REVISED WORK PLAN
VAPOR INTRUSION PATHWAY ASSESSMENT

BRUNO COOPERATIVE ASSOCIATION/ ASSOCIATED PROPERTIES SUPERFUND SITE BRUNO, NEBRASKA CONSENT DECREE NO. 8:02CV483

Prepared For:
Union Pacific Railroad

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1.0 INTRODUCTION

On behalf of Union Pacific Railroad (UPRR), Conestoga-Rovers & Associates (CRA) has prepared this Work Plan to assess the vapor intrusion pathway at the Bruno Cooperative Association/Associated Properties Superfund Site (Site) located in Bruno, Nebraska.

The Village of Bruno (Village) is a small farming community of approximately 150 people located in Butler County in east central Nebraska, approximately 60 miles west of Omaha. Figure 1.1 presents the location of the Site, and a Site Plan is presented on Figure 1.2. The Village has historically obtained its drinking water supply from groundwater supply wells 36-1 and 65-1 located near the Site. Operation of these wells was discontinued in 1990 due to presence of volatile organic compounds (VOCs) in the drinking water. A groundwater remedy has been implemented at the Site, which consists of an active pump and treat remedy to restore the aquifer by lowering contaminants of concern (COCs) below maximum contaminant level (MCL) via air stripping using tray aeration and discharge to surface water. The COCs for the Site are carbon tetrachloride, 1,2-dichloroethane, and chloroform.

The treatment system was constructed in 2004 and has operated since start-up in December 2004. The extraction well and treatment building locations are shown on Figure 1.2.

This Work Plan was developed in response to the United States Environmental Protection Agency's (USEPA's) letter dated January 12, 2007 regarding USEPA's assessment of the potential for vapor intrusion to occur into the two residential buildings located at 105 Railroad Street and 107 Railroad Street north of the Site. The unsaturated zone overlying Site groundwater is comprised of a fine-grained clay and silt deposit that is approximately 35 to 45 feet in thickness. The average depth to the groundwater table is approximately 37 feet. As such, the clay and silt deposit is expected to represent a significant attenuating mechanism to the upward vertical migration of any VOCs emitted from the groundwater table. The purpose of the Work Plan is to investigate soil gas quality and evaluate whether VOCs are being emitted from the groundwater table to soil gas to an extent that could potentially impact the indoor air quality of the two residential buildings north of the Site. The locations of these two buildings are shown on Figure 1.2.

This Work Plan consists of the investigation and assessment of off-Site soil gas quality. The investigation of off-Site soil gas quality will be conducted through the installation and sampling of soil gas probes at locations where the highest VOC concentrations have been detected off-Site in the upper portion of the aquifer. The soil gas quality data obtained will be evaluated from the perspective of potentially impacting the indoor air quality of the off-Site residential buildings. The soil gas probe sampling locations are selected to capture a worse case scenario since they are proposed at locations where the highest VOC concentrations are present in the upper portion of the aquifer off Site.

A brief summary of the existing Site conditions is presented in Section 2.0. The Work Plan to investigate off-Site soil gas quality and examine the vapor intrusion pathway is presented in Section 3.0. A schedule for implementing the Work Plan is presented in Section 4.0. All references cited in this Work Plan are listed in Section 5.0.

2.0 EXISTING SITE CONDITIONS

The remedy, which has been implemented at the Site, is described in the Record of Decision (ROD) executed on September 30, 1998, and as modified by an Explanation of Significant Differences (ESD) issued in August 2000. The remedy is described in the ROD as follows:

"The selected remedy is an active pump and treat remedy to restore the aquifer by lowering the COCs[1] to below MCLs[2] throughout the aquifer in the fastest time feasible for the Site. This alternative includes the use of extraction wells, treatment of contaminated water by air stripping using tray aeration, and discharge of the treated groundwater to a tributary of Skull Creek, and/or beneficial reuse of the pumped and treated water."

The COCs for the Site are carbon tetrachloride, 1,2-dichloroethane, and chloroform.

The treatment system was constructed in 2004 and has operated since start-up in December 2004. The extraction well and treatment building locations are shown on Figure 1.2. The remedy will serve to reduce VOC concentrations in groundwater in the future.

The Site is located along a narrow valley plain within a region of rolling hills known as the Loess Hills physiographic province. The Loess Hills consist of glacial drift sediments capped by wind-deposited silt (Ginsberg, 1983). These unconsolidated sediments are incised by small stream valleys that trend generally northward to the Platte River. Beneath the loess mantle, the unconsolidated sediments are comprised of alluvial derived sand with lesser amounts of clay, silt, and gravel. The unconsolidated sediments in the Bruno area range from approximately 100 to 250 feet thick. The glacial sediments rest on shale and limestone bedrock of the late Cretaceous period (Ginsberg, 1983).

The stratigraphic sequence of the unconsolidated sediments, from the ground surface downward, consists of an upper clay and silt unit approximately 35 to 45 feet thick, a middle sand unit approximately 60 to 80 feet thick, and a basal clay unit, which may not be present at all locations. The upper bedrock has been described as weathered shale with chalk inclusions (URS, 2000).

1 COCs - Contaminants of Concern

2 MCL - Maximum Contaminant Level. USEPA National Primary Drinking Water Regulations.

The aquifer is contained in the middle sand unit, which has been divided into three zones: an upper sand, a middle sand, and a lower sand. The aquifer is generally 60 feet thick in the Site vicinity. The average depth to the groundwater table in the upper sand is approximately 37 feet. As such, the clay and silt deposit that overlies the upper sand is expected to represent a significant attenuating mechanism to the upward vertical migration of any VOCs emitted from the groundwater table.

3.0 WORK PLAN

The Work Plan to assess potential vapor intrusion into indoor air of the residential properties consists of four main tasks, as follows: soil gas probe installation; soil gas probe sampling; initial soil gas quality data screening; and semi-Site-specific soil gas quality assessment. The semi-Site-specific soil gas quality assessment will be conducted only if the initial screening identifies the presence of the Site COCs in soil gas above screening levels (i.e., carbon tetrachloride, 1,2-dichloroethane, and chloroform). A description of each task is presented below.

Task 1: Soil Gas Probe Installation

To investigate the potential for VOCs to volatilize from Site groundwater to soil gas within the unsaturated overburden at the Site, the installation and sampling of permanent soil gas probes is proposed. Two permanent soil gas probe nests are proposed at the locations presented on Figure 3.1. Each soil gas probe nest will consist of one shallow (5 to 6 feet BGS) and one deep (10 to 11 feet BGS) soil gas probe. One soil gas probe nest is proposed adjacent to the shallow monitoring well MW-42U where the highest VOC concentrations are detected in Site shallow groundwater. One soil gas probe nest is proposed adjacent to the extraction well EW-4, which is approximately 60 feet away from the residential building (107 Railroad Street) that is located closest to the Site.

