in Stewart Creek, especially closer to Lake Lewisville. It is possible that the areas that were sampled are no longer representative of the predicted COC concentrations. This uncertainty will be addressed by oversampling (i.e., collecting more samples than needed), and evaluating the analytical results before choosing a subset for the toxicity testing and community analysis.

5.3 Reference Locations

Two freshwater creeks in the Frisco area were chosen as reference creeks. One location is a tributary to Stewart Creek and another is a creek located to the north of Stewart Creek. Criteria for selection of a reference area were: 1) not influenced by FOP activities, 2) similar flow as Stewart Creek (i.e., perennial) and 3) similar types of sediment to Stewart Creek. It is possible that there are unknown influences to the one or both of the reference creeks that could impact benthic community structure or toxicity. To address this uncertainty, the sediment samples from the reference streams will be analyzed for an expanded list of constituents including certain metals, SVOCs, pesticides and herbicides.

6.0 REFERENCES

ASTM, 2010. *Standard Test Method for Measuring the Toxicity of Sediment-Associated Contaminants with Freshwater Invertebrates*. Designation: E 1706-05. West Conshohocken, PA. March.

Bay, S.M. and S.B. Weisberg. 2012. Framework for Interpreting Sediment Quality Triad Data. *Integr Environ Assess Manag*. Oct 8(4) 773 pg. 589-596.

Benchmark Ecological Services, Inc. 2014. *Habitat Assessment Field Survey Report. Exide Technologies, Frisco, Collin County, Texas.*

California Environmental Protection Agency (Cal/EPA). 2004. *Overview of Freshwater and Marine Toxicity Tests: A Technical Tool for Ecological Risk Assessment.* Ecotoxicology Unit Reproductive and Cancer Hazard Assessment Section. Office of Environmental Health Hazard Assessment California Environmental Protection Agency.

Dunnett, C.W. 1964. New tables for multiple comparisons with a control. *Biometrics* 20: 482-491.

Golder. 2014. *Affected Property Assessment Report (APAR) for the Former Operating Plant (FOP) Exide Frisco Recycling Facility*. Dated May 22, 2014.

Keuls, M. 1952. The use of the “studentized range” in connection with an analysis of variance. *Euphytica* 1: 112-122.

Pastor, Behling & Wheeler (PBW) 2014. *Screening Level Ecological Risk Assessment Stewart Creek. Exide Technologies, Frisco, Texas*. May 24, 2014.

Sorensen, M.T., J.M. Conder, P.C. Fuchsman, L.B. Martello and R.J. Wenning. 2007. Using a Sediment Quality Triad Approach to Evaluate Benthic Toxicity in the Lower Hackensack River, New Jersey. *Arch. Environ. Contam. Toxicol.* 53:36-49.

Texas Commission on Environmental Quality (TCEQ, 2006). *Sediment PCLs, Direct Human Contact Sediment PCLs. Last Updated March 31, 2006.*

Texas Commission on Environmental Quality (TCEQ, 2012). *Surface Water Quality Monitoring Procedures, Volume 1: Physical and Chemical Monitoring Methods*. RG-415.

Texas Commission on Environmental Quality (TCEQ, 2014a). *Guidance for Conducting Ecological Risk Assessments at Remediation Sites in Texas*. RG-263.

Texas Commission on Environmental Quality (TCEQ, 2014b). *Surface Water Quality Monitoring Procedures, Volume 2: Methods for Collecting and Analyzing Biological Assemblages and Habitat Data*. RG-416.

United States Environmental Protection Agency (EPA, 1996). *Test Methods for Evaluating Solid Waste, Physical/Chemical Methods. (SW-846). Method 6010B Inductively Coupled Plasma-Atomic Emission Spectrometry*. *Revision 2*. December.

United States Environmental Protection Agency (EPA, 1997). *Ecological Risk Assessment Guidance for Superfund: Process for Designing and Conducting Ecological Risk Assessments. Interim Final*. Office of Solid Waste and Emergency Response, Washington, D.C. OSWER 9285.7-25. EPA 540-R-97-006. June.

United States Environmental Protection Agency (EPA, 2000). *Methods for Measuring the Toxicity and Bioaccumulation of Sediment –associated Contaminants with Freshwater Invertebrates. Second Edition*. Office of Research and Development. Mid-Continent Ecology Division. Duluth, Minnesota.

United States Environmental Protection Agency (EPA, 2002). *A Guidance Manual to Support the Assessment of Contaminated Sediments in Freshwater Ecosystems. Volume III – Interpretation of the Results of Sediment Quality Investigations.* Great Lakes National Program Office. Chicago, IL. EPA-905-B02-001-C. December.

Walkley, A. and I.A. Black. 1934. An Examination of Degtjareff method for Determining Soil Organic Moisture and a Proposed Modification of the Chromic Acid Titration Method. *Soil Sci.* 37:29-37.

TABLES

Table 1A. Designation of Response Categories – Example SQT Weight-of-Evidence for Chemistry

Sample ID	Sediment Chemistry (mg/kg)[1]			Sediment Chemistry Exposure Category[2]
	As	**Pb**	**Cd**	
Reference-1	< 21.4	< 82	< 3	Low
Example-1	40	< 82	<3	Moderate
Example-2	100	<82	<3	High

1 - Concentration data will be compared to default sediment benthic PCLs. The quotient method may be used.

2 - Possible categories are: minimal exposure, low exposure, moderate exposure and high exposure (See Table 2).

3 – These data are examples for illustration purposes on data organization and actual values will differ.

Table 1B. Designation of Response Categories – Example SQT Weight-of-Evidence for Toxicity Testing

Sample ID	Toxicity Testing[1, 2,]				Toxicity Category[3]
	% Survival – *C. dilutis*	**Ash-free dry weight – *C. dilutis***	**% Survival – *H. azteca***	**Ash-free dry weight – *H. azteca***	
Reference-1	99%	2	99%	2	NA
Example-1	85% / –	1.8 / –	90%/ –	2.1 / –	Non Toxic
Example-2	40% / +	0.9 / +	40%/+	0.5 / +	High

1 - “+” indicates a statistically significant difference between the Stewart Creek sample and the reference samples. “–” indicates no significant difference between the Stewart Creek sample and the reference samples.

2 - Endpoints will be growth and survival for *Hylella azteca* and *Chironomus dilutis*.

3 - Possible categories are: non toxic, low toxicity, moderate toxicity and high toxicity (See Tables 2 and 3).

4 - These data are examples for illustration purposes on data organization and actual values will differ.

Table 1C. Designation of Response Categories – Example SQT Weight-of-Evidence for Benthic Invertebrate Analysis

Sample ID	Benthic Community Analysis-Statistical Significance from Reference[1,2]							Benthic Community Disturbance Category[3]
	Abundance	Dominance	Richness	Community Composition	Functional Group Composition	Diversity	Stressor Identification Indices	
Reference-1	NA	NA	NA	NA	NA	NA	NA	Low
Example-1	–	+	+	–	–	–	–	Moderate
Example-2	+	+	+	+	+	+	–	High

1 - See Appendix A for definition and more information on metrics. The SSERA Report will contain and raw data worksheets generated by EcoAnalysts.

2 - “+” indicates a statistically significant difference between the Stewart Creek sample and the reference samples. “–” indicates no significant difference between the Stewart Creek sample and the reference samples.

3 - Possible categories are: reference, low disturbance, moderate disturbance, and high disturbance (See Table 3).

4 - These data are examples for illustration purposes on data organization and actual values will differ.

Table 2. Potential that Effects are Chemically Induced

		Sediment Toxicity Line of Evidence			
		Non Toxic	Low Toxicity	Moderate Toxicity	High Toxicity
Sediment Chemistry	Minimal Exposure	Minimal Potential	Minimal Potential	Low Potential	Moderate Potential
	Low Exposure	Minimal Potential	Low Potential	Moderate Potential	Moderate Potential
	Moderate Exposure	Low Potential (Example-1)	Moderate Potential	Moderate Potential	Moderate Potential
	High Exposure	Moderate Potential	Moderate Potential	High Potential (Example-2)	High Potential

Table 3. Severity of Effect Classifications

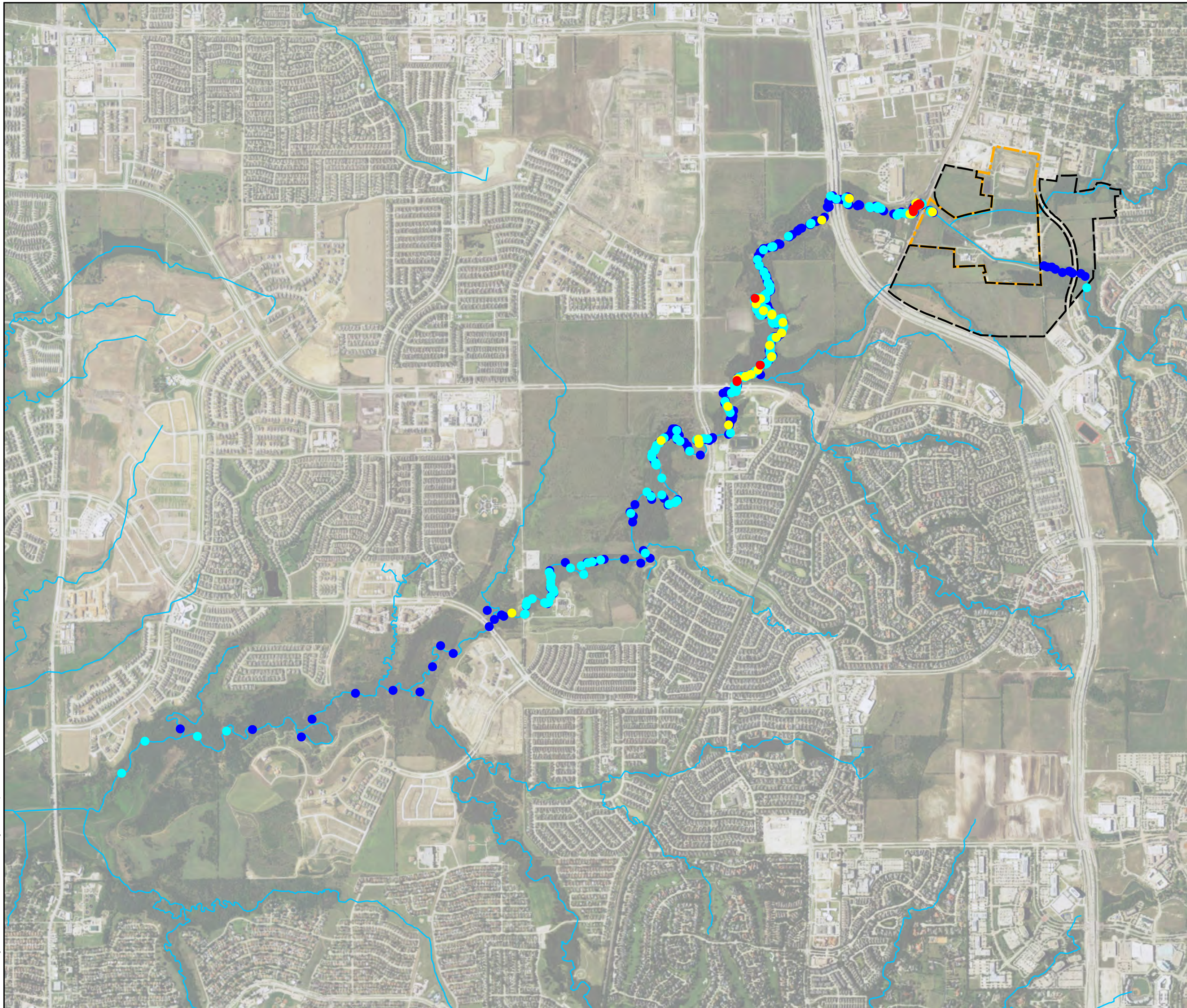
		Sediment Toxicity Line of Evidence			
		Non Toxic	**Low Toxicity**	**Moderate Toxicity**	**High Toxicity**
Benthic Community Analysis	**Reference**	Unaffected	Unaffected	Unaffected	Low Effect
	Low Disturbance	Unaffected	Low Effect	Low Effect	Low Effect
	Moderate Disturbance	Moderate Effect (Example-1)	Moderate Effect	Moderate Effect	Moderate Effect
	High Disturbance	Moderate Effect	High Effect	High Effect (Example-2)	High Effect

