90 years

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2 December 2009

Ms. Aimee Reynolds
Project Officer
Remediation Division
Montana Department of Environmental Quality
1100 North Last Chance Gulch
Helena, Montana 59601

Subject: Replacement Pages to Addendum No. 1 to Final Task F Stage I – Part 2 Pilot Test Work Plan For Volatile Organic Compound-Containing Alluvial Aquifer Groundwater Burlington Northern Livingston Shop Complex - Livingston, Montana
KJ 0996021.16

Dear Ms. Reynolds:

On behalf of BNSF Railway Company (BNSF), Kennedy/Jenks Consultants is pleased to submit four (4) hard copies of the replacement pages (Revision No. 2) to the revised *Addendum No. 1 to Final Task F Stage I – Part 1 Pilot Test Work Plan for Volatile Organic Compound-Containing Alluvial Aquifer Groundwater, Former Burlington Northern Fueling Facility, Livingston, Montana* dated November 2009. A PDF of the revised Addendum No. 1 with the replacement pages is also attached.

In its email to Kennedy/Jenks Consultants on 30 November 2009, the Montana Department of Environmental Quality (DEQ) required that Pages 3-1 and R-1 be changed to reflect that the referenced *Final Task F Stage I – Part 2 Pilot Test Report for Volatile Organic Compound-Containing Alluvial Aquifer Groundwater* dated November 2009 is currently in "draft" form pending DEQ review and approval.

Please contact us at (253) 835-6400 if you have questions regarding this submittal.

Very truly yours,

KENNEDY/JENKS CONSULTANTS

John E. Norris, P.G.
Project Manager

Amanda J Aldersley

Amanda Aldersley, L.G.
Assistant Project Manager

Enclosures

cc: Dave Smith, BNSF
Leo Berry, Browning, Kaleczyc, Berry & Hoven
Katherine Haque-Hausrath, DEQ Legal
Mark Hills, CDM - Helena
Kent Sorenson, CDM - Denver
Steve Caldwell, Park County Environmental Council
Robin Billau, RTI, Inc.

ADDENDUM NO. 1 TO FINAL TASK F STAGE I – PART 2 PILOT TEST WORK PLAN FOR VOLATILE ORGANIC COMPOUND-CONTAINING ALLUVIAL AQUIFER GROUNDWATER
Burlington Northern Livingston Shop Complex

Revision Tracking Form

Submittal Date	Revision Date	Revision No.	Pages to be Replaced	
12/2/09	December 2009	2	Page 3-1 Page R-1	Prepared in response to DEQ's email dated 30 November 2009.

Notes:

1) Insert this tracking form and cover letter in the front of the *Addendum No. 1 to Final Task F Stage I – Part 2 Pilot Test Work Plan for Volatile Organic Compound-Containing Alluvial Aquifer Groundwater* dated November 2009 (Revision No. 1).
2) Remove pages listed in the above table (shaded yellow) and insert replacement pages (attached).

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25 November 2009

Ms. Aimee Reynolds
Project Officer
Remediation Division
Montana Department of Environmental Quality
1100 North Last Chance Gulch
Helena, Montana 59601

Subject: Addendum No. 1 to Final Task F Stage I – Part 2 Pilot Test Work Plan For Volatile Organic Compound-Containing Alluvial Aquifer Groundwater Burlington Northern Livingston Shop Complex - Livingston, Montana KJ 0996021.16

Dear Ms. Reynolds:

On behalf of BNSF Railway Company (BNSF), Kennedy/Jenks Consultants is pleased to submit four (4) hard copies and one (1) electronic copy of the revised *Addendum No. 1 to Final Task F Stage I – Part 1 Pilot Test Work Plan for Volatile Organic Compound-Containing Alluvial Aquifer Groundwater, Former Burlington Northern Fueling Facility, Livingston, Montana* (Addendum No. 1).

The revised Addendum No. 1 incorporates the Montana Department of Environmental Quality (DEQ) changes to Addendum No. 1 transmitted in its letter to BNSF dated 20 November 2009 and reflects agreements reached in a conference call between Kennedy/Jenks Consultants and DEQ and its consultant (CDM) on 23 November 2009.

As discussed during our conference call, Kennedy/Jenks Consultants plans to begin drilling and well construction in the Former Electric Shop the week of 7 December 2009 and respectfully requests DEQ's approval of the revised Addendum No. 1 before that date. A description of the specific methods to be used for construction of the bedrock well required by DEQ will be submitted to DEQ for review and approval before that monitoring well is constructed.

Please contact us at (253) 835-6400 if you have questions regarding this submittal.

Very truly yours,

KENNEDY/JENKS CONSULTANTS

John E. Norris, P.G.
Project Manager

Amanda J Aldersley

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Addendum No. 1 to Final Task F Stage I – Part 2 Pilot Test Work Plan for Volatile Organic Compound-Containing Alluvial Aquifer Groundwater

Burlington Northern Livingston Shop Complex
Livingston, Montana

BNSF Railway Company

K/J 0996021.16
November 2009

Kennedy/Jenks Consultants

Addendum No. 1 to
Final Task F Stage I – Part 2 Pilot Test Work Plan for
Volatile Organic Compound-Containing Alluvial Aquifer Groundwater
Burlington Northern Livingston Shop Complex
Livingston, Montana

Prepared for

BNSF RAILWAY COMPANY

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K/J 0996021.16

25 November 2009

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Abbreviation	Description
bgs	below ground surface
BNSF	BNSF Railway Company
cfm	cubic feet per minute
CFR	Code of Federal Regulations
cis-1,2-DCE	cis-1,2-dichloroethene
COC	chemical of concern (COCs for plural)
DEQ	Montana Department of Environmental Quality
EPA	U.S. Environmental Protection Agency
ERCL	environmental requirement, criterion, and limitation (ERCLs for plural)
eV	electron volts
FID	flame ionization detector
g	gram
g/kg	gram per kilogram
gpm	gallons per minute
HASP	Health and Safety Plan
IDW	investigation-derived waste
ISCO	*in situ* chemical oxidation
mg/L	milligrams per liter
mg/kg	milligrams per kilogram
mL	milliliter
MSDS	material safety data sheet
$NaMnO_4$	sodium permanganate
ORP	oxidation-reduction potential
PCE	tetrachloroethene
PDB	passive diffusion bag (PDBs for plural)
PID	photoionization detector
psi	pounds per square inch
psig	pounds per square inch gauge
QAPP	quality assurance project plan
ROD	Record of Decision
ROI	radius of influence
SAP	Sampling and Analysis Plan
SOD	soil oxidant demand
SOG	Standard Operating Guideline (SOGs for plural)
SVE	soil vapor extraction
TCE	trichloroethene
TDS	total dissolved solids
UIC	underground injection control
VFD	variable frequency drive
VOC	volatile organic compound (VOCs for plural)
µg/L	micrograms per liter

1.0 INTRODUCTION

This addendum describes pre-design studies for, and the implementation of, additional *in situ* chemical oxidation (ISCO) and soil vapor extraction (SVE) pilot testing to address sources of dissolved chlorinated volatile organic compounds (VOCs) in groundwater at the Burlington Northern Livingston Shop Complex Facility (Facility) in Livingston, Montana. The chemical oxidant selected for further ISCO pilot testing at the Facility is sodium permanganate ($NaMnO_4$). This addendum is intended to supplement the Montana Department of Environmental Quality (DEQ) approved *Final Task F Stage I – Part 2 Pilot Test Work Plan for Volatile Organic Compound-Containing Alluvial Aquifer Groundwater* (Pilot Test Work Plan) (Kennedy/Jenks Consultants 2008c) with additional design and monitoring details provided to support follow-up testing of VOC source area remediation technologies. This addendum presents a plan to evaluate remediation of source areas for dissolution of VOCs into groundwater by coupling saturated zone ISCO with unsaturated zone SVE.

Note: The Facility-Wide Sampling and Analysis Plan (Facility-Wide SAP) (Kennedy/Jenks Consultants 2006) includes Standard Operating Guidelines (SOGs) and the Facility-Wide Quality Assurance Project Plan (QAPP). Field activities will be performed in a manner consistent with the SOGs identified in the Facility-Wide SAP. Field procedures in the Facility-Wide SAP are not repeated unless modifications/additions to a protocol or procedure are proposed.

A task-specific health and safety plan (HASP) was prepared for the initial pilot test (Kennedy/Jenks Consultants 2008a). Kennedy/Jenks Consultants will update the existing task-specific HASP and it will be used in conjunction with the *2008 Facility-Wide Health and Safety Plan (Revision No. 3)* (Facility-Wide HASP) (Kennedy/Jenks Consultants 2008b). The HASP will include Material Data Safety Sheets (MSDS) for the chemicals used in the pilot test. Daily safety briefings will be conducted to discuss scope of work and health and safety considerations.

The City of Livingston requires permits to construct groundwater wells, and such permits will be obtained prior to well construction activities. As part of the permitting process, the City of Livingston Building inspector will be contacted to inspect well construction activities.

Kennedy/Jenks Consultants will clear proposed boring/well locations of underground and aboveground utilities prior to conducting invasive activities in accordance with the procedures outlined in the Facility-Wide HASP (Kennedy/Jenks Consultants 2008b).

Investigation-derived waste (IDW) generated during well construction and follow-up chemical oxidation testing activities will include soil cuttings, construction/development water, decontamination water, purge water, and non-indigenous IDW [i.e., disposable personal protective equipment (PPE), disposable sample equipment]. The IDW will be managed as described in the Facility-Wide SAP unless otherwise directed by the DEQ.

Pilot test activities identified in this addendum comply with Environmental Requirements, Criteria, and Limitations (ERCLs) developed by DEQ for the Facility (see Appendix A).

2.0 CANDIDATE ISCO WELL CONSTRUCTION AND SAMPLING

2.1 OBJECTIVES

The primary objective of candidate ISCO well construction and sampling activities is to identify candidate ISCO testing areas and provide a portion of the infrastructure needed to perform further ISCO testing. Candidate ISCO wells will be constructed at the approximate locations shown on Figure 1. These new wells will serve two functions. They will be used as groundwater monitoring wells and, if warranted, will be used for additional ISCO testing. Each new well will be sampled for VOCs to evaluate the spatial distribution of VOC concentrations in alluvial aquifer groundwater and the potential presence of nearby VOC source areas in the saturated zone. Candidate ISCO wells located near apparent source areas will be integrated into subsequent ISCO testing in those areas. If the results of the candidate ISCO wells sampling described below indicate that testing of ISCO would be beneficial, then a follow-up recirculation test similar to that described in Section 3.0 for the former Electric Shop interior will be designed and operated.

2.2 CANDIDATE ISCO WELL LOCATIONS

The approximate locations of the candidate ISCO wells are shown on Figure 1. The layout of the candidate ISCO well arrays is intended to provide closely-spaced coverage that is roughly perpendicular to the direction of groundwater flow in the shops area and to also provide coverage along industrial wastewater sewer lines where soil gas data suggest that VOCs may have entered the subsurface.

2.3 SOIL SAMPLING AND ANALYSIS

The well boreholes will be advanced to bedrock using sonic drilling techniques. The soil from the borings will be field screened across the entire vertical interval to assess the potential presence of petroleum hydrocarbons and/or VOCs. Field screening techniques include:

- Visual inspection of soils to identify petroleum hydrocarbon staining.
- Sheen tests using deionized water to assess the potential presence of petroleum hydrocarbons in soil samples.
- Organic vapor headspace monitoring using a photoionization detector [PID; 11.7 electron volts (eV)] to identify the potential presence of VOCs in soil samples (see SOGs-4A and 4B).

Field screening will be performed for both unsaturated and saturated zone soils at each well boring location. Where field screening suggests that VOCs may be present at appreciable concentrations within the vadose zone, the unsaturated soil sample with the highest headspace PID measurement will be submitted for laboratory analysis. If, during borehole advancement and logging the continuous soil samples, field observations indicate that additional samples may provide important information, opportunistic samples will be collected and submitted for chemical analyses. This includes samples from the saturated zone. The soil samples selected for analyses will be shipped to Energy Laboratories in Billings, Montana (Energy) or another appropriately certified laboratory under standard chain-of-custody protocol (see SOG-3). Soil samples will be analyzed for VOC using EPA Method 8260.

Subsurface sampling procedures are outlined in SOG-7. Field personnel will perform borehole logging using the procedures described in SOG-13. Data collected during borehole advancement and well construction (e.g., soil conditions, depth to groundwater, etc.) and the specific well construction details will be documented on appropriate field forms (i.e., boring/well construction log).

2.4 WELL CONSTRUCTION

The candidate ISCO wells will fully penetrate the alluvial aquifer (i.e., be constructed to the top of bedrock). Each well will be completed with two screened intervals separated by a blank section of casing surrounded by an annular space bentonite seal to allow the upper and lower screened intervals to be isolated from one another, if necessary. Wells will be constructed of 4-inch diameter polyvinyl chloride (PVC) casing and well screen. The lower portion of the well will consist of an approximate 5-foot screened interval completed just above the top of bedrock. The upper portion of the well will be screened across the water table with a bottom depth selected based upon the thickness of the alluvial aquifer to allow for the insertion of at least 3 feet of blank casing between the upper and lower screens. The upper screen will extend to above the estimated high groundwater elevation. The candidate ISCO well design proposed will provide flexibility for both sampling as well as potential delivery of the chemical oxidant. If appropriate, a well packer could be used to facilitate selective injection of chemical oxidant into the lower and/or upper portions of the aquifer. General procedures to be followed for well construction are described in SOG-14 and SOG-15.

Following construction, the new wells will be developed as appropriate by surging and over-pumping and/or hand-bailing to remove fine-grained particles that might have entered the well and filter pack during construction. Well development will typically be performed until the groundwater is relatively sediment free. Water generated during well development will be captured, contained, and treated via the on-site Task D/E Remediation System Water Treatment Plant prior to discharge.

A Montana State registered land surveyor will survey the new wellheads to determine the vertical elevations with respect to the North American Vertical Datum 1988 (NAVD88).

2.5 GROUNDWATER SAMPLING AND ANALYSIS

The newly installed candidate ISCO wells will be sampled immediately following well development. Subsequently, the candidate ISCO wells will be sampled again during the next semiannual Task F groundwater sampling event. The candidate ISCO wells will be purged and sampled using the low-flow purge and sample collection procedures as described in Section 6.4 of the Pilot Test Work Plan (Kennedy/Jenks Consultants 2008c) and/or passive diffusion bags (PDBs). The groundwater samples will be shipped to Energy or another appropriately certified laboratory under standard chain-of-custody protocol (see SOG-3). Groundwater samples will be analyzed for VOC using EPA Method 8260.

3.0 FORMER ELECTRIC SHOP INTERIOR FOLLOW-UP CHEMICAL OXIDATION TESTING

The initial pilot test activities are documented in the draft *Final Task F Stage I – Part 2 Pilot Test Report for Volatile Organic Compound – Containing Alluvial Groundwater* (Pilot Test Report) (Kennedy/Jenks Consultants 2009), which is currently under review by DEQ and pending approval. The results of the initial pilot test and potential follow-up testing were discussed in a conference call with DEQ and CDM on 5 August 2009, at which time DEQ requested that BNSF proceed with the preparation of this addendum. Results and conclusions drawn from the initial pilot test were utilized to specify the objectives, technical approach, and procedures for implementing the follow-up testing.

3.1 OBJECTIVE

The objective of the follow-up ISCO testing is to specifically target treatment of VOCs in the saturated zone beneath the former Electric Shop interior in the general vicinity of well 89-3. This location has been selected by DEQ and CDM for the first ISCO follow-up testing because:

- The highest detected tetrachloroethene (PCE) concentrations have historically been detected in former Electric Shop building monitoring well 89-3, with concentrations generally increasing with depth based on PDB sampling and chemical analyses.

- In response to the $NaMnO_4$ injections, PCE concentrations declined temporarily in well 89-3. The temporary and unsustained reduction of PCE concentrations in the vicinity of well 89-3 may be attributed to continued dissolution of PCE from sources in fine grained unconsolidated sedimentary deposits and/or consolidated sedimentary rock fractures in the vicinity of this monitoring well.

Overall, it is hypothesized that small amounts of separate phase PCE could be retained in the primary and/or secondary porosity of the weathered bedrock contact (see boring log for well 89-3) which may continue to act as a source for dissolution of PCE into groundwater.

3.2 TECHNICAL APPROACH

The objective of the initial pilot test was to inject a pre-determined amount of $NaMnO_4$ in the designated treatment area groundwater and monitor for downgradient changes in groundwater VOC concentrations and other relevant performance parameters (e.g., injection radius of influence, permanganate concentrations, metal concentrations, total dissolved solids (TDS), chloride concentrations, sulfate concentrations, alkalinity, and pH). It was concluded from the initial pilot test (including bromide tracer testing) that relatively high groundwater seepage velocity coupled with significant dilution may have resulted in insufficient contact time at the design concentration of $NaMnO_4$ [0.5 gram $NaMnO_4$/kilogram soil (g/kg); 2.5 percent by weight or 25,000 milligram $NaMnO_4$/liter (mg/L) delivery concentration] to effectively oxidize sources of PCE and trichloroethene (TCE).

The ability to oxidize PCE is contingent upon achieving sufficient contact with source zone matrices. Research indicates that when permanganate concentrations are 10 times the concentrations of chlorinated VOCs, the half life of TCE and cis-1,2-dichloroethene (cis-1,2-DCE) ranges from 24 seconds to 18 minutes. However, for PCE, the half life is estimated at 257 minutes (approximately 4.3 hours). Therefore, for the follow-up pilot testing, the technical approach has been modified to maximize the contact time with the residual source material by implementing a groundwater recirculation system. The intent of the groundwater recirculation system is to improve control of chemical oxidant distribution in the target treatment area resulting in increased contact time and more efficient use of permanganate.

PCE first-order degradation rates and half-lives were calculated for the low and high $NaMnO_4$ loadings (see bench-scale study VOC destruction data presented in Table 6 of the Pilot Test Report) using the following equations:

$$C = C_o e^{-kt}$$

$$\ln(C) = \ln(C_0) - k * t;$$

$$t_{(1/2)} = \ln(2) / k$$

Where C is the PCE concentration at time t, C_0 is the PCE concentration at time zero, k is the first-order degradation rate, and t is time. As measured in the control sample used in the original bench scale test for the initial sodium permanganate pilot test, the initial PCE concentration was reported at 67 micrograms per liter (µg/L). For the low (0.5 g $NaMnO_4$/kg soil; 250 mg $NaMnO_4$/L) and high (1.5 g $NaMnO_4$/kg soil; 750 mg $NaMnO_4$/L) chemical oxidant loadings, PCE was detected at concentrations of 10 and 0.5 µg/L, respectively, 1 day following initiation of VOC destruction testing.

PCE first-order degradation rates for the low and high $NaMnO_4$ dosages were estimated at 1.8 and 4.9/day. PCE half-lifes for the low and high $NaMnO_4$ dosages were estimated at 9.2 and 3.4 hours, respectively. PCE first-order degradation rate and half-life calculations are summarized in Table 1.

3.3 GROUNDWATER RECIRCULATION SYSTEM DESIGN

Design of the planned oxidant-containing groundwater recirculation system included evaluating system layouts through modeling, estimating the required contact time and chemical oxidant mass, and assessing metal oxidation and attenuation.

