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City of Wichita

**Vapor Intrusion Assessment Work Plan
North Industrial Corridor Site
Wichita, Kansas**

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Prepared for:
City of Wichita
Department of Environmental Services
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Work Plan

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Section 1

Introduction

Camp Dresser & McKee Inc. (CDM) has been retained by the City of Wichita to prepare a vapor intrusion (VI) assessment work plan for the North Industrial Corridor (NIC) Site in Wichita, Kansas. This work plan has been prepared as requested by the Kansas Department of Health and Environment (KDHE). The VI assessment will be conducted in accordance with the KDHE's VI guidance document (KDHE 2007) and additional investigative techniques as discussed between CDM, the City of Wichita, and the KDHE.

1.1 Background Information

The NIC Site is located in the north-central portion of the City of Wichita, Sedgwick County, Kansas. The NIC Site consists of approximately 4,011 acres of urban industrial, commercial, recreational, residential, and agricultural property. In 1983, an Environmental Protection Agency (EPA) investigation revealed the presence of volatile organic compounds (VOCs) in groundwater produced from two industrial wells in the area. Subsequent investigations throughout the 1980s and early 1990s revealed widespread VOC contamination in groundwater beneath the NIC Site. The NIC Site was established in 1995 to combine and focus the efforts of three separate environmental investigations (as discussed in the June 2011 NIC Site-wide Groundwater Feasibility Study [FS] (CDM 2011a)). **Figure 1-1** depicts the current Site boundary. The original NIC Site boundary was established by the KDHE in the Settlement Agreement signed in November 1995. The Site boundary has subsequently been changed to include additional areas, maintain consistency with City limits, and eliminate overlap with the nearby Gilbert & Mosley Site.

1.1.1 Land Use

The NIC Site consists of approximately 4,011 acres and was developed from agricultural land over the last century. As of 2004, land use within the Site was comprised as noted below. **Figure 1-2** provides a map showing land use based data in the City's GIS database as of March 2011.

Land Use	Acreage	Percent of Site
Agriculture	339	8.5 %
Parks	57	1.4 %
Schools	9	0.2 %
Hospitals	45	1.1 %
Residential	490	12.2 %
Vacant	149	3.7 %
Commercial/Industrial	2,922	72.8 %
TOTAL	4,011	100.0 %

Residential properties are primarily located in the southeastern and southwestern portions of the Site, generally south of 17th Street. There is also a small residential community consisting of approximately 14 properties located on the west side of Hydraulic and north of 37th Street, west and northwest of the USD 259 property. The majority of the residential properties within the NIC Site consist of low- to moderate-income single-family housing.

The northernmost portions of the NIC Site contain agricultural areas. Commercial / industrial properties are primarily located in the northern portion of the Site between the northern boundary (north of 37th) and 19th Street, and along the Santa Fe/Washington corridor between 2nd Street and 19th Street. A few schools are present within the Site.

1.1.2 Chemicals of Potential Concern

Chemicals of potential concern (COPCs) for Site-wide groundwater, indoor air, surface water, and sediment, as selected based on the findings from the City's Remedial Investigation (RI) (CDM 2007a and CDM 2007b), were discussed in Section 1.5 of the NIC Site-wide Groundwater FS (CDM 2011a). COPCs were also selected for groundwater and soil in the sludge pit areas. **Table 1-1** provides a summary of the COPCs for each of the media. Of the identified COPCs, 10 compounds were identified as Site groundwater target compounds.

- Tetrachloroethene (PCE);
- Trichloroethene (TCE);
- *Cis*-1,2-Dichloroethene (cDCE);
- Vinyl chloride (VC);
- 1,1,1-Trichloroethane (111TCA);
- 1,1-Dichloroethane (11DCA);
- 1,1-Dichloroethene (11DCE);
- Carbon tetrachloride (CT);
- Chloroform (CFM); and
- Benzene (BEN).

These compounds were identified based on frequency of detection, exceedance of maximum contaminant levels (MCLs)/KDHE Tier 2 cleanup goals, extent of contamination, usability in source identification, and importance as a biodegradation product. Of the above compounds, TCE is the most widespread in both extent and mass present, with cDCE and PCE the second and third-most widespread, respectively. The remaining target compounds are fairly localized in extent and

minimal in mass. Because TCE, cDCE, and PCE are the most widespread, a sum of the concentrations of these three compounds has been used to create a contour map showing the anticipated worst extents of NIC Site-wide groundwater contamination for VOCs. The extent of these three COPCs, combined with land use information, has been used to develop a proposed approach for evaluating the VI pathway. Section 2 will discuss sampling location selection in more detail and includes contour maps as appropriate.

1.2 Objectives

The primary goal of the VI assessment is to identify whether vapors emanating from groundwater pose a risk to indoor inhabitants. The specific objectives for the NIC Site are:

1. Evaluate the VI pathway using a phased-approach to target properties most at-risk for a complete pathway, and also evaluate a sampling of properties with less presumed risk, to understand potential VI conditions for the entire NIC Site. Final decisions regarding risk for the VI pathway will be based on comparing analytical results to the KDHE's Tier 2 risk-based indoor air cleanup goals published in Appendix A of the *Risk Based Standards for Kansas RSK Manual* (KDHE 2010) (and discussed in Section 1.4) to assess the potential need for mitigation.
2. Based on the results of the proposed evaluation herein, determine additional actions for other buildings with a potentially complete VI pathway.

1.3 Overview of Investigation

CDM proposes a three-phase strategy to evaluate the VI pathway. The methodologies for these phases are described in Section 2. Overviews of the phases are described below:

Phase 1: Building Selection

- Identification of residences, schools, and daycares that overlie shallow groundwater contamination for the COPCs.
- Division of identified residences into four groups based on estimated combined concentration of PCE, TCE, and cDCE in shallow groundwater underneath buildings: 1-5 micrograms per liter ($\mu\text{g}/\text{L}$), 5-20 $\mu\text{g}/\text{L}$, 20-100 $\mu\text{g}/\text{L}$, >100 $\mu\text{g}/\text{L}$.
- Selection of 25% of residences from the >100 $\mu\text{g}/\text{L}$ group with consideration to spatial distribution across the Site and representativeness of building construction style.
- Selection of 5% of residences from the 20-100 $\mu\text{g}/\text{L}$ group with consideration to spatial distribution across the Site and representativeness of building construction style.

- Selection of 2% of residences from the 5-20 µg/L group with consideration to spatial distribution across the Site and representativeness of building construction style.
- Selection of 1% of residences from the 1-5 µg/L group with consideration to spatial distribution across the Site and representativeness of building construction style.
- Selection of all schools within the four groups and all daycares within the 20-100 µg/L and >100 µg/L groups, and selection of 50% of daycares within the 1-5 µg/L and 5-20 µg/L groups.

Phase 2: Screening Evaluation

- Collect outdoor air samples from 20 ambient air monitoring stations spatially distributed across the NIC Site using passive diffusion samplers deployed for seven days.
- For selected residences, schools, and daycares from Phase 1, perform a simplified building and product inventory to screen for common products known to contain PCE and TCE.
- For selected residences, schools, and daycares from Phase 1, collect indoor air samples using 7-day passive diffusion samplers.
- Compare indoor and outdoor results to the KDHE Tier 2 cleanup goals (discussed in Section 1.4). Submit the results and an evaluation of the data to the KDHE with recommendations for no further action or verification sampling by building.

Phase 3: Verification Sampling:

- Collect five additional outdoor air samples using 7-day passive diffusion samplers to verify the Phase 2 survey.
- Re-sample indoor air at 10% of the buildings from Phase 2 recommended for no further action using 24-hour stainless steel sample canisters to confirm results.
- For buildings requiring verification sampling, perform a detailed building and product inventory at select locations including the use of a portable field gas chromatography/mass spectroscopy (GC/MS) unit to quantitatively identify indoor sources and potential routes of entry for VI.
- Following completion of the detailed inventory, collect sub-slab, crawl space, and indoor air samples using stainless steel canisters.
- Compare verification sampling results to the KDHE Tier 2 cleanup goals (discussed in Section 1.4). Submit the results and an evaluation of the data to the KDHE with recommendations for no further action, mitigation, or additional analysis by

building. In addition, based on the results of the three-phased approach, offer recommendations for evaluating VI at other buildings.

1.4 Regulatory Overview

A regulatory framework for this project has been developed using the following guidance documents:

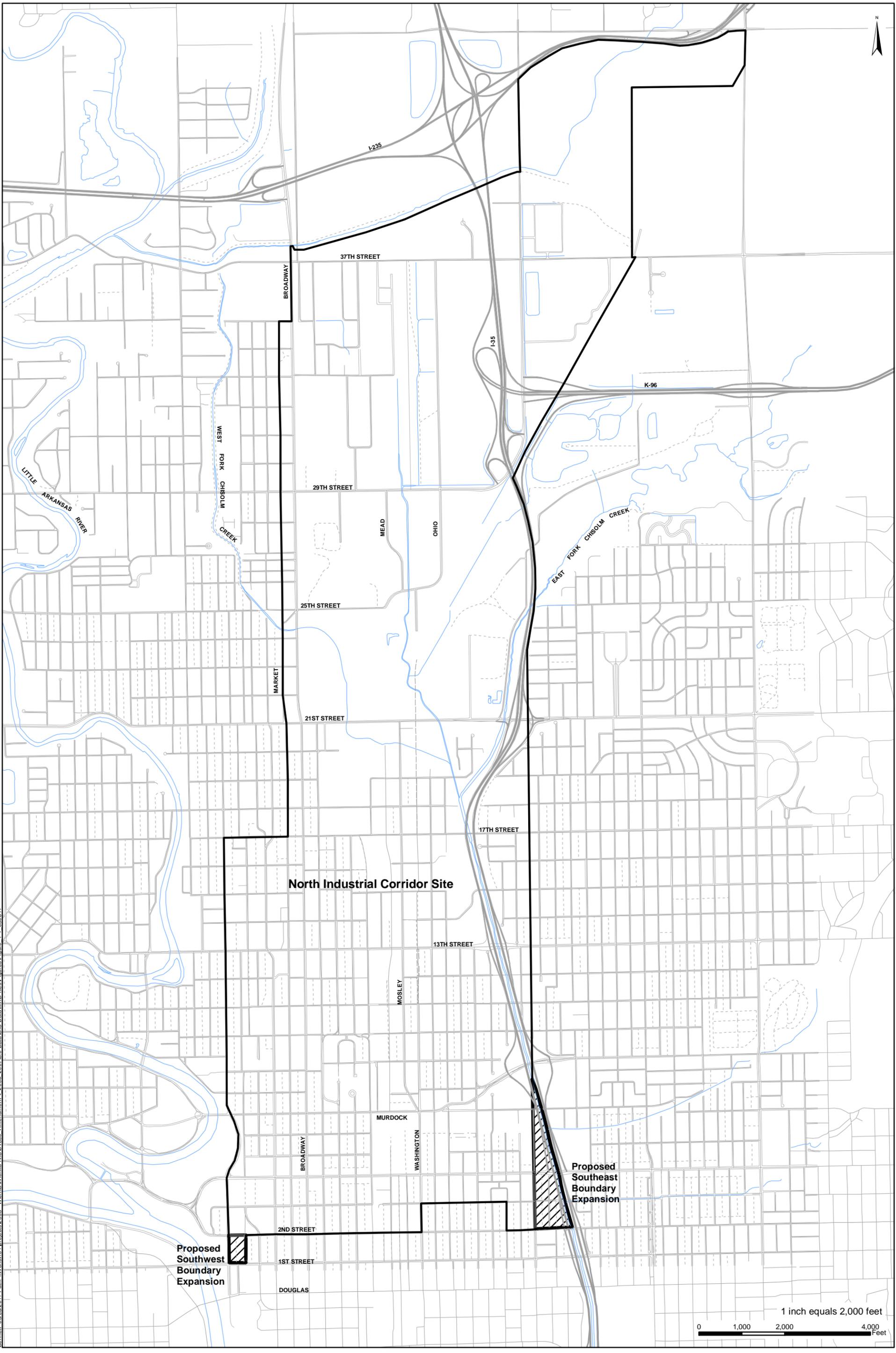
- *Kansas Vapor Intrusion Guidance, Chemical Vapor Intrusion and Residential Indoor Air, June 2007*
- *Risk-Based Standards for Kansas, RSK Manual – 5th Version, October 2010*

The KDHE has established chemical-specific, pre-determined acceptable risk-based cleanup goals for exposure pathways under Tier 2 in its RSK Manual (KDHE 2010). The Tier 2 cleanup goals represent an incremental risk of 1 in 100,000 (1×10^{-5}) for chronic exposure to carcinogens or a hazard quotient of 1.0 for non-carcinogens.

Section 1.1.2 outlined the 10 COPCs for the VI pathway for the NIC Site based on the results of the RI/FS (CDM 2011a, CDM 2007a, and CDM 2007b). The Tier 2 cleanup goals for the COPCs are:

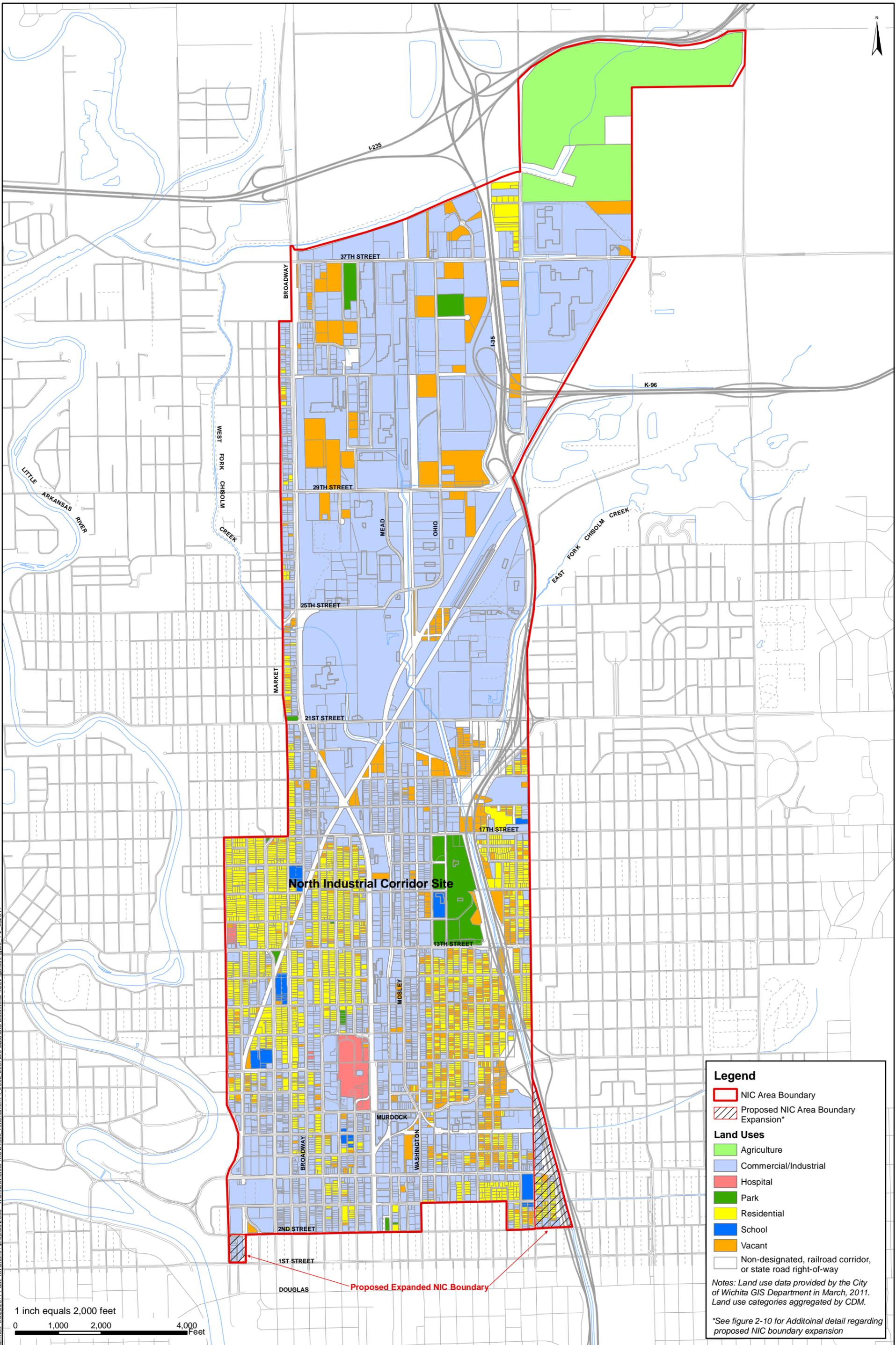
COPC	Tier 2 Cleanup Goal ($\mu\text{g}/\text{m}^3$)
PCE	4.12
TCE	12.2
cDCE	36.5
VC	5.53
111TCA	5,210
11DCA	15.2
11DCE	209
CT	4.06
CFM	1.06
BEN	3.12

The Tier 2 cleanup goals are subject to change based on revision of the RSK Manual by the KDHE.



