Indoor Air Quality Investigation Sampling and Analysis Plan Addendum Bozeman Landfill

Bozeman, Montana

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Indoor Air Quality Investigation
Sampling and Analysis Plan Addendum
Bozeman Landfill

Bozeman, Montana

Tetra Tech

August 2013

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LIST OF ACRONYMS

APH	Air Phase Hydrocarbon
bgs	below ground surface
CMA	Corrective Measures Assessment
COC	Chain-of-Custody
DEQ	Montana Department of Environmental Quality
DQO	Data Quality Objective
EPA	U.S. Environmental Protection Agency
inHg	Inches of Mercury
JSA	Job Safety Analysis
LEL	Lower Explosive Limit
LFG	Landfill Gas
MADEP	Massachusetts Department of Environmental Protection
PVC	Polyvinyl Chloride
QA/QC	Quality Assurance/Quality Control
RL	Reporting Limit
RSL	Regional Screening Level
SAP	Sampling and Analysis Plan
SIM	Select-Ion Monitoring
SOP	Standard Operating Procedure
VOC	Volatile Organic Compound

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1.0 INTRODUCTION

This document includes a Sampling and Analysis Plan (SAP) Addendum and Job Safety Analysis (JSA) for continued investigation of soil gas in the vicinity of the Bozeman Landfill. This project is funded by the City of Bozeman.

This SAP Addendum was prepared to guide continued work for the Bozeman Landfill indoor air quality investigation and is intended to be used in conjunction with the June 27, 2013 SAP (Tetra Tech, 2013a). The indoor air quality investigation is being conducted in response to the discovery of elevated concentrations of volatile organic compounds (VOCs) in soil gas near the southern border of the Bozeman Landfill and the neighboring community (Tetra Tech, 2013b). Additional sampling methods will be employed to determine whether VOCs found in residences along the southern boundary of the Landfill originate from beneath the structures or if they are background concentrations from typical consumer products and attached garages typical of the neighborhood. This SAP Addendum specifically addresses more direct sampling methods such as sub-slab soil gas sampling and depressurization system air sampling.

This SAP Addendum is organized as follows: *Section 1* presents the Introduction; *Section 2* presents a Site Summary; *Section 3* the Investigation Objectives, and; *Section 4* presents the Methodology. **Appendix A** presents the SAP Addendum JSA.

1.1 Objectives

The primary objective for sub-slab soil gas and depressurization system air sampling is to identify what concentrations of VOCs and petroleum hydrocarbons exist beneath residences.

In conjunction with indoor air sampling (Tetra Tech, 2013a), sub-slab soil gas and depressurization system air sampling provides a measure of control to make informed conclusions regarding indoor air quality by comparing concentrations of contaminants from beneath the home to concentrations in the indoor air. The collection of sub-slab samples is the preferred investigative method to determine the concentrations of VOCs present in soil gas beneath a residence because it provides the most direct form of measurement (DEQ, 2011).

Tetra Tech proposes to conduct one or both of these techniques in selected homes in the neighborhood along the southern border of the Bozeman Landfill during the course of this investigation and to confirm whether existing or future mitigation systems provide sufficient depressurization to remove VOCs from the subsurface pore space.

2.0 SITE SUMMARY UPDATE

The City of Bozeman purchased approximately 200 acres for use as a landfill in 1969. The location of the Bozeman Landfill is shown in **Figure 1**. Disposal of garbage at the site began soon afterwards. Class II, III, and IV wastes have been accepted. The majority of waste has been class II and includes decomposable wastes such as municipal and household solid waste including food, paper, cardboard, cloth, glass metal, and plastics. Class II designation prohibits the disposal of regulated hazardous wastes.

Garbage disposal was conducted in an unlined waste cell between 1969 and 1995. The unlined waste cell is in the southeastern corner of the landfill property. The cell is approximately 32 acres and contains waste up to approximately 100 feet in thickness.

Garbage disposal was conducted in a second waste cell between 1995 and 2008. The second cell has an impermeable liner with a leachate collection system connected to the municipal sewer. The second cell is approximately 12 acres and up to approximately 100 feet in thickness.

Groundwater contamination issues were identified in the late 1970s. Groundwater monitoring wells were installed and a groundwater monitoring program was implemented in 1981. Monitoring results have shown that groundwater quality has been impacted primarily by VOCs originating from the unlined waste cell. The network of groundwater monitoring wells is shown in **Figure 2**.

Bridger Creek Golf Course opened with adjacent residential development in 1994. The residential subdivisions surrounding the Bridger Creek Golf Course are within City of Bozeman limits and are connected to City water and sewer.