3.3.1 Layout Options

As part of the system design, groundwater recirculation system layouts were evaluated at the request of DEQ and CDM to select the number of extraction/injection wells, rates, and alignments. The evaluated layouts included the “5-spot” and “line-drive” scenarios. The “5-spot” scenario consisted of a single injection point proximal to well 89-3 and four extraction points surrounding the injection point (similar to the “5” on a 6-sided dice). The “line-drive” scenario consisted of three downgradient extraction points and two injection points located upgradient of well 89-3. The system layouts for the “5-spot” and “line-drive” are shown on Figures B-1 and B-2, respectively (see Appendix B).

3.3.2 Modeling

The two models ("5-spot" and "line-drive") were developed using the United States Geological Survey's MODFLOW software (Harbaugh et al. 2000). The models were developed with the specific goal of simulating local groundwater flow within an approximate 15-foot radius recirculation zone centered on well 89-3. The following assumptions were made in model setup:

- For the "5-spot" scenario, the extraction wells were equally spaced along the circumference of a 50-foot-diameter circle centered on well 89-3 (i.e., extraction wells situated approximately 25 feet from the centralized injection well).

- For the "line drive" scenario, two injection wells were aligned 18 feet upgradient of well 89-3, spaced 20 feet apart along a line perpendicular to groundwater flow. The three extraction wells were positioned approximately 20 feet downgradient from well 89-3, also situated along a line perpendicular to the flow direction. The central extraction well was placed on the groundwater flow line that runs through well 89-3, with the other two wells spaced approximately 15 feet in opposite directions from the central well.

- Unconfined flow was simulated.

- The groundwater flow domain was approximately 4,000 feet in the east-west direction, 1,600 feet in the north-south direction, and 24 feet in the vertical direction.

- Constant head boundary conditions were placed at the western and eastern end of the model domain and no-flow boundaries were placed on the northern and southern sides, along approximate flow lines. The boundary conditions produce simulated groundwater flow that is generally to the east.

- Based on previous bromide tracer testing, the hydrostratigraphy was conceptualized as a two-layer system, with a hydraulic conductivity of 800 feet per day in the lower 5 feet [approximately 30 to 35 feet below ground surface (bgs)] and a hydraulic conductivity of 380 feet per day in the overlaying material. Simulated hydraulic heads in each model approximated the average conditions in 2008.

- Each model was simulated to achieve a water balance at 50 gallons per minute (gpm) (i.e., extraction rate equals injection rate).

- MODPATH (Pollack 1994) was used to delineate the simulated directions and travel times of groundwater in the recirculation zone.

3.3.3 Planned ISCO Well Layout

The simulated recirculation zones for the “5-spot” and “line-drive” are shown on Figures B-1 and B-2, respectively (see Appendix B). Based on comparison of simulated flow paths and travel times for both scenarios, the “line drive” groundwater recirculation system was selected as the preferred approach as follows:

- Conceptually, the “5-spot” layout would require additional infrastructure to achieve complete contact within the target treatment zone (i.e., 15-foot radius centered on well 89-3). Comparatively, the “5-spot” layout would require up to nine wells (one central injection and eight perimeter extraction wells), while the “line-drive” requiring a total of six wells (three upgradient injection and three downgradient extraction wells).

- The “line-drive” well network is aligned such that the delivery of the chemical oxidant solution can take advantage of the natural groundwater flow direction, which results in greater efficiency (e.g., oxidant solution can be introduced in slug injections and take advantage of natural advective downgradient flow).

(Note: The modeling simulations were performed for the basic well construction scenarios as recommended by the DEQ in its comment letter dated 8 October 2009 to the draft Pilot Study Report. Although the specific injection and extraction well layout described in Section 3.4.2 and shown on Figure 2 was quantitatively modeled, this configuration was developed based upon the results of the generalized model simulations described in Section 3.3.2.).

3.3.4 Contact Time

As stated in Section 2.2, the PCE first-order degradation rates for the low and high $NaMnO_4$ loadings were estimated at 1.8 and 4.9/day, respectively. The required contact time at the low and high $NaMnO_4$ loadings was calculated as follows:

$$C = C_o e^{-kt}$$
$$\ln(C) = \ln(C_0) - k * t$$

Where C is the assumed PCE concentration detected at well 89-3 (750 µg/L), C_0 is the *Record of Decision* (ROD) (DEQ 2001) PCE cleanup concentration (5 µg/L), k is the first-order degradation rate, and t is time. The required contact time at maintained $NaMnO_4$ concentrations of 250 and 750 mg/L is estimated at 89 and 34 hours (3.7 and 1.4 days), respectively (see Table 1).

A PCE concentration of 750 µg/L was conservatively selected based on the maximum detected concentration of 712 µg/L in well 89-3 (PDB sampling at a depth of 30.9 feet below top casing on 12 August 2008).

3.3.5 Oxidant Mass Calculations

The mass and volume of $NaMnO_4$ required for the follow-up former Electric Shop interior chemical oxidation testing around well 89-3 was based on physical dimensions of the target PCE source treatment area and the value of the SOD obtained from the bench scale study and subsequently utilized for the initial pilot test. Input variables and calculations for estimating the required $NaMnO_4$ mass and volume are presented in Table 2. Critical input parameters are as follows:

- Soil oxidant demand (SOD) value of 0.5 g $NaMnO_4$/kg soil.
- The designated well 89-3 treatment area physical dimensions extends 40 feet parallel to and 30 feet perpendicular to the groundwater flow direction with a target saturated thickness of 5 feet. The designated treatment area encompasses a 15-foot radius around well 89-3.
- The target treatment soil mass is estimated at 300,000 kilograms.
- The target treatment pore volume is estimated at approximately 11,220 gallons.

Given the above, the required mass of $NaMnO_4$ is estimated at 330 pounds, equating to 826 pounds (i.e., 72 gallons) of 40 percent $NaMnO_4$ solution. This estimate is based strictly on physical dimensions and the specified SOD value of 0.5 g $NaMnO_4$/kg soil. Additional $NaMnO_4$ mass will be required to compensate for mass loss inherent to the groundwater recirculation system operation (see Section 3.4.3.2 below for additional design details).

Comparatively, for the initial pilot test, approximately 2,200 pounds (190 gallons) of 40 percent $NaMnO_4$ solution was delivered to the subsurface.

3.3.6 Metal Oxidation/Attenuation

For the initial pilot test, 2.5 percent by weight (or 25,000 mg/L) $NaMnO_4$ solution was delivered to the subsurface via four direct-push injection points (IW-01 through IW-04). Within 2 to 3 weeks following the injections, the $NaMnO_4$ oxidant was fully consumed in the test area. Results from the initial pilot test indicated that in the presence of sodium permanganate, selected metals (chromium, manganese, mercury, and silver) were oxidized and dissolved into groundwater at concentrations above baseline conditions.

Within 1 month, all metals (except for manganese) attenuated to baseline and/or below Circular DEQ-7, Montana Numeric Water Quality Standards (DEQ-7 standards) (DEQ 2008). At the Month 1 sampling event, manganese was detected at a concentration of 0.2 mg/L in monitoring well 07-2A (above the DEQ-7 standard of 0.05 mg/L). Dissolved manganese was not detected (reporting limit of 0.01 mg/L) in well 07-2A when sampled approximately 4 months later.

Given the $NaMnO_4$ mass delivery for the follow-up injections are consistent with loadings for the initial pilot test, it is assumed full consumption will occur within and immediately downgradient of the target treatment area within 2 to 3 weeks. As suggested in the bench-scale study and confirmed with post-injection monitoring data, site soils possess the ability to readily attenuate oxidized metals in the absence of $NaMnO_4$. For follow-up injections, it is anticipated that a temporary increase in dissolved manganese concentrations will be observed immediately downgradient of the target treatment area (i.e., as suggested by dissolved manganese detections in wells 07-2A and 07-2B located approximately 35 feet downgradient of initial pilot testing injection points).

3.4 FIELD IMPLEMENTATION PLAN

3.4.1 Site Preparation Activities

Site preparation activities will include activities specified in Section 1.0 and soliciting an underground injection control (UIC) permit-by-rule determination from the U.S. Environmental Protection Agency (EPA). For the initial pilot test, the EPA determined that the planned activity was “authorized by rule” [EPA letter to Kennedy/Jenks Consultants dated 14 March 2008; Appendix H of the Pilot Test Report (Kennedy/Jenks Consultants 2009)].

For the follow-up chemical oxidation testing, a summary of this injection plan will be submitted to the EPA prior to conducting the work for an evaluation of the applicability of Class V underground injection control regulation [Title 40 Code of Federal Regulations (CFR), Section 144.24].

3.4.2 Soil Borings and Well Construction

The groundwater recirculation system will consist of newly installed wells including three downgradient extraction wells, three upgradient injection wells, two alluvial aquifer monitoring wells, and one bedrock monitoring well. The proposed well locations are shown on Figure 2.

3.4.2.1 Soil Borings and Chemical Analyses. Borings for the ISCO wells will be drilled using sonic drilling techniques. The soil from the borings will be field screened across the entire vertical interval to assess the potential presence of VOCs using a PID (11.7 eV). Up to three soil samples may be collected from each soil boring to document the vadose zone conditions in the suspected source area. Soil samples may be collected from immediately below the concrete slab and fill material; 10 feet beneath the slab; and immediately above the water table in the vadose zone. If, during borehole advancement and logging the continuous soil samples, field observations indicate that additional samples may provide important information, opportunistic samples of unsaturated and/or saturated soils will be collected and submitted for chemical analyses.

If field screening of soils within the saturated zone (e.g., below the water table) suggests the presence of VOCs, soil samples will be collected from the saturated zone during well construction.

The soil samples selected for analyses will be shipped to Energy or another appropriately certified laboratory under standard chain-of-custody protocol (see SOG-3). Soil samples will be analyzed for VOCs using EPA Method 8260.

3.4.2.2 Well Construction. The intent of the groundwater recirculation process is to focus delivery of the chemical oxidant along the base of the alluvial aquifer to maximize contact with a potential residual VOC source material. Therefore, the groundwater extraction and injection wells will be constructed with 4-inch diameter PVC to the depth of bedrock with a 5-foot screened interval placed just above bedrock. Performance monitoring wells will be constructed of 2-inch diameter PVC and screened across the bottom 15 feet of the aquifer. All monitoring wells will be constructed in compliance with the Administrative Rules of Montana, Title 36, Chapter 21, Sub-chapter 8.

One additional monitoring well will be completed in the bedrock aquifer to investigate the potential presence of separate phase PCE within the primary and/or secondary porosity of the bedrock formation which may continue to act as a source for dissolution of PCE into the overlying alluvial groundwater. The bedrock aquifer monitoring well will be completed upgradient of well 89-3, between well 89-3 and the groundwater injection wells (IW-05, IW-06, and IW-07). The well will be constructed of 2-inch diameter well casing and well screen and will be completed within the uppermost “weathered” portion of the bedrock formation.

To limit the potential for advancement of chlorinated VOCs from the alluvial aquifer into the bedrock aquifer, the bedrock monitoring well will be constructed in two stages. In the first stage, a borehole will be drilled and cased through the overlying alluvium into the uppermost bedrock using sonic drilling techniques. The outer cased borehole will be advanced to approximately 2 to 5 feet into the uppermost weathered bedrock. The casing will be grouted in-place with a cement grout to provide a seal between the upper VOC-containing alluvial aquifer and the bottom of the casing within the bedrock aquifer. The grout will be forced through the bottom of the casing into the annular space between the casing and the borehole wall within the bedrock formation. The grout will be allowed to set overnight and tested to ensure the seal is effective prior to proceeding. When it has been determined that the casing is adequately sealed into bedrock, drilling will continue into the bedrock formation using a smaller diameter drill bit and casing. The inner borehole will be advanced at least 10 feet into the bedrock formation or until the uppermost water-bearing bedrock fractures are encountered. The monitoring well will be constructed over the uppermost water bearing zone within the bedrock aquifer. The actual depth of the bedrock aquifer monitoring well will be determined in the field by the field hydrogeologist in consultation with a DEQ representative based upon field conditions encountered at the time of well construction.

The specific methods and materials to be used in construction of this bedrock well will be provided to DEQ as a separate submittal for review and approval prior to construction of the well.

3.4.3 Groundwater Recirculation System

3.4.3.1 Equipment. The groundwater recirculation system will consist of a network of performance monitoring wells (alluvial monitoring wells 09-1, 09-2, and 89-3 and bedrock well 09-3), extraction wells (E-1, E-2, and E-3) and injection wells (IW-05, IW-06, and IW-07), an aboveground injection system, and monitoring equipment. The proposed system is schematically shown on Figure 3. The system includes the following components:

- The three extraction wells will house submersible extraction pumps capable of 20 gpm controlled by valves or a variable frequency drive (VFD). The groundwater extraction wells will be equipped with a pressure transducer and combination oxidation-reduction potential (ORP)/electrical conductivity (EC) sensor (In-Situ Inc. Level Troll 9500).

- A polyethylene mixing tank with a capacity of 500 gallons.

- The 40 percent $NaMnO_4$ stock solution (RemOx-L) as supplied by Carus Chemical will be stored in 55-gallon drums. $NaMnO_4$ stock solution will be delivered manually or by an electric metering pump to the mixing tank.

- A non-metallic, air diaphragm pump will be used to inject the $NaMnO_4$ solution. The pump body is thermoplastic (e.g., polypropylene) and compatible with $NaMnO_4$. The pump operates at a maximum flow rate of approximately 50 gpm at a maximum pressure of 120 pounds per square inch (psi) total dynamic head. Compressed air flow will be regulated at the pump inlet to vary the injection flow rate and pressure.

- A 0 to 60 pounds per square inch gauge (psig) and a 0 to 50 gpm in-line flow meter will be located on the discharge side of the pump to monitor injection pressures and total flow rate.

- Check valves and a manually-operated pressure relief valve will be used. The pressure relief valve will be on the discharge side of the pump and vented to the return line on the mixing tank in the event of over pressurization of the injection equipment.

- The extraction and injection manifolds will contain individual ball valves and in-line flow meters for flow regulation to/from the wells. Pressure gauges will be made available at the injection wellheads. Ports will also be made available for sample collection and sodium permanganate field-parameter measurements.

- Injection and monitoring wells (89-3, 09-1, 09-2, and 09-3) will be equipped with pressure transducers. The extraction and monitoring wells will also contain a combination ORP/EC sensor.

- A containment cell will be constructed to house the sodium permanganate injection equipment (pumps, injection manifold, mixing tank, and sodium permanganate stock solution). The cell will consist of plastic sheeting (e.g. 20 mil scrim) draped over railroad ties.

Field modifications may be made, as appropriate, to the components described above based upon field conditions and equipment availability.

Note: A manganese mass balance was performed using bench scale data to assess the potential of aquifer plugging due to precipitation of manganese dioxide (MnO_2) (Kennedy/Jenks Consultants 2009). The evaluation concluded up to 40 percent of the manganese was precipitated to MnO_2. Given the high groundwater seepage velocity, it is not anticipated that aquifer plugging will be of significant concern.

It appears that chlorinated ethene degradation in the presence of permanganate is subject to interfacial resistance caused by deposition of MnO_2 solids. Studies indicate that the rate of TCE (dense non-aqueous phase liquid - DNAPL) degradation was shown to decrease at high permanganate concentrations as a result of interfacial resistance caused by the MnO_2 film (Siegrist 2001). Therefore, to reduce the potential for well screen/filter pack and formation plugging and to minimize the potential for interfacial resistance, extracted groundwater will be passed through bag filtration prior to re-injection.

Studies also indicate that the initial rate of TCE (DNAPL) degradation was increased at high permanganate concentrations as a result of the chemical reaction. However, the degradation rate decreased rapidly with time, as result of interfacial resistance (Siegrist 2001).

3.4.3.2 System Operation and Duration. The system will operate as a closed-loop groundwater recirculation system. Groundwater will be extracted from the downgradient side of the target treatment area and injected upgradient to create a subsurface groundwater recirculation cell and achieve a water balance (i.e., extraction rate equals injection rate). Overall, the objective of the groundwater recirculation process is to maintain a 500 mg/L or greater $NaMnO_4$ concentration within the target treatment zone for a minimum of 89 hours (3.7 days). System operation will be conducted as follows:

- An initial slug injection will be performed by adding a total of 15 gallons of 40 percent $NaMnO_4$ (400,000 mg/L) stock solution to the injection wells. The primary objective of the initial slug injection is to establish a 750 mg/L $NaMnO_4$ concentration within the target treatment volume and assess dilution/consumption effects associated with downgradient advective transport. The initial slug injection equates to 70 pounds $NaMnO_4$ (or 175 pounds 40 percent $NaMnO_4$ solution).

  Assuming a groundwater velocity of 140 feet per day, the advective transport time between the injection and extraction wells is estimated at 7 hours. The groundwater velocity is supported by bromide detections at the 1 day sampling event (6 May 2008) in well 07-14 located approximately 140 feet downgradient of bromide injection well 07-16.

- Groundwater extraction will be initiated upon the observed presence of $NaMnO_4$ in the extraction wells (i.e., visual pink/purple color and/or increase in ORP). Assuming one-third of the volume of the produced groundwater drawn in by the extraction well network at the maximum extraction rate of 50 gpm contains 750 mg/L $NaMnO_4$ (i.e., two-thirds of the volume of the produced groundwater drawn in contains negligible concentrations of permanganate), the $NaMnO_4$ concentration in the extraction stream is estimated at 250 mg/L. The estimated $NaMnO_4$ concentration of 250 mg/L equates to a chemical oxidant mass loss of approximately 23 pounds $NaMnO_4$ for each pore volume removed.

- The extracted groundwater will be intermittently amended with the 40 percent stock solution to maintain a 500 mg/L or greater $NaMnO_4$ concentration within the target treatment zone for a minimum of 89 hours (3.7 days). (Note: A higher sustained $NaMnO_4$ concentration may be proposed to DEQ for review and approval during the actual testing if warranted based upon incoming data from the follow-up testing.) Groundwater samples will be collected from three alluvial monitoring wells (09-1, 09-2, and 89-3), bedrock monitoring well (09-3), and three extraction wells (E-1, E-2, and E-3) and measured for $NaMnO_4$ using a portable colorimeter (or equivalent). The real time data collected in the field at approximate 2-hour intervals will be used to adjust $NaMnO_4$ loadings.

- Amendment will be temporarily halted if the residual $NaMnO_4$ concentration in the groundwater extracted is equal to the injection concentration indicating that the $NaMnO_4$ is no longer being consumed in the aquifer.

- During the injection process, the extraction/injection rate and/or $NaMnO_4$ delivery concentration may be adjusted based on observed subsurface conditions in consultation with DEQ field personnel.

- For the purpose of estimating mass loading, a 500 mg/L $NaMnO_4$ delivery concentration at 50 gpm for 89 hours equates to 1,113 pounds $NaMnO_4$ (2,782 pounds and 243 gallons of 40 percent $NaMnO_4$ solution).

- The total mass loading (initial slug and recirculation mass) is estimated at 1,183 pounds $NaMnO_4$, equating to 2,958 pounds and 259 gallons of 40 percent $NaMnO_4$ solution.

Supporting information detailing system operation and duration is provided in Table 2.

3.4.3.3 Injection Process Monitoring. Injection monitoring activities will evaluate the presence and distribution of the $NaMnO_4$ during the injection event. Injection monitoring activities will be conducted within and immediately downgradient (i.e., within the former Electric Shop) of the designed target treatment zone as follows:

- Prior to injection activities, serial dilutions of the 40 percent $NaMnO_4$ stock solution will be prepared using collected groundwater from well 89-3. ORP and EC measurements will be performed for each serial dilution of known $NaMnO_4$ concentration to establish a standard curve.