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**Figure 1-1
North Industrial Corridor (NIC) Site
Site Map**



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Legend

- NIC Area Boundary
- Proposed NIC Area Boundary Expansion*

Land Uses

- Agriculture
- Commercial/Industrial
- Hospital
- Park
- Residential
- School
- Vacant
- Non-designated, railroad corridor, or state road right-of-way

Notes: Land use data provided by the City of Wichita GIS Department in March, 2011. Land use categories aggregated by CDM.

*See figure 2-10 for Additional detail regarding proposed NIC boundary expansion

1 inch equals 2,000 feet
 0 1,000 2,000 4,000 Feet

Figure 1-2
North Industrial Corridor (NIC) Site
Land Use Areas

**Table 1-1
North Industrial Corridor (NIC) Site
Chemicals of Potential Concern¹**

	Groundwater	Indoor Air	Surface Water	Sediment	Sludge Pit Area	
					Groundwater	Soils
Volatile Organic Compounds						
✓ Benzene	Y	Y			Y	
Bromodichloromethane	Y	Y				
✓ Carbon tetrachloride	Y	Y				
Chloroethane	Y	Y			Y	
✓ Chloroform	Y	Y				
Chloromethane	Y	Y				
Dibromochloromethane	Y	Y				
1,2-Dibromoethane	Y	Y				
✓ 1,1-Dichloroethane	Y	Y				
1,2-Dichloroethane	Y	Y				
✓ 1,1-Dichloroethene	Y	Y				
✓ <i>cis</i> -1,2-Dichloroethene	Y	Y				
<i>trans</i> -1,2-Dichloroethene	Y	Y				
1,2-Dichloropropane	Y	Y				
Ethylbenzene	Y	Y			Y	
<i>n</i> -Butylbenzene	Y	Y				
<i>sec</i> -Butylbenzene	Y	Y				
Isopropylbenzene	Y	Y				
<i>p</i> -Isopropylbenzene	Y	Y				
<i>n</i> -Propylbenzene	Y	Y				
Methylene chloride	Y	Y				
Methyl <i>tert</i> -Butyl Ether	Y	Y				
1,1,2,2-Tetrachloroethane	Y	Y				
✓ Tetrachloroethene	Y	Y				
Toluene	Y	Y				
✓ 1,1,1-Trichloroethane	Y	Y				
1,1,2-Trichloroethane	Y	Y				
✓ Trichloroethene	Y	Y	Y			
1,2,4-Trimethylbenzene	Y	Y				
1,3,5-Trimethylbenzene	Y	Y				
✓ Vinyl chloride	Y	Y	Y		Y	
<i>m,p</i> -Xylene	Y	Y			Y	
<i>o</i> -Xylene	Y	Y			Y	
Semivolatile Organic Compounds						
1,4-Dichlorobenzene	Y	Y				
Benzo(a)anthracene						Y
Benzo(a)pyrene				Y		Y
Benzo(b)fluoranthene				Y		Y
Bis(2-ethylhexyl)phthalate						Y
Chrysene					Y	
Ideno(1,2,3-cd)pyrene						Y
Naphthalene	Y	Y			Y	
Pyrene					Y	
Total Petroleum Hydrocarbons (TPH)						
TPH-Diesel-range Organics (DRO)	Y	Y			Y	Y
TPH-Gasoline-range Organics (GRO)	Y	Y			Y	Y
Metals						
Aluminum					Y	
Arsenic	Y	Y		Y	Y	Y
Barium	Y	Y			Y	
Iron	Y	Y			Y	Y
Lead	Y	Y			Y	Y
Manganese	Y	Y			Y	
Selenium	Y	Y				
Thallium	Y	Y				
Pesticides/Polychlorinated biphenyls (PCBs)						
PCB-1248						Y
PCB-1260				Y		Y

1 = List of COPCs (chemicals of potential concern) are from Tables 2-1 through 2-7 as presented in the KDHE-approved *Baseline Risk Assessment for the North Industrial Corridor* (CDM 2007c).

✓ = Groundwater target compound for vapor intrusion pathway

Section 2

Investigative Approach

This section presents a discussion of the planning and field activities to be conducted during the VI assessment. A detailed description of the methodologies to be used to complete the field activities is also presented in this section. Samples collected during this field investigation will be analyzed for VOCs to assess the magnitude and extent of potential VI impact at the Site.

2.1 General Approach

The VI assessment will be conducted in a phased approach, as briefly described in Section 1.3. The intent is to quantitatively screen risk at the point of exposure with a focus on buildings most potentially impacted by VI, while also evaluating a sampling of buildings within areas potentially less impacted by VI. If necessary, the phased approach also will allow a more detailed evaluation of the VI pathway for those buildings that have potentially unacceptable risk based on screening results. The proposed sampling process is summarized on **Figure 2-1**. Sample management procedures and documentation are discussed in Section 3.

2.1.1 Phase 1 – Building Selection

Nearly 1,000 occupied residential/school/daycare structures at the NIC Site overlie a shallow groundwater contaminant plume containing at least 1 µg/L of combined PCE/TCE/cDCE. Evaluation of VI at this many structures in a single winter season is not feasible from a time or resource perspective. In addition, some residences are presumably more at risk for a complete VI pathway because they are located above areas of greater concentrations of shallow groundwater contamination, or because of building construction style (i.e., basement), they are located closer to shallow groundwater contamination than other building styles (i.e., slab on grade and crawl space). Therefore, CDM has designed the VI investigative approach to maximize the number of buildings evaluated at the actual point of exposure this 2011-2012 winter season based on estimated risk for a potentially complete VI pathway.

The potentially-affected buildings have been divided into four groups based on the combined concentrations of PCE/TCE/cDCE in shallow groundwater at the Site: 1-5 µg/L, 5-20 µg/L, 20-100 µg/L, >100 µg/L. **Figure 2-2** depicts the isoconcentration contours for each of the four groups and includes shading to highlight residential and other properties within the groups. The table below shows the number of residential structures per concentration group.

Number of Occupied Residences	1-5 µg/L	5-20 µg/L	20-100 µg/L	>100 µg/L
	374	235	211	168

A subset of buildings will be selected from each group using a method that focuses evaluation on the residences/schools/daycares with the most potential risk for VI. This will be accomplished by having decreasing percentages of selected residences

per decreasing concentration groups. The following percentages and target number of locations are proposed for each concentration group:

- >100 µg/L: 25% of residences = 42 residences
- 20-100 µg/L: 5% of residences = 11 residences
- 5-20 µg/L: 2% of residences = 5 residences
- 1-5 µg/L: 1% of residences = 4 residences

The selected residential structures will be allocated to achieve a representative number of samples based on building type and spatial distribution per concentration group above the various groundwater plumes at the NIC Site. For each concentration group, ideally approximately 50% of the selected residences will have basement construction; approximately 25% will have slab on grade construction; and approximately 25% will have crawl space construction. These percentages represent generic goals, and may change based on actual construction styles and access issues for each concentration group. In addition, the individual buildings to be sampled are not proposed in this work plan because additional pre-planning is needed to confirm both building type and allowable access by property owners and/or tenants before identifying specific buildings; however, **Figure 2-3** shows the estimated number of residences targeted for each >100 µg/L contour based on the number of residences within each 100 µg/L contour. Please note that the >100 µg/L groundwater plume associated with the Apex Site has previously been evaluated for VI (CDM 2011b). No additional evaluation in the Apex plume area will occur at this time.

All schools that overlie the shallow groundwater plume of PCE/TCE/cDCE with an estimated concentration of >1 µg/L are included for evaluation. Lastly, all daycares that overlie the shallow groundwater plume of PCE/TCE/cDCE with an estimated concentration of >20 µg/L also are included for evaluation, while 50% of daycares that overlie the shallow groundwater plume of PCE/TCE/cDCE with an estimated concentration of <20 µg/L will be included for evaluation. **Figure 2-4** depicts the location of schools and known daycare facilities that overlie the targeted concentration groups for PCE/TCE/cDCE. Sampling of all schools and daycares, as with residences, is dependent on allowable access by property owners/tenants.

During Phase 1, a preliminary list of residences, schools, and daycares will be compiled for the affected areas of the NIC Site. CDM and the City will initiate activities to obtain access beginning in December 2011. Once access has been obtained, a final list of residences, schools, and daycares will be provided to the KDHE prior to initiation of Phase 2 activities.

2.1.2 Phase 2 – Screening Evaluation

2.1.2.1 Field Activities

The buildings selected in Phase 1 for evaluation will be screened for VI using passive diffusion samplers placed inside the buildings. The samplers will be deployed for seven days to better accommodate fluctuations in building and environmental conditions that have been shown to affect indoor air concentrations related to VI (Johnson, et al 2011).

Before deployment of the passive diffusion samplers, a simplified building and inventory form (**Appendix A**) will be completed with property owners/tenants to identify common products and indoor sources of PCE and TCE. Any identified indoor sources will be removed or minimized with approval from the property owners/tenants and given the feasibility of removal/minimization. The building occupants will be informed of the sampling process and provided instructions on living or working with the sampler for the following week. The samplers will be deployed in the lowest level of inhabitable space within each building. Inhabitable space will not be determined by a formal evaluation such as building code standards, but rather whether it is possible and reasonable for an individual to conduct extended activities befitting of occupancy (e.g., sleeping, avocations, and food preparation).

In addition to the indoor air screening samples, a concurrent outdoor air sampling program will be conducted to establish ambient air conditions during the screening evaluation. An estimated 20 passive diffusion samplers will be deployed for seven days in a staggered fashion to overlap with indoor air sampling. The outdoor air samples will be spatially located across the NIC Site with many in proximity to the buildings where indoor air sampling is occurring. **Figure 2-5** shows proposed locations for outdoor air samples.

2.1.2.2 Reporting

Following receipt of analytical data for the passive diffusion samplers, a memorandum-style summary of analytical results per building will be presented to the KDHE. The analytical results for outdoor air samples will be evaluated using the EPA's ProUCL software to determine a possible underlying data distribution and potential statistical application, such as 95% upper tolerance limits (UTLs) on the median of COPC data. The outdoor air statistics will be evaluated qualitatively when compared to indoor air data (i.e., outdoor air metrics will be evaluated from a perspective of the magnitude of indoor air COPC concentrations compared to the magnitude of outdoor air COPC concentrations).

A building with an indoor air concentration for a COPC that exceeds its corresponding KDHE Tier 2 risk-based indoor air cleanup goal, and the result is potentially attributable to VI, will be targeted in the Phase 3 evaluation. Buildings with no exceedance of a KDHE Tier 2 risk-based indoor air cleanup goal for any COPC will be recommended for no further action related to VI at this time; however,

10% of the buildings recommended for no further action will be re-sampled in Phase 3 to confirm the Phase 2 finding. As noted in Section 1.3, prior to beginning Phase 3 activities, results from the Phase 2 investigation will be submitted to the KDHE along with an evaluation of the data and recommendations for no further action or verification sampling by building.

2.1.3 Phase 3 – Verification Sampling

2.1.3.1 Field Activities

Buildings recommended for Phase 3 based on analytical results from Phase 2 will undergo a more intensive evaluation to determine the probable cause of COPC concentrations greater than the KDHE Tier 2 risk-based cleanup goals. The components of the Phase 3 investigation are:

- KDHE-recommended building questionnaire and product inventory (**Appendix B**);
- Survey of potentially impacted buildings using a portable GC/MS unit to screen for COPCs;
- Multiple lines of evidence sampling approach that includes sub-slab, crawl space (if applicable), and indoor air samples using stainless steel canisters; and
- Sub-sampling of previous outdoor air sample locations to confirm outdoor air concentrations of COPCs during Phase 3.

The building questionnaire and product inventory will be conducted with the property owner/tenant to identify and remove (if feasible/allowed) potential indoor sources of COPCs and also identify preferred sampling locations for sub-slab and indoor air samples. The portable GC/MS will be used to survey each room in the building to determine locations with elevated concentrations of COPCs. Rooms with elevated concentrations will be further scrutinized with the GC/MS unit to identify either indoor sources of COPCs or possible routes of entry for VI. Identified indoor sources will be removed or minimized, to the extent feasible, prior to sampling.

When the screening of the building is complete, indoor air and sub-slab or crawl space sampling will commence following standard procedures for these samples as noted in Section 2.2.

Lastly, as noted at the end of Section 2.1.2, 10% of the buildings recommended for no further action during Phase 2 will be re-sampled for indoor air using stainless steel canisters with 24-hour flow regulators to confirm that concentrations measured in Phase 2 with passive diffusion samplers were accurate for determining no further action.

2.1.3.2 Reporting

When the analytical results of the Phase 3 sampling are obtained from the laboratory, a VI assessment report will be prepared that documents the results of all three phases of the investigation. Analytical data will be validated. Field documentation and laboratory reports will be included as appendices. The use of the portable GC/MS in conjunction with the final sampling should allow for a determination of no further action or mitigation from VI, although the need for additional evaluation of a building may be required after evaluation of analytical results.

2.2 Air Sampling

Air sampling will be conducted during both Phase 2 and Phase 3. The types of air sampling to be performed are detailed in the subsections below.