A Corrective Measures Assessment (CMA) was prepared in 1995 to address VOC impacts to groundwater at the Bozeman Landfill site. Various cleanup alternatives were evaluated in the CMA with the preferred alternative being an active landfill gas (LFG) extraction system installed in the unlined, closed cell. The LFG extraction system was installed and operating by 1997 and continuously operates, at present. The system collects approximately 1,100 pounds of VOCs per year from the extracted LFG. The VOCs are thermally destroyed using a candlestick flare. The network of LFG extraction wells is shown in **Figure 2**.

Groundwater monitoring is being conducted twice per year, in June and December. Monitoring results indicate a southwesterly groundwater flow. Three groundwater wells (wells LF-2, LF-3, and MW-10) and one spring (McIlhattan Seep) are monitored downgradient and outside of the landfill property. These off-site monitoring stations indicate that groundwater is impacted with low concentrations of VOCs including tetrachloroethene and trichloroethene. The concentration of these VOCs have not met or exceeded regulatory action levels in groundwater outside of the landfill property since June 2003. There are two monitoring wells in the western portion of the residential neighborhood south of the landfill property (wells LF-2 and LF-3 shown in **Figure 2**). These wells indicate that depth to groundwater in the neighborhood is approximately 14 feet.

Methane monitoring is being conducted on a monthly basis to confirm that no explosive concentrations of methane are leaving the landfill property. In addition, oxygen, carbon dioxide, and nitrogen are measured. The monitoring also determines the effectiveness of the operating LFG extraction system. Methane has intermittently exceeded regulatory limits (25 percent of the lower explosive limit (LEL)) in several of the perimeter gas probes during springtime when soil has the greatest amount of moisture. Methane is now rarely detected in the perimeter gas monitoring probes following repairs to the LFG extraction well-heads and near continuous operation of the system. Location of the perimeter gas monitoring probes is shown in **Figure 2**.

Routine monitoring activities, attendant to LFG extraction system upgrades, detected additional VOCs in soil gas near the south boundary of the landfill in late 2012. In this initial investigation, gas samples were collected from four perimeter gas monitoring probes near the south boundary of the landfill property. Samples were analyzed for 62 VOC constituents by TO-15 analysis. Chloroform; benzene; trichloroethene; tetrachloroethene; ethylbenzene; and 1,2,4-trimethylbenzene were detected above U.S. Environmental Protection Agency (EPA) Residential Regional Screening Levels (RSL) for air. Concerned with potential health impacts to residents in the neighborhood south of the landfill, the City of Bozeman then conducted follow-up investigations in March through May 2013, in a residential neighborhood south of the landfill and again, along the south property boundary of the landfill. The analyte list included those parameters that had exceeded EPA RSLs in the first investigation and some additional petroleum hydrocarbon compounds and degradation compounds of tetrachloroethene. The subsequent investigations resulted in the detection of chloroform, benzene, trichloroethene, tetrachloroethene, and ethylbenzene exceeding EPA RSLs in a residential neighborhood south of the landfill. In addition, 1,2,4-trimethylbenzene and vinyl chloride were detected in excess of EPA RSLs in one soil gas location within the landfill property but near the south property boundary. The source of VOCs in soil gas is believed to be from the unlined closed cell and groundwater impacted with VOCs originating from the unlined closed cell.

Since June 2013 Tetra Tech has conducted indoor air monitoring in all but two residences along Saint Andrews Drive, Turnberry Court, and Caddie Court (**Figure 3**). Laboratory analytical results have shown concentrations of carbon tetrachloride, 1,4-dioxane, 1,2,4-trimethylbenzene, vinyl chloride, benzene, 1,2-dichloroethane, trichloroethane, tetrachloroethene, ethyl benzene, m,p-xylenes, and chloroform above EPA RSLs in residential indoor air. It is unclear whether these contaminants have originated from soil gas beneath the homes, whether they are caused by background concentrations from typical consumer products and attached garages, or if they are a combination of both scenarios.

3.0 INVESTIGATIVE OBJECTIVES

This section describes the objectives of the indoor air quality investigation and sub-slab soil gas and depressurization system air sampling. It identifies the study area boundaries, contaminants of potential concern, data quality objectives, and quality assurance and quality control (QA/QC) considerations for the project.

3.1 Project Objectives

The objectives of this indoor air quality investigation are to identify whether the vapor intrusion exposure pathway is being completed in residences in the project area. This will be completed by ascertaining whether VOCs are present in residential indoor air and sub-slab soil gas.

3.2 Contaminants of Potential Concern

Tetra Tech has identified the following contaminants of potential concern at or above laboratory analytical reporting limits in residences along the southern boundary of the Bozeman Landfill.