Table 4. Multiple Lines of Evidence Site Classifications

		Severity of Effect Classification			
		Unaffected	**Low Effect**	**Moderate Effect**	**High Effect**
Potential for Chemically Induced Effects	**Minimal Potential**	Unimpacted	Likely Unimpacted	Likely Impacted	Inconclusive*
	Low Potential	Unimpacted	Likely Unimpacted	Possibly Impacted	Possibly Impacted
	Moderate Potential	Likely Unimpacted (Example-1)	Possibly Impacted or Inconclusive*	Likely Impacted	Likely Impacted
	High Potential	Inconclusive*	Likely Impacted	Clearly Impacted (Example-2)	Clearly Impacted

*Inconclusive category applies when: chemistry = minimal exposure, benthos = reference and toxicity = high. Other lines of evidence combinations are classified as Possibly Impacted. Source: Bay and Weisberg, 2012

FIGURES



LEGEND

Arsenic Concentrations in Sediment (milligrams per kilogram)

- > 100
- > 50
- > 21.4
- ≤ 21.4
- Stewart Creek Centerline
- Former Operating Plant
- Undeveloped Buffer Property

NOTES

1. ARSENIC CONCENTRATIONS ARE FROM SAMPLES COLLECTED BY GOLDER IN 2014.
2. SSERA - SITE SPECIFIC ECOLOGICAL RISK ASSESSMENT
3. 21.4 MG/KG IS THE DEFAULT BENTHIC PCL

REFERENCE

1. SITE FEATURES - GOLDER, 2014
2. AERIAL IMAGERY - SOURCE: ESRI, DIGITALGLOBE, GEOEYE, EARTHSTAR GEOGRAPHICS, CNES/AIRBUS DS, USDA, USGS, AEX, GETMAPPING, AEROGRID, IGN, IGP, SWISSTOPO, AND THE GIS USER COMMUNITY

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CLIENT
EXIDE TECHNOLOGIES

PROJECT
SSERA WORK PLAN

TITLE
ARSENIC CONCENTRATIONS IN SEDIMENT - STEWART CREEK

CONSULTANT

Golder Associates

YYYY-MM-DD	2016-04-04
PREPARED	JWT
DESIGN	AM
REVIEW	AMF/BEF
APPROVED	JAW

PROJECT No.	CONTROL	Rev.	FIGURE
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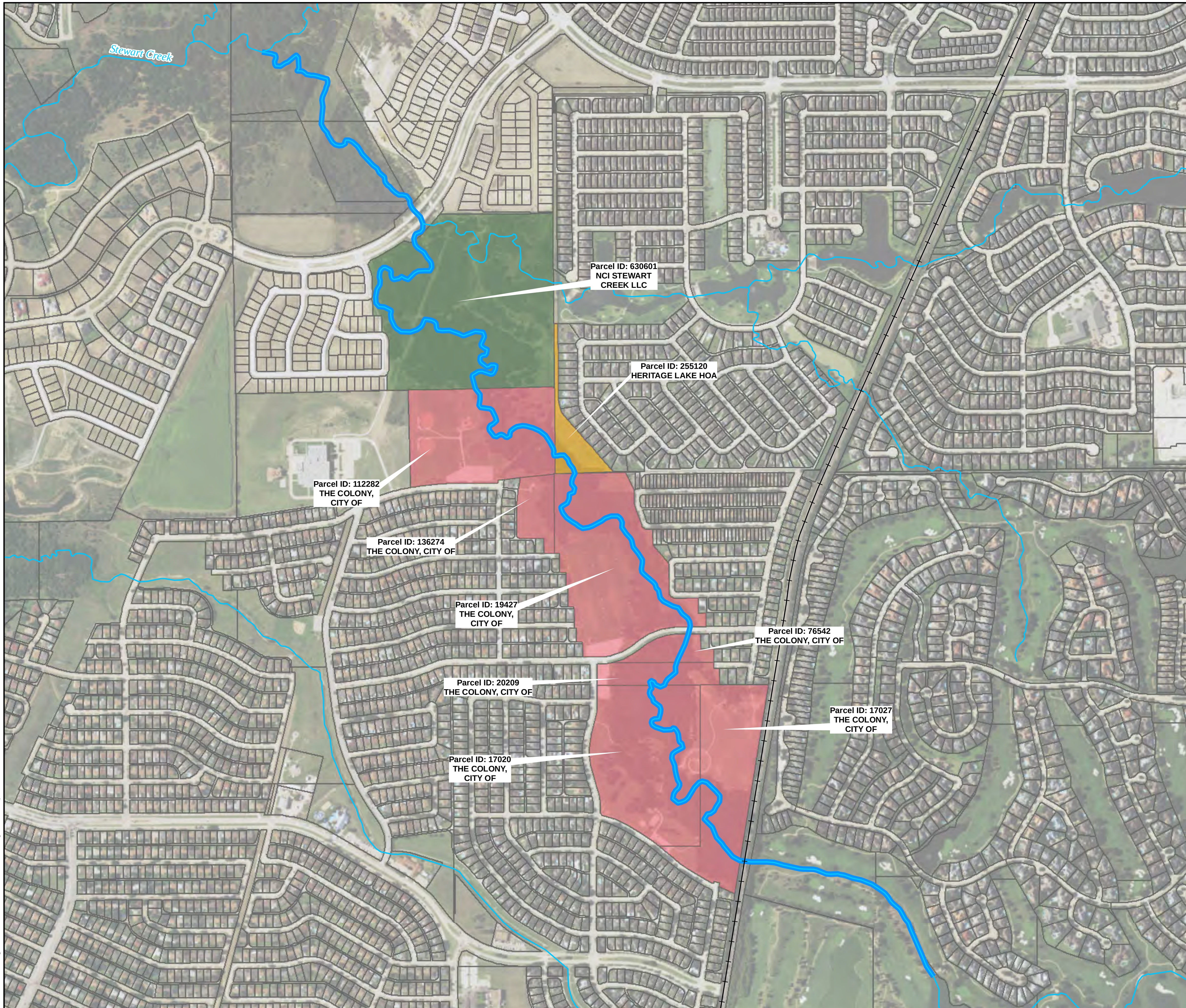
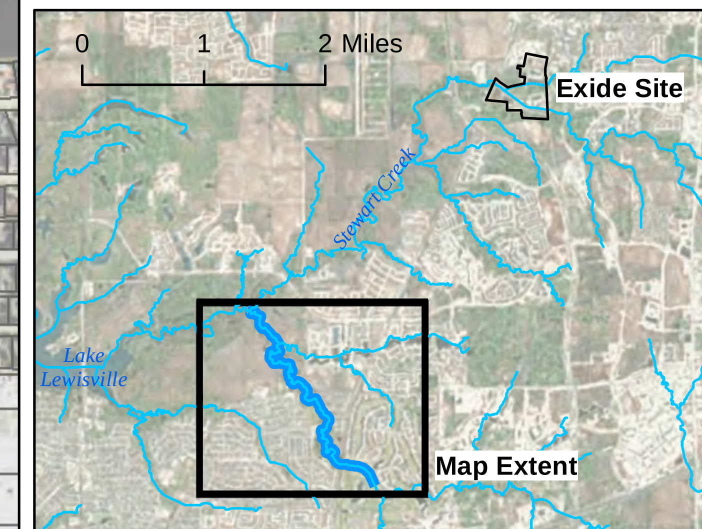


LEGEND

- Creek Centerline
- Tributary to Stewart Creek
- Heritage Lake HOA
- NCI Stewart Creek LLC
- City of Colony



NOTES

1. SSERA - SITE SPECIFIC ECOLOGICAL RISK ASSESSMENT

REFERENCE

1. HYDROGRAPHY - USGS NATIONAL HYDROGRAPHY DATASET
2. PARCELS - DENTON COUNTY VIA DENTONCOUNTY.COM, 2015
3. AERIAL IMAGERY - SOURCE: ESRI, DIGITALGLOBE, GEOEYE, EARTHSTAR GEOGRAPHICS, CNES/AIRBUS DS, USDA, USGS, AEX, GETMAPPING, AEROGRID, IGN, IGP, SWISSTOPO, AND THE GIS USER COMMUNITY

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CLIENT
EXIDE TECHNOLOGIES

PROJECT
SSERA WORK PLAN

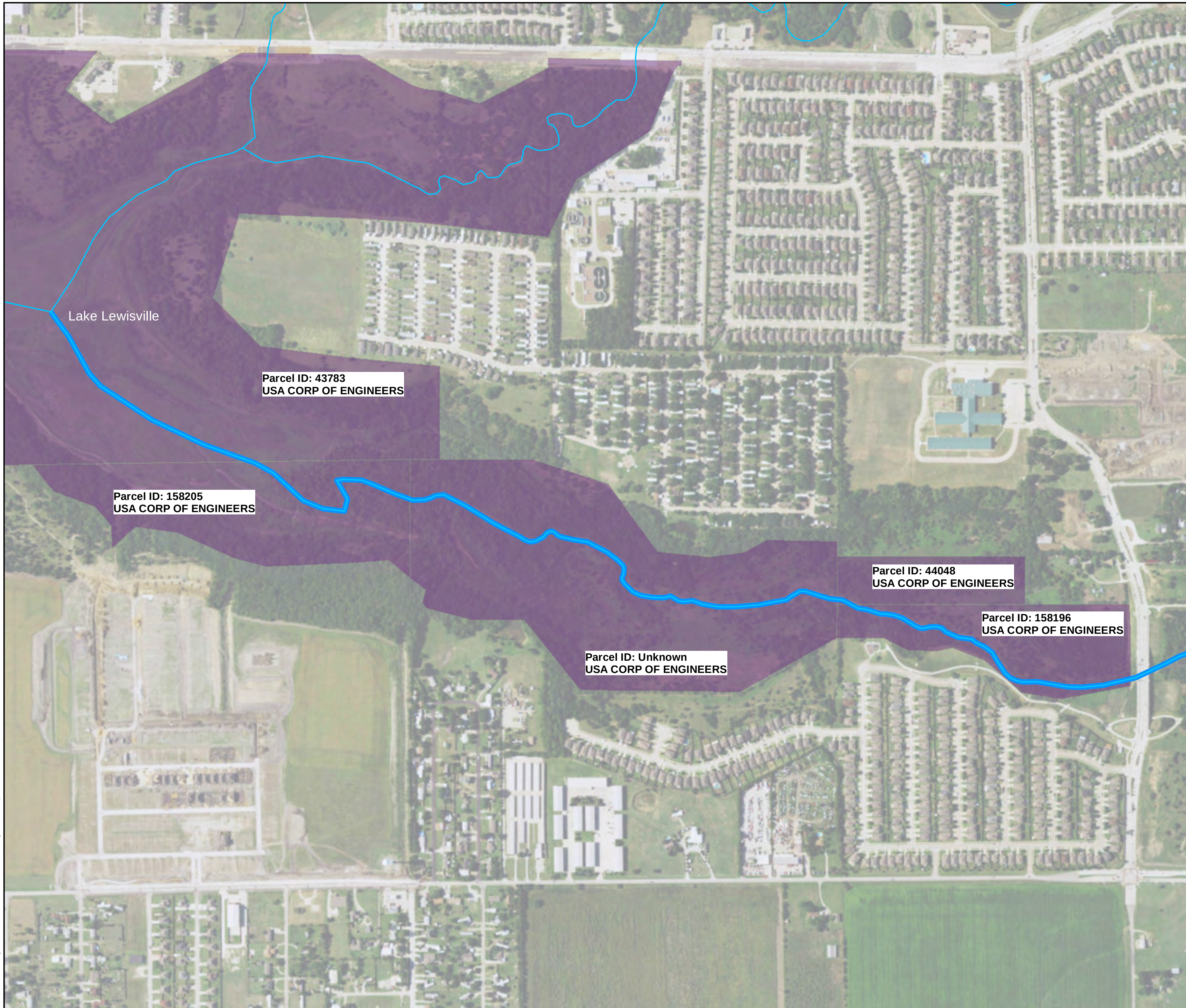
TITLE
STEWART CREEK TRIBUTARY AND PARCEL OWNERSHIP

CONSULTANT
Golder Associates

YYYY-MM-DD	2016-04-04
PREPARED	JWT
DESIGN	AM
REVIEW	AMF/BEF
APPROVED	JAW

PROJECT No.	CONTROL	Rev.	
13-02086	1302086U002.mxd	0	2A

IF THIS MEASUREMENT DOES NOT MATCH WHAT IS SHOWN, THE SHEET HAS BEEN MODIFIED FROM: ANSI B

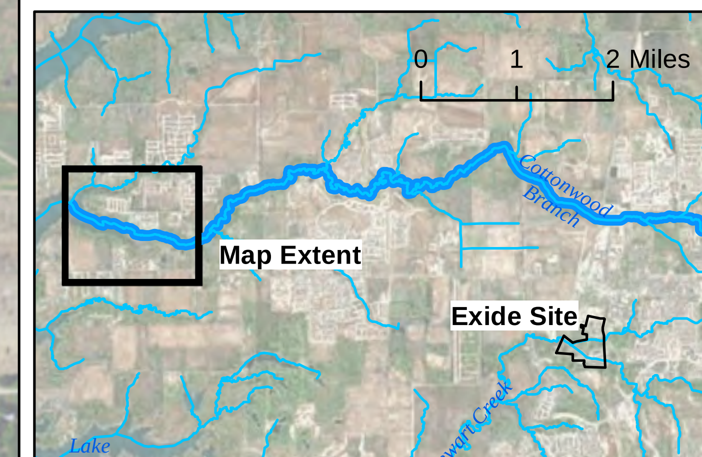


LEGEND

Creek Centerline

Cottonwood Branch

USA Corp of Engineers Property



NOTES

1. SSERA - SITE SPECIFIC ECOLOGICAL RISK ASSESSMENT

REFERENCE

1. HYDROGRAPHY - USGS NATIONAL HYDROGRAPHY DATASET
2. PARCELS - DENTON COUNTY VIA DENTONCOUNTY.COM, 2015
3. AERIAL IMAGERY - SOURCE: ESRI, DIGITALGLOBE, GEOEYE, EARTHSTAR GEOGRAPHICS, CNES/AIRBUS DS, USDA, USGS, AEX, GETMAPPING, AEROGRID, IGN, IGP, SWISSTOPO, AND THE GIS USER COMMUNITY