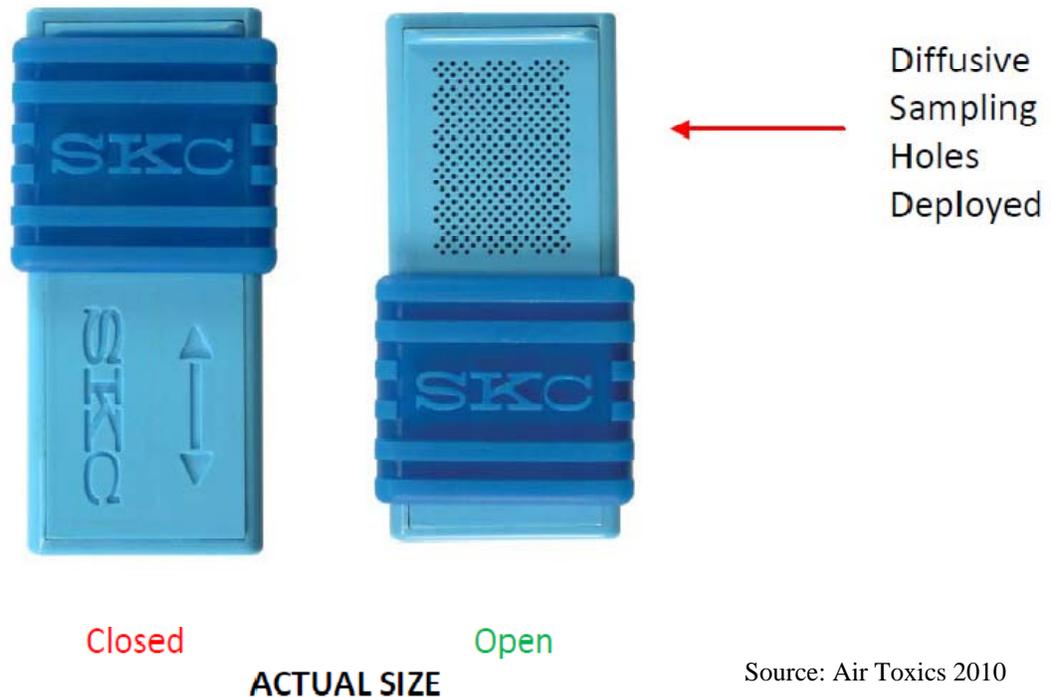
2.2.1 Passive Diffusion Air Sampling

SKC Ultra III passive diffusion samplers with Carbograph 5 sorbent will be deployed for the indoor screening evaluation of Phase 2 and all outdoor air samples. The Ultra III sampler is designed with a pre-loaded sorbent (in this case Carbograph 5) with inlet holes that allow for controlled diffusion and collection of VOCs. VOCs diffuse into the sampler at either an experimentally verified or theoretically determined rate for typical ambient conditions or indoor conditions (i.e., zero velocity). These “uptake” rates may be corrected for moisture, air flow, and temperature, if necessary. Experimental uptake rates for the samplers have been verified by the manufacturer for durations up to seven days.

The California Department of Toxic Substances Control (DTSC) has included an appendix on passive diffusion sampling as part of its recent *Guidance for the Evaluation and Mitigation of Subsurface Vapor Intrusion to Indoor Air (Vapor Intrusion Guidance)*, October 2011. DTSC recommends a careful review of data quality objectives before executing a sampling plan involving passive diffusion samplers, including a review of sampling objectives, contaminants of interest, reporting limits, environmental conditions, and sampling rates. For the NIC Site, passive diffusion samplers meet project goals by providing:

- A cost-effective method to screen many buildings for a large site;
- A selection of sampler and sorbent that provide experimentally-verified sampling rates for all COPCs at the point of exposure in indoor air sample;
- An analytical method that allows for analysis of all COPCs at reporting limits less than KDHE Tier 2 cleanup values; and
- Planning and equipment that accommodate potentially variable environmental conditions.

The diffusive surface is opened or closed via a simple sampler cover; no special handling or preparation of the sorbent is required in the field. The picture below shows the Ultra III sampler. **Appendix C** contains a sampling guide for the Ultra III sampler.



Outdoor air samples collected with passive diffusion samplers will be enclosed in a manufacturer-supplied shelter to prevent direct exposure to moisture, but still allow unobstructed access to ambient air conditions. A manufacturer supplied-sampling stand will be used for indoor sample locations to stabilize and prevent disturbance to the sampler during deployment.

The Carbograph 5 sorbent is an advantageous matrix for uptake of the 10 NIC Site COPCs and analysis of these COPCs at concentrations less than Tier 2 cleanup goals. Analysis of the passive diffusion samplers will be conducted using USEPA Method TO-17. Section 4 provides more detail on analytical methods and procedures.

2.2.2 GC/MS Sampling

The field-portable GC/MS is an analytical tool that can be used to identify and quantify COPCs in the field to significantly reduce the cost, time, and difficulties of environmental testing. This instrument is ideal for indoor air quality and has proven successful in VI assessments conducted by the Air Force Center for Engineering and the Environment (AFCEE) at Hill Air Force Base in Utah (Gorder and Dettenmaier

2011) and VI investigations managed by the Montana Department of Environmental Quality (GSI 2011).

In general operation mode, the instrument is calibrated for compounds on the EPA TO-15 analyte list with detection limits ranging from 10 to 100 parts per billion by volume (ppbv). However, for certain COPCs, such as PCE and TCE, the instrument may be calibrated to achieve a detection limit of 0.1 micrograms per cubic meter ($\mu\text{g}/\text{m}^3$). **Appendix D** contains the standard operating procedure for the portable GC/MS unit.

The investigative approach for using the GC/MS is to analyze “grab” samples for COPCs from every room in a building. Rooms with elevated COPCs will be further evaluated using a survey mode to screen individual products or entry routes for VI. If products containing COPCs are identified, they will be removed or minimized as previously indicated, and the building will be re-surveyed in a timeframe of two to 24 hours later, largely dependent on the requests of the building occupants, to determine the presence of possible additional indoor sources.

2.2.3 Indoor Air Canister Sampling

Indoor air sampling during Phase 3 will be conducted using certified clean, 6-liter, stainless steel canisters to collect time-integrated air samples over 24 hours using a calibrated flow controller. An indoor air sample will be collected from the main floor of each building, and also the basement if present. Samples will be collected from approximately breathing zone height indoors (between three and five feet above the floor) either by using a sampling cane or by elevating the canister. In the event that a crawl space exists at a residence instead of a basement (i.e., direct contact to soil with no concrete slab), an indoor air sample will be collected from the crawl space. Final sampling locations will be determined following a pre-sampling inspection.

The indoor air sampling procedure will be initiated as follows:

- Each canister will be inspected to verify full vacuum and identification of any mechanical problems. Flow controllers will be installed to the canisters. The sample identification and canister number will be recorded both on the canister’s custody tag and on the appropriate field data form.
- Each canister valve will be opened to initiate sampling. Sampling personnel will confirm during this initial valve opening that the canister’s vacuum gauge reads a starting vacuum of at least 28 ± 1 inches of mercury (“Hg) given that the elevation of Wichita is 1,300 feet above mean sea level and for each 1,000 feet above sea level canister vacuum decreases by approximately 1”Hg. The starting vacuum will be recorded both on the canister’s custody tag and on the appropriate field data form. Canisters showing vacuum outside this tolerance will be noted and possibly replaced before continuing sampling.

- Sampling personnel will record the sample initiation time and date and sample identification on the appropriate field data form (**Appendix B**). Weather conditions such as ambient temperature and barometric pressure, and any unusual events such as nearby work or the operation of combustion equipment that could affect sampling results will be documented.

After the sampling period has ended (nominally 24 hours later), the sample collection procedure will be as follows:

- Upon arrival to collect samples, sampling personnel will inspect the canister to note any possible tampering with the canister and/or flow controller. The canister's final vacuum will be recorded and the valve closed. The final vacuum will be recorded both on the canister's custody tag and on the appropriate field data form.
- Additional weather conditions and unusual events will be documented.
- Sampling personnel will complete the sample custody tag and verify that all information on the tag has been recorded correctly on the appropriate field data form.
- The sampling apparatus will then be dismantled.

All indoor and crawl space air samples will be shipped to an offsite NELAP-certified laboratory for analysis of VOCs by USEPA Method TO-15 MS SCAN for combined TO-15 and TO-15 SIM reporting.

2.2.4 Sub-Slab Air Canister Sampling

Sub-slab air sampling is a Phase 3 activity that will occur in conjunction with indoor air sampling. Sub-slab sampling will be conducted only for structures with slab on grade or basement slab construction and will only occur if permission is given by the property owner. Where performed, CDM anticipates that a single sub-slab sample will be collected per building. Sub-slab sampling locations are ideally located in a centralized location away from foundation footings while avoiding utilities that run beneath the slab and utility inlets into the structure. The sub-slab monitoring point and sampling procedure is described below.

2.2.4.1 Sub-Slab Monitoring Point Installation

CDM proposes to install temporary monitoring points. The installation procedure is as follows:

- The sub-slab area will be inspected and significant features (walls, cracks, sumps, drains, etc.) will be identified. Locations of utilities will be noted based on information from the resident(s) and field observations based on inlets and outlets for the various utilities.

- Sampling personnel will drill a ¾- to 1-inch diameter hole through the slab using a hammer drill or rotary hammer. The hole will be continued through the slab and extend approximately two to three inches into the sub-slab material.
- The total thickness of the slab and the depth drilled into the sub-slab material will be recorded on the appropriate field data sheet.
- Drill cuttings will be brushed or vacuumed from the around the hole.
- A piece of ¼-inch OD Teflon tubing will be cut to a length sufficient to pass through the slab leaving the bottom of the tube approximately even with the base of the slab and extend into the building.
- 10/20 silica sand will be poured in the bottom of the hole to a height above the base of the sample tubing. The remaining annular space in the hole will be filled with non-hardening, non-VOC modeling clay wrapped around the tubing during insertion. Additional modeling clay will be placed around the tubing at the surface of the slab to form a surface seal.
- The above-ground Teflon tubing will pass up through the leak detection system apparatus and be connected to the purging and sampling train.

2.2.4.2 Sub-Slab Monitoring Point Purging and Leak Detection

The leak detection system will consist of a shroud that encloses the sub-slab monitoring point. The shroud will have an inlet to allow helium to be flooded into the shroud and an outlet to allow the Teflon tubing from the sub-slab monitoring point to exit the shroud. Outside the shroud, the Teflon tubing will connect to a three-way manifold. The other two ends of the manifold will be used to connect a stainless steel sample canister with an in-line flow controller and a syringe for purging the sampling train and sub-slab monitoring point. Valves will be co-located at each end of the three-way manifold to allow closure of each endpoint.

The first step in the leak detection process is to tightness test the assembled sample train. The valve to the sub-slab monitoring point will be closed and a syringe will be used to pull a vacuum on the manifold and flow controller. The vacuum will be monitored to verify that leakage is not occurring.

Following completion of the tightness test, the purge and leak test of the sub-slab monitoring point will simultaneously be conducted. Helium will be injected into the shroud and an initial concentration of helium under the shroud will be measured using a helium detector. The initial concentration should be at least 20% helium.

The next step is the purge of the sample train and sub-slab monitoring point. Assuming a slab thickness of six inches, a slab penetration of three inches, a 1-inch diameter boring, and three feet of sample tubing, three purge volumes of the sampling train will be no more than 0.5 liters of air. An additional one liter of air will

also be purged to replicate the volume of air to be collected for the sub-slab sample. Therefore, a total of 1.5 liters of air will be purged by syringe. During purging and following completion of purging, the helium concentration in the shroud will be monitored to assure a concentration of at least 20% helium. At the completion of purging, the sub-slab monitoring point will be measured for helium concentration via the sampling train. A helium concentration of 10% or less in sub-slab air is considered acceptable for establishing an adequate seal between indoor air and sub-slab air.

2.2.4.3 Sampling

Sampling will commence once the purging and leak detection procedures are complete. Sub-slab samples will be collected using a certified clean, 1-liter stainless steel canisters to collect time-integrated air samples over five minutes using a calibrated flow controller. In addition, sub-slab sampling will occur either prior to or following indoor air sampling so that the slab has no open penetration during the duration of indoor air sampling.

Each canister will be inspected and any potential problems recorded before sampling. Canisters will be replaced as needed. The sample identification and canister number will be recorded both on the canister's custody tag and on the appropriate field data sheet. Each canister valve will be opened to initiate sampling. Sampling personnel will confirm during this initial valve opening that the canister's vacuum gauge reads a starting vacuum of at least 28 ± 1 "Hg. The starting vacuum will be recorded both on the canister's custody tag and on the appropriate field data sheet. Canisters showing vacuum outside this tolerance will be noted and possibly replaced before continuing sampling. The canister will be allowed to draw vapor until the vacuum gauge on the canister registers approximately 3 to 5 "Hg. The final vacuum will be read, the canister valve closed, and the reading recorded both on the canister's custody tag and on the appropriate field data sheet. Sampling personnel will also record the sampling date and sample identification. Weather conditions such as ambient temperature and barometric pressure, and any unusual events such as nearby work or the operation of combustion equipment that could affect sampling results will be recorded on the appropriate field data sheet.

Following sample collection, the temporary monitoring point will be removed and the slab penetration will be sealed using a concrete patch. Sub-slab samples will be submitted to a NELAP-certified offsite analytical laboratory for analysis of VOCs by USEPA Method TO-15.

2.3 Equipment

Table 2-1 provides a list of equipment anticipated to be required to conduct the proposed field investigation. Equipment maintenance, calibration, and operating procedures will be performed as recommended by the manufacturers. Maintenance and calibration operations performed on equipment will be documented as appropriate in the field logbook. Manufacturer instructions are not provided herein but will be available to field personnel during the investigation, as appropriate.