- Freon 12
- Chloromethane
- Bromomethane
- Chloroethane
- Freon 11
- Freon 113
- Acetone
- 2-Propanol
- Carbon Disulfide
- Methylene Chloride
- Hexane
- 2-Butanone (Methyl Ethyl Ketone)
- Tetrahydrofuran
- Carbon Tetrachloride
- 1,4-Dioxane
- 4-Methyl-2-pentanone
- 2-Hexanone
- Chlorobenzene
- Styrene
- Cumene
- Propylbenzene
- 1,2,4-Trimethylbenzene
- Cyclohexane
- Vinyl Chloride
- 1,1-Dichloroethane
- cis-1,2-Dichloroethene
- 1,1,1-Trichloroethane
- Benzene
- 1,2-Dichloroethane
- Trichloroethene
- Toluene
- Tetrachloroethene
- Ethyl Benzene
- m,p-Xylene

- o-Xylene
- trans-1,2-Dichloroethene
- Methyl tert-butyl ether
- Chloroform

3.3 Scope of Work

The scope of work for this investigation was developed based on analytical data from previous soil gas investigations conducted in October 2012, April 2013, and May 2013 (Tetra Tech, 2013b, 2013c, 2013d), and indoor air sampling conducted during June and July 2013 (Tetra Tech, 2013a). Tetra Tech proposes to complete the following as part of the scope of work for this project.

- Conduct sub-slab soil gas sampling in the neighborhood along the southern boundary of the landfill which includes Saint Andrews Drive, Turnberry Court, Caddie Court, and one home along Story Mill Road. Potentially conduct sub-slab soil gas sampling in homes along Augusta Drive, the Bridger Creek Golf Course clubhouse, and the residence along McIlhatten Road if the risk vapor intrusion exists.
- Conduct depressurization system air sampling in the neighborhood along the southern boundary of the landfill which includes Saint Andrews Drive, Turnberry Court, Caddie Court, and one home along Story Mill Road. Potentially conduct depressurization system air sampling in homes along Augusta Drive, the Bridger Creek Golf Course clubhouse, and the residence along McIlhatten Road if the risk vapor intrusion exists.
- Conduct indoor air sampling in homes along Augusta Drive and the Bridger Creek Golf Course clubhouse and the residence along McIlhatten road if the potential for vapor intrusion exists.

The investigative work will be performed immediately beginning on the date of this SAP Addendum. Work will continue as needed and will be executed with direction from the City of Bozeman. **Figure 3** presents the location of residences along Augusta Drive, the Bridger Creek Golf Course clubhouse, and the residence along McIlhatten Road.

3.4 Quality Assurance/Quality Control

Where applicable, Tetra Tech will follow procedures outlined in the Montana Department of Environmental Quality (DEQ) Vapor Intrusion Guide (DEQ, 2011). This SAP provides details on the collection frequency requirements for each QA/QC sample, as well as other QA/QC requirements and procedures for this project.

3.4.1 Data Validation

Data validation consists of completing a review of raw analytical data. The laboratory will validate raw data using EPA Contract Laboratory program National Functional Guidelines and according to specific analytical method requirements. The analytical laboratory will perform data validation on raw analytical data prior to preparing a final analytical report.

Data evaluation consists of completing a review of laboratory analytical reports that have undergone internal laboratory validation. The objective of data validation and evaluation is to identify any unreliable or invalid laboratory measurements and qualify data for interpretive use. The data evaluation will include review of field QA/QC data and additional review of qualifiers assigned to the data by the analytical laboratory. Additional qualifiers will be assigned to the data as necessary based on, but not limited to, precision and accuracy of results, blank contamination, and holding time exceedances.

Tetra Tech project personnel will complete a preliminary data evaluation according to the checklists outlined in the June 27, 2013 SAP (Tetra Tech, 2013a) and as data becomes available so it can be quickly distributed to potentially impacted residents. A more thorough Level II evaluation will be completed by Tetra Tech personnel once analysis of a given dataset has been completed (i.e. one round of indoor air monitoring for a given neighborhood).

The checklists provide a guide for review of the laboratory and field procedures and data collected. The review will evaluate whether the following were completed according to SAP requirements, EPA guidelines and/or method specifications:

- Chain-of-custody procedures;
- Holding times;
- Laboratory QA/QC (i.e. review of results for method blanks, control samples, calibration results, duplicates, and review detection limits are met);
- Lab data evaluation will also consider instrument tuning and system performance, calibration results, and detection limits; and,
- Field QA/QC (sample handling, duplicates, and field and equipment blanks).

Knowing the limitations of the data assists the data user when making interpretations. Data with limitations are usable for evaluation as long as the limitations are considered. Professional judgment is required and will be used to assess the impact of field QC on the overall quality and usability of the field data.