- In-Situ Inc. Level Troll 9500 transducers with pressure (water level) and combination ORP/EC sensor will be installed in three alluvial monitoring wells (09-1, 09-2, and 89-3), bedrock well (09-3), and three extraction wells (E-1, E-2, and E-3). Water level, ORP, and EC data will be logged during and following the injection process. Measurements recorded every 15 minutes or more frequently will be downloaded using a portable data logging device (i.e., Rugged Reader). ORP and EC recorded field data will be correlated to the established standard curve (as described above) to determine the in-field $NaMnO_4$ concentration.

- Groundwater samples will be collected from three alluvial monitoring wells (09-1, 09-2, and 89-3), bedrock well (09-3), and three extraction wells (E-1, E-2, and E-3) and measured for $NaMnO_4$ using a portable colorimeter (or equivalent). In-field $NaMnO_4$, ORP and EC data will be used to adjust $NaMnO_4$ loadings that will be conducted on approximate 2-hour intervals.

- Groundwater samples will be collected at least once daily from wells 07-2A, 07-2B, 07-13, 07-14, 07-15, 08-1, 08-2, 89-9, and L-87-5 for visual observation (presence/absence of pink/purple color) and ORP measurements. If visual observation or ORP measurements indicate the presence of $NaMnO_4$, the groundwater sample will be measured for $NaMnO_4$ using a portable colorimeter (or equivalent).

- Extraction/injection flow rates and injection pressures at the wellhead will be recorded on an hourly basis.

Note: The In-Situ Troll transducers will be removed from the wells when there is evidence of the $NaMnO_4$ being fully consumed (i.e., ORP measurements return to baseline conditions).

3.5 POST-INJECTION MONITORING PROGRAM

Groundwater monitoring will be conducted prior to and following the $NaMnO_4$ injection event to assess chlorinated VOC oxidation and residual permanganate concentrations. Groundwater monitoring will also be conducted to evaluate generation and transport of soluble metals sensitive to the oxidation reaction. The groundwater monitoring network will consist of newly installed wells IW-05, IW-06, IW-07, 09-1, 09-2, 09-3, E-1, E-2, and E-3 and existing wells 07-2A, 07-2B, 89-3, 07-13, 07-14, 07-15, 08-1, 08-2, 89-9, and L-87-5. Prior to $NaMnO_4$ injections, groundwater samples will be collected from the above-mentioned wells. Confirmation sampling will be performed as shown on the schedule presented in Table 3. Baseline and confirmation groundwater samples will be analyzed for the following parameters:

- VOCs using EPA Method 8260.

- Permanganate by absorbance at the 528 nanometers (nm) wavelength (spectrophotometric method).

- Dissolved metals including chromium, manganese, mercury, and silver using EPA Method 6010/6020/7470 Series. Other metals analyzed during the initial pilot test did

- Chloride using EPA Method 300.0.
- TDS using EPA Method 160.1.
- pH and ORP (field measurements).

The monitoring schedule includes weekly sampling for a 1-month period. The need for additional sampling events and changes in sampling parameters will be evaluated based on the results of the first month, and any requested changes will be proposed to DEQ for review and approval.

During the initial pilot test, total alkalinity and sulfate were included in the post-injection monitoring program. These parameters have been removed from the post-injection monitoring program based upon the following:

- Total alkalinity. A slight increase in total alkalinity was observed indicating chemical oxidation of soil carbonates. Additional collection of total alkalinity data is not warranted as it does not provide added value in interpreting overall treatment effectiveness.
- Sulfate. The observed trend in sulfate concentrations during the initial pilot test post-injection monitoring program did not indicate significant reduced sulfur compound oxidation by permanganate.

4.0 SOIL VAPOR EXTRACTION (SVE) EVALUATION

4.1 OBJECTIVE

Past interim remedial measures performed at the Facility included implementation of SVE in areas where soil containing VOCs were apparently acting as a source of dissolved VOCs in alluvial aquifer groundwater. Envirocon, Inc. of Missoula, Montana concluded that declining dissolved VOC concentrations in groundwater were, at least in part, attributable to source removal using SVE. An SVE system was operated from March 1992 through May 1995 at the former vapor degreaser area in the northwestern corner of the former Electric Shop building using wells VE-18, VE-19, VE-20, VE-23, and VE-37. SVE was also performed outside the former Electric Shop building using wells VE-23, VE-27, and VE-40 from April 1994 through May 1995. SVE locations in the vicinity of the former Electric Shop and Locomotive Shop are shown on Figure 2.1 of *Final Draft Soil and Groundwater Feasibility Study Report* (Envirocon 1998). According to Appendix 2A of the *Final Draft Soil and Groundwater Feasibility Study Report,* approximately 970 pounds of VOC constituents were removed from soil in the former vapor degreaser area.

The objective of the planned SVE testing described herein is to evaluate the efficacy of SVE in conjunction with ISCO to reduce dissolved VOC concentrations in alluvial aquifer groundwater. The SVE will be focused along an abandoned industrial wastewater sewer line in the former Electric Shop and Locomotive Shop area where past soil gas data support a conclusion that PCE and TCE in soil may serve as a continuing source of these VOCs for dissolution into groundwater. Since the SVE testing wells can be constructed and placed into operation rapidly, it is anticipated that pre- and post-SVE operation groundwater sampling data from some of the candidate ISCO wells described in Section 2.0 can be used to evaluate the efficacy of SVE at reducing vadose zone source VOC concentrations that may be impacting groundwater along, and downgradient of, the abandoned industrial wastewater sewer line. After the SVE has run for a relatively short period, the application of ISCO in the sample areas will allow for the evaluation of the effectiveness of ISCO at reducing VOC concentrations in groundwater in the same areas.

4.2 VAPOR EXTRACTION WELL LOCATIONS

The abandoned industrial wastewater sewer line and layout of the proposed SVE system are shown on Figure 4. The layout includes SVE wells positioned along the abandoned industrial wastewater sewer line on approximate 60-foot centers [assuming 40-foot radius of influence (ROI)]. Vapor monitoring points will also be installed in select locations to estimate the ROI.

Note: In June 2007, five SVE tests were conducted in the vicinity of the former Electric Shop (Kennedy/Jenks Consultants 2007). The short-term SVE tests were conducted for wells 07-2A, 07-13, 07-14, 07-15, and 07-16. The estimated ROI for the five SVE tests ranged from 36 to 63 feet, with the estimated ROI for four of the SVE tests ranging from 35 to 45 feet.

4.3 SOIL BORINGS/VAPOR EXTRACTION WELL CONSTRUCTION

The soil borings for vapor extraction well construction will be drilled using sonic drilling techniques. Field screening and soil sampling will be conducted consistent with the procedures described for the candidate ISCO wells (Section 2.4). Field screening will be performed for both unsaturated and saturated zone soils at each well boring location. Where field screening suggests that VOCs may be present at appreciable concentrations within the vadose zone, the unsaturated soil sample with the highest headspace PID measurement will be submitted for laboratory analysis. If, during borehole advancement and logging the continuous soil samples, field observations indicate that additional samples may provide important information, opportunistic samples will be collected and submitted for chemical analyses. This includes samples from the saturated zone. The soil samples selected for analyses will be shipped to Energy or another appropriately certified laboratory under standard chain-of-custody protocol (see SOG-3). Soil samples will be analyzed for VOC using EPA Method 8260.

The vapor extraction wells will be installed as dual-completion wells with two 2-inch diameter casings in one borehole to allow for future flexibility if depth discrete vapor extraction is chosen.

It is anticipated the wells will be screened at depth intervals of 3 to 12 feet and 13 to 18 feet bgs. Each well will be completed with two screened intervals separated by a blank section of casing surrounded by an annular space bentonite seal to allow the upper and lower screened intervals to be isolated from one another.

4.4 SVE SYSTEM

This section discusses the design and installation of the aboveground portion of the SVE system, which consists of a blower, moisture separator, and associated piping, valves, and controls. As the extraction well layout spans across the north of the former Electric Shop and through the Locomotive Shop, two separate equipment areas have been tentatively designated to house SVE system components. The equipment areas would be located in the former Electric Shop and Locomotive Shop to facilitate operation and maintenance and to prevent freezing of system components. A schematic of the SVE system is shown on Figure 5. The system will consist of the following:

- Well Head. The wells will be housed within a traffic rated vault. Each well will be piped individually to each respective extraction manifold and installed within common trenches. Flexible hoses, valves, and/or couplers will be utilized within the wellheads to allow flexibility in extraction from one or both screened intervals. Each wellhead will be equipped with a port for vacuum measurement.

- Extraction manifold. Individual piping at each respective system manifold will contain a ball valve, vacuum gauge, sample port, and a port for manual flow measurements for each individual SVE well. Manual measurement of individual flow rates will be conducted using a hot-wire anemometer.

- Moisture Separator. The moisture separator will consist of a 55-gallon drum designed to remove moisture from the extracted soil-gas prior to granular activated carbon (GAC) filtration. Standard features include site gauge, level switches (high and high-high), and manual drain (i.e., for removal of accumulated moisture). A dilution valve will be provided on the moisture knockout tank for added vacuum control.

- Vacuum blower. Each vacuum blower will provide 250 standard cubic feet per minute (scfm) at 60 inches water vacuum or more (up to 50 scfm for each wellhead). The blower skid will consist of a blower, inlet and discharge silencers, valves (butterfly, check, and pressure relief), temperature sensors (inlet and outlet), vacuum gauges, and pitot tube assembly for measuring total influent flow.

- Control Panel. Each system's control panel will consist of main disconnect, on/off/auto switch, and system alarm notifications. The system will electronically or telephonically alert operation personnel when alarms and shutdown occurs.

- System Alarm Response. System alarms will include: (1) high-level switch alarm in moisture separator requiring manual removal of accumulated moisture; (2) high-high level alarm in moisture separator with automatic blower shut-off; (3) low or high vacuum alarm at blower.

- Electrical Service. A separate electrical service will be installed to serve equipment at each designated equipment area.

4.5 GRANULAR ACTIVATED CARBON (GAC) TREATMENT

The extracted soil vapor will be treated via GAC prior to discharge to the atmosphere. The vapor-phase GAC filter system will consist of two GAC units plumbed in series. The GAC filtration system will be positioned upstream of the vacuum blower to minimize adsorption effects due to increase temperature (i.e., effluent discharge temperature may affect sorption of chlorinated ethenes to vapor phase GAC). The vessels will be equipped with pressure gauges, sample ports, and manual drain (i.e., for removal of accumulated moisture, if any).

4.6 SYSTEM MONITORING AND SAMPLING

Monitoring and sampling during the 12 week operation of the SVE system is anticipated to include the following activities:

- Periodic vacuum measurements at the extraction wellheads, extraction manifolds, and vapor monitoring points. Vacuum measurements at the extraction wellheads and vapor monitoring points will be performed using Magnahelic® gauges.

- Periodic flow measurements for individual wells at the extraction manifolds. Flow measurements will be conducted using a hot-wire anemometer.

- Total influent flow measurement using pitot tube assembly.

- Periodic influent and effluent temperature measurement.

- PID and flame ionization detector (FID) readings for individual wells at the extraction manifolds and the influent to the GAC units.

- Vapor samples will be collected at the influent (selected extraction wells and total influent), between the GAC vessels, and the effluent port. During the first week of system operation, vapor samples will be collected from the influent and effluent port on a daily basis. The samples will be collected using a Summa™ canister and submitted for analysis of VOC constituents (full list) using TO-15 selective ion monitoring (SIM). Additional data collection following the first week of operation will be determined based on interpretation of the initial one week data.

- Sampling of groundwater from selected candidate ISCO wells along the abandoned industrial wastewater sewer alignment to evaluate changes in dissolved VOC concentrations. Candidate ISCO wells will be selected for sampling based, in part, upon the results of the initial sampling described under Section 2.5 above.

5.0 DATA ANALYSIS AND EVALUATION

5.1 SITE INVESTIGATION ACTIVITIES

The data collected from the pre- and post-SVE operation groundwater sampling will be used to evaluate the efficacy of SVE at reducing VOC concentrations in groundwater along and downgradient of the abandoned industrial wastewater sewer line. The data collected from the ISCO well construction and sampling will be used to evaluate potential source areas that would warrant ISCO testing using the sodium permanganate chemical oxidant. Unsaturated chlorinated ethene soil analytical results and two rounds of quarterly monitoring data will be utilized for initial assessment of source areas. Based on the initial assessment, PDBs may be employed to evaluate the potential stratification of chlorinated VOCs in the alluvial aquifer groundwater.

5.2 FOLLOW-UP INJECTIONS

The data and information obtained from follow-up ISCO testing will be reviewed to evaluate the effectiveness of PCE oxidation using the sodium permanganate oxidant via a groundwater recirculation system. Data analysis and evaluation will include estimates for $NaMnO_4$ consumption, VOC removal efficiencies, soluble metal mobilization and attenuation, and manganese dioxide production. The groundwater recirculation system will be evaluated based on its ability to deliver the chemical oxidant and maintain the desired treatment zone $NaMnO_4$ concentration for the required contact period.

5.3 SOIL VAPOR EXTRACTION

System effects on the subsurface will be evaluated by estimating the ROI based on vacuum data from vapor monitoring points. Cumulative COC mass removal over time will be estimated using influent vapor sample data from the extraction wells and measurements of air flow.

Collected influent, midpoint, and effluent vapor data will be used to determine the VOC mass loadings on the carbon units as well as develop breakthrough curves for various constituents.

6.0 REPORTING

ISCO well construction and sampling, follow-up ISCO testing, and SVE system operation will be documented in the following submittals:

- Candidate ISCO Well Construction and Sampling. Upon receipt of each of the two rounds of groundwater sampling data, a letter report will be prepared summarizing the activities including description of work performed, general field observations (soil characteristics, field screening, etc.), and soil and groundwater sampling results. The letter reports will provide an evaluation of potential source areas based on interpretation of newly collected and historical soil, groundwater, and vapor data. Recommendations, such as deployment of PDBs in select wells and other ISCO test areas, will be provided for additional data collection to refine potential treatment areas (if warranted).

- Post-Injection Monitoring (1-Month). During the post-injection monitoring period, weekly letter reports shall be prepared and submitted to DEQ summarizing all field activities associated with the post-injection monitoring. Also, at the conclusion of the 1-Month post-injection groundwater monitoring event, an electronic submittal will be prepared summarizing groundwater sampling data and assessing metal mobilization and attenuation. A recommendation for continued monitoring will be provided if metal concentrations exceed baseline conditions. Upon completion of the post-injection groundwater monitoring program, a report will be prepared documenting follow-up pilot study activities.

- Soil Vapor Extraction. Upon 3-Months of system operation, a Soil Vapor Extraction Implementation Report will be prepared summarizing system installation and start-up activities and performance monitoring and sampling. The report will include calculation of the estimated ROI and tables summarizing system operation, monitoring (vacuum, flow, temperature, etc.), and sampling data (influent, midpoint, and effluent vapor samples). The report will also include calculated and plotted individual well and total cumulative mass removal rates.

7.0 SCHEDULE

A preliminary schedule for implementing the above scope of work is shown on Figure 6. This schedule does not include additional ISCO testing that may be proposed upon receipt of analytical results from sampling all of the new candidate ISCO wells. Schedule start dates depend upon DEQ approval of this Stage I – Part 2 addendum. The schedule is subject to contractor availability (i.e., drilling contractor, etc.), weather conditions, and any other unforeseen field conditions that could affect completion of the work in accordance with the preliminary schedule. DEQ will be notified of potential schedule delays.

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Tables

TABLE 1

FIRST-ORDER DEGRADATION RATE AND HALF-LIFE CALCULATIONS
Burlington Northern Livingston Shop Complex

$NaMnO_4$ Dosage	Initial PCE Concentration (C_o)(μg/L)[a]	Final PCE Concentration (C)(μg/L)[d]	Natural Logarithm Ln(C_o)	Natural Logarithm Ln(C)	First-Order Degradation Rate (day^{-1})[b]	Half-Life (hour)[b]
Low $NaMnO_4$ Dosage (0.5 grams $NaMnO_4$ / kilogram soil; 250 milligrams per Liter)						
Day 1	67	10.9	4.205	2.389	-1.8	9.2
Day 4	67	0.5	4.205	-0.693	-1.7	9.5
Low $NaMnO_4$ Dosage (1.5 grams $NaMnO_4$ / kilogram soil; 750 milligrams per Liter)						
Day 1	67	0.5	4.205	-0.693	-4.9	3.4
Day 4	67	0.5	4.205	-0.693	-1.7	9.5

$NaMnO_4$ Dosage	Initial PCE Concentration (C_o)(μg/L)[a]	Final PCE Concentration (C)(μg/L)[d]	Natural Logarithm Ln(C_o)	Natural Logarithm Ln(C)	First-Order Degradation Rate (day^{-1})[e]	Contact Time (hour)[f]
Low	750	5	6.620	1.609	-1.8	89
Low	750	5	6.620	1.609	-1.7	93
High	750	5	6.620	1.609	-4.9	34
High	750	5	6.620	1.609	-1.7	93

Notes:

(a) Initial and final tetrachloroethene (PCE) concentrations reported in Table 6 of the *Task F Stage I - Part 2 Pilot Test Report for Volatile Organic Compound-Containing Alluvial Aquifer Groundwater* (Bench-Scale Test - PCE and TCE Destruction Results) (Kennedy/Jenks Consultants 2009).

(b) First-order degradation rate and half-life calculated using following equations:

$C = C_o e^{-kt}$

$\ln(C) - \ln(Co) = - kt$

half-life = $t_{(1/2)} = \ln(2) / k$

(c) Assumed PCE concentration at well 89-3.

(d) Record of Decision cleanup level for PCE.

(e) Calculated first-order degradation rates for low and high $NaMnO_4$ dosages.

(f) Calculated contact time based on range of first-order degradation rates for PCE oxidation from 750 to 5 μg/L. PCE concentration of 750 μg/L selected based on maximum detected concentration of 712 μg/L in well 89-3 (passive diffusion bag sampling at depth of 30.9 feet below top of casing on 12 August 2008).