2.4 Site Management

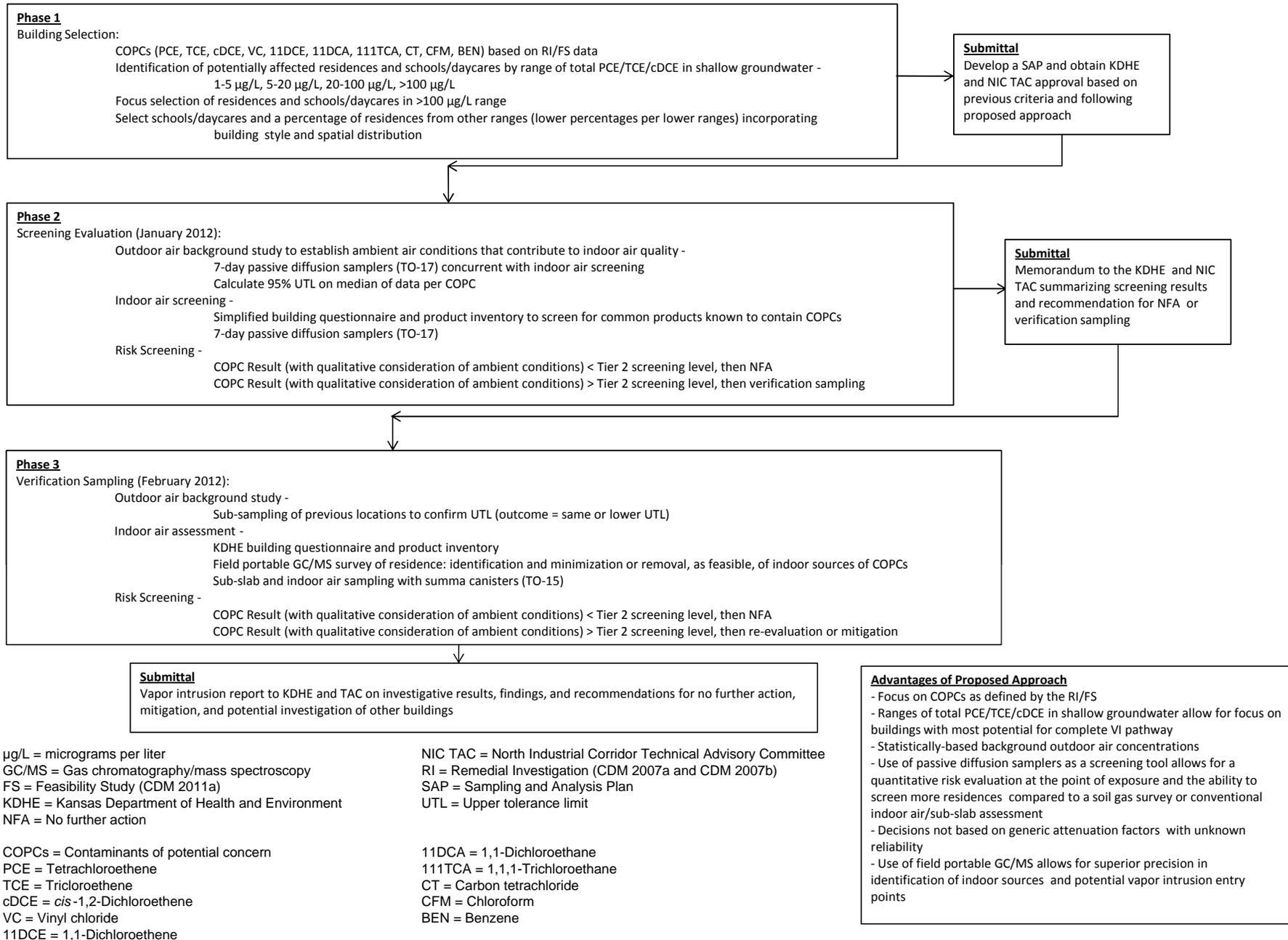
This section addresses the activities associated with Site management during the investigation.

Site Access

For Phases 2 and 3, permission will need to be obtained from the property owners / tenants of the selected sample buildings prior to conducting indoor air sampling activities. CDM anticipates working with the City to obtain access where possible. The KDHE may be asked to assist in this effort if the City and CDM are unable to obtain access to the selected or contingency buildings.

Site Security

The study area lies in an urban area with many individual property owners. Appropriate measures will be taken to assure that data collection efforts are consistent with Site protocols and the Site Health and Safety Plan.



µg/L = micrograms per liter
GC/MS = Gas chromatography/mass spectroscopy
FS = Feasibility Study (CDM 2011a)
KDHE = Kansas Department of Health and Environment
NFA = No further action

NIC TAC = North Industrial Corridor Technical Advisory Committee
RI = Remedial Investigation (CDM 2007a and CDM 2007b)
SAP = Sampling and Analysis Plan
UTL = Upper tolerance limit

COPCs = Contaminants of potential concern
PCE = Tetrachloroethene
TCE = Trichloroethene
cDCE = *cis*-1,2-Dichloroethene
VC = Vinyl chloride
11DCE = 1,1-Dichloroethene

11DCA = 1,1-Dichloroethane
111TCA = 1,1,1-Trichloroethane
CT = Carbon tetrachloride
CFM = Chloroform
BEN = Benzene

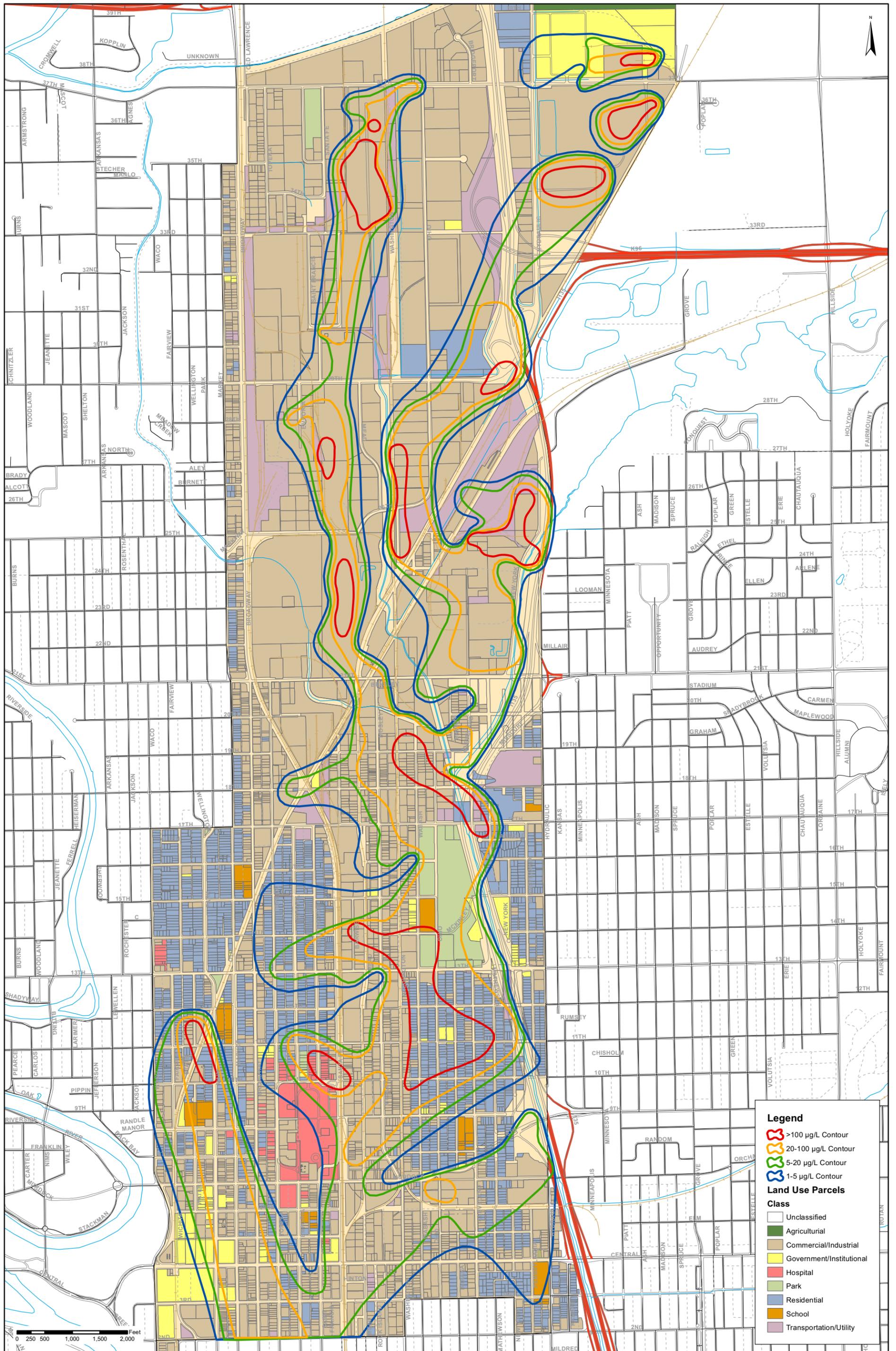


Figure 2-2
North Industrial Corridor (NIC) Site
Shallow Groundwater TCE/PCE/cDCE Contours and Land Use Categories

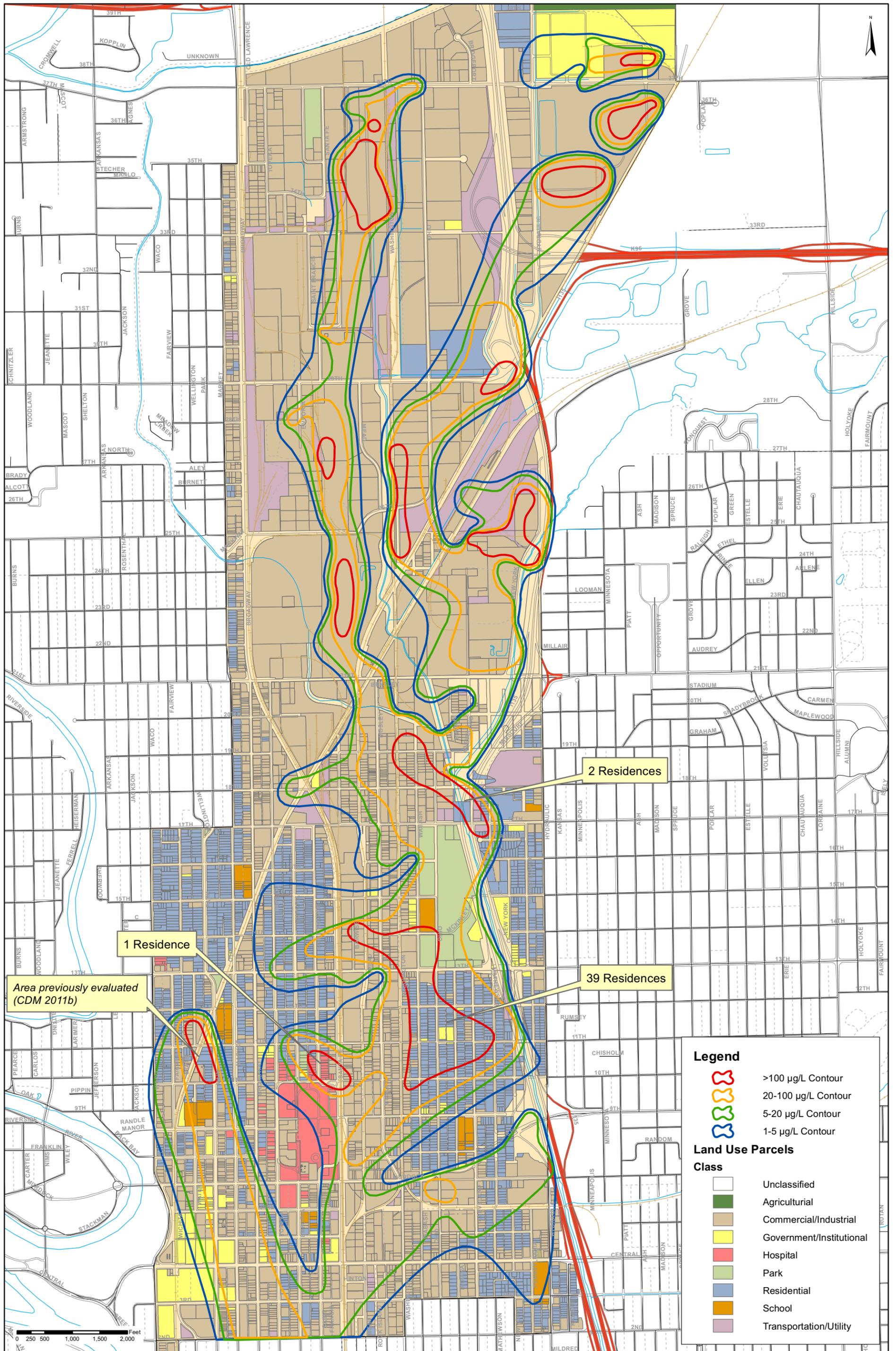


Figure 2-3
North Industrial Corridor (NIC) Site
Targeted Number of Residences per >100µg/L Contour