3.5 Project Organization

The overall project manager for the investigation is Mr. Dustin Johnson, P.E., City Engineer for the City of Bozeman. Mr. Mark Pearson is the Tetra Tech Project Manager. Mr. Nicholas Sovner is the Tetra Tech staff scientist assigned to work with Mr. Pearson to assist in executing field activities and project administration. Mr. Kirk Miller is the Tetra Tech Senior Project Manager and will provide technical oversight, assistance with public outreach, and will ensure field crews adhere to Tetra Tech health and safety protocols. Mr. Brooks Quaintance is the Tetra Tech field technician that will assist with field sampling efforts.

Tetra Tech may employ or subcontract additional staff that specialize in techniques such as mitigation system design, data validation, vapor intrusion sampling methods, or mitigation system installation. These personnel will work directly under Mark Pearson or Kirk Miller.

3.6 Data Quality Objectives

Data quality objectives (DQOs) for this investigation were developed to ensure data quality and to define procedures for data collection. The DQO process allows Tetra Tech to evaluate the level of data quality required for specific data collection activities.

3.6.1 Problem Statement

The City of Bozeman is interested in addressing the issue of vapor intrusion in residences along the southern border of the Bozeman Landfill which encompasses the neighborhood along Saint Andrews Drive, Turnberry Court, and Caddie Court, Augusta Drive and McIlhatten Road. Media affected by contaminants of potential concern at the Site may include groundwater, subsurface soil, soil gas, and residential and commercial indoor air. This investigation is necessary to confirm or deny the presence of environmental contamination at the above-mentioned neighborhoods and to determine the extent and magnitude of any impacts to indoor air.

3.6.2 Decision Statement

The indoor air quality investigation will involve collecting environmental data to confirm or deny the presence of VOCs in residential and commercial indoor air. Collected media will include indoor air from residences and a commercial building (the Bridger Creek Golf Course clubhouse). Tetra Tech will evaluate available data and make decisions based on the following decision statements:

- Do structures in the selected area contain VOC concentrations that are believed to have originated from the subsurface and meet or exceed federal indoor air quality regulatory standards?
- What actions will be necessary after the completion of the investigation to confirm the findings and what mitigation measures (if any) are necessary?

3.6.3 Site Conceptual Model

VOCs have been detected in soil gas and indoor air at the south boundary of the landfill and along Saint Andrews Drive, Turnberry Court, and Caddie Court. The presence of these VOCs may be due to landfill gas escaping from closed waste cells, or from impacted groundwater that has leached from these waste cells. The Bozeman Landfill is known to contain household and commercial waste products that may contain sources of VOCs (see *Section 2.0*).

The primary exposure pathway of concern for potential Site contaminants includes inhalation of soil gas within residences and a commercial building. The secondary exposure pathway of concern includes dermal contact or ingestion of groundwater impacted with VOCs through the use of private irrigation wells within the project area. Residences are known to utilize the municipal water supply for domestic use which is not believed to be impacted. Several of the residences and the golf course are known to use irrigation wells to water lawns and landscaping.

Sampling activities will investigate potential exposures at the Site. Indoor air exposure will be investigated through the direct sampling of indoor air and soil gas in and beneath participating residences. Groundwater will also be sampled in irrigation wells at participating residences.

3.6.4 Temporal Boundaries

The horizontal study boundary for the Site includes the residences shown in **Figure 3**. The vertical study boundary includes first encountered groundwater which is believed to exist at its shallowest elevation: 14 feet below ground surface (bgs) in the western part of the Site, soil gas from a maximum depth of approximately 30 feet bgs to its shallowest depth of approximately at or less than 6 feet bgs, and indoor air within the selected residences.

3.6.5 Decision Rule

Federal regulatory standards will be used to evaluate residential indoor air quality and State water quality standards will be used to evaluate groundwater quality.

- EPA Region 9, May 2013 RSLs for Residential and Industrial Air will be used to determine whether analytical results from air samples pose a health risk (EPA, 2013);
- Circular DEQ-7 October 2012 Montana Numeric Water Quality Standards for groundwater will be used to determine whether analytical results from water samples pose a health risk (DEQ, 2012b).

If the investigative work indicates that impacted media is present at concentrations above the applicable screening levels, standards, or guidelines for a particular reuse scenario, then further assessment or remediation may be required.

3.6.6 Tolerable Limits of Decision Errors

Decision errors are incorrect conclusions about a site caused by using data that are not representative of site conditions due to sampling or analytical error. Limits on decision error are typically established to control the effect of sampling and measurement errors on decisions regarding a site, thereby reducing the likelihood that an incorrect decision is made. The null hypothesis is that a site is contaminated. A false positive decision error is one that decides a site is clean when, in actuality, it is not clean. A false negative decision error is one that decides a site requires cleanup when, in actuality, it requires no cleanup. False positive and negative decision errors should be minimized as much as possible during this project.