The soil gas probe nests will be installed using direct-push drilling methods (i.e., a Geoprobe® drill-rig) to advance two (2) separate boreholes for the shallow and deep soil gas probes, located within 2 feet of each other. The shallow soil gas probe will be installed to screen a depth of approximately 11 to 12 feet BGS, and the deep soil gas probe will be installed to screen a depth of approximately 16 to 17 feet BGS. The screened interval depth for the shallow soil gas probes is selected to be approximately 5 feet below the assumed basement depth of the residential buildings located at 105 Railroad Street and 107 Railroad Street. Visual observations of these two buildings have identified windows in the foundation at ground level suggesting that each could have a basement. Assuming a typical basement depth of 6 feet BGS, the shallow soil gas probe screened interval at 11 to 12 feet BGS will be 5 feet below the basement depth. The screened interval for the deep soil gas probes is selected to be approximately 5 feet below the shallow soil gas probes to evaluate vertical attenuation between any detected soil gas concentrations.

The Geoprobe® drill-rig will hydraulically push a series of drive rods to the screened interval target depths. When the target depth has been reached, a Geoprobe® screen implant (approximately 1-foot in length) will be inserted down the annulus of the drive rods and will be attached to the drive point at the bottom of the drive rods. Geoprobe® screen implants will be used that are constructed of 1/8-inch diameter stainless steel tubing, equipped with an anchor. The screen implants will be set at the bottom 1-foot of each borehole. The implant will be connected to 1/8-inch diameter nylon sampling tubing of sufficient length to extend to ground surface. Once the implant is set in position, the drive rods will be removed leaving the implant in the subsurface. While removing the drive rods, a sand pack of inert 10/20 silica sand will be placed around the implant to 6 inches above the screened interval. A 1-foot thick seal comprised of dry granular bentonite will be placed on top of the sand pack. The remainder of the borehole will be filled with pre-hydrated granular bentonite to ground surface. Each soil gas probe will be completed at ground surface using a lockable flush-mount casing, and the tubing at ground surface will be terminated with a valve connection. A typical soil gas probe construction detail is presented on Figure 3.2.

The boreholes completed for each soil gas probe will be logged in accordance with the Modified Unified Soil Classification System (USCS) by a CRA representative. The locations and elevations of the boreholes will be surveyed for future reference. All soils encountered during the borehole investigation will be qualitatively screened based on visual and olfactory observations and quantitatively screened for the presence of undifferentiated organic vapors using a photo-ionization detector (PID). Qualitative and quantitative information will be included on the soil gas probe stratigraphic logs.

The collection of overburden soil samples is proposed at each soil gas probe borehole location for the analyses of the soil physical properties of moisture content, dry bulk density, grain size analyses, and fraction of organic carbon content. The soil physical properties will be applied in a semi-Site-specific soil gas quality assessment, if required (see Task 4 below).

A decontamination pad will be constructed on-Site to contain all cleaning fluids. Probing and sampling equipment will be decontaminated, as required, by washing with an Alconox detergent solution and rinsing with distilled water.

Task 2: Soil Gas Probe Sampling

The soil gas probe sampling is proposed to occur a minimum of 72 hours following the installation of the soil gas probes. Following soil gas probe installation using direct-push methods, California Environmental Protection Agency (CAEPA) considers 30 minutes of equilibration time to be sufficient for any formation disturbances created by probing activities to dissipate and for equilibrium conditions to be reestablished in the unsaturated zone (CAEPA, 2003). A 72-hour equilibration time is recommended since the vadose zone at the Site is comprised of fine-grained soils that may require more time for probe installation disturbances to dissipate. Equilibration time is needed because during the installation of the soil gas probes ambient air can be introduced into the vadose zone that could dilute soil gas concentrations. In addition, sampling will not be performed during or within 48 hours of a significant rain event [e.g., ≥0.5 inches after CAEPA (2003)]. The soil gas probes will be sampled twice: an initial sampling event; and a confirmatory sampling event.

Written documentation of all field activities, conditions, and sampling processes, including names of field personnel, dates and times, etc. is important to obtain. Documentation includes weather conditions (temperature, barometric pressure, wind direction and speed, and humidity); surface conditions (presence of standing water and/or non-vegetative cover); and groundwater elevation measurements in monitoring wells adjacent to the soil gas probes.

The soil gas samples will be collected using 1-liter or 1.7 liter capacity Summa™ canisters, depending on laboratory availability. Only canisters certified clean at the 100% level will be used for sampling so that data can be evaluated for the purpose of assessing potential human health risks due to vapor intrusion. The canisters will be fitted with a laboratory calibrated critical orifice flow regulation device sized to limit the soil gas sample collection flow rate to a maximum of approximately 100 milliliters per minute (mL/min). This soil gas sample collection flow rate corresponds to the lower end of the maximum soil gas sample flow rate range of 100 to 200 mL/min recommended by CAEPA (2003). A maximum flow rate of 100 mL/min is recommended to limit VOC stripping from soil, prevent the short-circuiting of ambient air from ground surface that would dilute the soil gas sample, and increase confidence regarding the location from which the soil gas sample is obtained. The low flow rate of ≤100 mL/min provides the most representative sample of in-situ soil gas conditions.

Prior to sample collection, soil gas probe purging will be conducted at a maximum flow rate of 100 mL/min. A maximum of one to two soil gas probe "dead volumes" will be purged to remove potentially stagnant air from the internal volume of the soil gas probe and ensure that soil gas representative of the formation is drawn into the soil gas probe. Since the vadose zone at the Site is comprised of fine-grained soils, limiting the purging to one to two probe volumes is recommended to minimize potential short-circuiting to ground surface and to increase the certainty in knowing the depth from which the soil gas samples are obtained. The soil gas probe "dead volumes" will be calculated based on field measurements of probe construction (i.e., below ground tubing length, tubing inner diameter, and sand pack length indicated in the soil gas probe stratigraphic logs) and the above ground sampling equipment. Further details regarding the soil gas sampling protocol are presented in Appendix A.

The soil gas samples will be analyzed using USEPA's TO-15 gas chromatograph/mass spectrometer (GC/MS) methodology. This analysis will provide results for VOCs in soil gas. As described further below, an outdoor ambient air sample will be collected coincident with the soil gas samples to assess potential presence of VOCs in background outdoor air. The outdoor air sample also will be analyzed using TO-15, but with the MS run in selected ion monitoring (SIM) mode to achieve lower detection limits.

Quality assurance/quality control (QA/QC) measures implemented during the soil gas sampling event will include leak testing, maintaining a minimum residual negative pressure in the Summa™ canisters of approximately 1 to 5 inches of Mercury following sample collection, collection of one field duplicate sample, and the analysis of an outdoor ambient air sample. Further details regarding the soil gas probe sampling QA/QC measures are presented in Appendix A. A brief description of the leak testing procedures is provided below.