800 400 0 800 Feet

CLIENT
EXIDE TECHNOLOGIES

PROJECT
SSERA WORK PLAN

TITLE
COTTONWOOD BRANCH AND PARCEL OWNERSHIP

CONSULTANT

Golder Associates

YYYY-MM-DD	2016-04-04
PREPARED	JWT
DESIGN	AM
REVIEW	AMF/BEF
APPROVED	JAW

PROJECT No.	CONTROL	Rev.	
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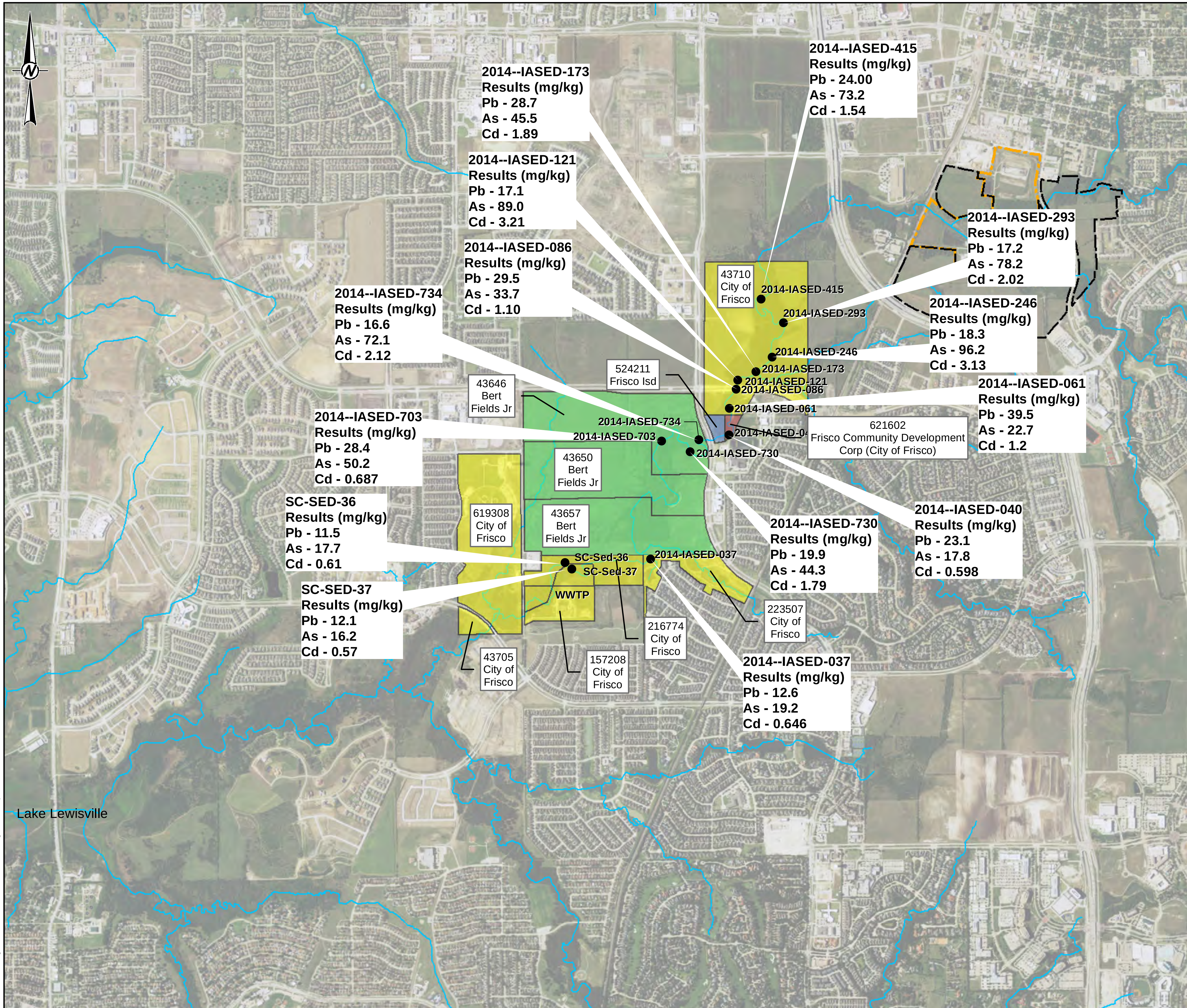

LEGEND

- ● Sediment Sample Location
- Creek Centerline
- Former Operating Plant
- Undeveloped Buffer Property
- Bert Fields Jr
- City of Frisco
- Frisco Community Development Corp (City of Frisco)
- Frisco Independent School District

Analyte	mg/kg
Lead (Pb) Benchmark	35.8
Lead (Pb) PCL	81.9
Cadmium (Cd) Benchmark	0.99
Cadmium (Cd) PCL	2.98
Arsenic (As) Benchmark	9.79
Arsenic (As) PCL	21.4

NOTES
1. IA - INTERIM ACTION
2. SSERA - SITE SPECIFIC ECOLOGICAL RISK ASSESSMENT
3. PCL - PROTECTIVE CONCENTRATION LEVELS
4. WWTP - WASTE WATER TREATMENT PLANT

REFERENCE
1. SITE FEATURES - GOLDER, 2014
2. AERIAL IMAGERY - SOURCE: ESRI, DIGITALGLOBE, GEOEYE, EARTHSTAR GEOGRAPHICS, CNES/AIRBUS DS, USDA, USGS, AEX, GETMAPPING, AEROGRID, IGN, IGP, SWISSTOPO, AND THE GIS USER COMMUNITY

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CLIENT
EXIDE TECHNOLOGIES

PROJECT
SSERA WORK PLAN

TITLE
STEWART CREEK PROPOSED SAMPLE LOCATIONS

CONSULTANT
Golder Associates

YYYY-MM-DD	2016-04-04
PREPARED	JWT
DESIGN	AM
REVIEW	AMF/BEF
APPROVED	JAW

PROJECT No.	CONTROL	Rev.	FIGURE
13-02086	1302086U004.mxd	0	**3**

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APPENDIX A-1

ECOANALYSTS, INC. STANDARD OPERATING PROCEDURES FOR BENTHIC MACROINVERTEBRATE INDICATORS

STANDARD OPERATING PROCEDURES

for

Laboratory Analysis: Benthic Macroinvertebrate Indicator

January 2015

Prepared by

EcoAnalysts, Inc.

LIFE IN WATER

1420 South Blaine Street, Suite 14

Moscow, Idaho 83843

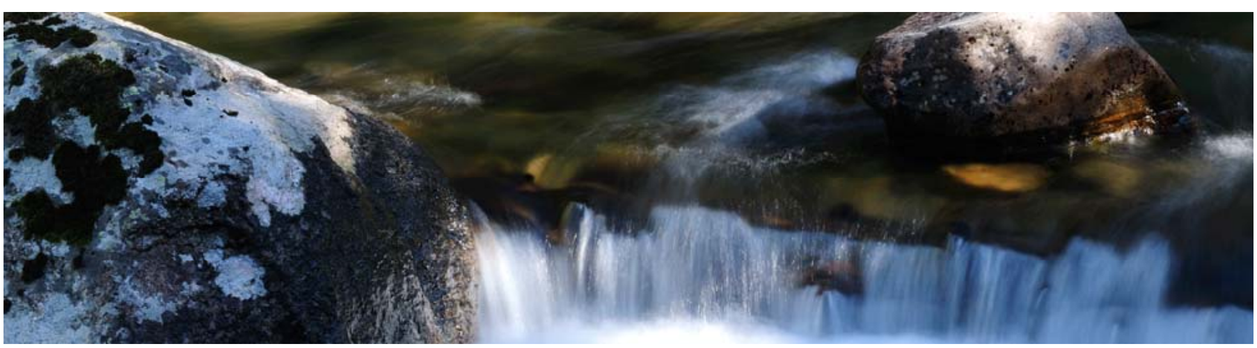

Table of Contents

1. Summary of Methods - EcoAnalysts, Inc. Benthic Macroinvertebrate Laboratory Standard Procedures for Sorting, Taxonomy, and Quality Assurance

1.1 The methods described in this laboratory manual are the standard methods used in the benthic macroinvertebrate laboratory and can be catered upon request to fit the requirements of specific study designs or a detailed scope of work. Unless otherwise specified, all equipment is calibrated and maintained according to the manufacturer's guidelines. Taxonomic references and other processing references are available upon request.

2. Sample Receiving and Chain of Custody Tracking

2.1 Immediately upon receipt of benthic macroinvertebrate samples, all containers are inspected for damage or leakage. Sample labels are checked against chain of custody forms and/or packing slips and any discrepancies are noted. Receipt records are reported to the client within one business day of sample receipt. Chain of custody logs are reported throughout the project according to timelines and methods requested by the client.

2.2 Samples are logged into the EcoAnalysts, Inc. custom Laboratory Information Management System, LIMS, database and assigned a unique sample tracking number.

3. Sorting Benthic Macroinvertebrate Samples

The purpose of this step is to remove benthic macroinvertebrates from debris in the samples prior to identification.

3.1 A sample is checked out by a trained sorting technician via the LIMS. A sorting bench sheet is printed containing that contains all of the sample information and sorting protocols designated to it.

3.2 The sorter records the primary matrix type and estimates the volume of detritus in the entire sample prior to rinsing. The standard descriptors for the types of sample matrix are: Inorganic, Coarse Organic, Fine Organic, Vegetation, and Filamentous Algae.

3.3 The sample is prepped for subsampling procedures by emptying the matrix into a mesh sieve of a specified mesh size to remove preservative and fine sediment.

3.3.1 If the sample matrix is made up of a significant percentage of inorganic material, the organic material will be elutriated from the inorganic material prior to sorting. The whole sample is washed into a shallow pan of water where any large pieces of organic material are rinsed, inspected thoroughly by another technician for attached invertebrates. The sample is agitated with water to separate any organic matter from inorganic sediments. After agitating the sample in water, the lighter organic material is poured back into the sieve. The inorganic portion of the sample remaining in the pan is repeatedly washed and decanted into the sieve until no more organic matter remains in the pan with the inorganic material. The remaining inorganic sediments are inspected under a magnifying lamp (3X) to look for any invertebrates too heavy to have been elutriated (e.g. mollusks, snails, stone-cased Trichoptera, etc.). If there are significant numbers of heavy invertebrates in the inorganic material – too many to easily remove under the magnifying lamp – the inorganic and organic matrix is recombined into the sieve and entire sample matrix will be subsampled according to section 3.3.2. If there are not significant numbers of heavy invertebrates in the inorganic material, they are removed under the magnifying lamp and placed with the organic matrix. Another technician double checks the inorganic material for organisms until it is determined there are no more invertebrates in the inorganic fraction of the sample. Unless otherwise requested, the inorganic elutriate is discarded.

3.3.2 The organic material and other contents of the sieve are then evenly distributed into the bottom of a Caton style tray. These are trays of various sizes consisting of gridded grids, each grid being 2 inches per side and the bottom is constructed of 250 micron mesh.