This SAP Addendum identifies specific field and laboratory methods and sampling strategies that reduce sampling error. The total study error will be reduced by collecting an appropriate number of environmental samples deemed necessary by the assessment team that are intended to represent the range of concentrations present at the Site. The sampling program is designed to reduce sampling error by specifying an adequate number and distribution of samples to meet project objectives.

4.0 METHODOLOGY

Tetra Tech will continue to collect indoor air samples on an as-needed basis to determine the extent of the soil gas plume associated with the Bozeman Landfill. Sub-slab soil gas and depressurization system air will also be sampled in conjunction with indoor air samples where necessary.

4.1 Indoor Air Sampling

Indoor air will continue to be sampled in potentially affected residences and at the golf course clubhouse utilizing the methodology described in *Section 4.1* of the June 27, 2013 SAP (Tetra Tech, 2013a).

4.2 Methane Monitoring

In addition to air sample analysis for APH and VOCs, field personnel will monitor methane gas while inside each structure. A *Gas Data LMSx Multigas Analyzer* will be used to screen for methane gas and will be measured in nitrogen percent by volume.

Residents will be notified if methane is detected. The regulatory limit of methane is 25 percent of LEL.

4.3 Sub-Slab Soil Gas Sampling

4.3.1 Direct Sub-Slab Sampling

Sub-slab soil gas samples will be collected in structures where a basement slab covers 50 percent or more of the building footprint. Once sub-surface utilities and radiant heat piping has been identified, a small hole approximately 0.75 to 1.25 inches will be drilled through the concrete slab in a discrete location acceptable to the property owner. Either a temporary or a permanent sampling port will be installed to collect soil gas from 3 to 4 inches beneath the slab. The sampling probe is constructed of 0.125 or 0.25 inch stainless steel or other inert tubing (i.e. Teflon) and stainless steel compression fittings, with a permeable probe tip. Silica sand will be used to fill the annular space around the probe tip and bentonite clay will be used to fill the borehole annular space between the probe tubing and the sub-slab gravel from the top of the probe tip to the base of the concrete foundation. Quick drying concrete will be used for permanent sampling ports, and will be allowed to dry for at least 30 minutes before collecting the sample. Three volumes of air will be purged from the probe tubing prior to collecting a sample using a *Gilian BDX Abatement Air Sampler* pump operating at approximately 200 liters per minute. Leak detection procedures and general sampling protocols will be followed according to the DEQ Montana Vapor Intrusion Guide (DEQ, 2011).

4.3.2 Depressurization System Air Sampling

If a depressurization system already exists in a structure identified to potentially have vapor intrusion of VOCs occurring, then air samples may be collected from within the system itself. This will be performed by drilling a small hole in the polyvinyl chloride (PVC) as close to the concrete slab as practical for collecting routine samples. A stainless steel ball valve and a brass flange and nipple will be installed to create a permanent sampling port on the PVC pipe.

4.3.3 Sample Collection

Sub-slab soil gas samples will be collected in individually certified 6 liter Summa Canisters supplied by Eurofins Air Toxics, Inc. laboratory in Folsom, California. Canisters will come with a pre-set vacuum and will be supplied with a flow controller set to 200 milliliters per minute, or a ½ hour collection time. Prior to collecting samples the vacuum pressure will be checked with the laboratory supplied vacuum gage in each canister to ensure canisters were shipped with an acceptable pressure (greater than -25 inches mercury (inHg)). Samples will be collected when canister vacuum pressures are between -10 and -5 inHg.

Samples will be shipped overnight delivery back to Air Toxics within 24 hours after sample collection to ensure that 30 day holding time limits are met. Summa Canisters and assembly components will be returned in the shipping containers in which they were received.

4.4 Analytical Methods

Air samples will be analyzed for Air Phase Hydrocarbons (APH) according to the Massachusetts Department of Environmental Protection (MADEP) December 2009 method and EPA Method TO-15 and TO-15 Select Ion Monitoring (SIM). The analyses will include 38 constituents. **Table 1** displays target detection limits in order to reach the May 2013 EPA RSLs. Additional analytical methods may include radon and methane depending on Eurofins Air Toxics, Inc. capabilities.

4.5 Field Methods

Field crews will mobilize from Tetra Tech’s Bozeman (851 Bridger Drive, Suite 6) and Helena (303 Irene Street), Montana offices. The Bozeman office will serve as the support facility during field activities and the center for supplies and equipment. The following sections describe Tetra Tech’s methods for conducting field investigations.