Leak testing will be performed to determine whether ambient air has infiltrated the sample collection system during sampling. The leak testing will consist of a two-step process. The first step, conducted prior to sample collection, will involve vacuum testing the sampling equipment after assembly to test the air-tightness of the assembly connections. The second step, conducted during sample collection, will involve placing paper towels soaked in a dilute solution of isopropanol placed around the soil gas probe surface casing, ground surface immediately surrounding the surface casing, and sample assembly connections at the surface casing. The paper towels will be covered by a plastic sheet to shroud the soil gas probe and sampling assembly connections at ground surface. The shroud will retain vapors emitted from the isopropanol solution. Isopropanol will serve as the tracer compound and is included in the analyte list for TO-15. For the first step, the sampling assembly will be connected to include the purge pump in a valved tee-connection before connecting to the Summa™ canister. Prior to purging the gas probe, the valve to the purge pump will be opened leaving closed the valve to the Summa™ canister and the valve to the gas probe. The pump will be operated to ensure that it draws no air from the sampling assembly (i.e., creates a negative pressure, or vacuum within the sampling assembly), thus establishing that all assembly connections are air-tight. Purging of the gas probe will then commence. Once purging is completed, the valve to the purge pump will be closed, and the second leak test step described above will be implemented. The valve to the Summa™ canister will then be opened and sample collection will commence. The soil gas sample analytical results will be reviewed to ensure that significant isopropanol is not present in the sample, thus ensuring that ambient air did not infiltrate into the sample.

Task 3: Screening Assessment of Soil Gas Quality Data

As an initial assessment of the significance of the soil gas sample analytical results, the chemical concentrations detected in the soil gas samples will be compared to, or screened against, chemical specific generic soil gas screening criteria. USEPA's *Draft Guidance for Evaluating the Vapor Intrusion to Indoor Air Pathway from Groundwater and Soils (Subsurface Vapor Intrusion Guidance)* (USEPA, 2002) presents allowable residential risk-based target indoor air concentrations. Generic soil gas screening criteria will be developed from these residential risk-based target indoor air concentrations through dividing them by USEPA's generic soil gas attenuation factor of 0.01 for deep soil gas (i.e., sample depth greater than 5 feet BGS below the basement depth) (USEPA, 2002). The target indoor air concentrations will correspond to those developed by USEPA based on a carcinogenic risk level of 1×10^{-6} and a non-carcinogenic hazard index of 1.0.

The soil gas attenuation factor represents the degree that vapor concentrations are attenuated (i.e., decreased) as they potentially migrate upward from the unsaturated zone, penetrate a building foundation, and mix with building indoor air. A smaller soil gas attenuation factor value represents an increased degree of attenuation. Considering the silty clay composition of the unsaturated zone at the Site, actual soil gas attenuation factor values for the Site are expected to be considerably less than USEPA's generic value of 0.01 for deep soil gas. Applying the generic soil gas screening criteria based on USEPA's generic soil gas attenuation factor value of 0.01 for deep soil gas is considered to represent a conservative initial screening of the soil gas quality data. The laboratory analytical results for all analytes will be reported for each soil gas sample, however the screening will be used to identify whether any of the Site COCs (i.e., carbon tetrachloride, 1,2-dichloroethane, and chloroform) are present in soil gas at concentrations that warrant further assessment. Should any of the Site COCs be detected in soil gas at concentrations greater than the generic soil gas screening criteria, the potential for the Site COCs to impact indoor air quality will be assessed further through the semi-Site-specific soil gas quality assessment, as is described further below in Task 4.

Task 4: Semi-Site-Specific Soil Gas Quality Assessment

Should any of the Site COCs be detected in soil gas at concentrations greater than the generic soil gas screening criteria, the potential for these COCs to impact indoor air quality will be assessed through the semi-Site-specific soil gas assessment, as described in USEPA (2002). Under the semi-Site-specific assessment, factors such as soil type and depth to soil gas samples are taken into consideration to select semi-Site-specific soil gas attenuation factors values that are more representative of the conditions present at the Site. Semi-Site-specific soil gas attenuation factors will be obtained from USEPA (2002; Figure 3a). The residential target indoor air concentrations will be divided by the attenuation factors to develop semi-Site-specific soil gas screening criteria.

The COC concentrations detected in soil gas then will be compared to the semi-Site-specific soil gas criteria to assess whether the detected concentrations are of concern from a vapor intrusion perspective. Should concentrations of the Site COCs from the initial and confirmatory sampling events be greater than the semi-Site-specific soil gas criteria, a subsequent work plan to further investigate the vapor intrusion pathway at the off-Site residential buildings will be proposed. It is anticipated that the subsequent work plan could consist of investigating soil gas quality adjacent to off-Site buildings and possibly indoor air quality testing. As part of any indoor air sampling that may be proposed in the subsequent work plan, a detailed building survey and inspection would be conducted to identify any potential indoor air sources of VOCs already present within the building (i.e., smoking, cleaning products, building products, grooming products, etc.).

4.0 SCHEDULE

The initial soil gas sampling event is planned for early to mid-May 2007, and the confirmatory sampling even is planned for early to mid-June 2007. A report summarizing the results of the vapor intrusion pathway assessment proposed herein will be submitted to USEPA within 30 days following receipt of the laboratory analytical results for the confirmatory sampling event. The report will summarize the soil gas probe installations, soil physical property data, soil gas quality data, outdoor ambient air quality data, and the assessment of the soil gas quality data. The results of this Work Plan will be assessed to evaluate the need to investigate soil gas quality adjacent to the residences, and the need to possibly investigate the indoor air quality of the residences. The soil gas sampling locations in this Work Plan are proposed where the greatest VOC impacts to shallow groundwater are detected. Thus, in the event that no potential soil gas air quality concerns are identified, conducting further assessment of the vapor intrusion pathway would not be warranted. Recommendations regarding the need to conduct a further assessment of the vapor intrusion pathway will be included as part of the report presenting the results of this Work Plan.

5.0 REFERENCES

CAEPA, 2003. Advisory – Active Soil Gas Investigations, Department of Toxic Substances Control, and Prepared Jointly with the California Regional Water Control Board – Los Angeles Region, January 28.