TABLE 2

SODIUM PERMANGANATE OXIDANT DEMAND AND DELIVERY CALCULATIONS
Burlington Northern Livingston Shop Complex

Item	Parameter	Calculated Value	Unit	Source/Equation
Dimensions				
A	Length	40	feet	See Figure 2.
B	Width	30	feet	See Figure 2.
C	Area	1,200	square feet	A * B
D	Satuated Thickness	5	feet	Target treatment zone thickness.
E	Effective Porosity	0.25	percent	
F	Groundwater Pore Volume	11,220	gallon	
G		42,468	Liter	F * (3.785 liter / gallon)
$NaMnO_4$ Loading Based on SOD[a]				
H	Mass Soil (based on 5 foot saturated thickness)	300,000	killogram	C * D * (110 pound / cubic feet) / (2.2 pound / kilogram)
I	$NaMnO_4$ Loading	0.5	gram $NaMnO_4$/kilogram soil	Bench-scale testing soil oxidant demand (SOD). Utilized for initial pilot test mass loading.
J	$NaMnO_4$ Required	330	pounds $NaMnO_4$	H * I / (454 gram / pound)
K	40% Mass $NaMnO_4$ Required	826	pound $NaMnO_4$	J / 0.4
L	40% Solution $NaMnO_4$ Required	72	gallon	K / (11.43 pound / gallon)
Slug Injection $NaMnO_4$ Mass				
M	$NaMnO_4$ Loading - Slug Injection	750	milligram per liter $NaMnO_4$	
N	Volume (5 feet saturated thickness)	42,468	Liter	G
O	Slug Injection Mass $NaMnO_4$ Required	70	pound $NaMnO_4$	M * N / (1,000 milligram / gram) / (454 gram / pound)
P	Slug Injection 40% Mass $NaMnO_4$ Required	175	pound $NaMnO_4$ (40% solution)	O / 0.4
Q	Slug Injection 40% Solution $NaMnO_4$ Required	15	gallon (40% solution)	P / (11.43 pound / gallon)
Hydraulics and $NaMnO_4$ Mass Required During Recirculation				
R	Flow Rate	50	gallon per minute	Initial system flow rate.
S	Time (1 groundwater pore volume exchange; 5 foot saturated thickness)	3.7	hour	F / R / (60 minute / hour)
T	Continuous $NaMnO_4$ Concentration	500	milligram per liter $NaMnO_4$	Arbitrarily selected based on mass loss within target treatment area via pumping.
U	Mass Loading	47	pound $NaMnO_4$/pore volume	R * S * T * (60 minute / hour) * (3.785 liter /gallon) / (1,000 milligram / gram) / (454 gram / pound)
V	Time Required	89	hour	Reduce PCE concentration from 750 to 5 µg/L based on calculated first-order degradation rate (see Table 1).
W	Pore Volume Exchanges Required	24	pore volume	V / S
X	Mass $NaMnO_4$ Required During Recirculation	1,113	pound $NaMnO_4$	U * W
Y	40% Mass $NaMnO_4$ Required During Recirculation	2,782	pound $NaMnO_4$ (40% solution)	X / 0.4
Z	40% Solution $NaMnO_4$ Required During Recirculation	243	gallon (40% solution)	Y / 11.43
AA	40% Solution $NaMnO_4$ Add Per 2-Hours	5.5	gallon	Z / V
Required $NaMnO_4$ Mass				
AB	Total Mass $NaMnO_4$ Required	1,183	pound $NaMnO_4$	O + X
AC	Total 40% Mass $NaMnO_4$ Required	2,958	pound $NaMnO_4$ (40% solution)	AB / 0.4
AD	Total 40% Solution $NaMnO_4$ Required	259	gallon (40% solution)	AC / 11.43

Notes:
(a) Sodium permanganate demand associated with dissolved phase chlorinated hydrocarbons were neglected in mass calculations. Mass loading calculated using bench-scale soil oxidant demand (SOD).
(b) Density of 40% sodium permanganate stock solution is approximately 11.43 pound per gallon.

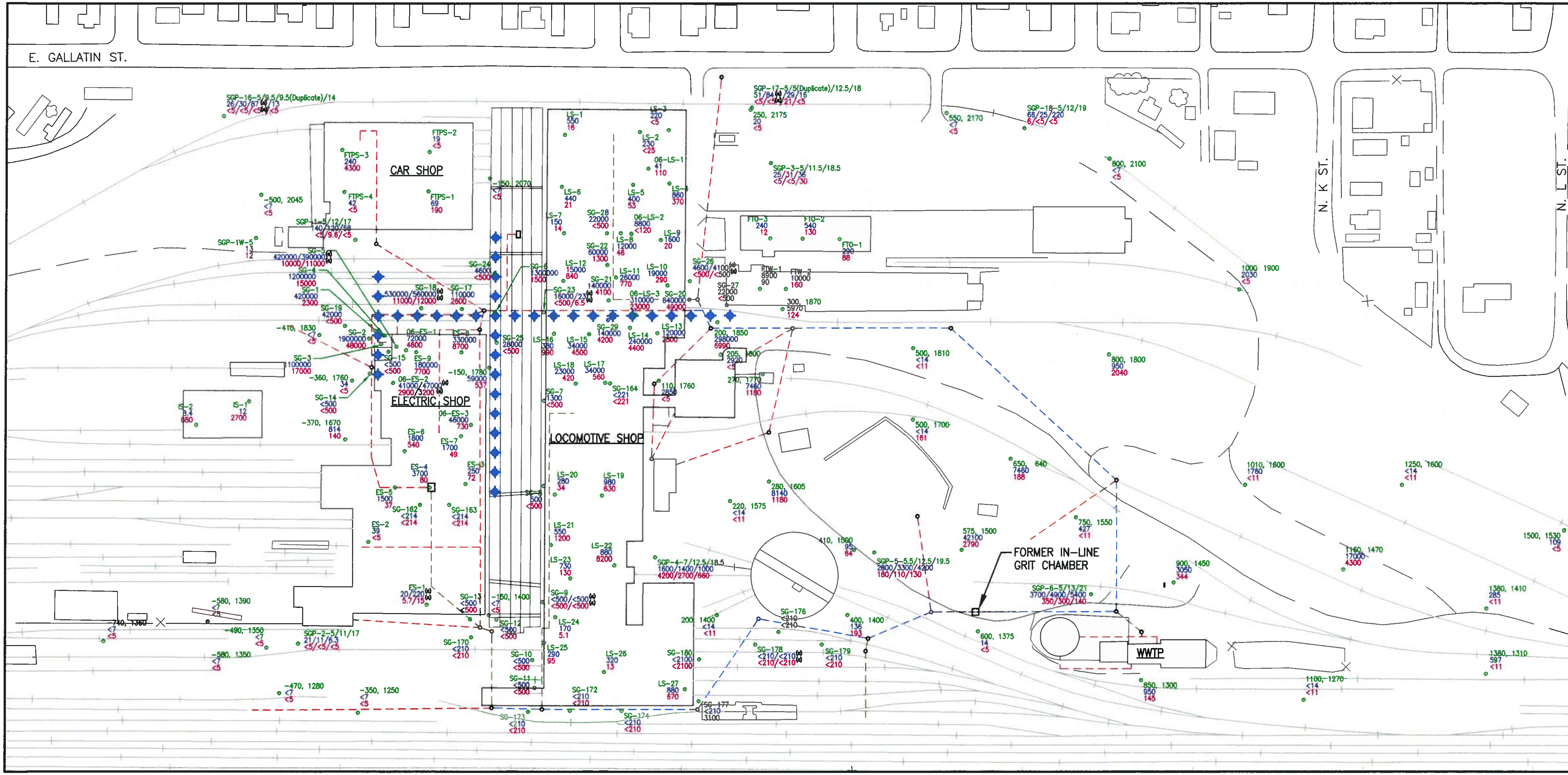
TABLE 3

GROUNDWATER SAMPLING SCHEDULE
Burlington Northern Livingston Shop Complex

Well	Sample Location (Approximate Location Relative to Well 89-3)	Baseline[a]				Day 1[b]			Day 2[b]			Day 3[b]			Week 1[c]				Week 2[c]				Week 3[c]				Month 1[c]			
		VOCs[d]	Metals[e]	TDS[f]	Chloride[g]	VOCs[d]	TDS[f]	Chloride[g]	VOCs[d]	TDS[f]	Chloride[g]	VOCs[d]	TDS[f]	Chloride[g]	VOCs[d]	Metals[e]	TDS[f]	Chloride[g]	VOCs[d]	Metals[e]	TDS[f]	Chloride[g]	VOCs[d]	Metals[e]	TDS[f]	Chloride[g]	VOCs[d]	Metals[e]	TDS[f]	Chloride[g]
07-2A	42 feet upgradient	X	X	X	X																						X	X	X	X
07-2B	42 feet upgradient	X	X	X	X																						X	X	X	X
07-13	40 feet cross gradient	X	X	X	X																						X	X	X	X
Injection Well (IW-05)	18 feet upgradient																													
Injection Well (IW-06)	18 feet upgradient	X	X	X	X																						X	X	X	X
Injection Well (IW-07)	18 feet upgradient																													
89-3	--	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
09-1	Directly cross-gradient	X	X	X	X	X			X			X			X				X	X	X	X					X	X	X	X
09-2	Directly cross-gradient	X	X	X	X	X			X			X			X				X	X	X	X					X	X	X	X
09-3	9 feet upgradient	X	X	X	X	X			X			X			X				X	X	X	X					X	X	X	X
Extraction Well (E-1)	20 feet downgradient																													
Extraction Well (E-2)	20 feet downgradient	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
Extraction Well (E-3)	20 feet downgradient																													
07-15	65 feet cross-gradient	X	X																	X				X			X	X		
07-14	80 feet downgradient	X	X																	X				X			X	X		
08-2	80 feet downgradient	X	X																	X				X			X	X		
08-1	192 feet downgradient	X	X																					X			X	X		
89-9	294 feet downgradient	X	X																					X			X	X		
L-87-5	503 feet downgradient	X	X																					X			X	X		

Notes:
(a) Baseline - sampling event conducted prior to start-up of groundwater recirculation system.
(b) Day 1, Day 2, and Day 3 - sampling events conducted 1, 2, and 3 days following initiation of groundwater sodium permanganate
(c) Week 1, Week 2, Week 3, and Month 1 - sampling events conducted approximately 1, 2, 3 weeks and 1 month following completion of groundwater recirculation system.
(d) VOC's - Volatile organic compounds using EPA Method 8260.
(e) Dissolved metals (chromium, manganese, mercury, and silver) using EPA Method 6010/6020/7470 Series.
(f) TDS - Total dissolved solids using EPA Method 160.1.
(g) Chloride using EPA Method 300.0.
(h) Other:
Permanganate by spectrophotometric method. Permangnate analyzed for groundwater samples with observed pink/purple color. Not analyzed for baseline event.
pH and oxidation-reduction potential (ORP) measured for each collected groundwater sample.

Figures



LEGEND

- ORIGINAL/REPLACED INDUSTRIAL WASTEWATER SEWER LINE
- SLEEVED INDUSTRIAL WASTEWATER SEWER LINE
- ABANDONED INDUSTRIAL WASTEWATER SEWER LINE
- MANHOLE
- PROPOSED ISCO MONITORING WELL LOCATION
- SG-25 — SOIL GAS SAMPLE LOCATION AND DESIGNATION
- 28000 — TETRACHLOROETHENE (PCE) CONCENTRATION IN SOIL GAS (ug/m^3)
- <500 — TRICHLOROETHENE (TCE) CONCENTRATION IN SOIL GAS (ug/m^3)

NOTE:

a) THE NUMBER REPRESENTS ANALYTICAL RESULT FOR A FIELD DUPLICATE SAMPLE.

BASEMAP SOURCE:
HORIZONS, INC. RAPID CITY, SD (1989)

0 75 150
APPROXIMATE SCALE IN FEET

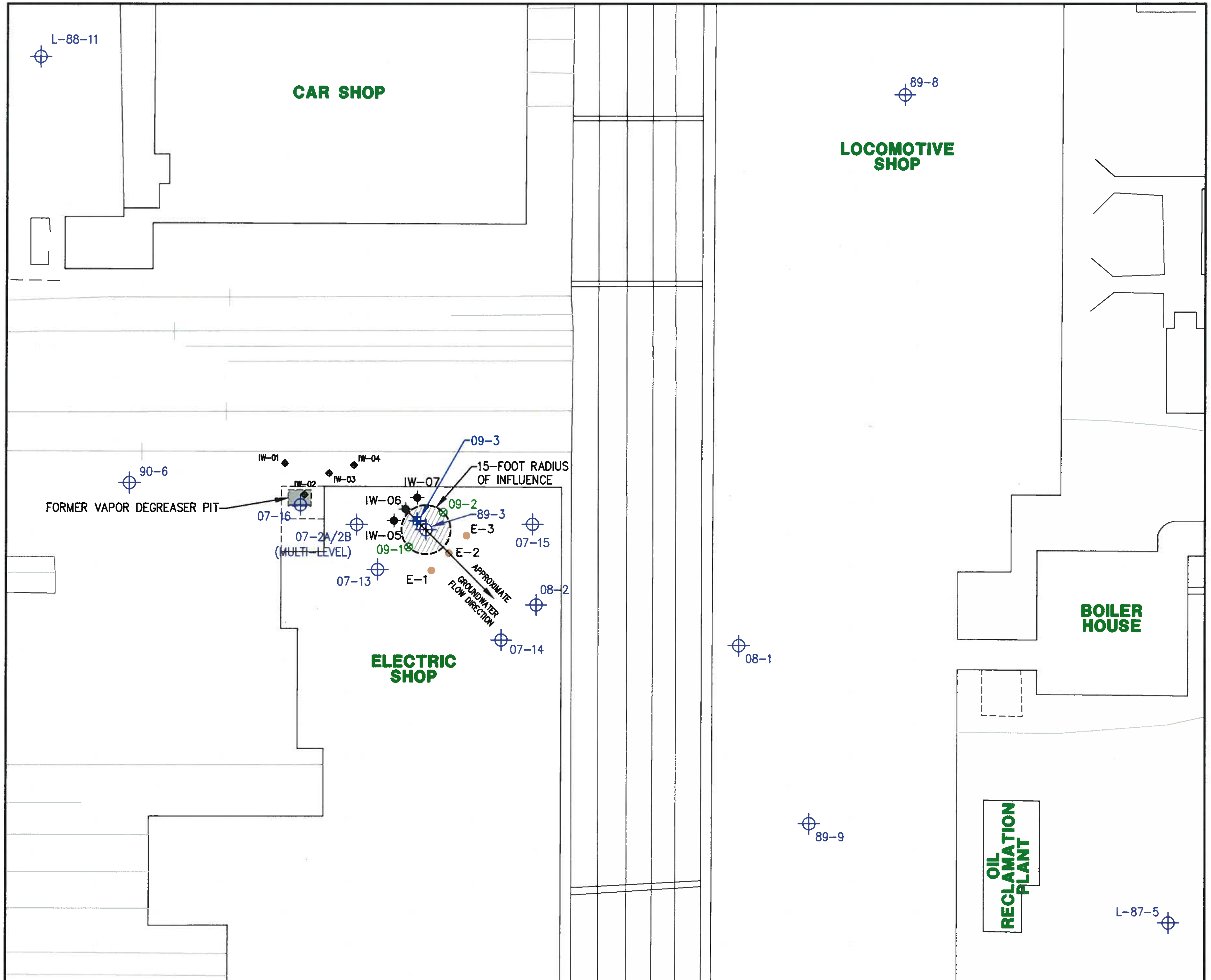
Kennedy/Jenks Consultants

BURLINGTON NORTHERN LIVINGSTON SHOP COMPLEX – LIVINGSTON, MT

CANDIDATE ISCO WELL LOCATIONS

0996021.16/Task F/PIWP/P09SK001r1

11/09 (Revision No. 1) **FIGURE 1**



LEGEND

IW-01	◆	2008 PERMANGANATE INJECTION BORING
89-3	⌖	EXISTING MONITORING WELL LOCATION
IW-07	✦	PROPOSED INJECTION WELL
E-3	●	PROPOSED EXTRACTION WELL
09-1	⊗	PROPOSED ALLUVIAL MONITORING WELL
09-3	✚	PROPOSED BEDROCK MONITORING WELL

NOTE:

1) ALL LOCATIONS ARE APPROXIMATE

N

0 30 60

APPROXIMATE SCALE IN FEET

BASEMAP SOURCE:

HORIZONS, INC. RAPID CITY, SD (1989)

Kennedy/Jenks Consultants

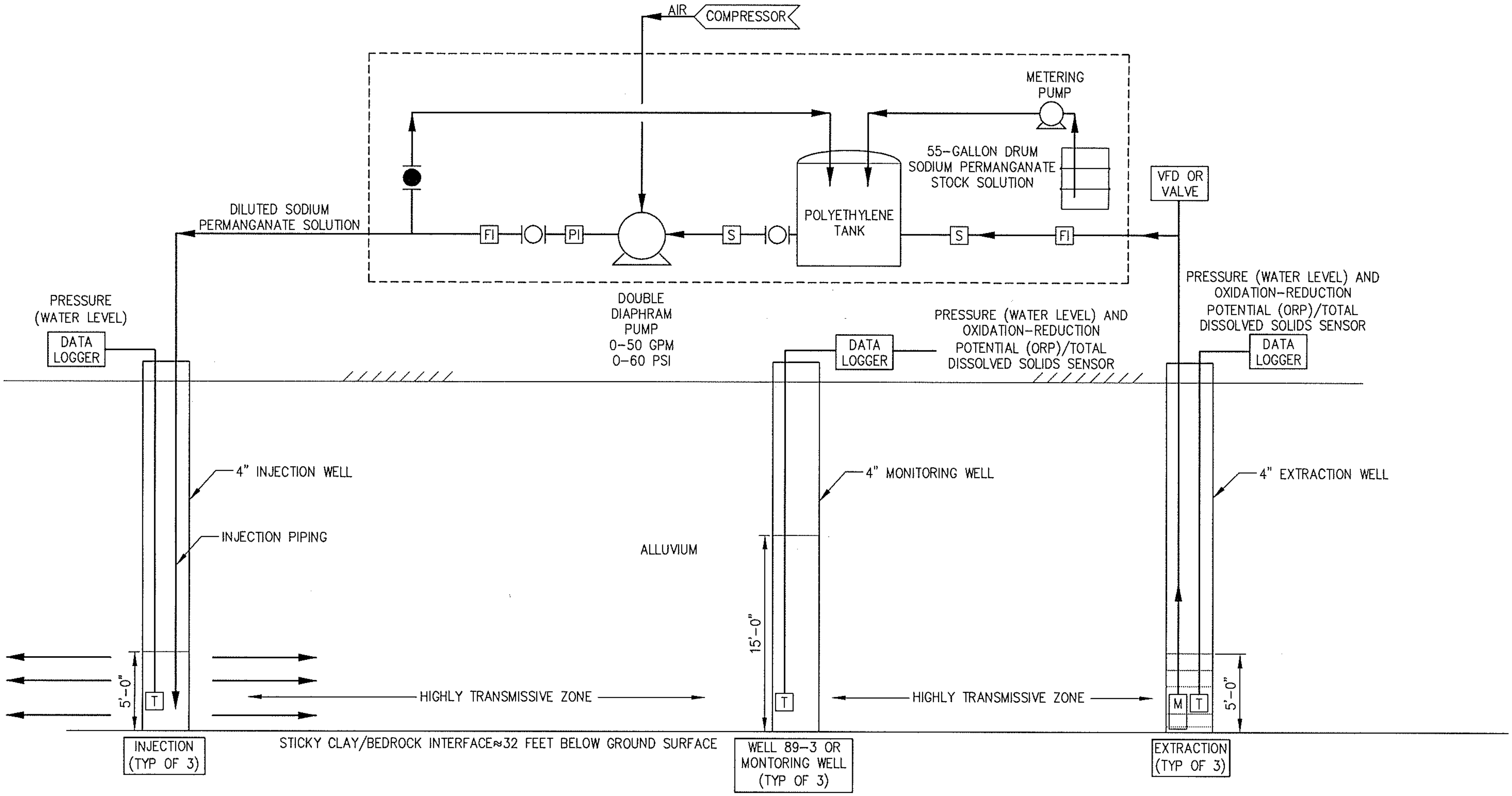
BURLINGTON NORTHERN LIVINGSTON SHOP COMPLEX – LIVINGSTON, MT

GROUNDWATER RECIRCULATION SYSTEM LAYOUT

0996021.16/Task F/PIWP/P09SK002r1

11/09 (Revision No. 1)

FIGURE 2



NOTE:

EACH INJECTION LINE WILL BE EQUIPPED WITH A BALL VALVE AND IN-LINE FLOW METER. PRESSURE GAUGES WILL BE MADE AVAILABLE AT THE WELLHEADS.