Indoor air samples will be collected prior to any sub-slab sample collection. Immediately after the indoor air sampling is completed, field crews will begin to collecting either sub-slab or depressurization system samples.

4.5.1 Field Notes

All field observations will be recorded in project-dedicated field notebooks in accordance with SOP-12, Sample Documentation. The standard project field books that will be used by all personnel will be the equivalent of the pocket-sized “Rite in the Rain”® All-weather Transit Notebook No. 301 (4-5/8 x 7” with numbered pages). Each field book will be labeled on the front cover with the project name, beginning entry date, final entry date, and general contents of notes (e.g. indoor air sampling).

The field team leader is responsible for recording information such as weather conditions, field crew members, visitors to the site, samples collected, the date and time of sample collection, procedures used, any field data collected, problems encountered in the field, and any deviations from this SAP. The field notebook will be the master log of all field activities. As such, in addition to standard field notations, information entered into the field notebook will also include: the number and type of measurements taken, the location and types of data recorded by another means (i.e. field forms), the number of samples collected each day, sample packaging and shipping summaries (i.e. number and type of shipping containers, shipping carrier, date and time of shipment, etc.), and any other information relevant to the field event. Field personnel will also provide a sketch showing the position of sample locations relative to site features and structures, or record this information on a copy of the building plans. All field forms/field notes will be completed prior to leaving the Site.

4.5.2 Sample Shipping and Chain-of-Custody Procedures

After samples have been collected, they will be maintained under strict chain-of-custody protocols. The field sampling personnel will complete a chain-of-custody record (COC) form for each shipping container (i.e., laboratory supplied shipping boxes) of samples to be delivered to the laboratory for analysis. The sampler is responsible for initiating and filling out the COC form. The COC will be signed by the sampler when he or she relinquishes the samples to anyone else. A copy of the COC can be found in *Appendix E* of the June 27, 2013 SAP (Tetra Tech, 2013a).

The sampling personnel whose signature appears on the COC is responsible for the custody of the samples from the time of sample collection until custody of the samples is transferred to a designated laboratory, a courier, or to another project employee for the purpose of transporting the sample to the designated laboratory. The sample is considered to be in custody when the sample is: (1) in the direct possession of the sample custodian; (2) in plain view of the sample custodian; or (3) is securely locked in a restricted-access area by the sample custodian.

Custody is transferred when both parties to the transfer complete the portion of the COC under "Relinquished by" and "Received by." Signatures, printed names, company names, dates and times are required. Upon transfer of custody, the sampling personnel who relinquished the samples will retain the third sheet (pink copy) of the COC. It is not necessary for courier personnel to sign the COC.

Samples will be shipped at the end of the sampling event, or sooner if required to meet holding time requirements. Upon receipt by the laboratory, the samples will be inspected for sample integrity. The COC will be reviewed to verify completeness. Any discrepancies between the COC and sample labels and any problems noted upon sample receipt will be communicated immediately to Tetra Tech. The laboratory will be responsible for following their internal custody procedures from the time of sample receipt until sample disposal.

4.5.3 Quality Assurance/Quality Control Sampling Requirements

The project manager and field staff will coordinate the field effort and be responsible for QA/QC for the project. The project manager will manage all data for the project once it has been collected. The data will be maintained in the project file in Bozeman, Montana. The project manager and field staff will be responsible for coordinating the project and ensure equipment is ready for use and sample containers have been ordered from the laboratory. The field team leader will be responsible for inspection of field equipment prior to use and periodically over the course of the project. Field personnel will be working near Tetra Tech's Bozeman office. Additional field equipment and tools will be stored at the Bozeman office should field equipment become compromised or damaged. Field personnel will collect QA/QC samples to evaluate precision, accuracy, representativeness, completeness, and comparability. Field personnel will use SOP 13 for guidance.

For every ten indoor air samples, one blind duplicate will be collected (10 percent ratio). Blind duplicates will be collected using a laboratory supplied T assembly component that allows for the simultaneous collection of indoor air samples. Samples will be labeled as if there is an additional floor in the residence and noted in the field book. Duplicates will be submitted to the laboratory for the same analytical methods as the field samples. Duplicates of ambient air samples will not be collected, the frequency at which ambient air samples are collected will serve as a QC measure of precision and accuracy.

A 10 percent ratio will also be applied to the number of blind duplicate groundwater samples. If less than ten samples are collected during each sampling event then only one blind duplicate groundwater sample will be collected. A trip blank and a temperature blank will also be included in each water sample shipment to the laboratory.