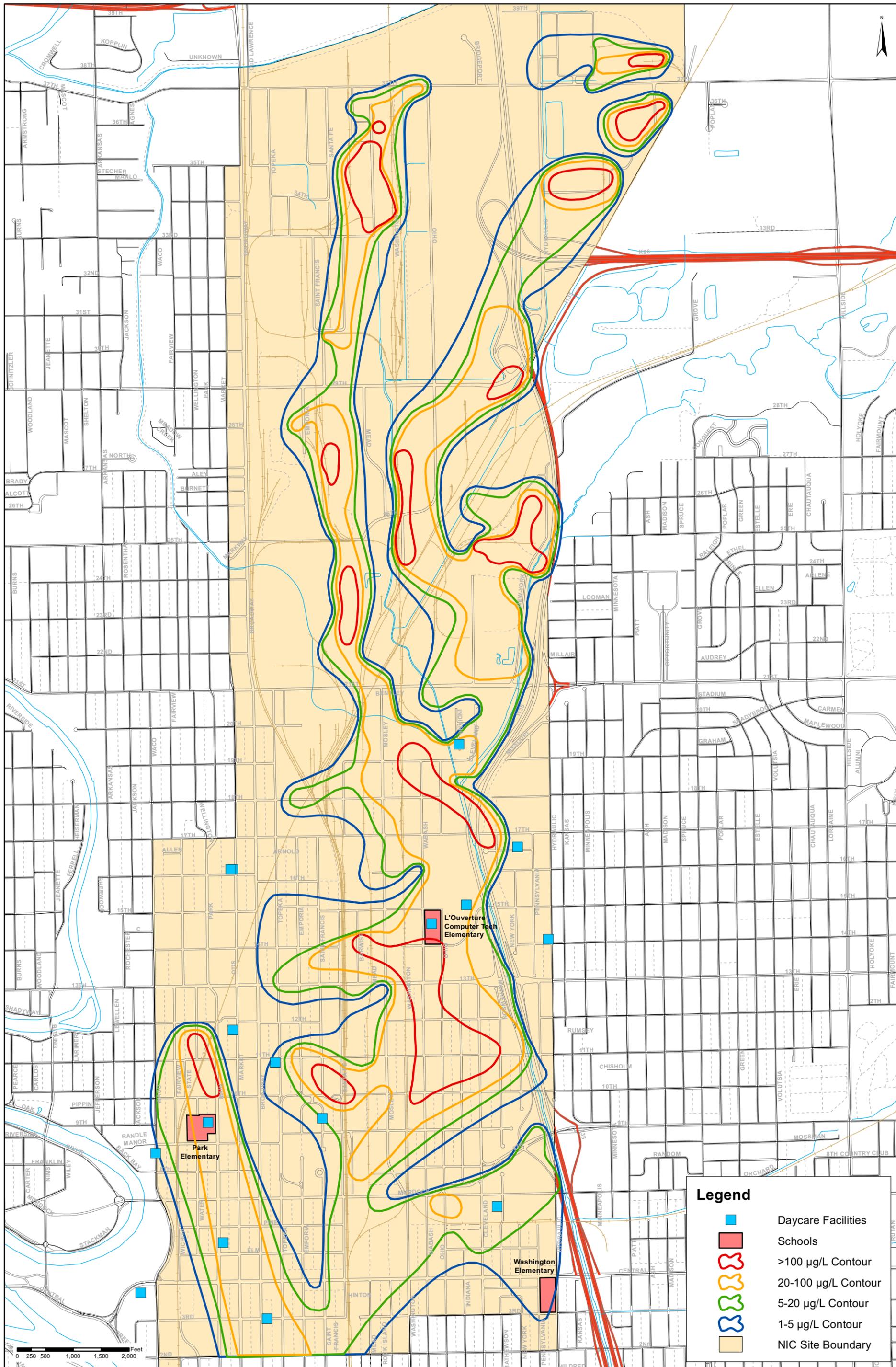


Figure 2-4
North Industrial Corridor (NIC) Site
Schools and Daycare Facilities

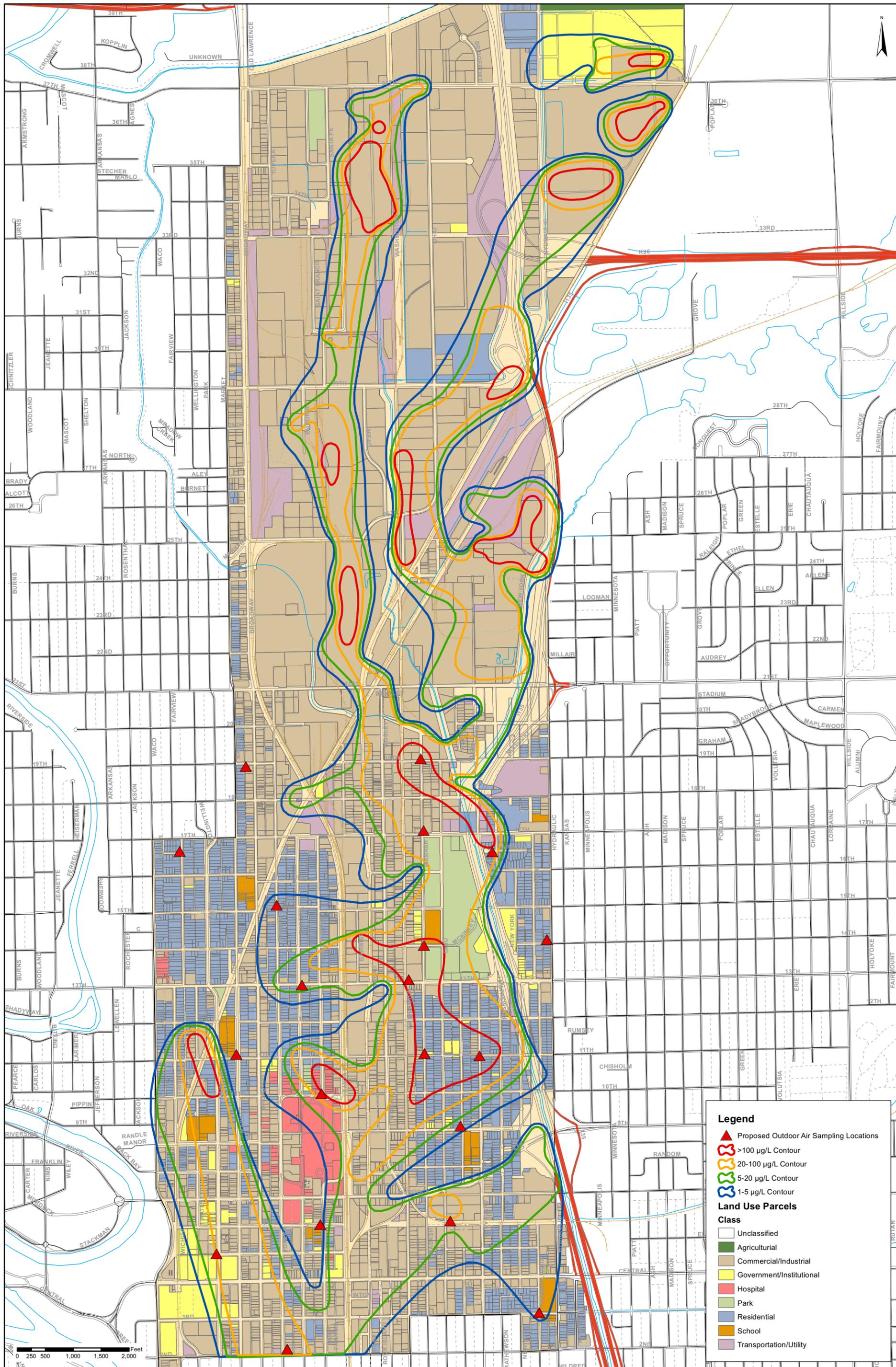


Figure 2-5
North Industrial Corridor (NIC) Site
Proposed Outdoor Air Sampling Locations

**Table 2-1
North Industrial Corridor (NIC) Site
Field Sampling Equipment**

<i>Item Description</i>	<i>Item Description</i>
General	
Steel toe boots	Field logbook
Nitrile gloves	Sampling and safety plans
Safety glasses	Pens/markers
Ear plugs	Camera
Measuring wheel/tape	Paper towels
Box knife/leatherman	
Decontamination/Waste Containment	
Wash tub	Sprayers
5-gallon bucket(s)	Brushes
Trash bags	Detergent (Alconox)
	Distilled Water
Indoor/Outdoor Air Sampling Equipment	
6L Summa canisters (laboratory supplied)	Candy cane attachment (as needed)
Passive diffusion samplers	Passive diffusion sampler stands and covers
Adjustable crescent wrench (2)	Flashlight
Lock boxes (optional for outdoor or select indoor air sampling)	Information sheet and diagram from residence survey - mark sample locations on sketch
Chain-of-custody form(s)	Acetate tape
Shipping label	
Subslab Sampling Equipment	
Hammer drill with 3/4-1" drill bit	Medical grade vinyl tubing (1/4" ID)
1/4" OD Teflon tubing	Helium tank
1/4" OD polyethylene tubing	5-gallon bucket or other raised surface (optional)
Leak detection shroud	Swedge-loc fittings (multiple)
Duct tape	Swedge-loc valves (1-2)
3-4 sand bags	PID meter (10.6 eV bulb)
3-way stopcock valve (1)	Isobutylene Calibration Gas (100-ppm conc.)
syringe for purging 1/4" OD line	1L Summa canisters (laboratory provided)
Helium detector	Chain-of-custody form(s)
Adjustable crescent wrench (2)	Shipping label
Acetate tape	Non-hardening, non-VOC modeling clay

Section 3

Sample Management Procedures and Documentation

The following subsections discuss various sample management procedures that will be followed during the field investigation activities.

3.1 Sample Collection

Indoor air, outdoor air, and possibly crawl space and sub-slab air samples will be collected during the field investigation program. Sampling procedures are described in Section 2.

3.2 Sample Labels

Each collected sample, including duplicates, and trip blanks will have a completed sample label securely attached to it. Labels will include the information outlined in Section 3.3. The person who physically collects the sample is the "Sampler" and will initial and fill out the sample label including the date and time of sample collection. Duplicates and blanks will be shipped "blind" to the laboratory, but will be assigned a unique identification code (Section 3.3) in order to facilitate identification of the laboratory results. All sample collection and documentation activities will be preserved in the field log book.

3.3 Sample Identification

A coding system will be used to identify each sample collected during this investigation. The coding system will allow tracking and retrieval of information concerning a particular sample and will assure that each sample is uniquely identified. Codes for sample media type designations will be as follows:

- IAP = Indoor air sample (passive diffusion sampler)
- IAS = Indoor air sample (stainless steel canister sampler)
- OA = Outdoor air sample
- SS = Sub-slab air sample
- CS = Crawl space air sample

Quality control (QC) codes will be appended to the location/station identification where appropriate. The following QC codes will be used:

- M = Trip Blank
- Q = Field duplicate sample
- K = Sample split with the KDHE

Each sample will be identified by sample media type, Site designation, location, depth interval (if applicable), and date. The Site designation for all samples collected during this investigation will be NIC, representing the North Industrial Corridor Site. CDM will use a sequential numeric system to identify buildings. To prevent misidentification of samples, the sampler will attach legible labels to each sample. The labels will contain, at a minimum, the following information:

- Site designation
- Sample identification number – using the following format

IAP-NIC-01Q-011512

where: IAP = indoor air passive diffusion sample
NIC = Site designation
01 = building identification
Q = duplicate sample (or see code list above)
011512 = sampling date

- Initials of sample collector
- Date and time of sample collection
- Analysis required / parameter(s) requested

3.4 Sample Containers and Preservation

All sample containers used will be pre-cleaned and include documentation from the analytical laboratory in accordance with USEPA protocols. No preservation of the air samples is necessary. Holding times for samples in stainless steel canisters are 30 days from the completion of sample collection and 21 days from completion of sampling for passive diffusion samplers. All sampling apparatus are anticipated to be provided by Air Toxics Laboratory.

3.5 Sample Custody and Documentation

Chain-of-custody procedures document the identity of a sample and its handling. Custody records trace a sample from its collection through all transfers of custody including delivery to the analytical laboratory. Internal laboratory records then document sample custody through its final disposition.

A sample is under custody if one or more of the following criteria are met:

- The sample is in the custodian's (sampler, lab personnel, etc.) possession;
- The sample is in the custodian's view after being in possession;

- The sample was in the custodian's possession and was sealed and/or secured to prevent tampering;
- The sample is in a designated secure area; and/or
- The custody label will act as a guarantor of sample custody.

The remainder of this section discusses chain-of-custody and document control requirements appropriate to the Site. If any deviations from these procedures occur, appropriate personnel will be notified and deviations will be noted in the field log book.

Field Custody Requirements

Chain-of-custody for samples collected in the field and transported or shipped to a state-accredited laboratory for analysis will be maintained. The field team will have a designated field sample custodian with overall responsibility for sample custody and field document control. The custodian will ensure that the sampling team(s) have and use the appropriate identification and custody records, resolve custody problems in the field, and correctly/accurately handle the shipment of samples to the analytical laboratory. The analytical laboratory will have an identified sample custodian and/or document/sample control officer for the submitted samples.

Chain-of-Custody Record Sheets

Chain-of-custody record sheets will be completed for all samples collected at the Site that are sent to the analytical laboratory. The multi-part carbonless copy forms will be correlated with the sample collection labels; and required information will be the same on both the labels and the custody forms. The Sampler or sample custodian will complete a Chain-of-Custody Record to accompany each sample shipment from the field to the laboratory. Blank Chain-of-Custody forms will be provided by the appropriate analytical laboratory. If multi-part carbonless copy forms are not available, the completed Chain-of-Custody form may be photocopied as needed.

The following information is generally supplied on a Chain-of-Custody Record:

- Project number;
- Signature of sampler;
- Sample identification;
- Sample matrix;
- Date and time of sample collection;
- Signatures of all persons receiving or relinquishing the samples;
- Sample analyses required for each sample.

One custody record will be used for each packaged lot of samples. The custody record should include all samples in that lot of samples. More than one custody record sheet may be used for one package, if necessary. The purpose of these records is to document the transfer of a group of samples traveling together. When the group of samples changes, a new custody record is initiated. The original custody record travels with the samples to the analytical laboratory; however, the initiator of the record will keep a copy. If custody of the same group of samples changes hands several times, some intermediate handlers will not have a copy of the custody record. This is acceptable, as long as the original custody record shows that each person who had received custody has properly relinquished custody (dated and signed as appropriate).

Laboratory Custody Procedures

The analytical laboratory will use sample identification and custody records to satisfy the requirements outlined below:

- Upon receipt at the laboratory, each sample shipment will be inspected to assess the condition of the shipping container and the individual samples. The condition and/or integrity of the custody seal(s) on a received shipment of samples will be documented at the time of receipt at the laboratory.
- Enclosed Chain-of-Custody Records will be cross-referenced with all the samples in the shipment. These records will be signed by the sample custodian and placed in the project file.
- The sample custodian will continue completing the Chain-of-Custody Record by assigning a unique laboratory number to each sample upon receipt. This number identifies the sample through all further laboratory handling.
- The analytical laboratory will keep internal laboratory log books and records that maintain the Chain-of-Custody Records throughout sample preparation, analysis, and data reporting.

3.6 Sample Shipment

Each sample shipped will be packed in accordance with Department of Transportation (DOT) regulations under 49 CFR 171-185, which includes documentation requirements. Samples obtained at uncontrolled hazardous waste sites are classified as either environmental samples or hazardous samples. Environmental samples are those that contain low levels of contaminants and require implementation of limited precautionary procedures. Hazardous samples are those which could possibly contain dangerous levels of contaminants. All samples collected during this investigation, unless data to the contrary is obtained, will be classified as environmental samples.

Samples will be packaged in sturdy packaging for shipment to the laboratory. Each sample will be identified with a sample identification label, and will be listed on the chain-of-custody record completed for each sample shipping container. The Chain-of-Custody Record will be placed inside the shipment packaging. The shipping containers will be sealed using tape and chain-of-custody seals. All samples requiring transport to the laboratory will be shipped by Federal Express (or equivalent overnight delivery service) or hand delivered.

Custody Seals

Custody seals are narrow strips of adhesive paper used to demonstrate that no tampering has occurred with sample containers or shipping coolers. The field investigator shall write the seal/shipment date and signature on the seal. The seal is then placed across the first point of sample shipment opening (outer packaging).

3.7 Field Log Books

Field forms and/or logbooks provide the means for recording all sample collection activities performed at the Site. As such, written entries will be legible and as descriptive and as detailed as possible so that a particular situation or incident can be reconstructed without reliance on the collector's memory. Entries into the form/logbook may contain a variety of information; however, at the beginning of each daily entry, the following information will be recorded in the logbook:

- The date, start time, weather, and level of personal protection being used onsite. This level of protection must match the level of protection required in the project health and safety plan.
- All field personnel present.
- All equipment used to make field measurements (including owner and model/serial number(s)). Calibration information for field instruments will also be recorded as appropriate.
- Observations about the Site or activity to be performed and any other information pertinent to the field activity will be recorded

Additional logbook entries for sampling activities will include, but may not be limited to, the following:

- Purpose of sampling;
- Date and time (24-hour clock notation) of general activity or notes;
- All field personnel and visitors and their respective times of arrival and departure will be identified in the field logbook;

- Date, time (24-hour clock notation), sample identification for laboratory analysis, sampling location, sample media, and method of sample collection;
- Sample volume, required analysis, and number of containers (if more than one);
- Any deficiencies or deviations from the sampling plan as well as the reason(s) for the deviation(s);
- Changes in weather, level of personal protection, and/or field instrumentation will be noted in the logbook.

Any field measurements collected, including measurement units and instrumentation used, may be noted in the logbook as appropriate; however, it is assumed this information will typically be noted by sampling location on the appropriate location-specific Indoor Air Sampling Form (**Appendix B**). Some information will be duplicated in both the form and the logbook. The form also includes additional information.

All data will be recorded directly and legibly in field logbook(s) or on the sampling form and all logbook pages containing data entries are to be signed and dated. Each line on each logbook page should contain data or a written line denoting that the line is intentionally left "blank". A note, such as n/a for not applicable, should be used on the sampling form to signify a blank. Significant field notebook entries (e.g., health and safety incidents, regulator/owner comments) will be countersigned by another member of the project team.

Any changes in entries will be made in a manner that avoids obscuring the original entry, i.e., a single line will be drawn through the incorrect entry and the new data will be written legibly. All changes will be initialed and dated by the individual at the time of the change. All pages will be accounted for; no pages are to be removed. If there is a change in the person recording field notes during a particular day, that person will be identified in the logbook prior to making entries.