3.4 A grid (or a standardized portion of a grid) is randomly selected and its contents transferred to a Petri dish. The material in the Petri dish is sorted under a dissecting microscope (minimum magnification = 10X). The benthic macroinvertebrates are counted as they are placed into vials containing 70% ethanol. Sorters are trained to pick and count only benthic macroinvertebrates with heads, those that were alive during sampling and contain the attributes required for taxonomic identification, and may include sub-aquatic organisms or other specified organisms according to the specific study design. Organisms rejected on standard include: Sub-aquatic Adults, Terrestrials, Vertebrates, Collembola, Copepoda, Zooplankton, Colonial Bryozoa, Porifera, Empty shells, Exuviae, and any organism without a head. We do include some debatable organisms such as Nematodes, Osctracoda, Hydra, and Adult Aquatic Beetles in the target count as a standard.

3.5 When the target count of organisms has been reached or target percentage of the sample has been sorted but not fully sorted, a special large and rare protocol may be followed. Organisms deemed relatively large or rare to the sample are found by a naked eye scan in the unsorted sample remnants and are not counted but picked and placed in a separate vial.

3.6 Laser-printed labels containing the appropriate sample tracking information are placed in the vial(s). The total number of organisms removed (not including large and rare organisms), the number of grids sorted out of the total, the time spent sorting, and the final volume of the remaining sample volume are all recorded on the sorting bench sheet as well as comments significant to the sorting and/or condition of the sample.

3.7 To ensure every sample meets a standard minimum level of sorting efficacy, EcoAnalysts, Inc. standard sorting quality assurance is maintained by re-sorting at least 20% of the sorted material of every sample that is processed in the lab.

3.7.1 The sorted sample is quality checked by a specially trained and designated sorting quality control technician (this will never be the technician who originally sorted the sample).

3.7.2 The QC technician re-sorts at least 20% of the sorted fraction of the sample to check if at least 90% of the organisms have been removed. An estimated percent efficacy is calculated by dividing the number of organisms found in the original sort by the total number of organisms estimated to be in the sorted material, based on those found in the 20% quality assurance re-sort, using the following equation:

$$\text{SortingEfficacy} = \frac{\text{OriginalCount}}{\text{OriginalCount} + \left(\dfrac{\text{QACount} * \text{QASquares}}{\text{QTSquares}} \right)} * 100$$

Where:

OriginalCount = the number of organisms picked by the first sorter
QACount = the number of organisms found in the Quality Assurance sort
QASquares = the number of grids sorted during the QA process
QTSquares = the total number of grids in the QA Caton

3.7.3 Sorting efficacy is measured as the estimated percent of the total organisms found during the original sorting process. If the estimated percent sorting efficacy is 90% or greater, the sample passes the quality assurance check. If the estimate is less than 90%, the sample is re-sorted. When this happens, the sample undergoes the quality assurance process again until it passes the 90% efficacy requirement.

There are specific instances where a sample might fall below the 90% efficacy internal minimum requirement but not be resorted by the original sorter. These instances include a training sample where the sorted material is double checked by a QC technician and/or Senior Training technician during the sorting process. Depending on the requirements of the scope of work, the sample may not undergo a separate QC re-sort after the training sample has been completed. Another instance is where a sample contains a significantly low abundance of organisms where one or two specimens found during the QA/QC would result in a calculated percent sorting efficacy below 90% but by fully QC re-sorting the sample would most likely not yield any more organisms.

3.7.4 Sorting quality assurance data is recorded on the bench sheet and entered into the database for documentation. Organisms found during the QC process are added to those found during the sort. If requested, a quality assurance report is generated and provided to the client.

Unless otherwise requested, the overall estimated percent of organisms recovered during the entire sorting and QA/QC process is reported in the Sort Report. An estimated percent recovery is calculated by dividing the number of organisms found in the sorting and QC by the total number of organisms estimated to be in the sorted material, based on those found in the 20% quality assurance re-sort, using the following equation:

$$\text{SortingRecovery} = \frac{\text{OriginalCount} + \text{QACount}}{\text{OriginalCount} + \left(\dfrac{\text{QACount} * \text{QASquares}}{\text{QTSquares}}\right)} * 100$$

4. Identification of Benthic Macroinvertebrates

The purpose of this process is to identify all benthic macroinvertebrates to the taxonomic level specified by the client. The following steps will be followed to accomplish this:

4.1 A taxonomist will select a sample for identification via the LIMS and empty it into a Petri dish. Under a dissecting and/or compound microscope the invertebrates are identified to the level specified by the study design. Taxonomic references used for the taxonomic analysis of samples may be provided upon request.

4.2 The taxonomist enters each taxon directly into the project database using a unique taxonomic code (this is done while at the microscope). The number of individuals of each taxon is counted and entered into the database.

4.2.1 As the sample is being identified, the taxonomist enters data directly into the computer using a custom built LIMS database and user interface. The data entry program has several features built into it, including steps for taxonomic identification of a specimen, the number of specimens in each taxon, life stage information, taxonomic notes, etc. There is a visual confirmation at each step which prompts for a user confirmation. A running tally of invertebrates as well as the number and type of taxa in the sample are displayed on the screen; therefore, a taxonomist can quickly look for low or high counts as a flag for major discrepancies. Note: With this process, we have successfully eliminated the need for handwritten bench sheets, thereby doing away with a secondary step of data entry and the errors associated with it.

4.3 A synoptic reference collection will be made, if requested, where at least one specimen (preferably 3-5 specimens) of each taxon encountered is placed into a 1-dram vial containing 70% ethanol and is properly labeled with identity and sample number. Chironomidae reference specimens will be permanently slide mounted and labeled with the EcoAnalysts, Inc. sample number and taxonomic determination.

4.3.1 Depending on the requirements of the project, one or several reference collections can be made. Also, organisms can be vouchered by a specified taxonomic level, i.e. vouchered by each taxon per sample.

4.4 If a synoptic reference collection is made, a second taxonomist will examine the reference collection specimens to verify the accuracy of all taxa identified in the project.

4.4.1 If requested, a specified number of the samples will be randomly selected for re-identification by a QC taxonomist where all specimens in a sample that were not set aside for the reference collection will be re-identified. Percent similarity is calculated using the *Whitaker and Fairbanks(1958)* model to compare both sets of data. Both taxonomists meet and discuss any discrepancies, either by re-examining the specimens or discussion, depending upon the nature of the difference. The final data will be adjusted according to the recommendations of both taxonomists. If requested, reconciliation reports are written and delivered to the client as part of the overall Quality Assurance Report.

5. Data Compilation and Delivery

The purpose of this step is to compile the analysis data for each sample.

5.1 Throughout the project and sample analysis, data entry is double checked for accuracy. Using our networked computer systems, the appropriate data are combined for each sample to obtain the sorting statistics and comprehensive taxa lists and counts.

5.2 Various metrics calculations are available output from the LIMS and a list is available upon request. Other metrics calculations, including Benthic Invertebrate Indices, may be provided upon request. Also available upon request are all QA/QC reports and/or data analysis and interpretation reports.

5.3 Data are delivered in an electronic format specified by the client and emailed to the technical contact(s). Hard copies and/or copies on compact disc can be mailed to the client upon request. The delivery schedule will be agreed upon by the client and EcoAnalysts, Inc. in advance, specifying the sample lots, dates, and components. EcoAnalysts, Inc. retains all raw data files used and derived in our projects.

6. Sample Components Retention and Return

The purpose of this step is to specify the logistics of handling the remaining sample materials after analysis and data delivery is complete.

6.1 Processed sample components may include Coolers, Sorted and Unsorted residues preserved in ethanol in jars and all identified organisms preserved in ethanol and/or slide mounted, including reference collection specimens if a synoptic reference collection was made.

6.2 The standard retention period for these components at EcoAnalysts, Inc. is at least 30 days after the data delivery date. We will store the sample components longer upon client request. After the retention period is over, the sample components specified for return by the client are returned with the chain of custody forms and according to the Department of Transportation (DOT) and International Air Transportation Association (IATA) rules and regulations for offering hazardous materials for shipment. Any components not requested to be returned to the client become the property of EcoAnalysts, Inc.

7. Equipment and Materials Required

Sieves of Various um Sizes
Caton-style Tray Mechanism and access to a Sink
Scissors
Pencils
Forceps
Tally Counters
Petri Dishes and/or Watch Glasses
20mL Plastic Screw-top Vials
5mL Glass Snap-cap Vials

Microscope Slides and Cover Slips
CMCP-10 Mounting Media
India Ink Pens
70%-90% Pure Grain Ethanol in Squeeze Bottles
5%-10% Buffered Formalin
Sorting Bench Sheet
Sample Labels
Magnifying Lamp (3x)
Stereo Zoom Microscope (6-10x)
Compound Microscope

8. Personnel Safety and Hazardous Materials Handling and Shipping

8.1 All personnel are trained to adhere to safety rules and regulations when working with lab and office equipment, materials, and sample preservatives. Sample material is to be disposed of according to local rules and regulations.

8.2 All hazardous materials shipping is done according to DOT and IATA rules and regulations. When importing or exporting benthic macroinvertebrates, all United States Fish and Wildlife Service (USFWS) and customs rules and regulations are followed.

APPENDIX A-2

ECOANALYSTS, INC. METRIC OUTPUT GUIDANCE DOCUMENT

ECOANALYSTS, INC.

LIFE IN WATER

METRIC OUTPUT GUIDANCE DOCUMENT

1420 South Blaine Street, Suite 14
Moscow, Idaho 83843
208-882-2588 phone
208-883-4288 fax
eco@ecoanalysts.com
WWW.ECOANALYSTS.COM

INTRODUCTION

The purpose of this document is to provide the basic explanations for metrics presented in the data summary provided to you, our valued client. This document is not intended to present an interpretation of your data. Should you need assistance with interpreting macroinvertebrate community data, EcoAnalysts, Inc. trained biologists are available to assist you. Please contact us for current hourly consulting fees for this service.

As part of our service to you, EcoAnalysts has provided you with taxa lists and counts, in addition to a selection of macroinvertebrate community indices. We calculate nearly 100 metrics and regional IBIs and have tailored your output to address the habitats and geographic region in which you have sampled. Therefore, you may see more metrics listed in the Guidance Document than in your Metric Output. If you wish to customize your output, or perform additional data analyses, EcoAnalysts can assist you. Please contact us for the current hourly consulting fees for this service.

Metric Output and Descriptions

The standard output is a single Excel 2000 file consisting of two worksheets. **The first worksheet includes the taxa list and counts for all samples processed**. The format is as follows:

Rows

- Rows 5-8 are the sample information provided to us by the client.
- Row 9 is the % of the sample that was picked to get the target count of invertebrates.
- Row 10 is the habitat the sample was collected in (some studies collect more than one habitat at a site).
- Row 11 is a sample identification number used internally by EcoAnalysts to track each sample through our lab.
- Invertebrate taxa are listed beginning in Row 12.
- The last row is the total number of invertebrate that were actually examined and identified in the sample or subsample. ***These counts are not adjusted for any subsampling that may have taken place.*** If the value in Row 9 is 100, then the entire sample was completely processed, and all invertebrates therein have been accounted for.

Columns

- Column A lists the major taxonomic groups found within the samples. The group name appears next to the first taxon in each group and all subsequent rows down to the next major group are included. ***Full phylogeny for each taxon is available, but is not part of the Standard Output.***

- Column B lists the name of each taxon found in the sample. Every effort is made to keep current with taxonomic updates; however, there may be instances where we are not aware of a change or have not yet incorporated a recent change in nomenclature.
- Columns C and higher are the actual samples.
- Cells include the raw count for each taxon in the sample.

The second worksheet, "Metrics," presents the data summary for each of the samples. The format is as follows:

<u>**Rows**</u>

- Rows 5-8 are the sample information provided to us by the client.
- Row 9 is the % of the sample that was picked to get the target count of invertebrates.
- Row 10 is the habitat the sample was collected in (some studies collect more than one habitat at a site).
- Row 11 is a sample identification number used internally by EcoAnalysts to track each sample through our lab.
- Row 13 and higher are the summary metrics that were calculated from the raw data presented in the "Taxa" worksheet.

<u>**Columns**</u>

- Column A lists the summary metric names.
- Column B and higher are the actual samples.
- Cells include the values for each metric for a sample. ***Values have been corrected for subsampling.***

LIST OF METRICS

<u>**ABUNDANCE MEASURES**</u>

Corrected Abundance: This is the estimated total number of invertebrates present in the sample. ***It is not a density measurement***.

EPT Abundance: The estimated total number of individuals in the insect orders <u>E</u>phemeroptera, <u>P</u>lecoptera and <u>T</u>richoptera (EPT) in the sample.