5.0 REFERENCES

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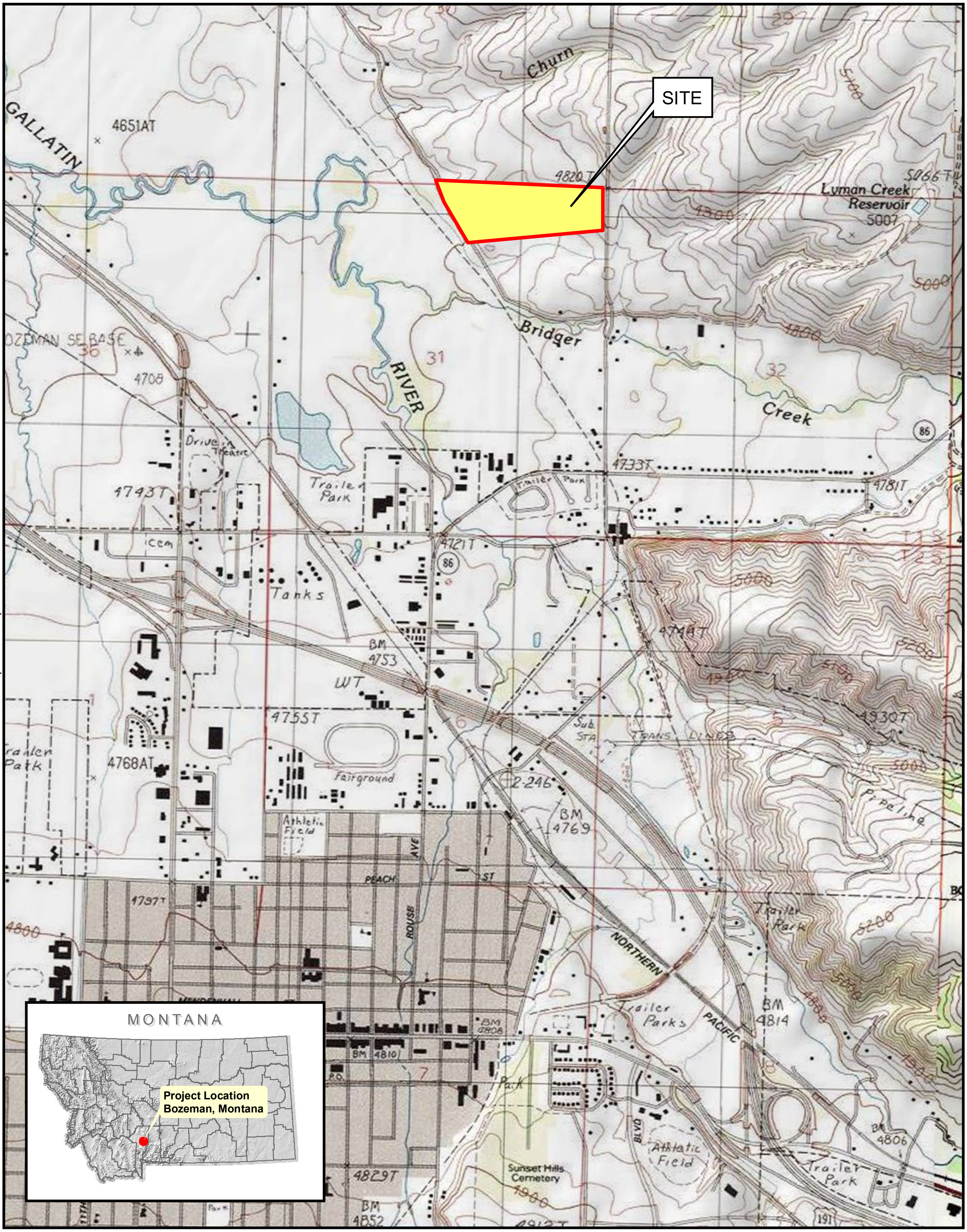
FIGURES

N:\PROJECTS\CITY OF BOZEMAN\Bozeman Landfill\114-710303 - Bozeman Landfill\GIS\ArcMap\Area Map.mxd



Area Map
City of Bozeman Landfill
Bozeman, Montana
August 2013
FIGURE 1

N:\PROJECTS\CITY OF BOZEMAN\Bozeman Landfill\114-710303 - Bozeman Landfill\GIS\ArcMap\Site Map.mxd

N
W E
S

0 250 500
Feet

Datum: NAD83
StatePlane Montana

Methane Monitoring Point
Groundwater Monitoring Well
Soil Gas Probe
New Residential Construction

Notes: Soil gas probes were installed in March and May, 2013; all probe locations are between the sidewalk and street curb in the public right-of-way or on Bozeman Landfill property.