At each station where a sample is collected or a measurement made, a detailed description of the location of the station will be recorded. If appropriate, this may be done on the field form rather than in the logbook. Photographs taken at the Site, if any, will also be noted and described.

The field logbook will identify any other forms which were completed each day and that constitute supplemental records to the field logbook entries. A copy of the completed form(s) will be included in the report of analytical results.

Section 4

Quality Control Procedures

This section discusses the analytical program and general quality assurance/quality control (QA/QC) activities for the Site.

4.1 Analytical Program

All air samples collected will be analyzed for VOCs. Air samples collected using passive diffusion samplers will be analyzed by GC/MS using USEPA method TO-17 to thermally extract and analyze adsorbed VOCs from the sorbent. Air samples collected in stainless steel canisters will be analyzed by GC/MS using USEPA method TO-15.

Air Toxics of Folsom, California, will conduct the analyses. **Table 4-1** presents a summary of the analytical program. **Appendix E** presents laboratory reporting limits for TO-15 and TO-17, including uptake rates for the passive diffusion samplers. The uptake rates have been experimentally verified for indoor, or zero-velocity, environments for all 10 NIC Site COPCs; therefore, comparison of Phase 2 analytical results for indoor air to KDHE Tier 2 cleanup goals will be based on validated uptake rates for all 10 COPCs. For outdoor environments, eight of the 10 COPCs have validated uptake rates; the two COPCs that rely on theoretical uptake rates are 11DCA and VC.

The laboratory will follow standard QC procedures designated by the method for TO-15 and TO-17, including the following:

- Method blanks;
- Laboratory control samples;
- Surrogate standards; and
- Laboratory duplicates.

In addition, for TO-17 analysis, the Ultra III sampler has an embedded blank correction chamber that is analyzed in conjunction with the thermally extracted sample to certify the absence of cross-contamination from pre- and post-sampling exposure of the sampler. **Appendix F** contains the TO-17 method manual from Air Toxics for thermal desorption, analysis, QC, and acceptance criteria for passive diffusion samplers.

4.2 Field QC Procedures

Duplicate samples will be collected at a frequency of one duplicate sample for every 10 original samples. Duplicate samples will be collected identically and concurrently to the primary/original sample (i.e., side-by-side). These samples will be handled and packaged in a manner identical to the other onsite samples collected. Duplicate

samples will be analyzed for the same parameters as for the original samples. CDM anticipates the KDHE may also collect sample splits for analysis by the KDHE's laboratory during select portions of this VI assessment program.

Other key QC procedures that will be employed in the field are:

- Calibration of field instruments prior to use, according to the manufacturer's procedures;
- Verification of canister integrity prior to and post sample collection;
- Evaluation of sub-slab monitoring points for leaks prior to sample collection; and
- Use of chain-of-custody controls for sample management.

Appendix D contains the standard operating procedure for the portable GC/MS unit.

4.3 Data Quality Indicators

Laboratory performance and analytical results will be checked through a QA validation and review. The review will assess analytical quality using five data quality indicators: completeness, accuracy, precision, comparability, and representativeness. The following are data quality objectives for each indicator:

- **Completeness** – 100% percent of all samples collected should be analyzed. Ninety percent (90%) of the results should be acceptable and useable for their intended purpose.
- **Accuracy** – Percent recoveries of laboratory control samples, laboratory blank samples, and surrogate recoveries in primary samples will be compared against laboratory control limits. Laboratory acceptance criteria are provided in **Appendix F**.
- **Precision** – Field and laboratory precision of air samples will be measured through the collection and analysis of duplicate replicate air samples. A duplicate air sample for stainless steel canisters involves filling two canisters from the same air mass over the same period of time and is a measure of field precision. A duplicate passive diffusion sample involves suspending two samplers in the same location. Relative percent differences for replicate air samples should be less than 30%.
- **Comparability** – Samples will be analyzed for similar parameters using the same sampling and analytical methods in order to compare data. Detection limits for decision-making samples (i.e., indoor air samples) should be less than KDHE Tier 2 cleanup goals (discussed in Section 1.4).
- **Representativeness** – Air samples in stainless steel canisters will be collected with pre-set regulators in 100% certified clean canisters to capture air samples over the

intended time frame. Passive diffusion samplers have blank chambers to verify that no cross-contamination occurs prior to and post-sampling efforts. In addition, leak tests will be performed for sub-slab samples to ensure that surface infiltration is not occurring.

4.4 Data Validation

Validation and review of all analytical data will be performed by a qualified professional experienced in data validation procedures. All data will be validated and reviewed in accordance with EPA procedural guidance documents. Reference documents include the *USEPA Guidance on Environmental Data Verification and Validation, EPA QA/G-8, November 2002* (EPA 2002) and the *USEPA Contract Laboratory Program National Functional Guidelines for Superfund Organic Methods Data Review (USEPA 540-R-08-01), June 2008* (EPA 2008).

**Table 4-1
North Industrial Corridor (NIC) Site
Analytical Methods and Sampling Requirements**

Sample Type	Analytical Parameter	EPA or Equivalent Method	Preservative	Holding Time	Container/Volume Requirement
Passive Diffusion	VOCs	TO-17	None	21 days	SKC Ultra III / 7 days
Indoor Air and Crawl Space	VOCs	TO-15 MS SCAN	None	30 days	6L, certified clean, stainless steel canister / 24 hours
Sub-Slab	VOCs	TO-15	None	30 days	1L, certified clean, stainless steel canister / 5 minutes

VOCs = volatile organic compounds

Section 5

Schedule and Reporting

The following schedule is proposed for executing the VI assessment for the NIC Site.

Milestone	Date
Submittal of Draft Work Plan to the KDHE	November 30, 2011
Initiate communications with potentially affected property owners/tenants to obtain access where possible	December 2011
Receipt of Comments from the KDHE	December 19, 2011
Submittal of Final Work Plan to the KDHE	December 30, 2011
Phase 1 Activities and Summary of Selected Buildings to the KDHE	January 13, 2012 *Dependant on ability to obtain access to selected residences, schools, and daycares
Phase 2 Activities	January 16 - January 30, 2012
Submittal of Phase 2 Summary Memorandum to the KDHE including Proposed Phase 3 Sampling Locations	February 13, 2012
Receipt of Comments from the KDHE	February 17, 2011
Phase 3 Activities	February 20 - March 2, 2012 *Dependant on ability to obtain second access to selected residences, schools, and daycares
VI Assessment Report	May 2012

Reporting deliverables will consist of a letter-style summary with figures for Phase 1. Phase 2 results will be summarized in a memorandum that presents figures and analytical results compared to the KDHE Tier 2 cleanup goals in table format. The final report summarizing all phases will be a formal report submittal.

Section 6

References

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Appendix A
Simplified Building Questionnaire and
Product Inventory Form

Simplified Building Questionnaire and Product Inventory From
Phase 2 – North Industrial Corridor Site
Vapor Intrusion Assessment

Does smoking occur in the building?

Is gasoline-powered equipment or fuel stored in the building?

Do building occupants regularly use dry cleaning?

Are any of the following products stored or used regularly in the building:

- Automobile cleaners – brake, fuel system, tires, etc (aerosol or liquid)?
- Adhesives?
- Stain removers?
- Silverware polish?
- Rust removers?

Appendix B
KDHE Building Questionnaire and Product
Inventory Form

Kansas Department of Health and Environment
 Bureau of Environmental Remediation
 Indoor Air Sampling Form

Project Name:	Sample Date:
Property ID:	Sampler:

Sample Information

	Sample Location:	Sample ID:	Canister Number:
(1)			
(2)			
(3)			
(4)			

Environmental Conditions

Outdoor Temperature:	Barometric Pressure:	Relative Humidity:
Wind Speed:	Wind Direction:	

Preliminary Screening

Instrumentation:	Calibration Date:	Calibration Time:
Location 1:	Reading 1:	
Location 2:	Reading 2:	
Location 3:	Reading 3:	
Location 4:	Reading 4:	

Air Sample Detail

	Start Time:	Initial Vacuum:	End Time:	Final Vacuum:	Flow Controller Number:
(1)					
(2)					
(3)					
(4)					

Note: This form is to be completed for each residence involved in indoor air sampling activities. Page 3 of the form provides space for additional notes or comments.

Property ID: _____

Indoor Air Sampling Form – Page 2

Resident/Owner Information

	Occupant Name:	Age:	Length of Occupancy:
(1)			
(2)			
(3)			
(4)			
(5)			
Mailing Address:		Phone Number:	
Smokers: <input type="checkbox"/> Yes <input type="checkbox"/> No		If yes, type (cigars, pipe, cigarettes) & frequency (#/day):	
Do occupants use dry cleaning service? <input type="checkbox"/> Weekly <input type="checkbox"/> Monthly <input type="checkbox"/> Not at All			
Property Owner (if different):			
Owner's Mailing Address:		Owner's Phone Number:	

Chemicals Used or Stored In the Residence

Chemical Type:	Used or Stored:	If yes, what type, when, & where stored:
Paint, Paint Thinners, or Varnishes	<input type="checkbox"/> Yes <input type="checkbox"/> No	
Gas-Powered Equipment	<input type="checkbox"/> Yes <input type="checkbox"/> No	
Gasoline	<input type="checkbox"/> Yes <input type="checkbox"/> No	
Pesticides	<input type="checkbox"/> Yes <input type="checkbox"/> No	
Cleaning Solvents	<input type="checkbox"/> Yes <input type="checkbox"/> No	
Cleaning Products	<input type="checkbox"/> Yes <input type="checkbox"/> No	
Carpet/Upholstery Cleaners	<input type="checkbox"/> Yes <input type="checkbox"/> No	
Moth Balls	<input type="checkbox"/> Yes <input type="checkbox"/> No	
Air Fresheners	<input type="checkbox"/> Yes <input type="checkbox"/> No	
Hobby Supplies	<input type="checkbox"/> Yes <input type="checkbox"/> No	
Cosmetic Products	<input type="checkbox"/> Yes <input type="checkbox"/> No	
Other: _____		

Note: To the extent possible, the products listed above should not be used in the residence for at least 48 hours before sampling to avoid background interferences.

Property ID: _____

Indoor Air Sampling Form – Page 3

Building Information

Building Type:	Year Constructed:	Foundation Type:
Foundation Walls:	Foundation Cracks:	Basement Moisture:
Basement Flooring:	Floor Drains:	Basement (% Finished):
Basement Occupancy: <input type="checkbox"/> Full-time <input type="checkbox"/> Occasionally <input type="checkbox"/> Seldom <input type="checkbox"/> Almost Never		
Private Well: <input type="checkbox"/> Yes <input type="checkbox"/> No	Well Use:	Sump: <input type="checkbox"/> Yes <input type="checkbox"/> No
Cistern: <input type="checkbox"/> Yes <input type="checkbox"/> No	Attached Garage: <input type="checkbox"/> Yes <input type="checkbox"/> No	
Radon Mitigation System Installed: <input type="checkbox"/> Yes <input type="checkbox"/> No		If yes, what type:
Recent Remodeling: <input type="checkbox"/> Yes <input type="checkbox"/> No		If yes, what activities:
Primary Water Supply:	<input type="checkbox"/> Public Water <input type="checkbox"/> Private Well	<input type="checkbox"/> Other: _____
Sewage Disposal:	<input type="checkbox"/> Public Sewer <input type="checkbox"/> Septic Tank	<input type="checkbox"/> Leach Field <input type="checkbox"/> Other: _____
Type of Heating System(s): (check all that apply)	<input type="checkbox"/> Hot Air Circulation <input type="checkbox"/> Heat Pump <input type="checkbox"/> Hot Air Radiation <input type="checkbox"/> Steam Radiation	<input type="checkbox"/> Wood Stove/Fireplace <input type="checkbox"/> Gas Fireplace <input type="checkbox"/> Kerosene Space Heater <input type="checkbox"/> Electric Baseboard Heat
Fuel Type(s): (Check all that apply)	<input type="checkbox"/> Natural Gas <input type="checkbox"/> Propane <input type="checkbox"/> Electric <input type="checkbox"/> Fuel Oil	<input type="checkbox"/> Solar <input type="checkbox"/> Coal <input type="checkbox"/> Other: _____
Type of Cooling and Ventilation System(s): (Check all that apply)	<input type="checkbox"/> Central Air Conditioning <input type="checkbox"/> Window Air Conditioning <input type="checkbox"/> Mechanical Fans <input type="checkbox"/> Bathroom Exhaust Fan <input type="checkbox"/> Kitchen Exhaust Fan	<input type="checkbox"/> Air to Air Exchanger <input type="checkbox"/> Attic Fan <input type="checkbox"/> Whole House Fan <input type="checkbox"/> Open Windows <input type="checkbox"/> Other: _____