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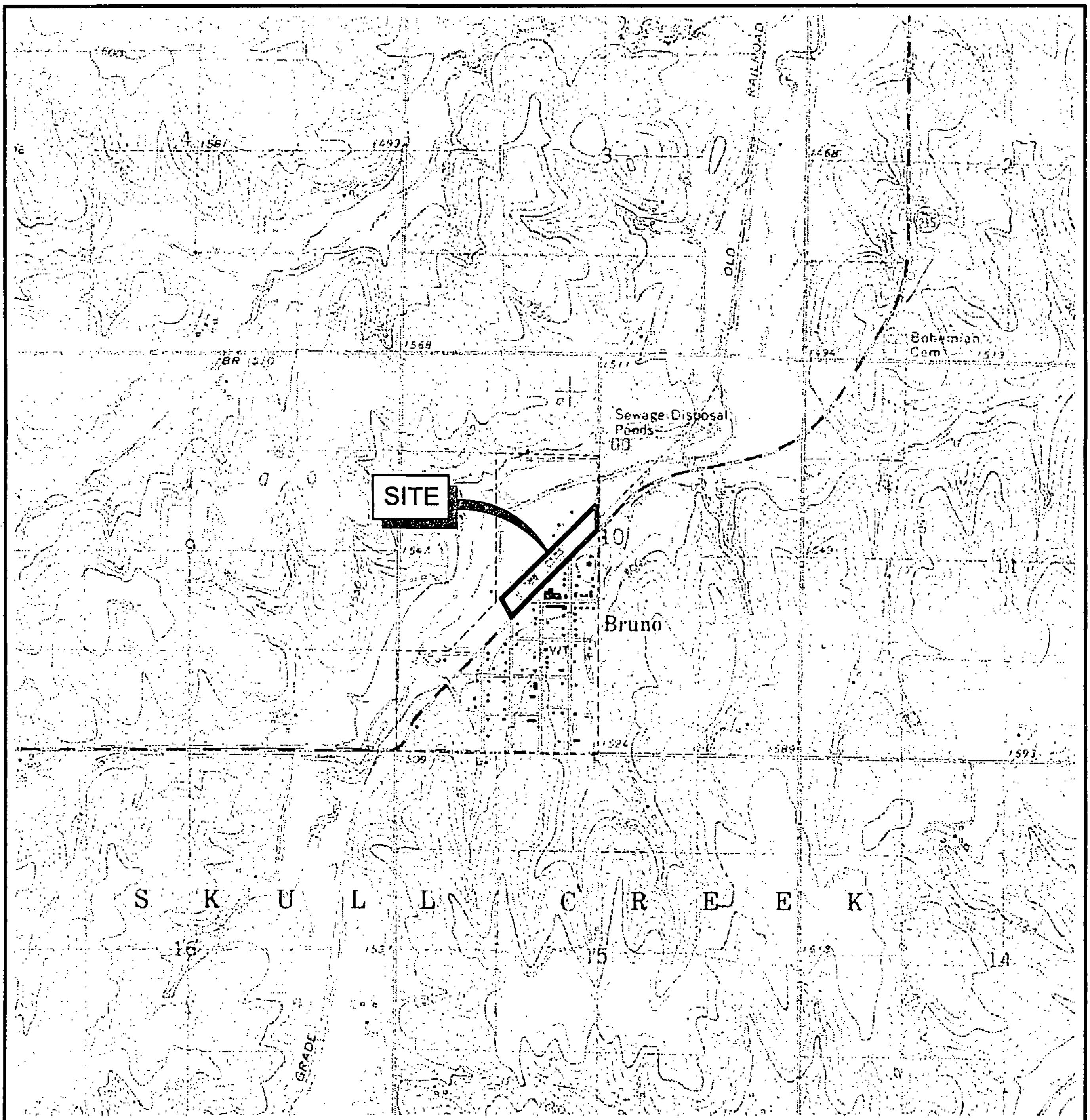
URS Greiner Woodward Clyde (URS), 2000. Emerging Technology Characterization Study Technical Memorandum, Bruno Superfund Site, Bruno, Nebraska, May.

USEPA, 2002. Draft Guidance for Evaluating the Vapor Intrusion to Indoor Air Pathway from Groundwater and Soils (Subsurface Vapor Intrusion Guidance), EPA Report No. EPA530-F-02-052, Office of Solid Waste and Emergency Response, November.

USEPA, 2004. User's Guide for Evaluating Subsurface Vapor Intrusion into Buildings, Office of Emergency and Remedial Response, Washington, DC, Revised February 22.



SOURCE: USGS 7.5 MINUTE QUAD
BRUNO, NEBR.

0 1000 2000ft

figure 1.1

SITE LOCATION
BRUNO COOPERATIVE ASSOCIATION/
ASSOCIATED PROPERTIES SUPERFUND SITE
Bruno, Nebraska

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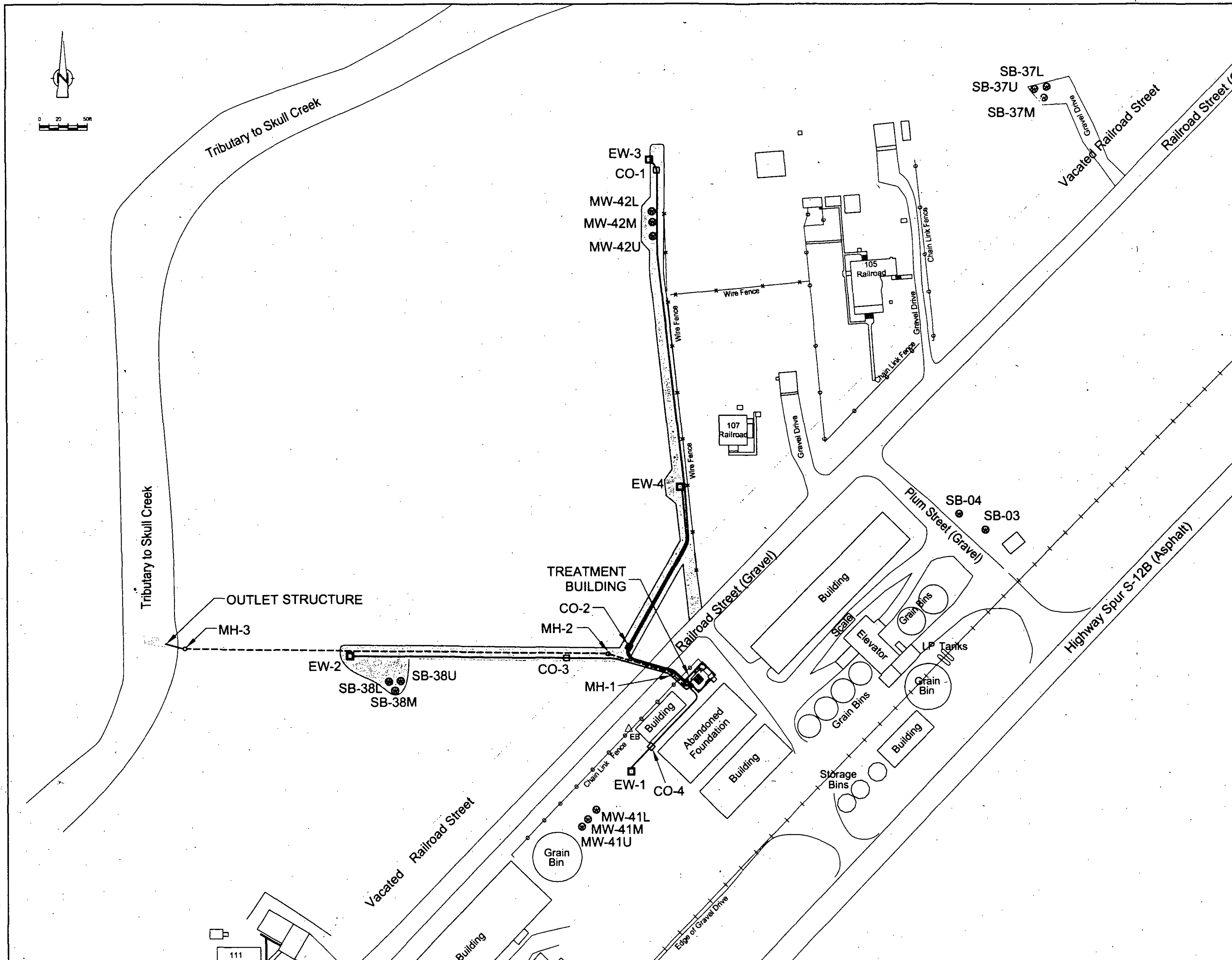