LEGEND

PI	PRESSURE GAUGE		BALL VALVE
FI	FLOW METER		FLOW DIRECTION
S	SAMPLE PORT		PUMP
M	MOTOR		SECONDARY CONTAINMENT
T	TRANSDUCER		
VFD	VARIABLE FREQUENCY DRIVE		

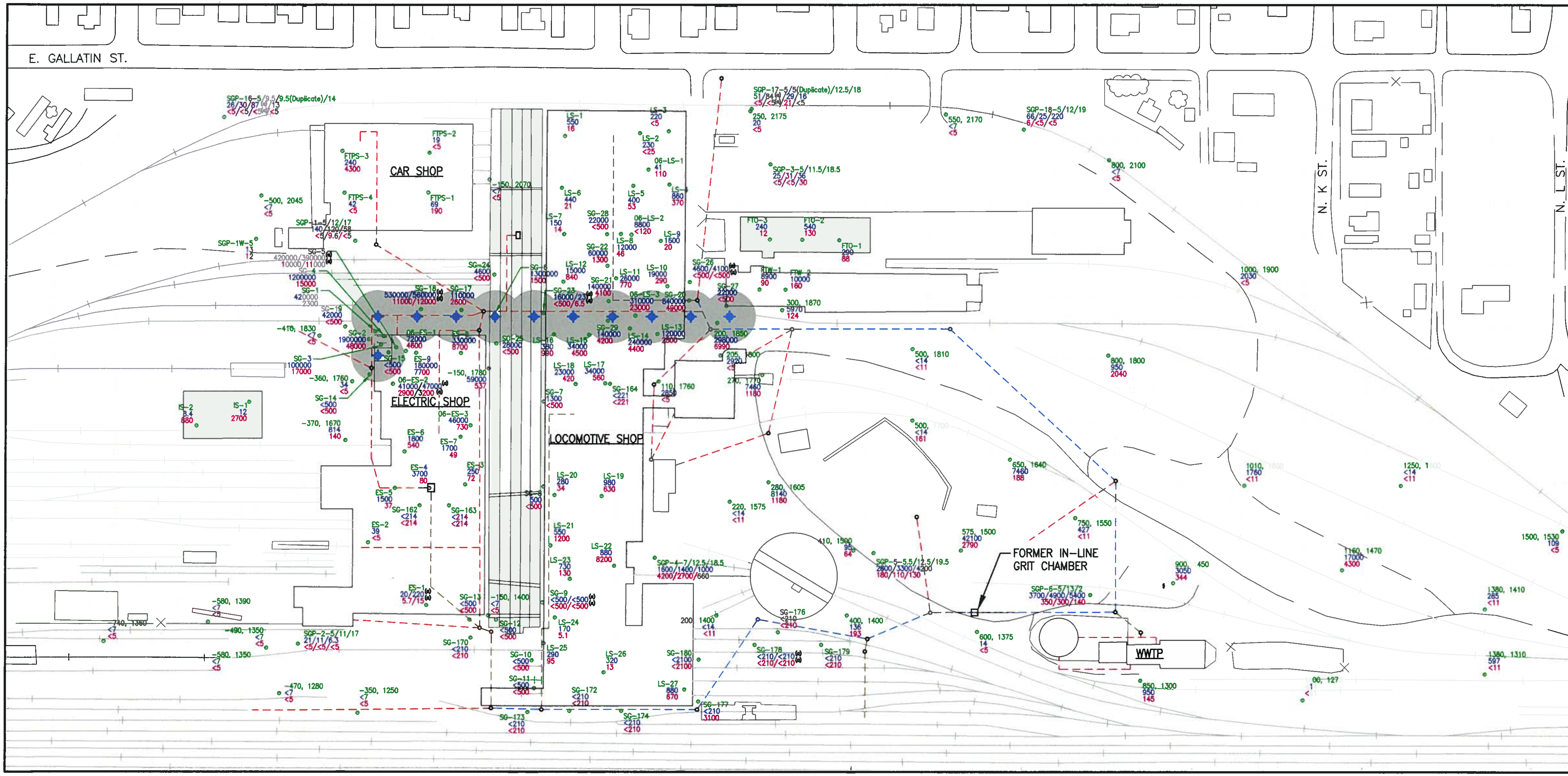
Kennedy/Jenks Consultants

BURLINGTON NORTHERN LIVINGSTON SHOP COMPLEX – LIVINGSTON, MT

SODIUM PERMANGANATE INJECTION SYSTEM SCHEMATIC

0996021.16/Task F/PIWP/P09SK003r1

11/09 (Revision No. 1) **FIGURE 3**



LEGEND

- ORIGINAL/REPLACED INDUSTRIAL WASTEWATER SEWER LINE
- SLEEVED INDUSTRIAL WASTEWATER SEWER LINE
- ABANDONED INDUSTRIAL WASTEWATER SEWER LINE
- MANHOLE
- SOIL VAPOR EXTRACTION WELL LOCATION WITH 40-FOOT RADIUS OF INFLUENCE
- SG-25 SOIL GAS SAMPLE LOCATION AND DESIGNATION
- 28000 TETRACHLOROETHENE (PCE) CONCENTRATION IN SOIL GAS (ug/m^3)
- <500 TRICHLOROETHENE (TCE) CONCENTRATION IN SOIL GAS (ug/m^3)

NOTE:

a) THE NUMBER REPRESENTS ANALYTICAL RESULT FOR A FIELD DUPLICATE SAMPLE.

BASEMAP SOURCE:
HORIZONS, INC. RAPID CITY, SD (1989)

0 75 150
APPROXIMATE SCALE IN FEET

Kennedy/Jenks Consultants

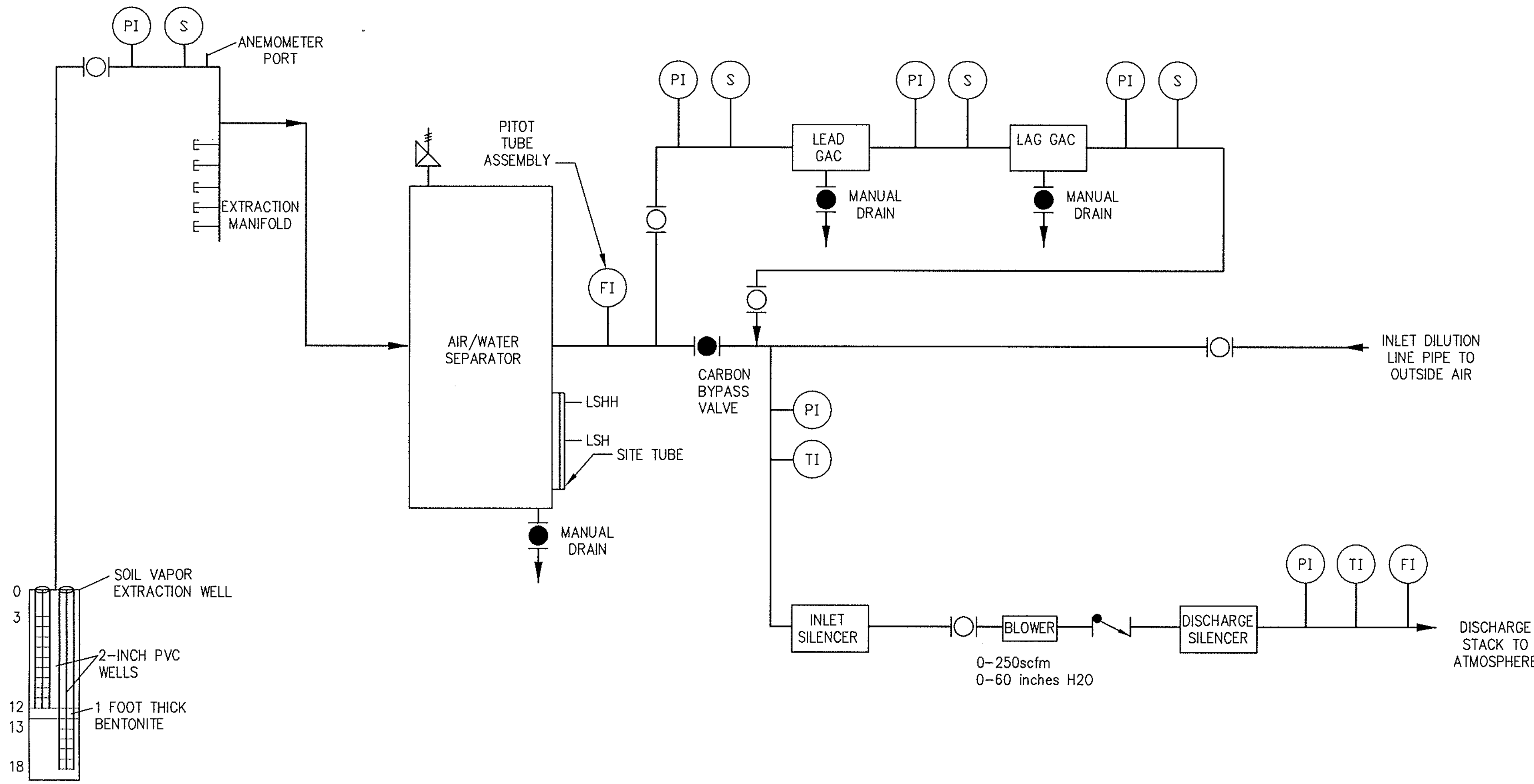
BURLINGTON NORTHERN LIVINGSTON SHOP COMPLEX – LIVINGSTON, MT

SOIL VAPOR EXTRACTION WELL LOCATIONS

0996021.16/Task F/PIWP/P09SK004r1

11/09 (Revision No. 1)

FIGURE 4



LEGEND

FI	FLOW INDICATOR (0–250scfm)		BALL VALVE (OPEN)
PI	PRESSURE INDICATOR (0–100" INCHES H20)		BALL VALVE (CLOSED)
S	SAMPLE PORT		CHECK VALVE
TI	TEMPERATURE INDICATOR (0–250°F)		FLOW DIRECTION
	VACUUM RELIEF VALVE		
LSH	LIQUID SWITCH HIGH (ALARM NOTIFICATION)		
LSHH	LIQUID SWITCH HIGH–HIGH (SYSTEM SHUTDOWN)		

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BURLINGTON NORTHERN LIVINGSTON SHOP COMPLEX – LIVINGSTON, MT

SOIL VAPOR EXTRACTION SYSTEM ILLUSTRATION

0996021.16/Task F/PIWP/P09SK005r1

11/09 (Revision No. 1) **FIGURE 5**

Appendix A

Environmental Requiremants, Criteria, and Limitations (ERCLs)

APPENDIX A

ENVIRONMENTAL REQUIREMENTS, CRITERIA, AND LIMITATIONS

Remedial actions undertaken pursuant to the Comprehensive Environmental Cleanup and Responsibility Act (CECRA), Section 75-10-701, et seq., Montana Code Annotated (MCA 1991), must "attain a degree of cleanup of the hazardous or deleterious substance and control of a threatened release or further release of that substance that assures present and future protection of public health, safety, and welfare and of the environment" [Section 75-10-721(1) (MCA 1991)]. Additionally, the Montana Department of Environmental Quality (DEQ) "shall require cleanup consistent with applicable state or federal environmental requirements, criteria, or limitations" (ERCLs) and "shall consider and may require cleanup consistent with substantive state or federal ERCLS that are well-suited to the site conditions" [Section 75-10-721(2)(a) and (b) (MCA 1991)].

"Applicable" requirements are those that by their terms meet the jurisdictional prerequisites and apply to a given action, item, or characteristic at the site. "Well-suited" requirements are those requirements that are not applicable, but address situations or problems sufficiently similar to those at the site that they are well-suited for use at the site.

ERCLs are generally of three types: contaminant-specific, location-specific, and action-specific. Contaminant-specific requirements are those that establish an allowable level or concentration of a hazardous or deleterious substance in the environment or that prescribe a level or method of treatment for a hazardous or deleterious substance. Action-specific requirements are those that are triggered by the performance of a certain activity as part of a particular remedy. Location-specific requirements are those that serve as restrictions on the concentration of a hazardous or deleterious substance or the conduct of activities solely they are in specific locations or affect specified types of areas.

ERCLs for the remedial action at the Burlington Northern Livingston Shop Complex were prepared by DEQ and were included in Appendix A of the *Record of Decision* (DEQ 2001). The following table presents a summary of the ERCLs from the ROD, including a description of each ERCL along with the regulatory citation(s), and an analysis of how the activities that will be performed during implementation of *Addendum No. 1 to Final Task F Stage I – Part 2 Pilot Test Work Plan for Volatile Organic Compound-Containing Alluvial Aquifer Groundwater* (Addendum No. 1) will comply with these ERCLs. ERCLs pertinent to pilot test activities are shaded in yellow.

Activities to be performed during implementation of the Addendum No. 1 comply with ERCLs.

ANALYSIS OF ENVIRONMENTAL REQUIREMENTS, CRITERIA, AND LIMITATIONS (ERCLS)[a] FOR ADDENDUM NO. 1 TO TASK F STAGE I - PART 2 PILOT TEST WORK PLAN
Burlington Northern Livingston Shop Complex

Federal or State ERCL Citation	Description	Compliance
	FEDERAL AND STATE CONTAMINANT SPECIFIC ERCLS	
Surface and Groundwater Quality Standards (Applicable)		
Section 75-5-605, Montana Code Annotated (MCA) Section 75-5-303, MCA	Causing of Pollution Section 75-5-605 of the Montana Water Quality Act prohibits the causing of pollution of any state waters. Section 75-5-103(21)(a)(i) defines pollution as contamination or other alteration of physical, chemical, or biological properties of state waters which exceeds that permitted by the water quality standards. Placement of Wastes Section 75-5-605, MCA states that it is unlawful to place or cause to be placed any wastes where they will cause pollution of any state waters. Any permitted placement of waste is not placement if the agency's permitting authority contains provisions for review of the placement of materials to ensure it will not cause pollution to state waters. Nondegradation Section 75-5-303, MCA states that existing uses of state waters and the level of water quality necessary to protect the uses must be maintained and protected, with certain limited exceptions.	Pilot test activities [sodium permanganate injection and soil vapor extraction (SVE)] proposed in *Addendum No. 1 to Task F Stage I - Part 2 Pilot Test Work Plan for VOC-Containing Alluvial Aquifer Groundwater* (Addendum No. 1) will not impact surface water. The sodium permanganate pilot test involves the injection of this chemical into the subsurface through soil borings. This chemical will introduce permanganate ions and potentially thallium and iron. It is expected that their presence in the groundwater will be short lived as the constituents precipitate from the groundwater. Hexavalant chromium concentrations may increase after the injection but attenuation of dissolved chromium occurs shortly after the permanganate has been consumed. Groundwater monitoring for metals of concern will be conducted during the sodium permanganate pilot test. Please refer to Attachment 1 of *Response to Comments - Final Task F Stage I - Part 2 Pilot Test Work Plan for VOC-Containing Alluvial Aquifer Groundwater* dated 11 July 2008.
Groundwater Quality Standards		
40 Code of Federal Regulations (CFR) 141	Maximum Contaminant Levels and Maximum Contaminant Level Goals (Well-Suited) Because the aquifer affected by the site is currently and has been used as a drinking water source, the MCLs and non-zero MCLGs specified in 40 CFR Part 141 (Primary Drinking Water Standards) are well-suited requirements which are ultimately to be attained by the remedy for the site[1]. Because many of the MCLs are equivalent with the State groundwater standards, the Primary Drinking Water Standards are listed below with the State groundwater standards.	The Record of Decision (ROD) specifies groundwater remediation as part of the remedial action and allows the treatment of groundwater as part of the selected remedy. Addendum No. 1 includes pilot testing a treatment technology to assess whether it will achieve the ROD cleanup levels.
40 CFR 143.3	Secondary Maximum Contaminant Levels (Well-Suited) Because the aquifer affected by the site is currently and has been used as a drinking water source, the Secondary Maximum Contaminant Levels (SMCLs) specified in 40 CFR Part 143.3 are well-suited requirements which are ultimately to be attained by the remedy for the site. 40 CFR 143.3 contains standards for color, odor (3 threshold odor number) and corrosivity which are well-suited to the remedial action.	To ensure state waters are not degraded/polluted, IDW generated during field activities associated with Task F will be managed as outlined in the Facility-Wide SAP. All purge water will be treated to the groundwater cleanup levels presented in the ROD and will meet all applicable permit requirements as specified in Petroleum Cleanup General Permit MTG7900013 before discharge to the Yellowstone River or disposed of according to the hazardous and solid waste procedures specified in Section 8.4 of the Final Facility-Wide Sampling and Analysis Plan and the SAP Addendum (Facility-Wide SAP).
Administrative Rules of Montana (ARM) 17.30.1006	Montana Groundwater Pollution Control System (Applicable) ARM 17.30.1006 classifies groundwater into Classes I through IV based upon its specific conductance and establishes the groundwater quality standards applicable with respect to each groundwater classification. Based upon its specific conductance, the groundwater at the site must meet the standards for Class I groundwater. These standards are applicable. Concentrations of substances in Class I may not exceed the human health standards for groundwater listed in department Circular WQB-7.[2] For the primary contaminants of concern, the Circular WQB-7 standards and MCLs are listed below. For all contaminants of concern except vinyl chloride, the MCLs and Circular WQB-7 standards are equivalent.[3] All levels are ug/l and are dissolved phase. VOCs: Tetrachloroethene - 5.0; Trichloroethene - 5.0; Cis-1,2-Dichloroethene - 70; Vinyl chloride - 0.15; Chlorobenzene - 100; 1,4-Dichlorobenzene - 75 PAHs (SVOCs): Acenaphthene - 420; Anthracene - 2,100; Benzo(a)anthracene - 0.48; Benzo(a)pyrene - 0.048; Benzo(b)fluoranthene - 0.48; Benzo(k)fluoranthene - 4.79; Chrysene - 48; Dibenzo(a,h)anthracene - 0.048; Fluoranthene - 280; Fluorene - 280; Indeno(1,2,3-cd)pyrene - 0.48; Naphthalene - 28; Pyrene - 210 Lead - 15 For concentrations of parameters for which human health standards are not listed in WQB-7, ARM 17.30.1006 allows no increase of a parameter to a level that renders the waters harmful, detrimental or injurious to the beneficial uses listed for Class I water. This includes the following petroleum constituents. All levels are "ug/l" and are dissolved phase.	DEQ determined that the pilot testing of sodium permanganate injection does not require a Montana Groundwater Pollution Control System (MGWPCS) permit under ARM 17.30.1023, because the pilot test is being performed under the Spring 2005 SOW. All substantive requirements of these regulations will be met. 40 CFR Part 143.3 and the Numeric Water Quality Standards for Montana's surface and groundwaters (formerly WQB-7 and now DEQ-7) contain a secondary MCL for manganese in groundwater of 0.05 milligrams per Liter (mg/L). Under DEQ-7, the concentration of manganese must not reach values that interfere with the uses specified in the surface and groundwater standards. Because the manganese and chromium will attenuate shortly after application (please refer to Attachment 1 of *Response to Comments - Final Task F Stage I - Part 2 Pilot Test Work Plan for VOC-Containing Alluvial Aquifer Groundwater* dated 11 July 2008), this action will be in compliance with DEQ-7.
ARM 17.30.1011	ARM 17.30.1011 provides that any groundwater whose existing quality is higher than the standard for its classification must be maintained at that high quality unless degradation may be allowed under the principles established in Section 75-5-303, MCA, and the nondegradation rules at ARM Title 17,chapter 30, subchapter 7.	Bench scale testing using a low-dose $NaMnO_4$ solution shows that the maximum hexavalent chromium concentration in the treatment zone might approach 0.2 mg/L and that the concentration will attenuate to less than 0.01 mg/L in and downgradient of the treatment zone within approximately 30 days of injection. However, bench-scale results are very conservative relative to concentrations anticipated during field application, given the prolific nature of the aquifer. As with manganese, dilution of temporary hexavalent chromium concentrations is anticipated within a short period of time within the railyard boundary. Please refer to Attachment 1 of *Response to Comments - Final Task F Stage I - Part 2 Pilot Test Work Plan for VOC-Containing Alluvial Aquifer Groundwater* dated 11 July 2008.
Surface Water Quality Standards (Applicable)		
Montana Water Quality Act, Section 75-5-101, et seq., MCA Federal Clean Water Act, 33 U.S.C. §§ 1251, et seq.	The Montana Water Quality Act, Sections 75-5-101 et seq., establishes requirements for restoring and maintaining the quality of surface and ground waters and the federal Clean Water Act, 33 U.S.C. Sections 1251 et seq., establishes requirements for restoring and maintaining the quality of surface waters. Under these Acts the state has authority to adopt water quality standards designed to protect beneficial uses of each water body and to designate uses for each water body. Montana's regulations classify state waters according to quality, place restrictions on the discharge of pollutants to state waters and prohibit the degradation of state waters.	To ensure state waters are not degraded/polluted, IDW generated during field activities associated with Task F will be managed as outlined in the Facility-Wide SAP. All purge water will be treated to the groundwater cleanup levels presented in the ROD and will meet all applicable permit requirements as specified in Petroleum Cleanup General Permit MTG7900013 before discharge to the Yellowstone River or disposed of according to the hazardous and solid waste procedures specified in the Facility-Wide SAP.
ARM 17.30.611	ARM 17.30.611(1) (Applicable) provides that the waters of the Yellowstone River drainage upstream of the Laurel water supply intake, which includes the Livingston area, are classified "B-1" for water use.	Please refer to Attachment 1 of *Response to Comments - Final Task F Stage I - Part 2 Pilot Test Work Plan for VOC-Containing Alluvial Aquifer Groundwater* dated 11 July 2008.
ARM 17.30.623	ARM 17.30.623 provides that concentrations of carcinogenic, bioconcentrating, toxic or harmful parameters which would remain in the water after conventional water treatment may not exceed the applicable standards set forth in department Circular WQB-7.	
WQB-7 standards	WQB-7 provides that "For surface waters the Standard is the more restrictive of either the Aquatic Life Standard or the Human Health Standard." For the primary Contaminants of Concern the Circular WQB-7 standards are the same as listed above in groundwater.	
ARM 17.30.623	The B-1 classification standards at ARM 17.30.623 also include the following criteria: 1) Dissolved oxygen concentration must not be reduced below the levels given in department Circular WQB-7; 2) Hydrogen ion concentration (pH) must be maintained within the range of 6.5 to 9.5; 3) the maximum allowable increase above naturally occurring turbidity is 5 nephelometric turbidity units; 4) Temperature increases must be kept within prescribed limits; 5) No increase are allowed above naturally occurring concentrations of sediment, settleable solids, oils, floating solids, which will or is likely to create a nuisance or render the waters harmful, detrimental, or injurious to public health, recreation, safety, welfare, livestock, wild animals, birds, fish or other wildlife. 6) True color must be kept within specified limits.	