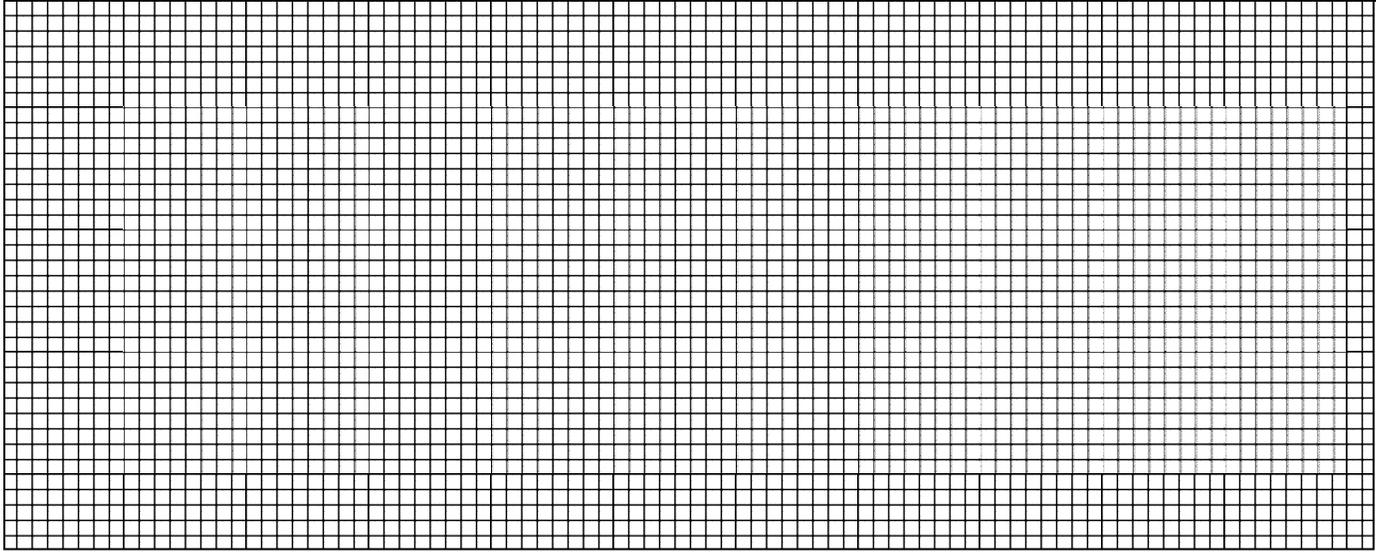
Other Comments

Property ID: _____

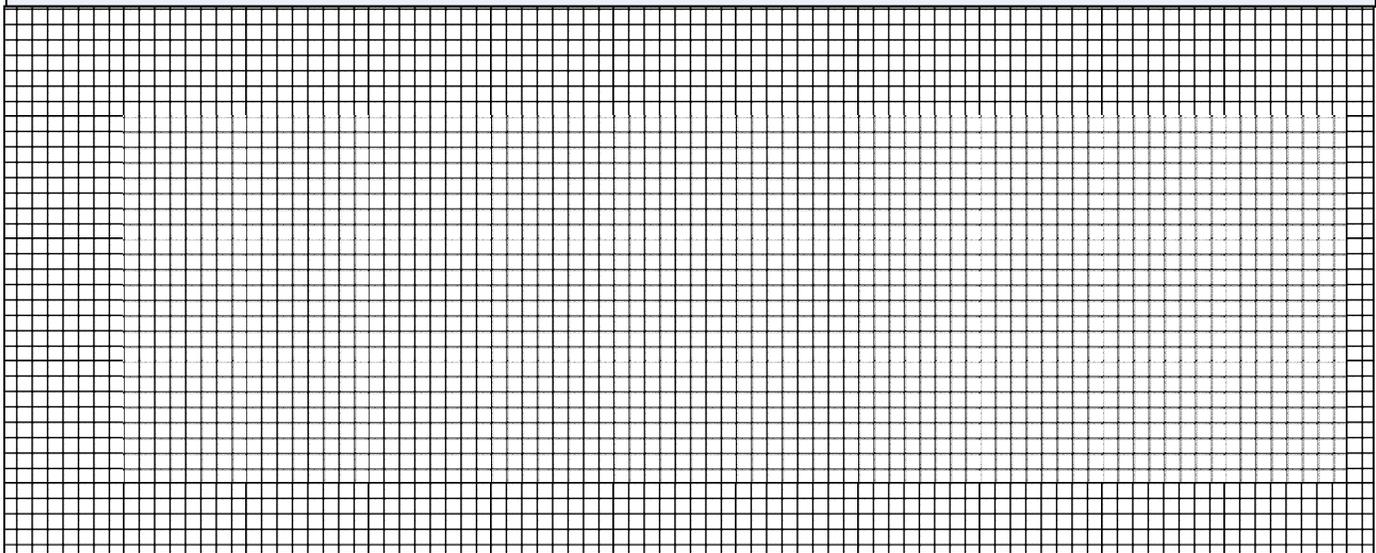
Indoor Air Sampling Form – Page 4

Floor Plans

Basement Layout: Identify furnace and water heater, chemical storage, indoor air pollution sources, preliminary screening locations, and sample locations. Also identify which direction is north.



First Floor Layout: Identify furnace and water heater, chemical storage, indoor air pollution sources, preliminary screening locations, and sample locations. Also identify which direction is north.



Appendix C

SKC Ultra III Sampling Guide



Directions for collecting indoor and outdoor air with the Ultra III sampler

OVERVIEW

The Ultra III sampler is shipped inside a sealed Zip-lock foil pouch along with a charcoal packet. A collapsible sampler stand is available for indoor air sampling. Do not open the foil pack until deployment.

Avoid using felt-tip markers and solvents during handling and deployment of the samplers.

SAMPLE LOCATION

The objectives of the study determine the specific sample placement. In general, indoor air samplers should be placed at the breathing zone height (approximately 3-5 ft high). The sampler should be placed away from sources of humidity such as showers and tubs. Avoid placement near sources that directly or indirectly generate heat or cold such as HVAC vents. The sampler should not be placed in locations with direct air flow. The sampler should be placed in an open unobstructed area and not tucked in a corner or behind an object. For additional information, refer to ASTM D 6306 Standard Guide for Placement and Use of Diffusion Controlled Passive Monitors for Gaseous Pollutants in Indoor Air.

When sampling outdoors, protect from moisture and direct wind. A shelter is recommended allowing for air circulation around the face of the sampler. Ideal performance is achieved with sampler face velocities of 5 to 200 cm/sec. The sampler can be oriented either parallel or perpendicular to the wind. The Ultra III has been validated for use in the temperature range of 10°C to 40°C (50°F to 100°F) and in the humidity range of 20 to 80%RH. Practitioners have successfully used the Ultra samplers outside of these ranges depending on the application.

DEPLOYMENT DURATION

Prior to deploying samplers, sampling durations should be discussed with the laboratory to insure reliable results are achieved. The Ultra III can be configured with various sorbent materials to optimize performance based on the compounds of concern, the reporting limit, and the anticipated concentrations of the test environment. It is critical that the minimum and maximum recommended durations are not exceeded. Exceeding the maximum recommended duration can result in either overloading the sampler or a reduction of the sampling rate. Insufficient sampling time can result in raised reporting limits.

Ultra III Deployment

1. Open the outer foil pouch and remove the sampler. Leave the charcoal packet in the foil pack and set aside for return shipping.



2. Holding the edges of the sampler, slide the cover down to expose the holes on the face of the sampler. Once the holes have been exposed to the environment, sampling has been initiated.
3. If applicable, clip the sampler on the stand during the sample collection period.
4. Record the date and time of deployment on the COC form along with the field sample ID and barcode. The sampler barcode is located on the back of the Ultra III sampler.
5. Take care not to disturb the sampler or touch the holes on the sampler during collection.
6. When sampling is completed, slide the cover back up to fully cover the holes on the sampler. Return to the foil pouch containing the charcoal packet. Insure that the zip-lock seal is secure and return to the shipping container. Return shipping on ice is not required unless specified by the project.
7. Record the date and time sampling was completed on the COC form. Complete the remaining information requested by the lab on the COC form, and ship the samplers and the COC to:
Air Toxics Ltd.
180 Blue Ravine Rd. Suite B
Folsom, CA 95630

For questions, please contact your project manager at 800-985-5955.

Appendix D
HAPSITE® Standard Operating Procedure

HAPSITE STANDARD OPERATING PROCEDURE

Center for Toxicology and Environmental Health, L.L.C. (CTEH®)

1.0 QA/QC Procedures

Quality assurance and quality control (QA/QC) measures will be conducted prior to and during the collection of real-time air monitoring and analytical sampling to ensure that air monitoring and sampling results are usable. The following sections describe QA/QC actions taken to ensure completeness and correctness of data.

1.1 Analytical Sampling

Steps are performed to ensure analytical samples are identified and handled properly in the field. The following sections describe these steps.

1.1.1 Sample Bag Inspection

Analytical Tedlar sampling bags will be shipped by a vendor and will be prepared by the manufacturer. Upon receipt by CTEH, Tedlar bags will be inspected prior to use in the field and during time of utilization by field personnel. If sampling bags appear to be damaged, broken, or incorrectly labeled, the bag will be discarded. Furthermore, field personnel will inspect Tedlar bags to ensure that sample integrity are not compromised prior to the sampling event. When samples are collected after a sampling event, they will be re-inspected prior to analysis.

1.1.2 Sample Identification and Labels

Each analytical sample prepared and collected will be allocated a unique identifier (sample ID). For the purpose of this project, GSI or CTEH personnel will label the tedlar bag with the agreed upon sample ID and document the sample ID appropriately. The corresponding HAPSITE file name of each sample ID will be recorded on a CTEH Field Form or notebook.

1.1.3 HAPSITE Calibration and Daily Checks

Foremost, it is necessary to establish that a given GC/MS meets tuning and standard mass spectral abundance criteria prior to initiating any data collection. Prior to the analyses of any samples, blanks, or calibration standards, the instrument performance check will be performed to establish that the GC/MS system meets the mass spectral ion abundance criteria. The instrument performance check solution will be analyzed initially and once per 24-hour time period of operation. In the event the instrument performance check standard does not meet criteria, the GC/MS instrument will not be used until corrections are made, however the MS only mode or survey mode may be used to look for the selected masses of the chemicals of interest. The HAPSITE will be calibrated using a minimum of five chemical concentrations that span the monitoring range of interest in an initial calibration sequence to determine instrument sensitivity and the linearity of GC/MS response for the target compounds.

Prior to the analysis of samples and blanks but after tuning criteria have been met, the initial calibration of the GC/MS system must be routinely checked by analyzing a continuing calibration verification (CCV) standard to ensure that the instrument continues to remain within control limits. The CCV standard will be performed once every 24 hours and contain all compounds on the target analyte list or will be flagged appropriately. CCVs are evaluated to

determine whether the instrument is within acceptable calibration criteria throughout a period in which samples will be analyzed. In short, the CCV is performed to verify that the initial calibration was applicable during the sample analyses. Strict CCV compliance criteria will not be used since the HAPSITE GC/MS will be used as a screening instrument to characterize the area and identify locations to collect representative air samples for laboratory analysis. One of the calibration points from the initial calibration curve will be at the same concentration as the daily calibration standard or CCV standard. The CCV standard will be prepared and analyzed daily prior to collecting samples. All CCVs will be prepared by cleaning a Tedlar bag three times with 99.99% nitrogen and cleaning all gas-tight syringes with nitrogen. If the CCV shows recovery of the individual analyte, then analysis can proceed. However, if there is no recovery for a specific analyte on the target compound list and sample detection is observed, the data will be flagged as "R" or rejected, since recovery cannot be verified. If a CCV shows no recovery for a compound and no detection is observed within the search criteria for an investigative sample, the CCV will not be flagged.

Since all QA/QC procedures, sampling, and analysis will be conducted in the field, field blanks or method blanks (MB) will be collected as field QC checks for the samples. Field blanks are designed to determine whether samples have been contaminated prior to or during the sampling event. The field blank/method blank is carried through each step of the analytical method to examine the potential for cross-contamination. MBs will be prepared in the same fashion as samples using all standards, equipment, and apparatus that are used for a sample analysis. MB Tedlar bags will be cleaned with nitrogen. An MB will be prepared at the frequency of at least once in every 24-hour analytical sequence.

Appendix E

Analytical Method Reporting Limits

TO-17 SKC Ultra III Badge (Thermal Desorption)

Duration				
Days	Hours	Minutes		Total Duration (min)
7	0	0	=	10080

Full List Target Analytes	Outdoor Reporting Limit (ug/m3)	Outdoor Reporting Limit Flag	Indoor Reporting Limit (ug/m3)	Indoor Reporting Limit Flag
1,1,1-Trichloroethane	0.0190		0.0285	
1,1-Dichloroethene	0.0161		0.0204	
1,2-Dichloroethane	0.0140		0.0168	
2-Butanone (Methyl Ethyl Ketone)	0.3468		0.9335	
Acetone	0.1566		0.1890	
Benzene	0.0992		0.1485	
Carbon Tetrachloride	0.0218		0.0295	
Chloroform	0.0183		0.0235	
cis-1,2-Dichloroethene	0.0134		0.0179	
Cyclohexane	0.1081		0.2173	
Ethyl Benzene	0.0169		0.0242	
Heptane	0.1427		0.2115	
Hexane	0.1249		0.1862	
m,p-Xylene	0.0173		0.0269	
Methyl tert-butyl ether	0.1313		0.1815	
Methylene Chloride	0.2362		0.3374	
o-Xylene	0.0183		0.0269	
Tetrachloroethene	0.0303		0.0396	
Toluene	0.0274		0.0446	
trans-1,2-Dichloroethene	0.0134		0.0195	
Trichloroethene	0.0180		0.0234	
Special Request Analytes	Outdoor Reporting Limit (ug/m3)	Outdoor Reporting Limit Flag	Indoor Reporting Limit (ug/m3)	Indoor Reporting Limit Flag
1,1,2,2-Tetrachloroethane	0.0286		0.0339	Estimated SR
1,1,2-Trichloroethane	0.0214		0.0285	Estimated SR
1,1-Dichloroethane	0.0161	Estimated SR	0.0151	
1,2,4-Trichlorobenzene	0.0644	Estimated SR	0.0759	Estimated SR
1,2,4-Trimethylbenzene	0.0205	Estimated SR	0.0250	
1,2-Dichlorobenzene	0.0236	Estimated SR	0.0277	Estimated SR
1,2-Dichloropropane	0.0160		0.0207	Estimated SR
1,3,5-Trimethylbenzene	0.0205	Estimated SR	0.0250	Estimated SR
1,3-Butadiene		0-3 Day Est. SR	0.0364	Estimated SR
1,3-Butadiene	0.0992	4-7 Day Est SR		
1,3-Dichlorobenzene	0.0234	Estimated SR	0.0277	Estimated SR
1,4-Dichlorobenzene	0.0234	Estimated SR	0.0277	
1,4-Dioxane	0.1116	Estimated SR	0.1784	Estimated SR
2,2,4-Trimethylpentane	0.1919	Estimated SR	0.2749	Estimated SR
2-Hexanone	0.1481	Estimated SR	0.3744	Estimated SR
4-Ethyltoluene	0.0213	Estimated SR	0.0250	Estimated SR
Butane	0.0658	Estimated SR	0.2053	Estimated SR
Carbon Disulfide	0.1625	Estimated SR	0.6349	Estimated SR
Chlorobenzene	0.0161	Estimated SR	0.0259	Estimated SR
Chloroethane	0.0202	Estimated SR	0.0446	Estimated SR

Cumene	0.0194	Estimated SR	0.0250	Estimated SR
Ethanol	0.0459		0.1435	Estimated SR
Freon 11	0.0167	Estimated SR	0.0343	Estimated SR
Freon 113	0.0267	Estimated SR	0.0546	Estimated SR
Hexachlorobutadiene	0.1039	Estimated SR	0.1354	Estimated SR
Isopentane	0.0913	Estimated SR	0.1417	Estimated SR
Methylcyclohexane	0.1397	Estimated SR	0.2302	Estimated SR
Naphthalene	0.0423	Estimated SR	0.0955	Estimated SR
Propylbenzene	0.0212	Estimated SR	0.0250	Estimated SR
Vinyl Chloride	0.0061	Estimated SR	0.0074	

Compounds with Estimated SR will be flagged as "C" on the final report.



Method : Modified TO-15 Hi/Lo (LL Full List)-Std 17 RLs

Compound	Rpt. Limit (uG/m3)
Vinyl Chloride	0.026
1,1-Dichloroethene	0.040
1,1-Dichloroethane	0.082
cis-1,2-Dichloroethene	0.080
1,1,1-Trichloroethane	0.11
Benzene	0.16
1,2-Dichloroethane	0.082
Trichloroethene	0.11
Toluene	0.076
1,1,2-Trichloroethane	0.11
Tetrachloroethene	0.14
Ethyl Benzene	0.088
m,p-Xylene	0.18
o-Xylene	0.088
1,1,2,2-Tetrachloroethane	0.14
trans-1,2-Dichloroethene	0.40
Methyl tert-butyl ether	0.37
Freon 12	0.50
Freon 114	0.71
Chloromethane	0.21
1,3-Butadiene	0.22
Bromomethane	0.39
Chloroethane	0.27
Freon 11	0.57
Ethanol	0.96
Freon 113	0.78
Acetone	1.2
2-Propanol	1.2
Carbon Disulfide	1.6
Methylene Chloride	0.71
Hexane	0.36
2-Butanone (Methyl Ethyl Ketone)	0.30
Tetrahydrofuran	1.5
Chloroform	0.50
Cyclohexane	0.35
Carbon Tetrachloride	0.64
Heptane	0.42
1,2-Dichloropropane	0.47
1,4-Dioxane	0.37
Bromodichloromethane	0.68
cis-1,3-Dichloropropene	0.46
4-Methyl-2-pentanone	0.42
trans-1,3-Dichloropropene	0.46

Reporting Limits cited do not take into account sample dilution due to canister pressurization.