Site Map
City of Bozeman Landfill
Bozeman, Montana
August 2013
FIGURE 2

N:\PROJECTS\CITY OF BOZEMAN\Bozeman Landfill\114-7103030 - Bozeman Landfill\GIS\ArcMap\F-03 Building Identification Map.mxd

N
W E
S

0 180 360
Feet

Datum: NAD83 StatePlane Montana

- Methane Monitoring Point
- Groundwater Monitoring Well
- Soil Gas Probe
- New Residential Construction
- AI-1 Residential Codes for Samples

Building Identification Map
City of Bozeman Landfill
Bozeman, Montana
August 2013
FIGURE 3

TABLES

Table 1
Summary of Air Sample Reporting Limits vs. EPA Residential RSLs
August 2013 Sampling and Analysis Plan Addendum
Bozeman Landfill
Bozeman, Montana

Compound	RL (µg/m³)	EPA RSL (µg/m³)
Freon 12	0.49	100
Chloromethane	0.21	94
Bromomethane	1.9	5.2
Chloroethane	1.3	10000
Freon 11	0.56	730
Freon 113	0.77	31300
Acetone	1.2	32000
2-Propanol	1.2	7300
Carbon Disulfide	1.6	730
Methylene Chloride	0.69	96
Hexane	0.35	730
2-Butanone (Methyl Ethyl Ketone)	1.5	5200
Tetrahydrofuran	1.5	2090
Carbon Tetrachloride	0.63	0.406
1,4-Dioxane	0.36	0.316
4-Methyl-2-pentanone	0.41	3130
2-Hexanone	2.0	31
Chlorobenzene	0.46	52
Styrene	0.42	1000
Cumene	0.49	420
Propylbenzene	0.49	1000
1,2,4-Trimethylbenzene	0.49	7.3
Cyclohexane	0.34	6260
Vinyl Chloride	0.026	0.16
1,1-Dichloroethane	0.081	1.52
cis-1,2-Dichloroethene	0.079	35
1,1,1-Trichloroethane	0.11	5200
Benzene	0.16	0.31
1,2-Dichloroethane	0.081	0.094
Trichloroethene	0.11	0.43
Toluene	0.075	5210
Tetrachloroethene	0.14	9.4
Ethyl Benzene	0.087	0.97
m,p-Xylene	0.17	104
o-Xylene	0.087	104
trans-1,2-Dichloroethene	0.40	63
Methyl tert-butyl ether	0.36	9.36
Chloroform	0.098	0.11

RL-Reporting Limit
EPA RSL- May 2013 EPA Regional Screening Level for residential air
µg/m³-micrograms per meters cubed
RL exceeds EPA RSL

APPENDIX A
JOB SAFETY ANALYSIS

TETRA TECH
Safety Excellence

Job Safety Analysis (JSA) Form

	JOB/TASK DESCRIPTION	*Vapor Intrusion Sampling*	
	JOB TITLE:	**Bozeman Landfill**	
DATE: 8/6/2013	NEW ☑ REVISED ☐	REQUIRED AND/OR RECOMMENDED PPE:	*Level D: Closed toe work boots, eye protection, hearing protection, leather gloves.*
ANALYSIS BY: (NAMES/TITLES)	*Nick Sovner/Staff Scientist*		
REVIEWED BY:(NAME/TITLE)	*Mark Pearson/Project Manager*		

SEQUENCE OF BASIC JOB STEPS	POTENTIAL HAZARDS	RECOMMENDED ACTION OR PROCEDURE
Select a location to drill.	Observe the potential for unstable objects to fall off elevated surfaces during drilling activities and watch out for tripping hazards. Site location will be in basements so be aware of utilities, animal excrament, spiders, rodents, etc.	Give yourself a clear area to work to prevent tripping hazards while operating a rotohammer drill. Remove any unstable objects from elevated surfaces. Where close-toed shoes and sturdy clothing.
Operate roto-hammer drill.	Contact between drill bit and operator, hearing damage, concrete dust getting into someone's eye, dropping the drill on oneself or other field personnel, tripping while operating the drill.	Use caution while operating the roto-hammer drill. Where appropriate PPE to prevent injury to body, hearing, or eyes. Ensure the work area is clear of tripping or overhead hazards.
Sub-slab sampling.	If using a leak detection system that includes a helium tank be aware of special precautions while using compressed gases and carrying heavy tanks.	Use proper lifting techniques while carrying the helium tank or consider using a dolly. Never transport, store or operate a compressed gas tank on its side. Be careful not to dislodge the regulator from the apex of the tank.
Post sampling cleanup.	Heavy lifting, tripping hazards.	Ensure that the surface and work area is in similar or better condition than it was found to prevent building occupants from tripping over left objects. Use proper lifting techniques when carry heavy tools and equipment from the job site.

Reviewed By: **Date:**

Reviewed By: **Date:**

Reviewed By: **Date:**