APPENDIX A

ANALYSIS OF ENVIRONMENTAL REQUIREMENTS, CRITERIA, AND LIMITATIONS (ERCLS)[(a)] FOR ADDENDUM NO. 1 TO TASK F STAGE I - PART 2 PILOT TEST WORK PLAN
Burlington Northern Livingston Shop Complex

Federal or State ERCL Citation	Description	Compliance
ARM 17.30.637	ARM 17.30.637 which prohibits discharges containing substances that will: (a) settle to form objectionable sludge deposits or emulsions beneath the surface of the water or upon adjoining shorelines; (b) create floating debris, scum, a visible oil film (or be present in concentrations at or in excess of 10 milligrams per liter) or globules of grease or other floating materials; (c) produce odors, colors or other conditions which create a nuisance or render undesirable tastes to fish flesh or make fish inedible; (d) create concentrations or combinations of materials which are toxic or harmful to human, animal, plant or aquatic life; (e) create conditions which produce undesirable aquatic life.	
ARM 17.30.705	ARM 17.30.705 provides that for any surface water, existing and anticipated uses and the water quality necessary to protect these uses must be maintained and protected unless degradation is allowed under the nondegradation rules at ARM 17.30.708.	To ensure state waters are not degraded/polluted, IDW generated during field activities associated with Task F will be managed as outlined in the Facility-Wide SAP. All purge water will be treated to the groundwater cleanup levels presented in the ROD and will meet all applicable permit requirements as specified in Petroleum Cleanup General Permit MTG7900013 before discharge to the Yellowstone River or disposed of according to the hazardous and solid waste procedures specified in the Facility-Wide SAP.
Water Quality Act, Title 17, Chapter 30, Sub-Chapters 6 and 13 and ARM 17.30.1332	Stormwater Runoff (Applicable) Pursuant to authority under the Water Quality Act, Title 17, Chapter 30, Sub-Chapter 6, and Title 17, Chapter 30, Sub-Chapter 13, including ARM 17.30.1332, the Water Quality Division issues general stormwater permits for certain activities. For construction activities, the following permit must be obtained: General Discharge Permit for Storm Water Associated with Construction Activity, Permit No. MTR100000 (May 19, 1997). Generally, the permits require the permittee to implement Best Management Practices (BMP) and to take all reasonable steps to minimize or prevent any discharge which has a reasonable likelihood of adversely affecting human health or the environment. However, if there is evidence indicating potential or realized impacts on water quality due to any storm water discharge associated with the activity, an individual MPDES permit or alternative general permit may be required.	Pilot test activities will not impact surface water runoff at the Facility.
Ambient Air Quality Standards (Applicable)		
40 CFR 50.12 and ARM 17.8.222	The following standards are applicable at the site[4]: 40 CFR 50.12 and ARM 17.8.222. Ambient air quality standard for lead. Lead concentrations in the ambient air shall not exceed the following 90-day average: 1.5 micrograms lead per cubic meter of air.	Pilot test activities will not result in exceedances of ambient air quality standards for lead or ozone.
40 CFR 50.9 and ARM 17.8.213 40 CFR 50.10	40 CFR 50.9 and ARM 17.8.213. Ambient air quality standard for ozone. No person shall cause or contribute to concentrations of ozone in the ambient air exceeding: 0.10 ppm 1-hour average (0.12 ppm federal standard). 40 CFR 50.10 establishes a daily maximum 8-hour average 0.08 parts per million (ppm).	
ARM 17.8.220	ARM 17.8.220. Ambient air quality standard for settled particulate matter. Particulate matter concentrations in the ambient air shall not exceed the following 30-day average: 10 grams per square meter.	
40 CFR 50.6 and ARM 17.8.223	40 CFR 50.6 and ARM 17.8.223. Ambient air quality standards for PM-10. PM-10 concentrations in the ambient air shall not exceed the following standards: 150 micrograms/cubic meter of air, 24-hour average; and 50 micrograms/cubic meter of air, expected annual average.	Pilot test activities include well installation and soil borings. However, these actions will include wetting and other best management practices related to fugitive dust control. Remedial actions will be halted if significant dust is generated and will not resume until adequate dust control measures are in place. These dust control measures will ensure that ambient air standards will not be exceeded during the proposed remedial action.
40 CFR 50.8 and ARM 17.8.212	40 CFR 50.8 and ARM 17.8.212. Ambient air quality standards for carbon monoxide. Carbon monoxide concentrations in the ambient air shall not exceed the following standards: 9 ppm 8-hour average; and 23 ppm for a 1-hour average (35 ppm for federal).	Pilot test activities will not result in exceedances of ambient air quality standards for carbon monoxide.
Emission Standards (Applicable)		
Sections 75-2-101, et seq., MCA	Montana has promulgated standards to regulate emissions of certain contaminants into the air. The state emission standards are enforceable under the Montana Clean Air Act, Sections 75-2-101 et seq., MCA.	Pilot test activities will not result in volatile organic compound (VOC) emissions. Extracted soil vapors from the SVE system will be treated with granular activated carbon (GAC) prior to discharge to the atmosphere.
ARM 17.8.304	ARM 17.8.304. Visible Air Contaminants. No source may discharge emissions into the atmosphere that exhibit an opacity of 20 percent or greater, averaged over six consecutive minutes. This standard is limited to point sources, but excludes wood waste burners, incinerators, and motor vehicles.	
ARM 17.8.308	ARM 17.8.308. Airborne Particulate Matter. Emissions of airborne particulate matter from any stationary source shall not exhibit an opacity of 20 percent or greater, averaged over six consecutive minutes. This standard applies to the production, handling, transportation, or storage of any material; to the use of streets, roads, or parking lots; and to construction or demolition projects.	
ARM 17.8.315	ARM 17.8.315. Odors. If a business or other activity will create odors, those odors must be controlled, and no business or activity may cause a public nuisance.	Pilot test activities will not generate odors. No open burning will be conducted during implementation of the pilot test.
ARM 17.8.604	ARM 17.8.604. Prohibited open burning. Open burning of numerous specific materials, including but not limited to oil and petroleum products and hazardous wastes, is prohibited.	
ARM 17.8.705	ARM 17.8.705 requires that permits be obtained for the construction, installation, alteration, or use of specified air contaminant sources. All air permits required for remedial actions must be obtained.	According to the Air Resources Management Bureau of Montana Deprtament of Environmental Quality (DEQ), the proposed SVE system does not require air permits.
ARM 17.8.715	ARM 17.8.715 requires sources for which air quality permits are required to use best available control technology (BACT) or to meet the lowest achievable emission rate (LAER), as applicable.	
	FEDERAL LOCATION SPECIFIC ERCLS	
Criteria Classification of Solid Waste Disposal Facilities and Practices (Applicable and Well-Suited)		
40 CFR 257	Under the selected remedy, no solid or hazardous waste (other than media treated to cleanup levels) may be disposed on-site. The standards therefore are pertinent to the cinder pile (well-suited) and placement of ex situ soils treated to cleanup levels (applicable) and post-jurisdictional wastes (applicable). The criteria contained in 40 CFR Part 257, establish standards with which solid waste disposal must comply to avoid possible adverse effects on health or the environment. 40 CFR Part 257 includes the following standards: Section 257.3-1(a) requires that facilities or practices in the floodplain not result in the washout of solid waste so as to pose a hazard to human life, wildlife, or land or water resources. Section 257.3-2 provides for the protection of threatened or endangered species. Section 257.3-3 provides that a facility shall not cause the discharge of pollutants into waters of the United States. Section 257.3-4 states that a facility or practice shall not contaminate underground drinking water.	Investigated derived waste (IDW) will be generated during implementation of the pilot tests. Depending on the constituents and concentrations present and upon approval from the DEQ, this material may be landspread at the Livingston railyard, or treated, if feasible, and landspread at the Livingston railyard. Alternatively, the IDW will be disposed offsite at an appropriate permitted disposal facility. See the Facility-Wide SAP for additional information on how IDW generated during implementation of the pilot tests will be managed to comply with these ERCLs. Landspreading of soil and water, if approved by DEQ, will not occur in areas of a floodplain nor be conducted in a manner to cause discharge of pollutants into water. Other IDW or solid waste generated during implementation of the pilot tests will be disposed offsite at an appropriate permitted disposal facility.

APPENDIX A

ANALYSIS OF ENVIRONMENTAL REQUIREMENTS, CRITERIA, AND LIMITATIONS (ERCLS)[a] FOR ADDENDUM NO. 1 TO TASK F STAGE I - PART 2 PILOT TEST WORK PLAN

Burlington Northern Livingston Shop Complex

Federal or State ERCL Citation	Description	Compliance
The Endangered Species Act (Well-Suited)		
16 U.S.C. §§ 1531 – 1544, 50 CFR Part 402, 40 CFR 6.302(h), 40 CFR 257.3-2	This statute and implementing regulations (16 U.S.C. § 1531 et seq., 50 CFR Part 402, 40 CFR 6.302(h), and 40 CFR 257.3-2) require that any federal activity or federally authorized activity may not jeopardize the continued existence of any threatened or endangered species or destroy or adversely modify a critical habitat. Compliance with this requirement involves consultation with the U.S. Fish and Wildlife Service (USFWS) and a determination of whether there are listed or proposed species or critical habitats present at the Site, and, if so, whether any proposed activities will impact such wildlife or habitat. No endangered or threatened species was identified onsite although the Yellowstone Trout is treated as a species of special concern by the State. Any action affecting federal or State endangered or threatened species must comply with all listed requirements.	Pilot test activities will not impact endangered species. According to the ROD, no endangered species or threatened specifies were identified at the Facility, although the Yellowstone Trout is treated as a species of special concern by the State.
Sections 87-5-106, -107, -111, and -201, MCA	Sections 87-5-106, 107, and 111, MCA (Applicable): Endangered species should be protected in order to maintain and to the extent possible enhance their numbers. These sections list endangered species, prohibited acts and penalties. See also, §§ 87-5-106 and 87-5-201, MCA, (Applicable) concerning protection of wild birds, nests and eggs.	
ARM 12.5.201	ARM 12.5.201 (Applicable). Certain activities are prohibited with respect to specified endangered species.	
Migratory Bird Treaty Act (Well-Suited)		
16 U.S.C. §§ 703, et seq.	This requirement (16 U.S.C. § 703 et seq.) establishes a federal responsibility for the protection of the international migratory bird resource and requires continued consultation with the USFWS during remedial design and remedial action to ensure that the cleanup of the site does not unnecessarily impact migratory birds.	Pilot test activities will not impact migratory birds. Migratory birds may be present near the Facility. However, the Livingston railyard does not provide the majority of habitat for these species relative to the surrounding area, and no features exist that are particularly attractive to these species.
Bald Eagle Protection Act (Well-Suited)		
16 U.S.C. §§ 668, et seq.	This requirement (16 U.S.C. § 668 et seq.) establishes a federal responsibility for protection of bald and golden eagles, and requires continued consultation with the USFWS during remedial design and remedial action to ensure that any cleanup of the site does not unnecessarily adversely affect the bald and golden eagle.	Pilot test activities will not impact bald eagles. Bald eagles may be present near the Facility. However, the Livingston railyard does not provide the majority of habitat for these species relative to the surrounding area, and no features exist that are particularly attractive to these species.
Historic Sites, Buildings, Objects, and Antiquities Act (Well-Suited)		
16 U.S.C. 461, et seq.	These requirements, found at 16 U.S.C. 461 et seq., provide that, in conducting an environmental review of a proposed action, the responsible official shall consider the existence and location of natural landmarks using information provided by the National Park Service pursuant to 36 CFR 62.6(d) to avoid undesirable impacts upon such landmarks. No historic sites were identified.	Pilot test activities will not impact historic sites. According to the ROD, no historic sites were identified at the Livingston railyard.
Fish and Wildlife Coordination Act (Well-Suited)		
16 U.S.C. 661, et seq. and 40 CFR 6.302(g)	These standards are found at 16 U.S.C. § 661 et seq. and 40 CFR 6.302(g) and require that federally funded or authorized projects ensure that any modification of any stream or other water body affected by a funded or authorized action provide for adequate protection of fish and wildlife resources.	Pilot test activities do not involve the modification of any stream or other water body.
Floodplain Management Order (Well-Suited)		
40 CFR Part 6, Appendix A, Executive Order No. 11,988	This requirement (40 CFR Part 6, Appendix A, Executive Order No. 11,988) mandates that federally funded or authorized actions within the 100 year floodplain avoid, to the maximum extent possible, adverse impacts associated with development of a floodplain.	The proposed area(s) where the pilot tests will be implemented and locations of the proposed new wells are not located in the floodway or floodplain. Therefore, the pilot test activities will not impact a floodway or floodplain.
Protection of Wetlands Order (Well-Suited)		
40 CFR Part 6, Appendix A, Executive Order No. 11,990 Section 404(b)(1), 33 U.S.C. Section 1344(b)(1)	This requirement (40 CFR Part 6, Appendix A, Executive Order No. 11,990) mandates that federal agencies and potentially responsible parties avoid, to the extent possible, the adverse impacts associated with the destruction or loss of wetlands and to avoid support of new construction in wetlands if a practicable alternative exists. Section 404(b)(1), 33 U.S.C. § 1344(b)(1), also prohibits the discharge of dredged or fill material into waters of the United States. Together, these requirements create a "no net loss" of wetlands standard.	According to Montana's Natural Resource Information System, no wetlands have been identified in the Livingston area. Pilot test activities will not impact wetlands.
	STATE LOCATION SPECIFIC ERCLS	
Solid Waste Management Regulations (Applicable and Well-Suited)		
Solid Waste Management Act, Sections 75-10-201 et seq., MCA	Regulations promulgated under the Solid Waste Management Act, Sections 75-10-201 et seq., MCA, specify requirements that apply to the location of any solid waste management facility. Under the selected remedy, no solid or hazardous waste (other than media treated to cleanup levels) may be disposed on-site. The standards therefore are pertinent to the cinder pile (well-suited) and placement of ex situ soils treated to cleanup levels (applicable) and post-jurisdictional wastes (applicable).	Non-hazardous IDW such as personal protective equipment (PPE) and IDW that has determined to be non-hazardous through analytical testing generated during implementation of the pilot tests will be contained in 55-gallon drums or other appropriate containers and temporarily stored in a centralized storage area pending characterization and final disposition. If non-hazardous investigation-derived soil or water cannot be landspread at the Livingston railyard, it will be disposed offsite along with other non-hazardous IDW at an appropriate permitted disposal facility. See the Facility-Wide SAP for additional information regarding the management of IDW. Any other solid waste generated (i.e., tape removed from boxes, plastic bags and/or boxes containing supplies that are not reused, etc.) will be contained in a plastic garbage bag (if necessary) and placed in a garbage can for collection and appropriate disposal as solid waste. Pilot test activities do not involve the cinder pile or propose treatment of soil (ex-situ). If treatment of soil (ex-situ) is proposed, a SAP addendum will be submitted to DEQ as discussed in Section 8.4.2 of the Facility-Wide SAP.
ARM 17.50.505(1)	Under ARM 17.50.505(1), a facility for the treatment, storage or disposal of solid wastes: (a) must be located where a sufficient acreage of suitable land is available for solid waste management; (b) may not be located in a 100-year floodplain; (c) may be located only in areas which will prevent the pollution of ground and surface waters and public and private water supply systems; (d) must be located to allow for reclamation and reuse of the land; (e) drainage structures must be installed where necessary to prevent surface runoff from entering waste management areas; and (f) where underlying geological formations contain rock fractures or fissures which may lead to pollution of the ground water or areas in which springs exist that are hydraulically connected to a proposed disposal facility, only Class III disposal facilities may be approved.	Non-hazardous IDW generated during implementation of the pilot tests will be contained in 55-gallon drums or other appropriate containers and stored inside/near the Former C&P Packing Building (see Section 8.4.4 1 of the Facility-Wide SAP). The Former C&P Packing Building and surrounding areas represent sufficient acreage for IDW management. The area is not located in a 100-year floodplain. IDW will be stored in appropriate containers to prevent pollution of groundwater, surface water, and public supply systems.