<u>**DOMINANCE MEASURES:**</u>

1st Dominant Taxon: The most abundant taxon in the sample.
1st Dominant Abundance: Estimated total number of the most abundant taxon in the sample.
2nd Dominant Taxon: The second most abundant taxon in the sample.
2nd Dominant Abundance: Estimated total number of the second most abundant taxon in the sample.

3rd Dominant Taxon: The third most abundant taxon in the sample.
3rd Dominant Abundance: Estimated total number of the third most abundant taxon in the sample.
% 1 Dominant Taxon: Relative occurrence of the most abundant taxon expressed as a percent of the total number of individuals in the sample.
% 2 Dominant Taxa: Relative occurrence of the two most abundant taxa combined, expressed as a percent of the total number of individuals in the sample.
% 3 Dominant Taxa: Relative occurrence of the three most abundant taxa combined, expressed as a percent of the total number of individuals in the sample.

RICHNESS MEASURES

Species Richness: Total number of identifiably distinct taxa in a sample.
EPT Richness: Total number of identifiably distinct taxa in the insect orders Ephemeroptera, Plecoptera, and Trichoptera.
Ephemeroptera Richness: Total number of identifiably distinct taxa in the insect order Ephemeroptera.
Plecoptera Richness: Total number of identifiably distinct taxa in the insect order Plecoptera.
Trichoptera Richness: Total number of identifiably distinct taxa in the insect order Trichoptera.
Chironomidae Richness: Total number of identifiably distinct taxa in the insect family Chironomidae (Order = Diptera).
Oligochaeta Richness: Total number of identifiably distinct taxa in the class Oligochaeta.
Non-Chironomidae + Non-Oligochaeta Richness: All identifiably distinct taxa in the sample minus Chironomidae and Oligochaeta.
Rhyacophila Richness: Total number of identifiably distinct taxa within the genus *Rhyacophila sp*. (Trichoptera: Rhyacophilidae).

COMMUNITY COMPOSITION

% Ephemeroptera: Relative abundance of all individuals in the insect order Ephemeroptera, expressed as a percent of the total number of individuals in the sample.
% Plecoptera: Relative abundance of all individuals in the insect order Plecoptera, expressed as a percent of the total number of individuals in the sample.
% Trichoptera: Relative abundance of all individuals in the insect order Trichoptera, expressed as a percent of the total number of individuals in the sample.
% EPT: Relative abundance of all individuals in the insect orders Ephemeroptera, Plecoptera, and Trichoptera, expressed as a percent of the total number of individuals in the sample.
% Baetidae: Relative abundance of all individuals in the insect family Baetidae (Order = Ephemeroptera), expressed as a percent of the total number of individuals in the sample.

% Ephemerellidae: Relative abundance of all individuals in the insect family Ephemerellidae (Order = Ephemeroptera), expressed as a percent of the total number of individuals in the sample.
% Perlidae: Relative abundance of all individuals in the insect family Perlidae (Order = Plecoptera), expressed as a percent of the total number of individuals in the sample.
% Pteronarcyidae: Relative abundance of all individuals in the insect family Pteronarcyidae (Order = Plecoptera), expressed as a percent of the total number of individuals in the sample.
% Brachycentridae: Relative abundance of all individuals in the insect family Brachycentridae (Order = Trichoptera), expressed as a percent of the total number of individuals in the sample.
% Hydropsychidae: Relative abundance of all individuals in the insect family Hydropsychidae (Order = Trichoptera), expressed as a percent of the total number of individuals in the sample.
% Diptera: Relative abundance of all individuals in the insect order Diptera, expressed as a percent of the total number of individuals in the sample.
% Chironomidae: Relative abundance of all individuals in the insect family Chironomidae (Order = Diptera), expressed as a percent of the total number of individuals in the sample.
% Simuliidae: Relative abundance of all individuals in the insect family Simuliidae (Order = Diptera), expressed as a percent of the total number of individuals in the sample.
% Odonata: Relative abundance of all individuals in the insect order Odonata, expressed as a percent of the total number of individuals in the sample.
% Coleoptera: Relative abundance of all individuals in the insect order Coleoptera, expressed as a percent of the total number of individuals in the sample.
% Oligochaeta: Relative abundance of all individuals in the class Oligochaeta, expressed as a percent of the total number of individuals in the sample.

FUNCTIONAL GROUP COMPOSITION

% Filterers: The relative abundance of all individuals in a sample whose ***primary*** feeding mechanism is to filter suspended fine particulates, expressed as a percentage of the total number of individuals in the sample.
% Gatherers: The relative abundance of all individuals in a sample whose ***primary*** feeding mechanism is to gather deposited fine particulates, expressed as a percentage of the total number of individuals in the sample.
% Predators: The relative abundance of all individuals in a sample whose ***primary*** feeding mechanism is to pierce or engulf other invertebrates, expressed as a percentage of the total number of individuals in the sample.
% Scrapers: The relative abundance of all individuals in a sample whose ***primary*** feeding strategy is to scrape attached periphyton and other particulates, expressed as a percentage of the total number of individuals in the sample.

% Shredders: The relative abundance of all individuals in a sample whose ***primary*** feeding mechanism is to shred coarse particulate organic matter (CPOM), expressed as a percentage of the total number of individuals in the sample.
% Piercer-Herbivore: The relative abundance of all individuals in a sample whose ***primary*** feeding mechanism is to pierce vegetation (filamentous algae and other), expressed as a percentage of the total number of individuals in the sample.
% Unclassified: The relative abundance of all individuals in a sample whose ***primary*** feeding mechanism is unknown or unclassified, expressed as a percentage of the total number of individuals in the sample.
Filterer Richness: The total number of distinctly identifiable taxa in a sample whose ***primary*** feeding mechanism is to filter suspended fine particulates.
Gatherer Richness: The total number of distinctly identifiable taxa in a sample whose ***primary*** feeding mechanism is to gather deposited fine particulates.
Predator Richness: The total number of distinctly identifiable taxa in a sample whose ***primary*** feeding mechanism is to pierce or engulf other invertebrates.
Scraper Richness: The total number of distinctly identifiable taxa in a sample whose ***primary*** feeding strategy is to scrape attached periphyton and other particulates.
Shredder Richness: The total number of distinctly identifiable taxa in a sample whose ***primary*** feeding mechanism is to shred CPOM.
Piercer-Herbivore Richness: The total number of distinctly identifiable taxa in a sample whose ***primary*** feeding mechanism is to pierce vegetation (filamentous algae and other).
Unclassified: The total number of distinctly identifiable taxa in a sample whose ***primary*** feeding mechanism is unknown or unclassified.

<u>DIVERSITY/EVENNESS MEASURES</u>

Shannon-Wiener H’ (log2): A classic community diversity index, calculated using log base 2.
Shannon-Wiener H’ (log e): The same classic community diversity index, calculated using log base e.
Shannon-Wiener H’ (log 10): The same classic community diversity index, calculated using log base 10.
Margalef's Richness: An index of community diversity.
Pielou’s J’: An index of community evenness. Values range up to 1.0. Higher values indicate a more even community.
Simpson’s Heterogeneity: A measure of the concentration of taxa. The simplest of diversity measures, this give the probability that two individuals randomly sampled from a community will be of the same taxon.

<u>STRESSOR IDENTIFICATION INDICES</u>

Hilsenhoff Biotic Index (HBI): An index of community tolerance to organic pollution. Values range from 0–10, with higher values indicating more organic influence at a site.

The index is influenced primarily by organic enrichment, but other factors including temperature and sediment also have an influence. It is a weighted average of values assigned to each species present in a sample. Different agencies may use different values for each species. ***EcoAnalysts' default values are those currently (2001) in use in USEPA Region 10. If you wish to have your local values used, you should contact us to re-run the Metric Output using your preferred tolerance values.***

Metals Tolerance Index (MTI): An index of community tolerance to metal contamination, primarily copper and similar acting metals. As with the HBI, values range from 0-10, with higher values indicating a possible effect due to metal contaminants. Values used for this calculation are those currently in use by Montana DEQ.

Fine Sediment Biotic Index (Summed): An index of fine sediment impact at a site. Developed for nearly 100 wide-ranging taxa in the western USA (Relyea et al. 2000). Each taxon is assigned a tolerance value, and the summed value for all taxa present in a sample is compared to….

Fine Sediment Biotic Index (Averaged): The values used by Relyea et al. (2000) are averaged for the sample. This is a modification of Relyea's index and is included for evaluation purposes only.

Fine Sediment Biotic Index (Weighted Average): A weighted average of the sediment tolerance values is calculated in a manner identical to the HBI and MTI. This is another modification of Relyea's index and is included for evaluation purposes only.

Temperature Preference Metric (Average): According to work recently done by Darren Brandt of Idaho DEQ (Brandt 2001), nearly 200 of the most common taxa in Idaho have been rated according to their preferred temperature. An average value is calculated for all taxa in a sample that have been assigned ratings (unrated taxa are not included). This value can then be used to reliably predict average summertime stream temperature within 1.5 degrees Celsius.

Temperature Preference Metric (Weighted Average): This is a modification of Brandt's temperature metric, whereby a weighted average is calculated in a manner identical to HBI and MTI. It is included for evaluation purposes only.

DEQ MBI: This is a multimetric index calculated by Idaho DEQ that may be applicable to neighboring streams outside Idaho. The index is ecoregion-specific. The MBI is not the same as the Stream Macroinvertebrate Index (SMI) that has recently been developed by Idaho DEQ.

<u>KARR IBI</u>

This is a multimetric index of biotic integrity developed for streams in the Puget Lowlands area. EcoAnalysts provides this index calculation for those contracts that specifically request it. The index consists of 10 biological metric components. Raw values for each metric are ranked to a 1,3,5 scale and the ranks are summed. The total IBI score can range from a low of 10 to a high of 50. Component metrics include: total taxa richness, Ephemeroptera richness, Plecoptera richness, Trichoptera richness, intolerant taxa richness, clinger taxa richness, long-lived taxa richness, percent tolerant individuals, percent predator, and percent dominant 3 taxa. This section of the Metric Output lists only those component metrics not previously listed. They are:

Long-lived Taxa Richness: The total number of taxa in a sample that require more than one year to complete their life cycle. These taxa must overwinter in the stream and are exposed to any effects of human disturbance that may occur during the winter season. They are not usually found in ephemeral streams or streams prone to severe flooding.

Clinger Taxa Richness: The total number of taxa in a sample having morphological adaptations allowing them to hold on to ("cling to") smooth, stable substrates in flowing water. Clinger taxa are sensitive to sediment deposition, which can fill in their preferred habitat found in the crevices between rocks in the streambed.

Intolerant Taxa Richness: The number of taxa in a sample identified as intolerant to disturbance. Usually this represents 5-10% of all the taxa in a region, as the remainder are either moderately or very tolerant. Typically this includes those taxa with HBI values of 8 or higher. Increased disturbance will decrease the number of tolerant taxa present at a site.

% Tolerant Individuals: The relative abundance of all individuals in a sample having HBI values of 8 or greater, expressed as a percentage of the total number of individuals in the sample. Although tolerant taxa may be found in many sites, they do not usually become dominant unless a disturbance removes intolerant taxa. The tolerant taxa can then dominate a community and fill in the niches left as intolerant taxa disappear.

LAKE METRICS

If your samples were from a lake, or other lentic environment, EcoAnalysts will include the following metrics in your data output:

% Orthocladiinae: Relative abundance of all individuals in the subfamily Orthocladiinae (Family = Chironomidae), expressed as a percent of the total number of individuals in the sample.

Orthocladiinae Richness: Total number of identifiably distinct taxa in the subfamily Orthocladiinae.

% Chironomini: Relative abundance of all individuals in the tribe Chironomini (Family = Chironomidae), expressed as a percent of the total number of individuals in the sample.

Chironomini Richness: Total number of identifiably distinct taxa in the tribe Chironomini.

%Tanytarsini: Relative abundance of all individuals in the tribe Tanytarsini (Family = Chironomidae), expressed as a percent of the total number of individuals in the sample.

%Tanytarsus: Relative abundance of all individuals in the genus *Tanytarsus* sp. (Family = Chironomidae), expressed as a percent of the total number of individuals in the sample.