Nº	Revision	Date	Initial

LEGEND

- SS — SANITARY SEWER
- E — OVERHEAD POWER LINE
- UGT — UNDERGROUND TELEPHONE LINE
- W — WATER LINE
- CHAIN LINK FENCE
- WIRE FENCE
- FOUND MONUMENT
- SET 5/8" x 24" REBAR with PLASTIC SURVEY CAP
- SET RAILROAD SPIKE
- BENCH MARK
- FL — FLOW LINE
- PP — POWER POLE
- LP — LIGHT POLE
- TP — TRANSFORMER POLE
- ANC — ANCHOR
- EB — ELECTRICAL BOX
- PED — UTILITY PEDESTAL
- FH — FIRE HYDRANT
- WELL
- EXTRACTION WELL
- MH — MAN HOLE
- WV — WATER VALVE
- GRAVEL ACCESS ROAD
- INFLUENT FORCEMAIN LINE
- DISCHARGE LINE
- CLEANOUT
- MANHOLE

SCALE VERIFICATION

THIS BAR MEASURES 1" ON ORIGINAL. ADJUST SCALE ACCORDINGLY.

Approved

DRAWING STATUS

Status	Date	Initial

BRUNO COOPERATIVE ASSOCIATION/
ASSOCIATED PROPERTIES SUPERFUND SITE
BRUNO, NEBRASKA

SITE PLAN

CONESTOGA-ROVERS & ASSOCIATES

Source Reference

SNYDER ENGINEERING COMPANY, INC., JULY 2003

Project Manager:	Reviewed By:	Date	
J. CHRISTOFFERSON	E. HOGLUND	MARCH 2007	
Scale: 1"=50'	Project Nº: 19020-00	Report Nº: 013	Drawing Nº: figure 1.2

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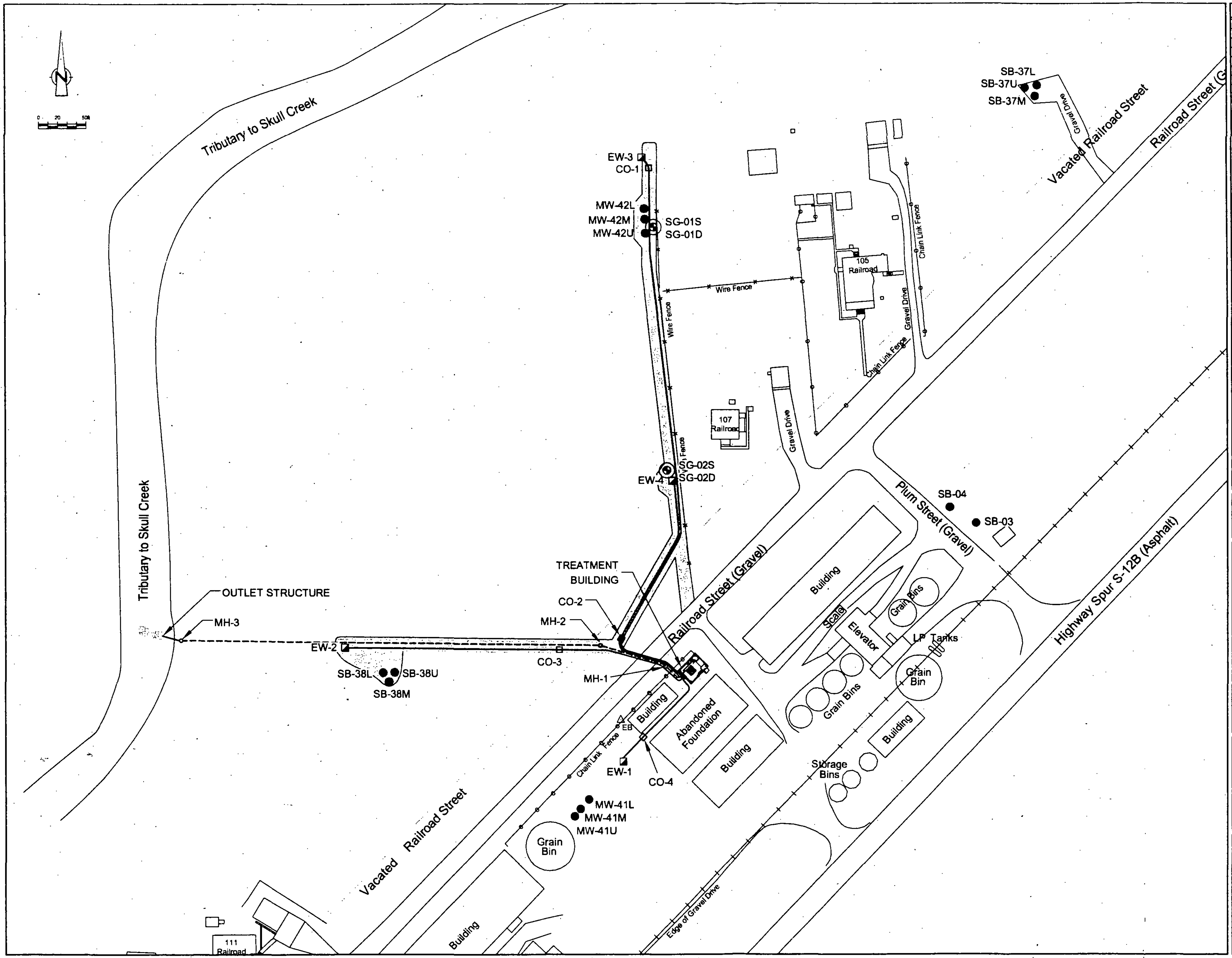

Nº	Revision	Date	Initial

LEGEND

SS	SANITARY SEWER
E	OVERHEAD POWER LINE
UGT	UNDERGROUND TELEPHONE LINE
W	WATER LINE
	CHAIN LINK FENCE
	WIRE FENCE
	FOUND MONUMENT
	SET 5/8" x 24" REBAR with PLASTIC SURVEY CAP
	SET RAILROAD SPIKE
	BENCH MARK
FL	FLOW LINE
PP	POWER POLE
LP	LIGHT POLE
TP	TRANSFORMER POLE
ANC	ANCHOR
EB	ELECTRICAL BOX
PED	UTILITY PEDESTAL
FH	FIRE HYDRANT
SB-37L	WELL
EW-4	EXTRACTION WELL
SG-01S	PROPOSED SOIL GAS PROBE
MH	MAN HOLE
WV	WATER VALVE
	GRAVEL ACCESS ROAD
	INFLUENT FORCEMAIN LINE
	DISCHARGE LINE
	CLEANOUT
	MANHOLE

SCALE VERIFICATION

THIS BAR MEASURES 1" ON ORIGINAL. ADJUST SCALE ACCORDINGLY.