Method : Modified TO-15 Hi/Lo (LL Full List)-Std 17 RLs

Compound	Rpt. Limit (uG/m3)
2-Hexanone	2.1
Dibromochloromethane	0.86
1,2-Dibromoethane (EDB)	0.78
Chlorobenzene	0.47
Styrene	0.43
Bromoform	1.0
Cumene	0.50
Propylbenzene	0.50
4-Ethyltoluene	0.50
1,3,5-Trimethylbenzene	0.50
1,2,4-Trimethylbenzene	0.50
1,3-Dichlorobenzene	0.61
1,4-Dichlorobenzene	0.61
alpha-Chlorotoluene	0.53
1,2-Dichlorobenzene	0.61
1,2,4-Trichlorobenzene	3.8
Hexachlorobutadiene	5.4

Surrogate	Method Limits
1,2-Dichloroethane-d4	0-0
Toluene-d8	0-0
4-Bromofluorobenzene	0-0

Reporting Limits cited do not take into account sample dilution due to canister pressurization.

Appendix F
Air Toxics TO-17 Methods Manual

18.0 PASSIVE SAMPLING ANALYZED BY THERMAL DESORPTION - VOLATILE ORGANIC COMPOUNDS

This method involves GC/MS analysis of VOCs collected using passive samplers. These samplers are used to measure vapor-phase VOCs in a variety of gaseous matrices including indoor air, outdoor air and soil gas. VOCs in the sampling environment pass through a diffusive barrier or permeable membrane at a controlled rate and adsorb to the sorbent bed of the sampler. The sorbent is transferred to an empty tube, if needed, and the tubes are thermally desorbed by heating and purging with UHP Helium. The resulting gaseous effluent is transferred to secondary trap for re-concentration and desorption onto the gas chromatograph equipped with a mass spectrophotometer. The retention time and spectral pattern of a compound are compared with that of a known standard. Concentrations of the analytes are calculated from the average relative response factors of calibration curves obtained from analysis of standard solutions. Results are reported in ng/sample or ug/m³ if the sampling rate and duration are known.

The analysis is performed using the analytical protocols of EPA Method TO-17. The only deviation from the TO-17 method is that the samples are collected using passive samplers as opposed to the method defined procedure of using a pump to actively pull vapors through the sorbent.

Table 18.1. Summary of Method TO-17 Modifications

Requirement	TO-17	ATL Modifications
Sample collection	Active	Passive

Table 18.2. Radiello 145

Analytes	Reporting Limit (ng)	Acceptance Criteria		
		ICAL (%RSD)	LCS (% R)	CCV
1,1,1-Trichloroethane	5.5	30	70 – 130	30
Benzene	5.0	30	70 – 130	30
Ethyl Benzene	2.2	30	70 – 130	30
m,p-Xylene	2.2	30	70 – 130	30
o-Xylene	2.2	30	70 – 130	30
Tetrachloroethene	3.4	30	70 – 130	30
Toluene	1.9	30	70 – 130	30
Trichloroethene	2.7	30	70 – 130	30
1,1-Dichloroethene	4.0	30	70 – 130	30
Carbon Tetrachloride	6.3	30	70 – 130	30
cis-1,2-Dichloroethene	2.0	30	70 – 130	30
Styrene	4.2	30	70 – 130	30
trans-1,2-Dichloroethene	2.0	30	70 – 130	30
Vinyl Chloride	1.3	30	70 – 130	30

Analytes	Reporting Limit (ng)	Acceptance Criteria		
		ICAL (%RSD)	LCS (% R)	CCV
1,1,2-Trichloroethane*	5.4	30	70 – 130	30
1,1-Dichloroethane*	2.0	30	70 – 130	30
1,2,4-Trimethylbenzene*	4.9	30	70 – 130	30
1,2-Dichloroethane*	2.0	30	70 – 130	30
1,3,5-Trimethylbenzene*	4.9	30	70 – 130	30
Chloroform*	4.9	30	70 – 130	30
Cyclohexane*	3.4	30	70 – 130	30
Heptane*	4.1	30	70 – 130	30
Tetrahydrofuran*	2.9	30	70 – 130	30
Internal Standards				
Analyte	CCV IS % Recovery		Sample IS % Recovery	
Bromochloromethane	60 – 140		60 – 140	
1,4-Difluorobenzene	60 – 140		60 – 140	
Chlorobenzene-d ₅	60 – 140		60 – 140	
Analytical Surrogate				
Analyte	% Recovery			
4-Bromofluorobenzene	70 – 130			

Compounds in **bold** indicate that the associated Sampling Rate is calculated. A “C” flag will be applied to these results, as they should be considered as estimated.

*Compounds require prior approval as a Sampling Rate has not been determined and additional laboratory set-up is required.

Table 18.3. Ultra III and SKC Badge

Analytes	Reporting Limit (ng)	Acceptance Criteria		
		ICAL (%RSD)	LCS (% R)	CCV (%R)
1,1,1-Trichloroethane	2.7	30	60 – 140	70 – 130
1,1-Dichloroethene	2.0	30	60 – 140	70 – 130
1,2-Dichloroethane	2.0	30	60 – 140	70 – 130
Acetone	24	30	60 – 140	70 – 130
Benzene	16	30	60 – 140	70 – 130
Carbon Tetrachloride	3.1	30	60 – 140	70 – 130
Chloroform	2.4	30	60 – 140	70 – 130
cis-1,2-Dichloroethene	2.0	30	60 – 140	70 – 130

Analytes	Reporting Limit (ng)	Acceptance Criteria		
		ICAL (%RSD)	LCS (% R)	CCV (%R)
Cyclohexane	17	30	60 – 140	70 – 130
Ethyl Benzene	2.2	30	60 – 140	70 – 130
Heptane	20	30	60 – 140	70 – 130
Hexane	18	30	60 – 140	70 – 130
m,p-Xylene	2.2	30	60 – 140	70 – 130
Methyl tert-butyl ether	18	30	60 – 140	70 – 130
Methylene Chloride	35	30	60 – 140	70 – 130
o-Xylene	2.2	30	60 – 140	70 – 130
Tetrachloroethene	4.0	30	60 – 140	70 – 130
Toluene	4.0	30	60 – 140	70 – 130
trans-1,2-Dichloroethene	2.0	30	60 – 140	70 – 130
Trichloroethene	2.7	30	60 – 140	70 – 130
1,1,2,2-Tetrachloroethane	3.4	30	60 – 140	70 – 130
1,1,2-Trichloroethane	2.7	30	60 – 140	70 – 130
1,1-Dichloroethane	2.0	30	60 – 140	70 – 130
1,2,4-Trichlorobenzene	7.4	30	60 – 140	70 – 130
1,2,4-Trimethylbenzene	2.5	30	60 – 140	70 – 130
1,2-Dichlorobenzene	3.0	30	60 – 140	70 – 130
1,2-Dichloropropane	2.3	30	60 – 140	70 – 130
1,3,5-Trimethylbenzene	2.5	30	60 – 140	70 – 130
1,3-Butadiene	2.2	30	60 – 140	70 – 130
1,3-Dichlorobenzene	3.0	30	60 – 140	70 – 130
1,4-Dichlorobenzene	3.0	30	60 – 140	70 – 130
1,4-Dioxane	18	30	60 – 140	70 – 130
2,2,4-Trimethylpentane	23	30	60 – 140	70 – 130
2-Hexanone	20	30	60 – 140	70 – 130
4-Ethyltoluene	2.5	30	60 – 140	70 – 130
Butane	12	30	60 – 140	70 – 130
Carbon Disulfide	32	30	60 – 140	70 – 130
Chlorobenzene	2.3	30	60 – 140	70 – 130
Chloroethane	5.3	30	60 – 140	70 – 130
Cumene	2.5	30	60 – 140	70 – 130
Ethanol	9.4	30	60 – 140	70 – 130
Freon 11	2.8	30	60 – 140	70 – 130

Analytes	Reporting Limit (ng)	Acceptance Criteria		
		ICAL (%RSD)	LCS (% R)	CCV (%R)
Freon 113	3.8	30	60 – 140	70 – 130
Hexachlorobutadiene	11	30	60 – 140	70 – 130
Isopentane	15	30	60 – 140	70 – 130
Methylcyclohexane	20	30	60 – 140	70 – 130
Naphthalene	5.2	30	60 – 140	70 – 130
Propylbenzene	2.5	30	60 – 140	70 – 130
Vinyl Chloride	1.3	30	60 – 140	70 – 130
Internal Standards				
Analyte	CCV IS % Recovery		Sample IS % Recovery	
Bromochloromethane	60 – 140		60 – 140	
1,4-Difluorobenzene	60 – 140		60 – 140	
Chlorobenzene-d ₅	60 – 140		60 – 140	
Analytical Surrogate				
Analyte	% Recovery			
4-Bromofluorobenzene	70 – 130			

Note: Compounds in **bold** indicate that the associated Indoor and/or Outdoor Sampling Rate is calculated. A “C” flag will be applied to these results, as they should be considered as estimated.

Table 18.4 WMS Samplers

Analytes	Reporting Limit (ng)	Acceptance Criteria		
		ICAL (%RSD)	LCS (% R)	CCV (% R)
1,1-Dichloroethene	2.0	30	70 – 130	70 – 130
Acetone	48	30	70 – 130	70 – 130
Methyl tert-butyl ether	1.8	30	70 – 130	70 – 130
trans-1,2-Dichloroethene	2.0	30	70 – 130	70 – 130
Hexane	18	30	70 – 130	70 – 130
1,1-Dichloroethane	2.0	30	70 – 130	70 – 130
2-Butanone (Methyl Ethyl Ketone)	59	30	70 – 130	70 – 130
cis-1,2-Dichloroethene	2.0	30	70 – 130	70 – 130
Chloroform	2.4	30	70 – 130	70 – 130
1,1,1-Trichloroethane	2.7	30	70 – 130	70 – 130
Cyclohexane	1.7	30	70 – 130	70 – 130
Carbon Tetrachloride	3.1	30	70 – 130	70 – 130

Analytes	Reporting Limit (ng)	Acceptance Criteria		
		ICAL (%RSD)	LCS (% R)	CCV (% R)
Benzene	16	30	70 – 130	70 – 130
1,2-Dichloroethane	2.0	30	70 – 130	70 – 130
Heptane	20	30	70 – 130	70 – 130
Trichloroethene	2.7	30	70 – 130	70 – 130
4-Methyl-2-pentanone	20	30	70 – 130	70 – 130
Toluene	19	30	70 – 130	70 – 130
1,1,2-Trichloroethane	5.5	30	70 – 130	70 – 130
Tetrachloroethene	3.4	30	70 – 130	70 – 130
Chlorobenzene	2.3	30	70 – 130	70 – 130
Ethyl Benzene	2.2	30	70 – 130	70 – 130
m,p-Xylene	22	30	70 – 130	70 – 130
o-Xylene	22	30	70 – 130	70 – 130
Styrene	4.3	30	70 – 130	70 – 130
1,1,2,2-Tetrachloroethane	3.4	30	70 – 130	70 – 130
Propylbenzene	25	30	70 – 130	70 – 130
1,3,5-Trimethylbenzene	4.9	30	70 – 130	70 – 130
1,2,4-Trimethylbenzene	4.9	30	70 – 130	70 – 130
1,3-Dichlorobenzene	6.0	30	70 – 130	70 – 130
1,4-Dichlorobenzene	6.0	30	70 – 130	70 – 130
1,2-Dichlorobenzene	8.0	30	70 – 130	70 – 130
Naphthalene	20	30	70 – 130	70 – 130
Internal Standards				
Analyte	CCV IS % Recovery	Sample IS % Recovery		
2-Fluorotoluene	60 – 140	60 – 140		
Surrogates				
Analyte	% Recovery			
4-Bromofluorobenzene	70-130			

Table 18.5 Summary of Calibration and QC Procedures for Method TO-17 (Volatile Organic Compounds)

QC Check	Minimum Frequency	Acceptance Criteria	Corrective Action
BFB Tune Check	Every 24 hours	SW - 846 tune criteria.	Correct problem then repeat tune.
5-Point Calibration	Prior to sample Analysis.	%RSD \leq 30%, 2 allowed out up to 40%	Correct problem then repeat Initial Calibration Curve.
LCS	After each initial Calibration Curve and daily prior to analysis.	Recovery 70-130% or as noted in Tables 6.17.2 through 6.17.5.	Check the system and reanalyze the standard. Re-prepare the standard if necessary. Re-calibrate the instrument if the criteria cannot be met.
LCSD	Each analytical batch	Recovery 70 – 130% or as noted in Tables 6.17.2 through 6.17.5; %RPD \leq 25%	If more than 5% target compounds exceed criteria, evaluate system and recollection process. Correct problem and reanalyze.
Continuing Calibration Verification (CCV)	At the start of each analytical clock	70 – 130 %	If project specified risk drivers exceed this criteria, more than 5% of the compounds exceed this criteria, or any VOC exceeds 50-150% recovery, maintenance is performed and the CCV test repeated. If the system still fails the CCV, perform a new 5-point Calibration Curve.
Laboratory Blank	After the CCV and at the end of the analytical batch.	Results less than the laboratory RL.	Inspect the system and re-analyze the Blank. No corrective action for Lab Blank at end of batch.
Internal Standard (IS)	As each standard, Blank, and sample is being loaded.	CCVs: area counts 60-140%, RT w/in 20 sec of mid-point in ICAL. Blanks and samples: Retention time (RT) must be within \pm 0.33 minutes of the RT in the CCV. The IS area must be within \pm 40% of the CCV's IS area for the Blanks and samples.	CCV: inspect and correct system prior to sample analysis. Blanks: inspect the system and re-analyze the Blank. Samples: samples cannot be re-analyzed due to the nature of the sorbent cartridges. However investigate the problem by reviewing the data. If necessary, run a Lab Blank to check the instrument performance. Report the data and narrate.

QC Check	Minimum Frequency	Acceptance Criteria	Corrective Action
Field Surrogates	Each clean sample tube used for pumped sample collection and lab blank and QC samples	50 – 150%.	<p>For blanks: inspect the system and re-analyze the Blank.</p> <p>For samples: If no obvious reason can be ascertained after evaluation of the data and sample collection parameters, the sample should be reanalyzed to verify out of control recovery. If recovery is out of acceptance criteria in both the primary and recollected sample, the primary sample is reported with the surrogate flagged.</p>
Analytical Surrogate	Each passive sampler and Lab Blank and QC samples during sample desorption	70-130%.	<p>For blanks: inspect the system and re-analyze the Blank.</p> <p>For samples: If no obvious reason can be ascertained after evaluation of the data, the sample should be reanalyzed to verify out of control recovery. If recovery is out of acceptance criteria in both the primary and recollected sample, the primary sample is reported with the surrogate flagged.</p>