%Chironomus: Relative abundance of all individuals in the genus *Chironomus* sp. (Family = Chironomidae), expressed as a percent of the total number of individuals in the sample.
%Dicrotendipes: Relative abundance of all individuals in the genus *Dicrotendipes* sp. (Family = Chironomidae), expressed as a percent of the total number of individuals in the sample.
%Dicrotendipes+Chironomus: Combined relative abundance of all individuals in the genera *Dicrotendipes* sp. and *Chironomus* sp., expressed as a percent of the total number of individuals in the sample.
%Corbicula: Relative abundance of all individuals in the genus *Corbicula* sp. (Bivalvia: Corbiculidae), expressed as a percent of the total number of individuals in the sample.
%Manayunka speciosa: Relative abundance of all individuals of the species *Manayunkia speciosa* (Polychaeta: Sabellidae), expressed as a percent of the total number of individuals in the sample.
Average Abundance Per Taxon: The total number of individuals in a sample divided by the total number of taxa in the sample.
% Intolerant: Relative abundance of all individuals in the sample that have a tolerance value of 2 or less.
%Non-Insect: Relative abundance of all individuals in the sample that are not in the class Insecta, expressed as a percent of the total number of individuals in the sample.
%Crustacea: Relative abundance of all individuals in the sample that are crustaceans, expressed as a percent of the total number of individuals in the sample.
%Mollusca: Relative abundance of all individuals in the sample that are mollusks, expressed as a percent of the total number of individuals in the sample.
%Crustacea+Mollusca: Combined relative abundance of all individuals in the sample that are either crustaceans or mollusks, expressed as a percent of the total number of individuals in the sample.
%Non-Chironomidae: Relative abundance of all individuals in the sample that are not in the insect family Chironomidae, expressed as a percent of the total number of individuals in the sample.

LITERATURE CITED

Brandt, D. 2001. Temperature response regressions for 162 common macroinvertebrate taxa and supporting documentation. Idaho DEQ, Boise, ID. 90pp.

Relyae, C.D., G.W. Minshall, R.J.Danehy. 2000. Stream insects as bioindicators of fine sediment. Watershed Management 2000 Conference.

APPENDIX B

NELAP LABORATORY ACCREDITATION

Texas Commission on Environmental Quality

NELAP-Recognized Laboratory Accreditation is hereby awarded to

Atkins Environmental Toxicology Laboratory

888 West Sam Houston Parkway South, Suite 110
Houston, TX 77042-1917

in accordance with Texas Water Code Chapter 5, Subchapter R, Title 30 Texas Administrative Code Chapter 25, and the National Environmental Laboratory Accreditation Program.

The laboratory's scope of accreditation includes the fields of accreditation that accompany this certificate. Continued accreditation depends upon successful ongoing participation in the program. The Texas Commission on Environmental Quality urges customers to verify the laboratory's current location(s) and accreditation status for particular methods and analyses (www.tceq.texas.gov/goto/lab). Accreditation does not imply that a product, process, system or person is approved by the Texas Commission on Environmental Quality.

Certificate Number: T104704202-15-8
Effective Date: 10/1/2015
Expiration Date: 9/30/2016

Executive Director Texas Commission on Environmental Quality

Texas Commission on Environmental Quality

NELAP - Recognized Laboratory Fields of Accreditation

Atkins Environmental Toxicology Laboratory

888 West Sam Houston Parkway South, Suite 110
Houston, TX 77042-1917

Certificate:	**T104704202-15-8**
Expiration Date:	**9/30/2016**
Issue Date:	**10/1/2015**

These fields of accreditation supercede all previous fields. The Texas Commission on Environmental Quality urges customers to verify the laboratory's current accreditation status for particular methods and analyses.

Matrix: ***Non-Potable Water***

Method EPA 1000.0

Analyte	**AB**	**Analyte ID**	**Method ID**
Chronic toxicity	TX	3325	10252605

Method EPA 1002.0

Analyte	**AB**	**Analyte ID**	**Method ID**
Chronic toxicity	TX	3325	10253006

Method EPA 1003.0

Analyte	**AB**	**Analyte ID**	**Method ID**
Chronic toxicity	TX	3325	10253200

Method EPA 1006.0

Analyte	**AB**	**Analyte ID**	**Method ID**
Chronic toxicity	TX	3325	10253802

Method EPA 1007.0

Analyte	**AB**	**Analyte ID**	**Method ID**
Chronic toxicity	TX	3325	10254009

Method EPA 2000.0

Analyte	**AB**	**Analyte ID**	**Method ID**
Acute toxicity	TX	3300	10264809

Method EPA 2006.0

Analyte	**AB**	**Analyte ID**	**Method ID**
Acute toxicity	TX	3300	10216407

Method EPA 2007.0

Analyte	**AB**	**Analyte ID**	**Method ID**
Acute toxicity	TX	3300	10216009

Method EPA 2021.0

Analyte	**AB**	**Analyte ID**	**Method ID**
Acute toxicity	TX	3300	10215404

Texas Commission on Environmental Quality

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888 West Sam Houston Parkway South, Suite 110
Houston, TX 77042-1917

Certificate: T104704202-15-8
Expiration Date: 9/30/2016
Issue Date: 10/1/2015

These fields of accreditation supercede all previous fields. The Texas Commission on Environmental Quality urges customers to verify the laboratory's current accreditation status for particular methods and analyses.

Matrix: ***Solid & Chemical Materials***

Method ASTM E1367

Analyte	AB	Analyte ID	Method ID
Toxicity	TX	10338	ASTM E1367-03

Method ASTM E1688a

Analyte	AB	Analyte ID	Method ID
Bioaccumulation	TX	10339	ASTM E1688-00a

Method ASTM E1706

Analyte	AB	Analyte ID	Method ID
Toxicity	TX	10338	ASTM E1706-05

Method EPA 600-R-99-064

Analyte	AB	Analyte ID	Method ID
Bioaccumulation	TX	10339	EPA 600-R-99-064
Toxicity	TX	10338	EPA 600-R-99-064

Method EPA 821-R-02-012

Analyte	AB	Analyte ID	Method ID
Acute toxicity	TX	3300	EPA 821-R-02-012

Method EPA 821-R-02-013

Analyte	AB	Analyte ID	Method ID
Chronic toxicity	TX	3325	EPA 821-R-02-013

Method EPA 821-R-02-014

Analyte	AB	Analyte ID	Method ID
Chronic toxicity	TX	3325	EPA 821-R-02-014

Method EPA 823-B-98-004

Analyte	AB	Analyte ID	Method ID
Toxicity	TX	10338	EPA 823-B-98-004

APPENDIX C

CHAIN OF CUSTODY FORM FOR BENTHIC COMMUNITY ANALYSIS

EcoAnalysts, INC.

EcoAnalysts, Inc.
1420 S. Blaine St., Suite 14
Moscow, ID 83843
(208) 882-2588

EcoAnalysts Project# :	*(EcoA use)*
Company:	
Total # of Samples this project:	
# of Samples Shipped this shipment:	

	#of Containers	**Stream**	**Site #**	**Rep**	**Device Type**	**Device Dimensions**	**Habitat**	**Collection Date**	**Notes**
example	*2jars*	*Burro Creek*	*36554*	*T2*	*Kick*	*N/A*	*Riffle*	*4/26/2005*	*Priority Sample.*
1									
2									
3									
4									
5									
6									
7									
8									
9									
10									
etc.									
Insert more rows here.									

Relinquished By/ Date: ____________________ **Condition:** ____________________

Company:

Received By/ Date: ____________________ **Condition:** ____________________

Company:

Relinquished By/ Date: ____________________ **Condition:** ____________________

Company:

Received By/ Date: ____________________ **Condition:** ____________________

Company:

Relinquished By/ Date: ____________________ **Condition:** ____________________

Company:

Received By/ Date: ____________________ **Condition:** ____________________

Company:

APPENDIX F

RATIONALE FOR USE OF A BACKGROUND UPPER PREDICTION LIMIT (UPL) IN LIEU OF BIOLOICALLY DERIVED PROTECTIVE CONCENTATIONL LEVEL (PCL)

January 16, 2017

Rationale for Use of a Background Upper Prediction Limit (UPL) in Lieu of Biologically-derived Protective Concentration Level (PCL)

A Site-Specific Ecological Risk Assessment (SSERA) Work Plan for the development of a site-specific arsenic benthic PCL for Stewart Creek Sediments (PBW, 2016) was approved by TCEQ in April 2016. This Work Plan outlined a study that relied on three main components:

- Collection of sediment samples with arsenic concentrations in three concentrations ranges: low (< default PCL of 21.4 mg/kg), medium (> 21.4 mg/kg – 70 mg/kg) and high (70 mg/kg – 100 mg/kg);
- Evaluation of the benthic community structures in samples from the three arsenic concentration range categories; and
- Performance of laboratory toxicity tests using the sediment from the three arsenic concentration range categories.

As described below, another critical aspect of this study is the identification of reference streams that have similar flow, stream bed, and sediment characteristics to the Stewart Creek study area. Sampling of the sediments in Stewart Creek and in the two reference creeks began in May 2016; however, the target range of arsenic concentrations in Stewart Creek was not found. Specifically, of the 14 samples taken from Stewart Creek only two samples exceeded the default PCL of 21.4 mg/kg (26.4 mg/kg and 32.2 mg/kg) and no samples contained arsenic at levels for the high concentration range category. Figure 1 shows the data and the locations of the sediment samples from Stewart Creek. This figure also shows the sample data from 2014 that was used to target these areas for sampling in 2016.

Because only relatively low concentrations of arsenic were found in the sampled sediment, analysis of the benthic community structure and the toxicity testing could not be correlated with medium and high arsenic concentration ranges as planned. This circumstance made completion of the proposed biological testing irrelevant and the planned development of a site-specific sediment benthic PCL for arsenic unachievable via this methodology.

An important aspect of the study was to be the comparison of the toxicity and benthic community structure to samples taken from reference creeks. With TCEQ approval, two creeks located in the general vicinity, the Stewart Creek Tributary and Cottonwood Branch, were chosen to represent similar aquatic habitat but without any impacts from site activities. Analysis of arsenic in sediment from 20 samples taken in the two creeks (10 in each creek) showed arsenic concentrations ranging from 1.34 mg/kg to 42.2 mg/kg (Table 1). Figures 2 and 3 show the sample locations of the sediment reference samples and the data.

An upper prediction limit (UPL) was estimated as the representative background (reference) arsenic concentration for Stewart Creek using the reference creek data. Since 2004, TCEQ has recommended the use of a UPL as the interval estimator for the determination of a background (natural or anthropogenic) concentration, for constituents of concern, upgradient or upstream of an affected property. This is particularly applicable for small datasets where a single high or low value can greatly influence the variability. TCEQ also recommends statistical means comparisons or, if approved, alternative statistical methods between background and site (i.e., a certain stretch of Stewart Creek) concentrations (§350.79(2)(B)). For Stewart Creek, both a UPL and a means comparison can follow §350.51(l) that requires evaluating all assumptions for selected statistical methods and requires a minimum number of site-specific background samples.

A UPL was computed using EPA's ProUCL program version 5.1.002 (released May 2016, https://www.epa.gov/landresearch/proucl-software). Attachment 1 shows the ProUCL output. An arsenic UPL with 95% confidence for the reference creek data is 39.7 mg/kg and is proposed as the sediment arsenic PCL in lieu of the default benthic based PCL of 21.4 mg/kg.

An arsenic UPL of 39.7 mg/kg was selected as the representative background concentration based on the arsenic data appearing to follow a gamma distribution (the value is outlined in the ProUCL output in Attachment 1). To be conservative, the Wilson Hilferty (WH) approximate gamma UPL was selected, rather than the Hawkins Wixley (HW) approximate gamma UPL simply because it was lower; neither approximate gamma UPL is more preferable.

Goodness of Fit tests were performed to test whether data follow a normal, gamma, or lognormal distribution. The Shapiro Wilk and Lilliefor's Goodness of Fit tests were used to determine whether data follow a normal or lognormal distribution. The Anderson-Darling (A-D) and Kolmogorov Smirnov (K-S) tests performed to determine whether data follow a gamma distribution. The tests evaluating normality indicated conflicting results—the Shapiro Wilk test indicated the data do not follow a normal distribution, but Lilliefor's test (a test preferable for larger data sets, with 50 or more samples) indicated the data follow a normal distribution. Both sets of tests evaluating lognormality and the gamma distribution indicated that the arsenic data follow a lognormal and gamma distribution, respectively. The ProUCL guidance recommends "…when a data set follows a distribution using all goodness-of-fit (GOF) tests (e.g., distribution A) and also follows an approximate distribution using one of the available GOF tests [i.e., the two GOF test results conflict] (e.g., distribution B), it is preferable to use the distribution A" (Singh et al., 2015a, p.50). Furthermore, EPA guidance documents (such as, Singh et al., 2002; Singh et al., 2015 a,b) discourage using the assumption of a lognormality and prefer the assumption of a gamma distribution. So the arsenic data appear to follow gamma distribution, most reasonably. And so, a gamma UPL was selected as the representative background concentration, and hence the site-specific arsenic sediment PCL.