Approved

DRAWING STATUS

Status	Date	Initial

BRUNO COOPERATIVE ASSOCIATION/
ASSOCIATED PROPERTIES SUPERFUND SITE
BRUNO, NEBRASKA

PROPOSED SOIL GAS PROBE LOCATIONS

CONESTOGA-ROVERS & ASSOCIATES

Source Reference:
SNYDER ENGINEERING COMPANY, INC., JULY 2003

Project Manager:	Reviewed By:	Date:	
J. CHRISTOFFERSON	E. HOGLUND	MARCH 2007	
Scale:	Project Nº:	Report Nº	Drawing Nº:
1"=50'	19020-00	013	figure 3.1

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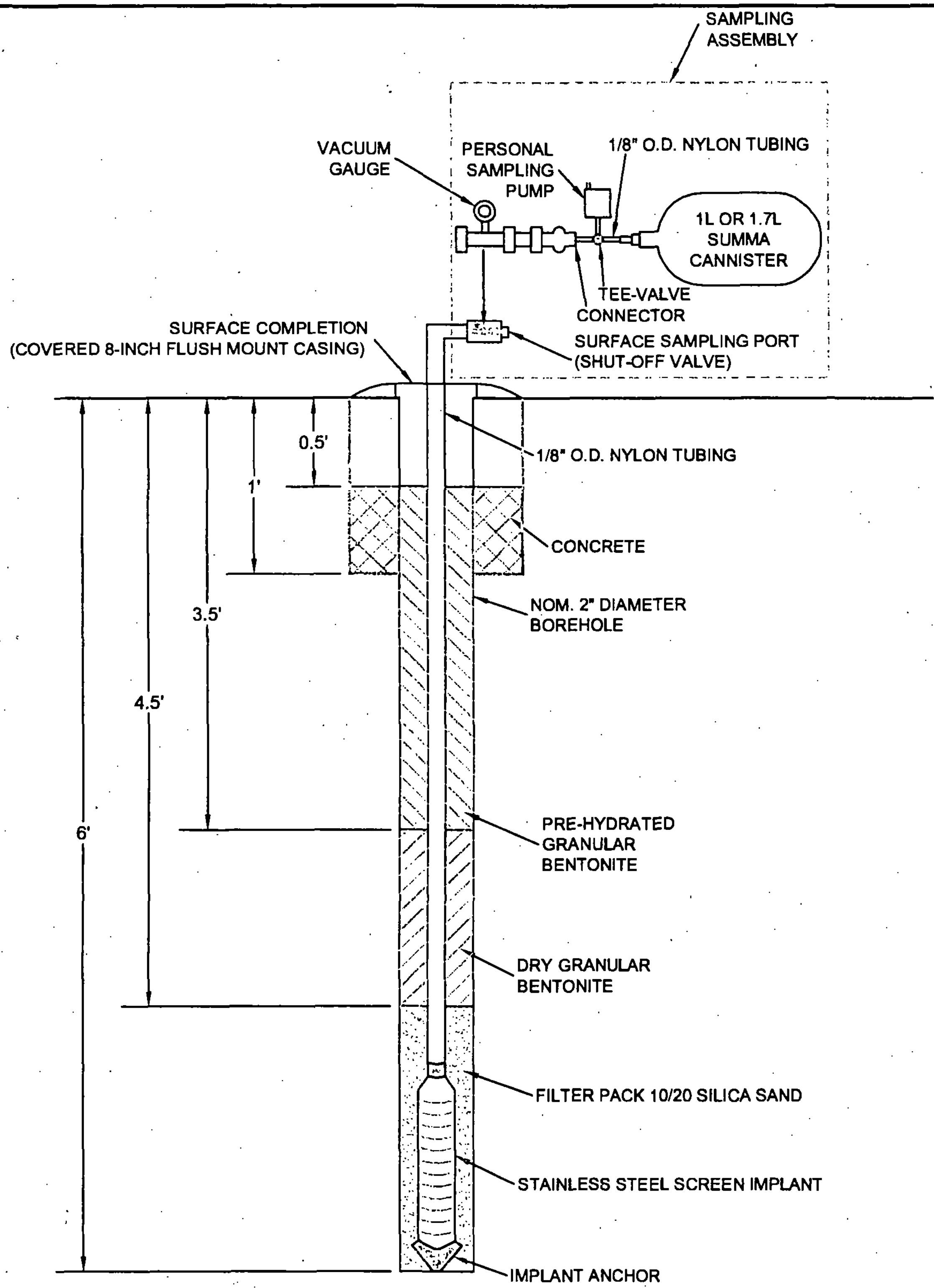

figure 3.2

TYPICAL SOIL GAS PROBE COMPLETION DETAIL
BRUNO COOPERATIVE ASSOCIATION/
ASSOCIATED PROPERTIES SUPERFUND SITE
Bruno, Nebraska

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APPENDIX A

SOIL GAS AND OUTDOOR AIR SAMPLING PROTOCOL

TABLE OF CONTENTS

1.0 INTRODUCTION

This Appendix presents the soil gas and outdoor air sampling protocols to be implemented at the Bruno Cooperative Association/Associated Properties Superfund Site (Site) located in Bruno, Nebraska. The Quality Assurance/Quality Control (QA/QC) measures to be applied during the soil gas and outdoor air sampling are outlined. The soil gas sampling protocol outlined herein is based on the soil gas sampling protocols developed by the California Environmental Protection Agency (CAEPA) (CAEPA, 2003) and by the Missouri Department of Natural Resources (MDNR) (MDNR, 2005).

2.0 SOIL GAS SAMPLING PROTOCOL

The soil gas sampling protocol consists of a sampling step and a leak testing step. The steps involved in the soil gas sampling are described in Section 2.1. The steps involved in the leak testing are described in Section 2.2.