ANALYSIS OF ENVIRONMENTAL REQUIREMENTS, CRITERIA, AND LIMITATIONS (ERCLS)[(a)] FOR ADDENDUM NO. 1 TO TASK F STAGE I - PART 2 PILOT TEST WORK PLAN
Burlington Northern Livingston Shop Complex

Federal or State ERCL Citation	Description	Compliance
Floodplain and Floodway Management Act and Regulations (Applicable)		
	A portion of the site is in a designated floodplain. The following standards are included here to indicate the restrictions on any related activities that might occur in or affect the floodway or floodplain.	The proposed area(s) where the pilot tests will be implemented and locations of the proposed new wells are not located in the floodway or floodplain. Therefore, pilot test activities will not impact a floodway or floodplain.
Section 76-5-401, MCA and ARM 36.15.601	Residential, certain agricultural, industrial-commercial, recreational and other uses are permissible within the designated floodway, provided they do not require structures other than portable structures, fill or permanent storage of materials or equipment. Section 76-5-401, MCA; ARM 36.15.601.	
Section 76-5-402, MCA and ARM 36.15.701	In the flood fringe (i.e., within the floodplain but outside the floodway), residential, commercial, industrial, and other structures may be permitted subject to certain conditions relating to placement of fill, roads, and floodproofing. Section 76-5-402, MCA; ARM 36.15.701.	
ARM 36.15.602(6)	Domestic water supply wells may be permitted, even within the floodway, provided the well casing and well meets certain conditions. ARM 36.15.602(6).	
ARM 36.15.602(5), 36.15.605, and 36.15.703	Solid and hazardous waste disposal and storage of toxic, flammable, hazardous, or explosive materials are prohibited anywhere in floodways or floodplains. ARM 36.15.602(5), 36.15.605, and 36.15.703.	
Section 76-5-402, MCA	The following are prohibited in a floodway: buildings for living purposes or place of assembly or permanent use by human beings; any structure or excavation that will cause water to be diverted from the established floodway, cause erosion, obstruct the natural flow of water, or reduce the carrying capacity of the floodway; and the construction or permanent storage of an object subject to flotation or movement during flood level periods. Section 76-5-402, MCA.	The proposed area(s) where the pilot tests will be implemented and locations of the proposed new wells are not located in the floodway or floodplain. Therefore, pilot test activities will not impact a floodway or floodplain.
Section 76-5-406, MCA and ARM 36.15.216	Section 76-5-406, MCA and ARM 36.15.216 contain substantive factors which address obstruction or use within the floodway or floodplain.	
ARM 36.15.604, ARM 36.15.602(1), and ARM 36.15.603	Further conditions or restrictions that generally apply to specific activities within the floodway or floodplain can be found at ARM 36.15.604 (increase in upstream elevation or significantly increase flood velocities); ARM 36.15.602(1) (excavation of material from pits or pools); ARM 36.15.603 (water diversions or changes in place of diversion).	
ARM 36.15.701(3)(c)	ARM 36.15.701(3)(c) requires that roads, streets, highways and rail lines must be designed to minimize increases in flood heights.	
ARM 36.15.701(3)(d)	Structures and facilities for liquid or solid waste treatment and disposal must be floodproofed to ensure that no pollutants enter flood waters and may be allowed and approved only in accordance with DEQ regulations, which include certain additional prohibitions on such disposal. ARM 36.15.701(3)(d).	
ARM 36.15.702(2)	Standards applied to residential, commercial or industrial structures are found at ARM 36.15.702(2).	
ARM 36.15.606	Flood control works are subject to ARM 36.15.606, which requires compliance with safety standards for levees, floodwalls, and riprap.	
ARM 36.15.901	ARM 36.15.901 requires electrical systems to be flood-proofed.	
	FEDERAL AND STATE ACTION SPECIFIC ERCLS	
Federal Hazardous Waste Management Regulations (Applicable)		
42 U.S.C. §§ 6901 et seq., and Montana Hazardous Waste Act, Sections 75-10-401 et seq., MCA	The Resource Conservation and Recovery Act (RCRA), 42 U.S.C. Sections 6901 et seq., and the Montana Hazardous Waste Act, Sections 75-10-401 et seq., MCA, and regulations under these acts establish a regulatory structure for the generation, transportation, treatment, storage and disposal of hazardous wastes. These requirements are applicable to substances and actions at the site which involve the active management of hazardous wastes. Burlington Northern operated the site and generated waste through 1986-7. Therefore, in certain instances, disposal was not pre-jurisdictional and the hazardous waste requirements are applicable now. However, DEQ does not have the documentation showing the dates of individual discharges, and therefore has, for purposes of this ROD, made a determination to treat all historic waste and media containing waste as pre-jurisdictional (in accord with the NCP and EPA guidance). Therefore, under this ROD, the historic waste which is characteristic or listed becomes hazardous upon excavation (generation).	Pilot test activities are being conducted in the area containing F-listed constituents, IDW generated during the pilot test will be suspected of containing F-listed constituents and will be managed as a hazardous waste unless analytical testing shows otherwise. The types of hazardous IDW expected to be generated are discussed in Section 10.0 of the work plan. Hazardous IDW will be managed in accordance with Section 10.0 of the pilot test work plan and with the Facility-Wide SAP. While DEQ has the authority to waive non-substantive permit requirements for remedial actions conducted entirely at the Facility, that authority does not extend to offsite permitted activities such as transporting and disposing of hazardous waste. Environmental samples containing RCRA-regulated constituents submitted to the analytical laboratory are exempt from RCRA; however, they become subject to RCRA again when they are disposed of by the analytical laboratory. Analytical laboratory will dispose of environmental samples in accordance with state and federal regulations.
Indentification and Listing of Hazardous Waste		
40 CFR 261 ARM 17.54.501-502	Wastes may be designated as hazardous by either of two methods: listing or demonstration of a hazardous characteristic. Listed wastes are the specific types of wastes determined by EPA to be hazardous as identified in 40 CFR Part 261, Subpart D (40 CFR 261.30 - 261.33). Listed wastes are designated hazardous by virtue of their origin or source, and must be managed as hazardous wastes regardless of the concentration of hazardous constituents. Characteristic wastes are those that by virtue of concentrations of hazardous constituents demonstrate the characteristic of ignitability, corrosivity, reactivity or toxicity, as described at 40 CFR Part 261, Subpart C. Certain of the wastes at the site demonstrate the characteristic of toxicity, and are therefore characteristic hazardous wastes upon excavation. The site also contains F001 and F002 which are listed hazardous wastes for chlorinated solvents. The various media and wastes at the site contaminated by the F001 and F002 wastes are also hazardous wastes pursuant to 40 CFR Part 261 upon excavation. The RCRA requirements specified below are applicable requirements for the treatment, storage and disposal of these wastes. See 40 CFR 261.31 (Hazardous Waste Numbers F001 and F002) and ARM 17.54.501. These ERCLs apply to remedial activities; on-going operations must comply with State and federal requirements and permits. EPA has advised EPA Regions and States that conservative, health-based levels derived from direct exposure pathways would clearly be acceptable as "contained-in" levels. [See memorandum from Sylvia K. Lowrance to Jeff Zelikson, Region IX, (January 24, 1989)]. EPA and many States specify conservative, risk-based levels calculated with standard conservative exposure assumptions (usually based on unrestricted access), or site-specific risk assessments. 61 FR at 18795 (April 29, 1996); 63 FR 28556 (May 26, 1998) [Part I of II]. For the BN Livingston Shop Complex, soils treated to below cleanup levels will be allowed to return to the site (from, for example, the electric shop) to an approved location in compliance with RCRA.	Pilot test activities are being conducted in the area containing F-listed constituents, IDW generated during the pilot test will be suspected of containing F-listed constituents and will be managed as a hazardous waste unless analytical testing shows otherwise. Hazardous IDW will be managed in accordance with Section 10.0 of the pilot test work plan and with the Facility-Wide SAP. If offsite disposal is warranted, additional testing of the IDW may be required by the disposal facility and will be performed if necessary.
40 CFR 261 ARM 17.54.501-502 (cont.)	For media which contain hazardous waste, all standards are applicable except for disposal requirements for "contained-out" soils. For all non-media wastes, the standards are applicable. However, no on-site disposal of hazardous waste is allowed under the selected remedy. Therefore, all hazardous wastes, including all media not treated to cleanup levels must be disposed off-site at a regulated subtitle C facility. These standards specifically apply to free product removed from within the solvent plume. For free product removed from outside the solvent plume 40 CFR Part 279 is applicable.	

ANALYSIS OF ENVIRONMENTAL REQUIREMENTS, CRITERIA, AND LIMITATIONS (ERCLS)[(a)] FOR ADDENDUM NO. 1 TO TASK F STAGE I - PART 2 PILOT TEST WORK PLAN
Burlington Northern Livingston Shop Complex

Federal or State ERCL Citation	Description	Compliance
ARM 17.53.111 and 112, MCA	Because of the presence of listed and characteristic hazardous waste, the permit requirements specified in ARM 17.53.112 are applicable. However, DEQ is exempting remedial actions involving hazardous waste from RCRA permit requirements pursuant to 75-10-721(3), MCA (1993) as long as substantive requirements are met. This does not, however, affect the requirement to comply with ARM 17.53.111, Registration and EPA Identification Numbers for Generators and Transporters. Workplans will require detailed information on compliance with all procedural and substantive standards (as well as all ERCLs). Set out below are the hazardous waste requirements that are applicable for the types of waste management units or the waste management practices anticipated in the remedial actions at the site.	BNSF has obtained a hazardous waste identification number for the Livingston railyard (EPA ID No. MTT310010087).
Standards for Transporters of Hazardous Waste		
40 CFR Part 263	The RCRA regulations at 40 CFR Part 263, establish standards that apply to transporters of hazardous waste. These standards include requirements for immediate action for hazardous waste discharges. These standards are applicable for any on-site transportation. These standards are independently applicable (see Other Laws section) for any off-site transportation.	If hazardous waste needs to be transported outside the Facility, the waste will be manifested and a hazardous waste transporter will be used as discussed in Section 8.4.4 of the Facility-Wide SAP.
Standards for Owners and Operators of Hazardous Waste Treatment, Storage, and Disposal Facilities		
40 CFR 264, Subpart B	General Facility Standards The regulations at 40 CFR 264, Subpart B, establish general facility requirements. These standards include requirements for general waste analysis, security and location standards.	Hazardous IDW will be managed in accordance with the Facility-Wide SAP.
40 CFR 264, Subpart F	Releases from Solid Waste Management Units The regulations at 40 CFR 264, Subpart F, establish requirements for groundwater protection for RCRA-regulated solid waste management units (i.e., waste piles, surface impoundments, land treatment units, and landfills). The regulations at Subpart F establish monitoring requirements for RCRA-regulated solid waste management units (i.e., waste piles, surface impoundments, land treatment units, and landfills). Subpart F provides for three general types of groundwater monitoring: detection monitoring (40 CFR 264.98); compliance monitoring (40 CFR 264.99); and corrective action monitoring (40 CFR 264.100). Monitoring wells must be cased according to 264.97(c). Monitoring is required during the active life of a hazardous waste management unit. If hazardous waste remains, monitoring is required for a period necessary to protect human health and the environment.	Hazardous IDW will be managed in accordance with the Facility-Wide SAP.
40 CFR Part 264, Subpart G	Closure and Post-Closure Monitoring and Maintenance of Waste Management or Disposal Facilities 40 CFR Part 264, Subpart G, establishes that hazardous waste management facilities must be closed in such a manner as to (a) minimize the need for further maintenance and (b) control, minimize or eliminate, to the extent necessary to protect public health and the environment, post-closure escape of hazardous wastes, hazardous constituents, leachate, contaminated runoff or hazardous waste decomposition products to the ground or surface waters or to the atmosphere. Requirements for facilities requiring post-closure care include the following: the facilities must undertake appropriate monitoring and maintenance actions, control public access, and control postclosure use of the property to ensure that the integrity of the final cover, liner, or containment system is not disturbed. In addition, all contaminated equipment, structures and soil must be properly disposed of or decontaminated unless exempt and free liquids must be removed or solidified, the wastes stabilized, and the waste management unit covered.	
40 CFR Part 264, Subparts I and J 40 CFR 261.7	Waste Containers and Tanks 40 CFR Part 264, Subparts I and J apply to owners and operators of facilities that store hazardous waste in containers, and store or treat hazardous waste in tanks, respectively. These regulations are applicable to any storage or treatment in these units at the site. The related provisions of 40 CFR 261.7, residues of hazardous waste in empty containers, are also applicable.	Hazardous IDW and IDW suspected to be hazardous generated during implementation of the pilot tests will be stored in drums, tanks, or other appropriate containers and managed as outlined in the Facility-Wide SAP.
40 CFR Part 264, Subpart L	Waste Piles 40 CFR Part 264, Subpart L, applies to owners and operators of facilities that store or treat hazardous waste in piles. The regulations include requirements for the use of run-on and run-off control systems and collection and holding systems to prevent the release of contaminants from waste piles. These regulations are applicable to any storage in waste piles at the site.	IDW generated during implementation of the pilot tests will not be stored in waste piles. IDW (soil, water, non-indigenous) generated during the pilot tests will be stored in drums, tank(s) or other appropriate containers as described in Section 8.4 of the Facility-Wide SAP.
40 CFR 264.554	Staging Piles 40 CFR 264.554 sets forth a new storage unit called the staging pile. A staging pile must be located within the contiguous property under the control of the owner/operator where the wastes to be managed in the staging pile originated. The staging pile must be designed so as to prevent or minimize releases of hazardous wastes and hazardous constituents into the environment, and minimize or adequately control cross-media transfer, as necessary to protect human health and the environment (for example, through the use of liners, covers, run-off/run-on controls, as appropriate). The staging pile must not operate for more than two years and cannot be used for treatment.	IDW generated during implementation of the pilot tests will not be stored in staging piles. IDW (soil, water, non-indigenous) generated during the pilot tests will be stored in drums, tank(s) or other appropriate containers as described in Section 8.4 of the Facility-Wide SAP.
40 CFR Part 268 HWIR Media Rule (63 Fed. Reg. 65874)	RCRA Land Disposal Restrictions Since the wastes to be treated are listed and characteristic wastes, the RCRA Land Disposal Restrictions (LDRs) treatment levels set forth in 40 CFR Part 268 are applicable requirements including the treatment levels for F001 and F002 listed wastes for the disposal of hazardous wastes generated at the site. With the exception of treated soils, hazardous wastes are prohibited from disposal on-site. The HWIR Media Rule, promulgated at 63 Fed. Reg. 65874 (November 30, 1998) allows listed waste treated to levels protective of human health and the environment to be disposed on-site without triggering land ban or minimum technology requirements for these disposal requirements. Treated soils containing hazardous waste will need to meet cleanup levels to avoid triggering land ban or minimum technology requirements for these disposal requirements.	If investigation-derived soil or water is proposed for landspreading, documentation showing that concentrations are below LDR standards will be included in the request for a written contained-in determination as discussed in the Facility-Wide SAP.
40 CFR 268.45	Hazardous debris Since on-site disposal of solid and hazardous wastes is prohibited at the site, any hazardous debris remaining on-site must comply with 40 CFR 268.45 prior to off-site disposal as a solid waste (all off-site disposal must also comply with LDR certification requirements, which apply to these wastes). If the debris does not fully comply with 40 CFR 268.45, it must be disposed off-site at a regulated subtitle C facility.	If hazardous debris is generated during pilot test activities, it will be managed as a hazardous waste along with hazardous IDW as outlined in the Facility-Wide SAP.
40 CFR Part 270	Substantive Permit Requirements 40 CFR Part 270 sets forth the hazardous waste permit program. The substantive requirements set forth in 40 CFR Part 270, Subpart C (permit conditions), including the requirement to properly operate and maintain all facilities and systems of treatment and control are applicable requirements.	The substantive permit requirements that pertain to the management of hazardous waste (including generation, storage, and disposal) are included in the Facility-Wide SAP.
40 CFR Part 279	Used Oil 40 CFR Part 279 sets forth the standards for the management of used oil. For product removed from outside the solvent plume, 40 CFR Part 279 is applicable.	Pilot test activities will not result in the generation of used oil.

APPENDIX A

ANALYSIS OF ENVIRONMENTAL REQUIREMENTS, CRITERIA, AND LIMITATIONS (ERCLS)[a] FOR ADDENDUM NO. 1 TO TASK F STAGE I - PART 2 PILOT TEST WORK PLAN
Burlington Northern Livingston Shop Complex