References:

Singh, A., A.K. Singh, and R.J. Iaci. (2002). Estimation of the Exposure Point Concentration Term Using a Gamma Distribution. EPA/600/R-02/084. October 2002. Technology Support Center for Monitoring and Site Characterization, Office of Research and Development, Office of Solid Waste and Emergency Response, U.S. Environmental Protection Agency, Washington, D.C.

Singh, A., A. Singh. (2015a). ProUCL Version 5.1 Technical Guide. EPA/600/R-07/041, October 2015. Office of Research and Development, U.S. Environmental Protection Agency, Washington, D.C.

Singh, A., R. Maichle. (2015b). ProUCL Version 5.1 User Guide. EPA/600/R-07/041, October 2015. Office of Research and Development, U.S. Environmental Protection Agency, Washington, D.C.

Table 1
Stewart Creek SSERA
Metals Analytical Data

Stewart Creek Site-Specific Ecological Risk Assessment (SSERA)
Metals Analytical Data
Frisco, Texas

Analyte:			**Arsenic**	**Lead**	**Cadmium**
TRRP Critical Sediment PCL:			**21.4**	**81.9**	**2.985**
Units:			**mg/kg**	**mg/kg**	**mg/kg**
Creek	**Sample ID**	**Date Sampled**			
Stewart Creek	2016-SSERA-SED-06	05/12/2016	11.7	15.8	0.586
	2016-SSERA-SED-07	05/12/2016	26.4	12.8	1.46
	2016-SSERA-SED-08	05/13/2016	8.41	17.3	0.189 J
	2016-SSERA-SED-09	05/13/2016	7.17	23.0	0.357 J
	2016-SSERA-SED-10	05/13/2016	10.4	20.4	0.511
	2016-SSERA-SED-11	05/13/2016	7.79	15.3	0.437
	2016-SSERA-SED-12	05/14/2016	19.9	24.2	1.06
	2016-SSERA-SED-13	05/14/2016	32.2	9.30	1.34
	2016-SSERA-SED-14	05/14/2016	15.4	23.3	1.37
	2016-SSERA-SED-15	05/14/2016	9.91	29.4	0.749
	2016-SSERA-SED-16	05/14/2016	14.8	25.5	1.17
	2016-SSERA-SED-17	05/14/2016	14.6	39.0	1.16
	2016-SSERA-SED-18	05/15/2016	15.2	13.9	1.08
	2016-SSERA-SED-19	05/15/2016	8.24	33.3	0.675
Stewart Creek Tributary (Reference Creek)	2016-SSERA-SED-01	05/10/2016	25.0	4.82	0.175 J
	2016-SSERA-SED-02	05/11/2016	24.3	9.22	0.291
	2016-SSERA-SED-03	05/11/2016	39.6	21.6	0.0882 J
	2016-SSERA-SED-04	05/11/2016	17.5	8.76	0.441
	2016-SSERA-SED-05	05/12/2016	42.2	10.3 J	0.319
	2016-SSERA-SED-20	07/06/2016	18.5	11.1	1.82
	2016-SSERA-SED-21	07/06/2016	18.0	9.13	1.83
	2016-SSERA-SED-22	07/06/2016	12.4	8.75	1.23
	2016-SSERA-SED-23	07/06/2016	16.4	9.60	1.73
	2016-SSERA-SED-24	07/06/2016	16.0	9.63	2.03
Cottonwood Branch (Reference Creek)	2016-SSERA-SED-25	07/06/2016	14.6	7.60	2.33
	2016-SSERA-SED-26	07/06/2016	3.72	15.4	1.52
	2016-SSERA-SED-27	07/06/2016	6.53	14.6	2.36
	2016-SSERA-SED-28	07/06/2016	7.67	28.8	2.67
	2016-SSERA-SED-29	07/06/2016	5.13	13.5	2.00
	2016-SSERA-SED-30	07/06/2016	1.34 J	13.5	1.43
	2016-SSERA-SED-31	07/06/2016	4.29	14.3	1.86
	2016-SSERA-SED-32	07/06/2016	3.79	15.8	2.14
	2016-SSERA-SED-33	07/06/2016	6.33	2.79	1.04
	2016-SSERA-SED-34	07/06/2016	8.20	3.94	1.47

NOTES

Indicates that the detection exceeds the default benthic PCL.

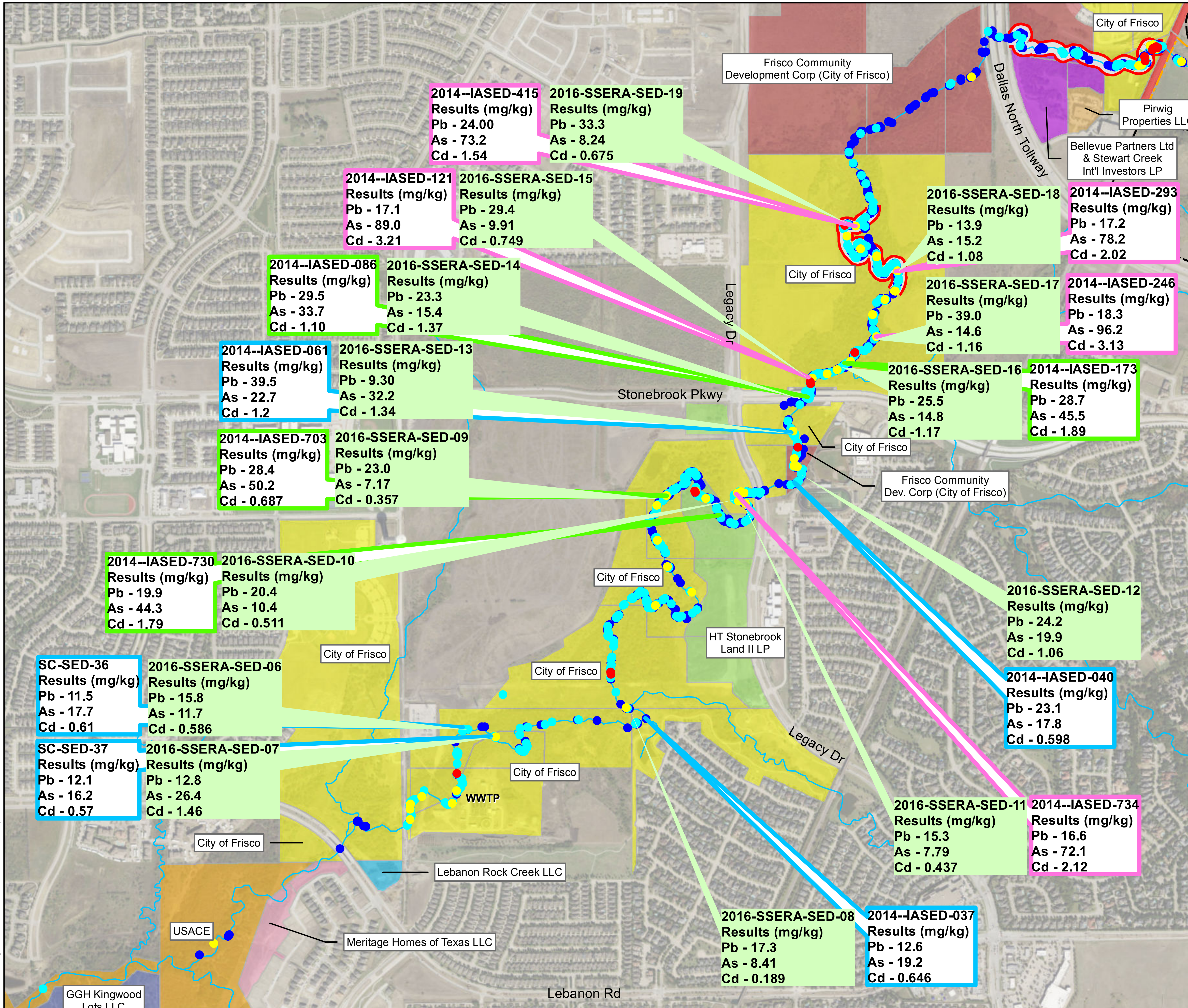
J - Estimated. The analyte was detected and identified. The associated numerical value is the approximate concentration of the analyte in the sample.

mg/kg - Milligrams per kilogram

PCL - Protective Concentration Level

TRRP - Texas Risk Reduction Program

Figures



LEGEND

Arsenic Concentrations in Sediment (milligrams per kilogram)

- > 100
- > 50
- > 21.4
- ≤ 21.4
- Stewart Creek Centerline
- Areas of Stewart Creek Exempt from 2016 Sampling
- Former Operating Plant
- Undeveloped Buffer Property
- Bellevue Partners Ltd & Stewart Creek International Investors LP
- Burlington Northern Santa Fe RR Co Property Tax Department (NO ACCESS)
- City of Frisco
- Frisco Community Development Corp (City of Frisco)
- GGH Kingwood Lots LLC
- HT Stonebrook Land II LP
- Lebanon Rock Creek LLC
- Meritage Homes of Texas LLC
- Pirwig Properties LLC
- USACE

High Arsenic Concentration | Medium Arsenic Concentration | Low Arsenic Concentration

REFERENCE
1. SITE FEATURES - GOLDER, 2014 AND 2016
2. AERIAL IMAGERY - SOURCE: ESRI, DIGITALGLOBE, GEOEYE, EARTHSTAR GEOGRAPHICS, CNES/AIRBUS DS, USDA, USGS, AEX, GETMAPPING, AEROGRID, IGN, IGP, SWISSTOPO, AND THE GIS USER COMMUNITY

0.2 0.1 0 0.2 Miles

CLIENT
EXIDE TECHNOLOGIES

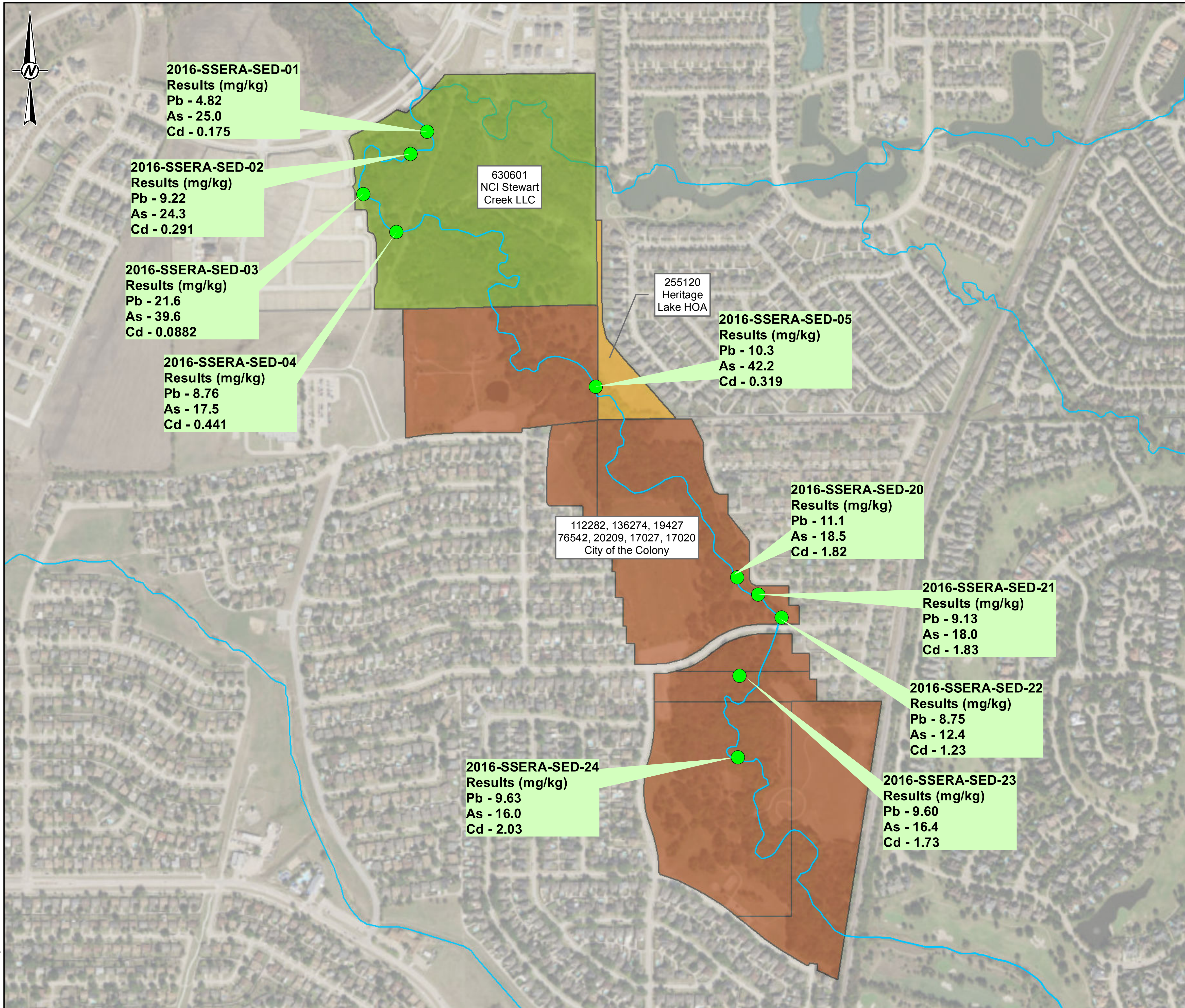
PROJECT
SSERA REPORT

TITLE
ARSENIC CONCENTRATIONS IN STEWART CREEK SEDIMENT – 2014-2016 DATA

CONSULTANT
Golder Associates

YYYY-MM-DD	2017-01-11
PREPARED	JWT
DESIGN	AM
REVIEW	EPW
APPROVED	AMF

PROJECT No.	CONTROL	Rev.	FIGURE
13-02086	1302086ZE001.mxd	0	1



LEGEND

- 2016 SSERA Sample Location
- Creek Centerline
- Heritage Lake HOA
- NCI Stewart Creek LLC
- City of the Colony