2.1 SOIL GAS SAMPLING

A summary of the steps involved in the soil gas sampling protocol is presented below:

- Soil gas sampling will be conducted a minimum of 72 hours following installation of the soil gas probes to allow the formation to return to equilibrium conditions.
- Depending upon availability from the laboratory, soil gas samples will be collected using 1-liter, or 1.7-liter, capacity Summa™ canisters to ensure that smaller sample volume is drawn from the formation during sampling increasing confidence that the sample is derived from adjacent to the soil gas probe screened interval.
- The sampling assembly will be connected to the soil gas probe. The sampling assembly will consist of 1/8-inch diameter nylon tubing connected to the soil gas probe valve at the surface casing through a tee-valve connection to a vacuum gauge, through a tee-valve connection to a personal sampling pump, and then connected to the Summa™ canister (i.e., in the order of soil gas probe, vacuum gauge, pump, and canister). The vacuum gauge is to be provided by laboratory and will be returned with the canister samples to check residual canister vacuum at the laboratory prior to sample analysis and recorded on the analytical data report (this is described further below). The vacuum gauge is to be provided by the laboratory, used during sampling, and returned to the laboratory to ensure consistency in vacuum measurements taken both in the field and by the laboratory. The personal sampling pump will be used to purge the soil gas probe prior to sample collection.
- Prior to purging, a vacuum, or tightness, test will be conducted on the sampling assembly as the first of two leak testing steps, as is described further in Section 2.2. Briefly, the vacuum test will consist of opening the valve to the personal sampling pump leaving closed the valve to the Summa™ canister and the valve to the gas probe. The pump will then be operated to ensure that it draws no air from the sampling assembly (i.e., creates a negative pressure, or vacuum within the sampling assembly), thus establishing that all assembly connections are air-tight. The reading from the vacuum gauge pressure will be recorded in the field logbook. Further details of this first leak testing step are provided in Section 2.2.

- Following the vacuum tests, the soil gas probes will be purged prior to sampling using the personal sampling pump complete with low flow valves calibrated using Buck flow calibrator (primary standard calibration method). The sampling pump will be set for a flow rate slightly less than 100 milliliters per minute (mL/min) [corresponding to the lower end of the maximum soil gas sampling flow rate recommended by CAEPA (2003) of 100 to 200 mL/min].
- The purging will be conducted to remove a maximum of one to two probe volumes (calculated considering the volume of the screened interval sand pack, with assumed sand porosity of 30 percent, the probe casing volume, and the sampling assembly). Since the vadose zone at the Site is comprised of fine-grained soils, limiting the purging to one to two probe volumes is recommended to minimize potential short-circuiting to ground surface and to increase the certainty in knowing the depth from which the soil gas samples are obtained.
- The soil gas probe purging will commence by opening the valve to the soil gas probe and activating the personal sampling pump. At the start and the end of the purging period, the total concentration of volatile organic vapors of the personnel sampling pump exhaust gas will be monitored using a portable photoionization detector (PID) meter. The PID meter will be connected in series after the personal sampling pump. Since typical PID instrument flow rates vary from approximately 300 mL/min to 500 mL/min (depending on the manufacturer and model), drawing a sample into the PID meter through the personal sampling pump likely will increase the purging flow rate temporarily until a reading from the PID meter is obtained. PID readings will be recorded and entered in the field logbook and chain of custody form. The PID readings will provide the laboratory with an indication of whether a sample could require dilution before analysis.
- Following purging, the valve to the Summa™ canister will be opened to draw a soil gas sample into the canister.
- Prior to sample collection, a tracer compound will be placed at ground surface around the soil gas probe as the second of two leak testing steps to test the integrity of the soil gas probe seal, as described further in Section 2.2. Paper towels soaked in a dilute solution of isopropanol will be wrapped around the soil gas probe surface casing and ground surface immediately surrounding the surface casing. The soil gas probe surface casing then will be covered using plastic sheeting to shroud the soil gas probe and sampling assembly connections at ground surface. The ground surface finish permits, the plastic sheeting will be sealed to the ground surface using tape or by weighting the edges of the plastic sheeting with dry benonite. Further details of this second leak testing step are provided in Section 2.2.

- The Summa™ canisters will be fitted with a laboratory calibrated critical orifice flow regulation device sized to allow the collection of the soil gas sample over a 10-minute, or 17-minute, sample collection time, depending upon the capacity of thw canisters (i.e., 1-liter or 1.7-liter). The 10-minute sample collection time for a 1-liter, 17-minute sample collection time for a 1.7-liter, capacity Summa™ canister corresponds to a maximum soil gas sample collection flow rate of approximately 100 mL/min [corresponding to the lower end of the maximum soil gas sampling flow rate recommended by CAEPA (2003) of 100 to 200 mL/min]. A maximum flow rate of 100 mL/min is recommended to limit VOC stripping from soil, prevent the short-circuiting of ambient air from ground surface that would dilute the soil gas sample, and increase confidence regarding the location from which the soil gas sample is obtained. The vacuum gauge reading will be recorded during sample collection.
- To ensure some residual vacuum remains in each canister following sample collection, at approximately 8 minutes for a 1-liter canister, or 14 minutes for a 1.7-liter canister, after start of sample collection, the valve to the soil gas probe will be closed. The canister vacuum will be measured using a vacuum gauge provided by the laboratory. A residual vacuum in the Summa™ canisters of approximately 1 to 5 inches Mercury (Hg) will be achieved to ensure a sufficient sample volume is collected. A maximum residual vacuum of 10 inches Hg is allowed. A canister residual vacuum above this value will require continued sampling until vacuum reading is below the threshold. Should the vacuum remain elevated above 10 inches Hg for 30 minutes or more, this will be taken to indicate that the initial vacuum in the canister is not dissipating and that the soil screened by the soil gas probe does not produce sufficient soil gas to permit sample collection.
- The residual Summa™ canister vacuum will be measured and recorded. A minimum 1-inch Hg vacuum will be required for the sample to be considered valid, or the sampling will be repeated using a fresh Summa™ canister. Once the vacuum is measured, the safety cap will be securely tightened on the inlet of the Summa™ canister prior to shipment to the laboratory under chain of custody procedures.
- Vacuum gauge provided by laboratory will be returned with the canister samples to check residual vacuum in the laboratory prior to sample analysis and recorded on the analytical data report. This check will ensure sample integrity prior to laboratory analysis.
- All canisters will be pre-cleaned at the laboratory in accordance with the TO-15 method and documentation of the cleaning activities will be provided. Canisters will be laboratory certified clean at the 100% level.

- All valves/fittings, critical orifice flow regulation devices, vacuum gauge, and the personal sampling pump to be re-used during sampling will be cleaned in accordance with laboratory requirements by purging orifice with zero air (provided by laboratory) for minimum 45 seconds at minimum 75 psi. New nylon tubing will be used at each probe location.
- The canisters will be labeled noting the unique sample designation number, date, time, and sampler's initials. A bound field logbook will be maintained to record all soil gas and air sample data.
- The canisters will be listed on the chain-of-custody in order of suspected highest to lowest impact and recorded PID readings. Indicate on the chain-of-custody for the laboratory to analyze the canisters in order from the lowest to highest PID reading.
- The soil gas samples will be analyzed using USEPA's TO-15 gas chromatograph/mass spectrometer (GC/MS) methodology.