Analyte	mg/kg
Lead (Pb) Benchmark	35.8
Lead (Pb) PCL	81.9
Cadmium (Cd) Benchmark	0.99
Cadmium (Cd) PCL	2.98
Arsenic (As) Benchmark	9.79
Arsenic (As) PCL	21.4

NOTES
1. IA - INTERIM ACTION
2. SSERA - SITE SPECIFIC ECOLOGICAL RISK ASSESSMENT
3. PCL - PROTECTIVE CONCENTRATION LEVELS
4. WWTP - WASTE WATER TREATMENT PLANT

REFERENCE
1. SITE FEATURES - GOLDER, 2014
2. AERIAL IMAGERY - SOURCE: ESRI, DIGITALGLOBE, GEOEYE, EARTHSTAR GEOGRAPHICS, CNES/AIRBUS DS, USDA, USGS, AEX, GETMAPPING, AEROGRID, IGN, IGP, SWISSTOPO, AND THE GIS USER COMMUNITY

600 300 0 600
Feet

CLIENT
EXIDE TECHNOLOGIES

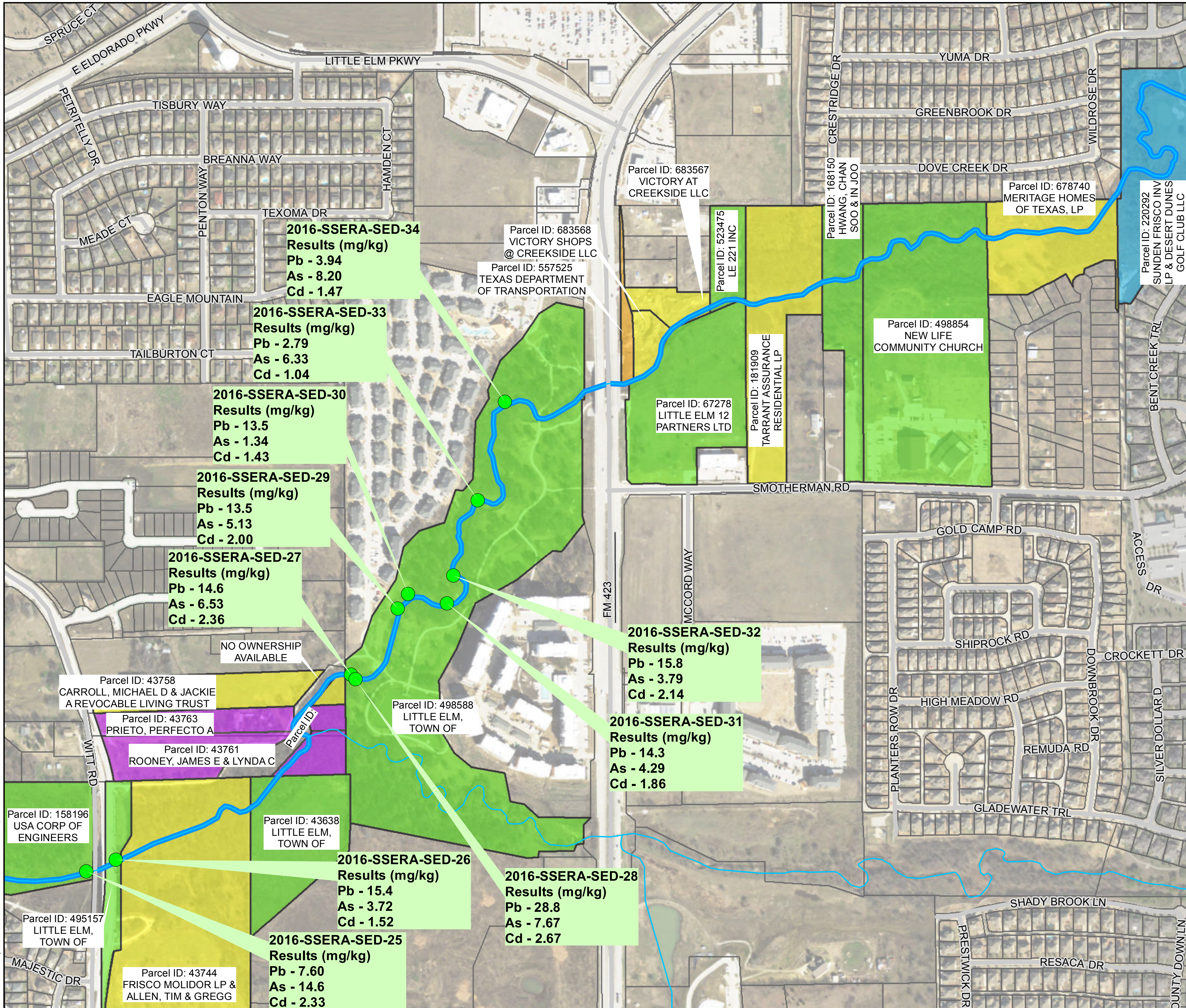
PROJECT
SSERA REPORT

TITLE
METALS CONCENTRATIONS IN STEWART CREEK TRIBUTARY SEDIMENT – 2016 SSERA DATA

CONSULTANT
Golder Associates

YYYY-MM-DD	2016-08-29
PREPARED	JWT
DESIGN	AM
REVIEW	EPW
APPROVED	AMF

PROJECT No.	CONTROL	Rev.	FIGURE
13-02086	1302086ZE002.mxd	0	2



LEGEND

- Creek Centerline
- Cottonwood Branch

Access Status

- Denied Access
- Exide To Review
- Granted Access
- In Progress
- No Contract Confirmed (Letter Sent)

Analyte	mg/kg
Lead (Pb) Benchmark	35.8
Lead (Pb) PCL	81.9
Cadmium (Cd) Benchmark	0.99
Cadmium (Cd) PCL	2.98
Arsenic (As) Benchmark	9.79
Arsenic (As) PCL	21.4

NOTES

1. SSERA - SITE SPECIFIC ECOLOGICAL RISK ASSESSMENT

REFERENCE

1. HYDROGRAPHY - USGS NATIONAL HYDROGRAPHY DATASET
2. PARCELS - DENTON COUNTY VIA DENTONCOUNTY.COM, 2015
3. AERIAL IMAGERY - SOURCE: ESRI, DIGITALGLOBE, GEOEYE, EARTHSTAR GEOGRAPHICS, CNES/AIRBUS DS, USDA, USGS, AEX, GETMAPPING, AEROGRID, IGN, IGP, SWISSTOPO, AND THE GIS USER COMMUNITY

500 250 0 500
Feet

CLIENT
EXIDE TECHNOLOGIES

PROJECT
SSERA REPORT

TITLE
METALS CONCENTRATIONS IN COTTONWOOD BRANCH SEDIMENT – 2016 SSERA DATA

CONSULTANT

Golder Associates

YYYY-MM-DD	2016-08-29
PREPARED	JWT
DESIGN	AM
REVIEW	EPW
APPROVED	AMF

PROJECT No.	CONTROL	Rev.	FIGURE
13-02086	1302086ZE003.mxd	0	3

IF THIS MEASUREMENT DOES NOT MATCH WHAT IS SHOWN, THE SHEET HAS BEEN MODIFIED FROM ANSI B

January 16, 2017

Attachment – ProUCL Output

Background Statistics for Uncensored Full Data Sets

Arsenic

General Statistics

Total Number of Observations	20	Number of Distinct Observations	20
Minimum	1.34	First Quartile	6.03
Second Largest	39.6	Median	13.5
Maximum	42.2	Third Quartile	18.13
Mean	14.58	SD	11.39
Coefficient of Variation	0.781	Skewness	1.207
Mean of logged Data	2.358	SD of logged Data	0.884

Critical Values for Background Threshold Values (BTVs)

Tolerance Factor K (For UTL)	2.396	d2max (for USL)	2.557

Normal GOF Test

Shapiro Wilk Test Statistic	0.873	**Shapiro Wilk GOF Test**
5% Shapiro Wilk Critical Value	0.905	Data Not Normal at 5% Significance Level
Lilliefors Test Statistic	0.165	**Lilliefors GOF Test**
5% Lilliefors Critical Value	0.192	Data appear Normal at 5% Significance Level

Data appear Approximate Normal at 5% Significance Level

Background Statistics Assuming Normal Distribution

95% UTL with 95% Coverage	41.86	90% Percentile (z)	29.17
95% UPL (t)	34.75	95% Percentile (z)	33.31
95% USL	43.69	99% Percentile (z)	41.07

Gamma GOF Test

A-D Test Statistic	0.281	**Anderson-Darling Gamma GOF Test**
5% A-D Critical Value	0.756	Detected data appear Gamma Distributed at 5% Significance Level
K-S Test Statistic	0.112	**Kolmogorov-Smirnov Gamma GOF Test**
5% K-S Critical Value	0.197	Detected data appear Gamma Distributed at 5% Significance Level

Detected data appear Gamma Distributed at 5% Significance Level

Gamma Statistics

k hat (MLE)	1.704	k star (bias corrected MLE)	1.482
Theta hat (MLE)	8.551	Theta star (bias corrected MLE)	9.834
nu hat (MLE)	68.18	nu star (bias corrected)	59.29
MLE Mean (bias corrected)	14.58	MLE Sd (bias corrected)	11.97

Background Statistics Assuming Gamma Distribution

$\boxed{\text{95\% Wilson Hilferty (WH) Approx. Gamma UPL} \quad 39.71}$		90% Percentile	30.46
95% Hawkins Wixley (HW) Approx. Gamma UPL	41.37	95% Percentile	38.12
95% WH Approx. Gamma UTL with 95% Coverage	55.28	99% Percentile	55.43
95% HW Approx. Gamma UTL with 95% Coverage	59.73		
95% WH USL	59.85	95% HW USL	65.3

Lognormal GOF Test

Shapiro Wilk Test Statistic	0.961	**Shapiro Wilk Lognormal GOF Test**
5% Shapiro Wilk Critical Value	0.905	Data appear Lognormal at 5% Significance Level
Lilliefors Test Statistic	0.143	**Lilliefors Lognormal GOF Test**

5% Lilliefors Critical Value	0.192	Data appear Lognormal at 5% Significance Level	

Data appear Lognormal at 5% Significance Level

Background Statistics assuming Lognormal Distribution

95% UTL with 95% Coverage	87.9	90% Percentile (z)	32.82
95% UPL (t)	50.62	95% Percentile (z)	45.25
95% USL	101.3	99% Percentile (z)	82.65

Nonparametric Distribution Free Background Statistics

Data appear Approximate Normal at 5% Significance Level

Nonparametric Upper Limits for Background Threshold Values

Order of Statistic, r	20	95% UTL with 95% Coverage	42.2
Approx, f used to compute achieved CC	1.053	Approximate Actual Confidence Coefficient achieved by UTL	0.642
		Approximate Sample Size needed to achieve specified CC	59
95% Percentile Bootstrap UTL with 95% Coverage	42.2	95% BCA Bootstrap UTL with 95% Coverage	42.2
95% UPL	42.07	90% Percentile	26.46
90% Chebyshev UPL	49.58	95% Percentile	39.73
95% Chebyshev UPL	65.44	99% Percentile	41.71
95% USL	42.2		