2.2 LEAK TESTING

The use of sampling assembly vacuum test and a tracer compound is recommended as a quality control check to ensure ambient air has not leaked into the vapor probe or sampling assembly, which may affect (i.e., dilute) the analytical results. Isopropanol can be used as a tracer compound because it can be detected by the analytical method [it is a tentatively identified compound (TIC) in Method TO-15], it is readily available (i.e., as rubbing alcohol) and it is safe to use. The use of isopropanol in the leak testing procedure is consistent with the protocol outlined by CAEPA (2003) and MDNR (2005).

The leak test procedure will be implemented in two steps, as follows:

Step 1 – Vacuum Test:

- The sampling assembly will be connected to the soil gas probe valve at the surface casing through a vacuum gauge and then connected to the Summa™ canister through a tee-valve connection leading to a personal sampling pump.
- The vacuum gauge provided by laboratory will be returned with the canister samples to check residual canister vacuum at the laboratory prior to sample analysis and recorded on the analytical data report.
- The personal sampling pump will be used to conduct the vacuum test. The vacuum test will consist of opening the valve to the personal sampling pump leaving closed the valve to the Summa™ canister and the valve to the gas probe. The pump will then be operated to ensure that it draws no air from the sampling assembly

(i.e., creates a negative pressure, or vacuum within the sampling assembly), thus establishing that all assembly connections are air-tight. The sampling pump low-flow detect switch will likely activate with 10 to 15 seconds, turning the pump off.

- If the pump is capable of drawing flow, all fittings and tubing will be checked for tightness (or replaced) and the vacuum test will be repeated.
- The vacuum within the sampling assembly created by the pump should be sustained for at least 1 minute.
- The reading from the vacuum gauge pressure will be recorded in field logbook to demonstrate that the pump was able to create a vacuum within the sampling assembly (it will also be noted whether the low-flow detect switch on the pump was activated and whether the vacuum was sustained for greater than 1 minute).

Step 2 – Tracer Compound:

- Paper towels soaked in a dilute solution of isopropanol will be wrapped around the soil gas probe surface casing and ground surface immediately surrounding the surface casing. The soil gas probe surface casing then will be covered using plastic sheeting to shroud the soil gas probe and sampling assembly connections at ground surface. The ground surface finish permits, the plastic sheeting will be sealed to the ground surface using tape or by weighting the edges of the plastic sheeting with dry benonite. The sampling assembly coming off of the soil gas probe can remain outside of the shroud, since the integrity of the sampling assembly is confirmed using Step 1. A hole in the plastic sheeting can be made to permit passing the tubing from the soil gas probe to the sampling assembly through the shroud, which can be sealed using tape.
- Isopropanol will serve as the tracer compound and is a included as an analyte USEPA's Method TO-15.
- Approximately 1 teaspoon (approximately 4 mL) of isopropanol (rubbing alcohol) will be mixed in 1 gallon of de-ionized water to create an approximate 1/1000 solution.
- Immediately after conducting the soil gas probe purging and before opening the Summa™ canister, remove the paper towels from the solution wringing out the towels so they are very damp, but not dripping. The paper towels are then wrapped around the soil gas probe surface casing and ground surface immediately surrounding the surface casing and covered with the plastic sheeting.
- The isopropanol solution will be kept fresh, with new solution being made every hour. The solution will be mixed at a central location away from the sampling activities. The isopropanol will be kept tightly capped. The solution will be kept away from the sampling assembly until immediately before sample collection

begins. Sampling personnel will wear latex gloves while handling the solution and soaked paper towels, and will remove and dispose of the gloves while working with the sampling assembly.

3.0 AMBIENT OUTDOOR AIR SAMPLING

A summary of the steps involved in the ambient outdoor air sampling protocol is presented below:

- The outdoor air samples will be collected using 6-liter capacity Summa™ canisters fitted with a laboratory calibrated critical orifice flow regulation device sized to allow the collection of the soil vapor sample over a 30-minute sample collection time. The 30-minute sample collection time for a 6-liter capacity Summa™ canister corresponds to a maximum sample collection flow rate of approximately 200 mL/min.
- The canister will be positioned at a height of 3 feet above ground level during sample collection.
- At approximately 25 minutes after start of sample collection, the valve to the canister will be closed and the canister vacuum will be measured using a vacuum gauge provided by the laboratory. A residual vacuum in the Summa™ canisters of approximately 1 to 5 inches Hg will be achieved to ensure a sufficient sample volume is collected. A canister residual vacuum above this value will require continued sampling until vacuum reading is below the threshold.
- The canister will be located away from any obvious potential emission source such as automobiles, sewer vents, furnace vents, etc., to the extent practical.
- The canisters will be labeled noting the unique sample designation number, date, time, and sampler's initials. A bound field logbook will be maintained to record all sampling data.

4.0 QA/QC ACTIVITIES

The level of the quality assurance/quality control (QA/QC) effort will include:

- a field duplicate; and
- a trip blank.

Field blank and field duplicate samples will be analyzed to assess the quality of the data resulting from the field sampling program. A trip blank will consist of an unused Summa™ canister submitted to the analytical laboratory to provide the means to assess the quality of the data resulting from the field sampling program. The trip blank sample will be analyzed to check for procedural contamination at the Site, which may cause sample contamination.

One field duplicate sample will be obtained for each day of sampling. The duplicate sample will be collected by using a splitter located upgradient of the flow controller, with separate sampling tubes connecting the splitter to two Summa™ canisters. The flow controller must be set such that the flow rate from the sampling probe is <100 mL/min. Note that this will double the required sampling time since two canisters are being filled simultaneously. Duplicate samples will be analyzed to check for sampling and analytical reproducibility.

The background outdoor air sample will also be applied for QA/QC purposes to evaluate the presence of background influences on both the soil gas and outdoor air sampling results.

The level of QA/QC effort provided by the project laboratory for the samples analyses will correspond to the level of QA/QC effort specified in "The Determination of Volatile Organic Compounds in Ambient Air Using Summa™ Passivated Canister Sampling and Gas Chromatographic Analysis" (USEPA, 1988).

5.0 FIELD INSTRUMENTATION CALIBRATION

Sampling or monitoring equipment used in the soil gas and outdoor air sampling program to gather, generate, or measure environmental data will be calibrated with sufficient frequency and in such a manner that accuracy and reproducibility of results are consistent with the manufacturer's specification and requirements. Field calibration of the personal sampling pump and PID meter will be carried out prior to sampling activities.

The vacuum gauge used to measure canister vacuum will be calibrated and provided by the laboratory. The vacuum gauge will be returned to the laboratory for the laboratory to obtained vacuum measurements prior to sample analysis (checking canister integrity was maintained during shipment). Using a common vacuum gauge will avoid variations in vacuum measurements that can arise due to using different vacuum gauges.

6.0 REFERENCES

CAEPA, 2003. Advisory – Active Soil Gas Investigations, Department of Toxic Substances Control, January 28.

MDNR, 2005. Missouri Risk-Based Corrective Action (MRBCA) For Petroleum Storage Tanks, Soil Gas Sampling Protocol, April 21.