Federal or State ERCL Citation	Description	Compliance
State Hazardous Waste Management Regulations (Applicable)		
Sections 75-10-401 et seq., MCA	The Montana Hazardous Waste Act, Sections 75-10-401 et seq., MCA, and regulations under this act establishes a regulatory structure for the generation, transportation, treatment, storage and disposal of hazardous wastes. These requirements are applicable to substances and actions at the site which involve listed and characteristic hazardous wastes.	Pilot test activities are being conducted in an area containing F-listed constituents, IDW generated during the pilot tests will be suspected of containing F-listed constituents and will be managed as a hazardous waste unless analytical testing shows otherwise. Hazardous IDW will be managed in accordance with Section 10.0 of the work plan and with the Facility-Wide SAP.
ARM 17.53.501-502	ARM 17.53.501-502 adopts the equivalent of RCRA regulations at 40 CFR Part 261, establishing standards for the identification and listing of hazardous wastes, including standards for recyclable materials and standards for empty containers, with certain State exceptions and additions.	
ARM 17.53.601-604	ARM 17.53.601-604, adopts the equivalent to RCRA regulations at 40 CFR Part 262, establishing standards that apply to generators of hazardous waste, including standards pertaining to the accumulation of hazardous wastes, with certain State exceptions and additions.	
ARM 17.53.701-708	ARM 17.53.701-708, adopts the equivalent to RCRA regulations at 40 CFR Part 263, establishing standards that apply to transporters of hazardous waste, with certain State exceptions and additions.	
ARM 17.53.801-803	ARM 17.53.801-803, adopts the equivalent to RCRA regulations at 40 CFR Part 264, establishing standards that apply to hazardous waste treatment, storage and disposal facilities, with certain State exceptions and additions.	
ARM 17.53.1101-1102	ARM 17.53.1101-1102, adopts the equivalent to RCRA regulations at 40 CFR Part 268, establishing land disposal restrictions, with certain State exceptions and additions.	
Section 75-10-422 MCA	Section 75-10-422 MCA prohibits the unlawful disposal of hazardous wastes.	
ARM 17.53.1101-1102	ARM 17.53.1101-1102, adopts the equivalent to RCRA regulations at 40 CFR Part 270, which establish standards for permitted facilities, with certain State exceptions and additions.	
ARM 17.53.1401	ARM 17.53.1401, adopts the equivalent of RCRA regulations at 40 CFR Part 279 which set forth the standards for the management of used oil.	Pilot test activities will not result in the generation of used oil.
National Emission Standards for Hazardous Air Pollutants (NESHAPs)		
ARM 17.8.341 (Incorporates by reference 40 CFR Part 61)	Asbestos (Well-Suited) The federal Clean Air Act requires the EPA to set emission standards for hazardous air pollutants. 42 U.S.C Section 7412. Implementation and enforcement of these standards in Montana has been delegated to the State. See 40 CFR 61.04(b)(BB). Federal standards for hazardous air pollutants (NESHAPs) at 40 CFR Part 61, are incorporated by reference by ARM 17.8.341. The NESHAPs for asbestos are well-suited to the cinder pile and are discussed in the Asbestos section below; however, the solid waste requirements are the more stringent of the ERCLs that must be complied with with respect to covering of the cinder pile.	Pilot test activities will not result in air emissions of asbestos.
40 CFR 61.145	40 CFR 61.145. (well-suited). Standard for demolition and renovation. This section contains standards for demolition or renovation of a facility. The standards are designed to reduce or eliminate asbestos emissions from such operations, and include provisions for notification regarding intended project, wetting of asbestos materials, use of exhaust systems, careful movement of asbestos materials, and presence on site of a trained asbestos removal person. This section applies to any demolition or renovation of a structure, installation, building, or waste disposal area at the site containing asbestos materials.	
40 CFR 61.151	40 CFR 61.151. (well-suited). Standard for inactive waste disposal sites for asbestos mills and manufacturing and fabricating operations. There must either be no discharge of visible emissions from the site to the outside air, or the specified covering or treatment methods must be followed. Warning signs must be posted and prior notice must be given to EPA or the State before the waste material is excavated or disturbed.	
40 CFR Part 61, Subpart F	Vinyl Chloride (Applicable) 40 CFR Part 61, Subpart F contains the national emission standard for vinyl chloride. 40 CFR 61.64(b) requires concentrations from vinyl chloride in each exhaust gas stream from each stripper not exceed 10 ppm.	Pilot test activities will not result in air emissions of vinyl chloride.
National Pollutant Discharge Elimination System (NPDES) and the Montana Pollutant Discharge Elimination System (MPDES) (Applicable)		
40 CFR Part 122, Subpart C and ARM 17.30.1342 - .1344	40 CFR Part 122, Subpart C and ARM 17.30.1342-1344 set forth the substantive requirements applicable to all MPDES and NPDES permits. Permits must be obtained for all surface and groundwater systems that are part of remedial actions, including proper operation and maintenance of all facilities and systems of treatment and control.	Pilot test activities will not result in any surface water discharge(s).
Technology-Based Treatment (Applicable)		
40 CFR Part 125 and ARM 17.30.1344	40 CFR Part 125 and ARM 17.30.1344 set forth criteria and standards for dischargers. Based on the source, the technology-based treatment standards include the best practicable control technology (BPT), best conventional pollutant control technology (BCT), or Best Available Technology Economically Achievable (BAT).	To ensure state waters are not degraded/polluted, all purge water will be treated to the groundwater cleanup levels presented in the Record of Decision (ROD) (DEQ 2001) and will meet all applicable permit requirements as specified in Petroleum Cleanup General Permit MTG7900013 before discharge to the Yellowstone River.
Underground Injection Control Program (Well-Suited)		
40 CFR 146	The Underground Injection Control Program set forth at 40 CFR 146, sets forth the standards and criteria for the injection of substances into aquifers. Wells are classified as Class I through V, depending on the location and the type of substance injected. For all classes, no owner may construct, operate or maintain an injection well in a manner that results in the contamination of an underground source of drinking water at levels that violate MCLs or otherwise adversely affect the health of persons. Each classification may also contain further specific standards, depending on the classification.	Pilot test activities involve the construction/operation of boreholes for injection of reagents related to environmental remediation, and a groundwater recirculation system(s). These are not subject to underground injection control permitting and are most likely rule-permitted. However, if requested by EPA, information required and any mitigation measures will be provided for discussion.

ANALYSIS OF ENVIRONMENTAL REQUIREMENTS, CRITERIA, AND LIMITATIONS (ERCLS)[(a)] FOR ADDENDUM NO. 1 TO TASK F STAGE I - PART 2 PILOT TEST WORK PLAN
Burlington Northern Livingston Shop Complex

Federal or State ERCL Citation	Description	Compliance
Solid Waste Management Regulation (Applicable and Well-Suited)		
ARM 17.50.505	ARM 17.50.505(2) specifies standards for solid waste management facilities, including the requirements that: 1. Class II landfills must confine solid waste and leachate to the disposal facility. If there is the potential for leachate migration, it must be demonstrated that leachate will only migrate to underlying formations which have no hydraulic continuity with any state waters; 2. adequate separation of group II wastes from underlying or adjacent water must be provided; and 3. no new disposal units or lateral expansions may be located in wetlands. ARM 17.50.505 also specifies general soil and hydrogeological requirements pertaining to the location of any solid waste management facility.	Pilot test activities do not involve siting, construction, operation/maintenance, and closure of a solid waste management facility.
ARM 17.50.511	ARM 17.50.511 sets forth general operational and maintenance and design requirements for solid waste facilities using landfilling methods. Specific operational requirements, specified in ARM 17.14.511 are run-on and run-off control systems requirements, requirements that sites be fenced to prevent unauthorized access, and prohibitions of point source and nonpoint source discharges which would violate Clean Water Act requirements.	
ARM 17.50.530	ARM 17.50.530 sets forth the closure requirements for landfills. Class II landfills must meet the following criteria: 1. install a final cover that is designed to minimize infiltration and erosion. 2. design and construct the final cover system to minimize infiltration through the closed unit by the use of an infiltration layer that contains a minimum 18 inches of earthen material and has a permeability less than or equal to the permeability of any bottom liner, barrier layer, or natural subsoils or a permeability no greater than 1 X 10-5 cm/sec, whichever is less; 3. minimize erosion of the final cover by the use of a seed bed layer that contains a minimum of six inches of earthen material that is capable of sustaining native plant growth and protecting the infiltration layer from frost effects and rooting damage; 4. revegetate the final cover with native plant growth within one year of placement of the final cover.[5]	
ARM 17.50.531	ARM 17.50.531 sets forth post closure care requirements for Class II landfills. Post closure care must be conducted for a period sufficient to protect human health and the environment. Post closure care requires maintenance of the integrity and effectiveness of any final cover, including making repairs to the cover as necessary to correct the effects of settlement, subsidence, erosion, or other events, and preventing run-on and run-off from eroding or otherwise damaging the cover and comply with the groundwater monitoring requirements found at ARM Title 17, chapter 14, subchapter 7.	
Transportation of Solid Waste (Applicable)		
Section 75-10-212 ARM 17.50.523	For solid wastes, Section 75-10-212 prohibits dumping or leaving any debris or refuse upon or within 200 yards of any highway, road, street, or alley of the State or other public property, or on privately owned property where hunting, fishing, or other recreation is permitted. ARM 17.50.523 requires that such waste must be transported in such a manner as to prevent its discharge, dumping, spilling, or leaking from the transport vehicle.	Non-hazardous IDW [including non-indigenous waste (i.e., PPE) and IDW determined through analytical testing to be non-hazardous] generated during implementation of the pilot tests will be contained in 55-gallon drums or other appropriate containers and temporarily stored in a centralized storage area pending characterization and final disposition. If investigation-derived soil and water cannot landspread at the Livingston railyard, it will be disposed offsite along with other non-hazardous IDW as discussed in the Facility-Wide SAP. Any other solid waste generated (i.e., tape removed from boxes, plastic bags and/or boxes containing supplies that are not reused, etc.) will be contained in a plastic garbage bag (if necessary) and placed in a garbage can for collection and appropriate disposal as solid waste. Solid waste generated during implementation of pilot test will be transported in a manner to prevent discharge, dumping, spilling, and leaking.
Underground Storage Tank (USTs) Regulations (Applicable)		
	These standards are applicable. To the extent certain UST systems were removed prior to the effective date of the regulations, diesel is found separate and distinct from an UST system, or UST regulations are not applicable, the UST requirements remain well-suited since they address situations or problems sufficiently similar to those at the site.	Pilot test activities do not involve USTs.
40 CFR Part 280, Subpart F	40 CFR Part 280, Subpart F sets forth requirements for Release Response and Corrective Action for UST Systems Containing Petroleum or Hazardous Substances. These include initial response, initial abatement measures, site characterization, free product removal, and investigations for soil and groundwater cleanup.	
40 CFR 280.64	40 CFR 280.64 provides that where investigations in connection with leaking underground storage tanks reveal the presence of free product, owners and operators must remove free product to the maximum extent practicable as determined by the implementing agency. This regulation also requires that the free product removal be conducted in a manner that minimizes the spread of contamination into previously uncontaminated zones by using recovery and disposal techniques appropriate to the hydrogeologic conditions at the site, and that properly treats, discharges or disposes of recovery byproducts in compliance with applicable local, State and Federal regulations. 40 CFR 280.64 provides that abatement of free product migration is a minimum objective for the design of the free product removal system provides that any flammable products must be handled in a safe and competent manner to prevent fires or explosions.	
40 CFR Part 280, Subpart D	40 CFR Part 280, Subpart D sets forth requirements for release detection.	
40 CFR 280.43	40 CFR 280.43 (well-suited) specifies groundwater monitoring requirements for underground storage tanks and requires continuous monitoring devices or manual methods used to detect the presence of at least 1/8 of an inch of free product on top of the groundwater in the monitoring wells.	
Title 17, Chapter 56, Sub-Chapter 4	The Montana regulations regarding underground storage tanks include similar requirements. Title 17, Chapter 56, Sub-Chapter 4 specifies release detection.	
ARM 17.56.407	ARM 17.56.407 specifies groundwater monitoring requirements for underground storage tanks and requires continuous monitoring devices or manual methods used to detect the presence of at least 1/8 of an inch of free product on top of the groundwater in the monitoring wells.	
Title 17, Chapter 56, Sub-Chapter 6	Title 17, Chapter 56, Sub-Chapter 6 specifies release response and corrective action for tanks containing petroleum or hazardous substances.	
ARM 17.56.602 - 605	ARM 17.56.602 through 605 requires certain mitigation measures including removal of as much of the regulated substance from the system as is necessary to prevent further release into the environment and prevention of further migration of the released substance into surrounding soil and groundwater.	

APPENDIX A

ANALYSIS OF ENVIRONMENTAL REQUIREMENTS, CRITERIA, AND LIMITATIONS (ERCLS)[(a)] FOR ADDENDUM NO. 1 TO TASK F STAGE I - PART 2 PILOT TEST WORK PLAN
Burlington Northern Livingston Shop Complex

Federal or State ERCL Citation	Description	Compliance
Asbestos Regulation in Building Construction and Demolition (Well-Suited)		
Sections 50-64-101, et seq., MCA 50-64-104, MCA	Sections 50-64-101 et seq., MCA, regulate construction and demolition of structures that contain asbestos. Section 50-64-104, MCA. provides for various safeguards to prevent release of asbestos into the air. The prescribed safeguards include notification of the local fire department, posting of warning signs, wetting of surfaces, dust emission control, covering and wetting during transport, and deposition at a landfill where materials are unlikely to be disturbed and where signs warn that asbestos-containing material is buried in the landfill. The listed safeguards are well-suited to the covering of the cinder pile.	Pilot test activities do not involve construction or demolition of any asbestos-containing structures.
Well Drilling (Applicable)		
Section 85-2-505, MCA	Section 85-2-505, MCA, precludes the wasting of groundwater. Any well producing waters that contaminate other waters must be plugged or capped, and wells must be constructed and maintained so as to prevent waste, contamination, or pollution of groundwater.	Pilot test activities involve the installation of wells. Wells will be constructed and maintained so as to prevent waste, contamination, or pollution of groundwater. Wells will be constructed and sampled in accordance with Standard Operating Guidelines (SOGs) presented in Appendix A of the Facility-Wide SAP. Drillers will be required to file a well log report within 60 days after completion of the well. The statute now requires that the well logs be filed with the Montana Bureau of Mines and Geology, which will be done.
Section 85-2-516, MCA	Section 85-2-516, MCA states that within 60 days after any well is completed a well log report must be filed by the driller with the Montana Department of Natural Resources and Conservation and the appropriate county clerk and recorder.	
ARM 17.30.641	ARM 17.30.641 provides standards for sampling and analysis of water to determine quality.	
ARM 17.30.646	ARM 17.30.646 requires that bioassay tolerance concentrations be determined in a specified manner.	
ARM 36.21.670-678 and 810	ARM 36.21.670-678 and 810 specifies certain requirements that must be fulfilled when abandoning monitoring wells.	If wells are to be abandoned following completion of the pilot tests, they will be abandoned in accordance with SOG-20 (presented in Appendix A of the Facility-Wide SAP), which complies with these regulations.
Reclamation Requirements (Well-Suited)		
	Certain portions of the Montana Strip and Underground Mining Reclamation Act and Montana Metal Mining Act are well-suited requirements for certain revegetation and construction activities at the site.	Pilot test activities do not involve any major land disturbances, which trigger these requirements.
Section 82-4-231, MCA	Section 82-4-231, MCA: Requires operators to reclaim and revegetate affected lands using most modern technology available.	
Section 82-4-233, MCA	Section 82-4-233, MCA: Operators must plant vegetation that will yield a diverse, effective, and permanent vegetative cover of the same seasonal variety native to the area and capable of self-regeneration.	
Section 82-4-336, MCA	Section 82-4-336, MCA: Disturbed areas must be reclaimed to utility and stability comparable to areas adjacent.	
ARM 17.24.501	ARM 17.24.501: Provides general backfilling and grading requirements.	
ARM 17.24.519	ARM 17.24.519: Pertinent areas where excavation will occur will be regraded to minimize settlement.	
ARM 17.24.631	ARM 17.24.631: Disturbances to the prevailing hydrologic balance will be minimized. Changes in water quality and quantity, in the depth to groundwater and in the location of surface water drainage channels will be minimized, to the extent consistent with the selected response alternatives. Other pollution minimization devices must be used if appropriate, including stabilizing disturbed areas through land shaping, diverting runoff, planting quickly germinating and growing stands of temporary vegetation, mulching, and control of toxic-forming waste materials.	
ARM 17.24.633	ARM 17.24.633: Surface drainage from a disturbed area must be treated by the best technology currently available (BTCA). Treatment must continue until the area is stabilized.	
ARM 17.24.634	ARM 17.24.634: Disturbed drainages will be restored to the approximate pre-disturbance configuration, to the extent consistent with the selected response alternatives.	
ARM 17.24.638	ARM 17.24.638: Sediment control measures must be implemented during operations.	
ARM 17.24.639	ARM 17.24.639: Sets forth requirements for construction and maintenance of sedimentation ponds.	
ARM 17.24.640	ARM 17.24.640: Discharges from sedimentation ponds, permanent and temporary impoundments, must be controlled to reduce erosion and enlargement of stream channels, and to minimize disturbance of the hydrologic balance.	
ARM 17.24.643 - 646	ARM 17.24.643 through 17.24.646: Provisions for groundwater protection, groundwater recharge protection, and groundwater and surface water monitoring.	
ARM 17.24.701 and 702	ARM 17.24.701 and 702: Requirements for redistributing and stockpiling of soil for reclamation. Also outline practices to prevent compaction, slippage, erosion, and deterioration of biological properties of soil will be employed.	
ARM 17.24.711	ARM 17.24.711: Requires that a diverse, effective and permanent vegetative cover of the same seasonal variety and utility as the vegetation native to the area of land to be affected must be established. This provision would not be well-suited in certain instances, for example, where there is dedicated development.	
ARM 17.24.713	ARM 17.24.713: Seeding and planting of disturbed areas must be conducted during the first appropriate period for favorable planting after final seedbed.	
ARM 17.24.714	ARM 17.24.714: Mulch or cover crop or both must be used until adequate permanent cover can be established.	
ARM 17.24.716	ARM 17.24.716: Establishes method of revegetation.	
ARM 17.24.718	ARM 17.24.718: Requires soil amendments, irrigation, management, fencing, or other measures, if necessary to establish a diverse and permanent vegetative cover.	
ARM 17.24.723	ARM 17.24.723: States that operators shall conduct approved periodic measurements of vegetation, soils, and water.	
ARM 17.24.724	ARM 17.24.724: Specifies that revegetation success must be measured by approved unmined reference areas. Required management for these reference areas is set forth.	
ARM 17.24.726	ARM 17.24.726: Sets the required methods for measuring productivity.	
ARM 17.24.728	ARM 17.24.728: Sets requirements for measurements of the composition of vegetation on reclaimed areas.	
ARM 17.24.761	ARM 17.24.761: This specifies fugitive dust control measures which will be employed during excavation and construction activities to minimize the emission of fugitive dust.	

ANALYSIS OF ENVIRONMENTAL REQUIREMENTS, CRITERIA, AND LIMITATIONS (ERCLS)[(a)] FOR ADDENDUM NO. 1 TO TASK F STAGE I - PART 2 PILOT TEST WORK PLAN

Burlington Northern Livingston Shop Complex

Federal or State ERCL Citation	Description	Compliance
Noxious Weeds (Applicable)		
ARM 4.5.201 through .204 Section 7-22-2109(2)(b) Section 7-22-2152 Section 7-22-2101(7)(a), MCA	§ 7-22-2101(7)(a), MCA defines "noxious weeds" as any exotic plant species established or that may be introduced in the state which may render land unfit for agriculture, forestry, livestock, wildlife, or other beneficial uses or that may harm native plant communities and that is designated: (i) as a statewide noxious weed by rule of the department; or (ii) as a district noxious weed by a board, following public notice of intent and a public hearing. Designated noxious weeds are listed in ARM 4.5.201 through 4.5.204 and must be managed consistent with weed management criteria developed under MCA § 7-22-2109(2)(b). Notification and plan must occur as set forth in § 7-22-2152, MCA, as amended.	Pilot test activities do not involve the introduction or planting of plants, nor will significant land disturbance occur which would trigger these requirements.
	OTHER LAWS	
	These laws are laws which are independently applicable rather than ERCLs for the site.	
Section 85-2-101, MCA	Surface Water and Groundwater Act Section 85-2-101, MCA, declares that all waters within the state are the state's property, and may be appropriated for beneficial uses. The wise use of water resources is encouraged for the maximum benefit to the people and with minimum degradation of natural aquatic ecosystems.	Pilot test activities will not require any surface water or groundwater to be appropriated.
Parts 3 and 4 of Title 85, Chapter 2, MCA	Groundwater and Surface Water Appropriation Parts 3 and 4 of Title 85, Chapter 2, MCA, set out requirements for obtaining water rights and appropriating and utilizing water. All requirements of these parts are laws which must be complied with in any action using or affecting waters of the state.	Pilot test activities will not require any water rights to be obtained.
Section 85-2-507, MCA Section 85-2-506, MCA	Controlled Ground Water Area Pursuant to Section 85-2-507 MCA, the Department of Natural Resources and Conservation may grant either a permanent or a temporary controlled ground water area. The maximum allowable time for a temporary area is four years.[6] Pursuant to 85-2-506 MCA, designation of a controlled groundwater area may be proposed if (a) that ground water withdrawals are in excess of recharge to the aquifer or aquifers within the ground water area; (b) that excessive ground water withdrawals are very likely to occur in the near future because of consistent and significant increases in withdrawals from within the ground water area; (c) that significant disputes regarding priority of rights, amounts of ground water in use by appropriators, or priority of type of use are in progress within the ground water area; (d) that ground water levels or pressures in the area in question are declining or have declined excessively; (e) that excessive ground water withdrawals would cause contaminant migration; (f) that ground water withdrawals adversely affecting ground water quality within the ground water area are occurring or are likely to occur; or (g) that water quality within the ground water area is not suited for a specific beneficial use defined by 85-2-102(2)(a).	Pilot test activities will not require a controlled groundwater area.
29 CFR Part 1910	Occupational Safety and Health Act The federal Occupational Safety and Health Act regulations found at 29 CFR 1910 are applicable to worker protection during conduct of RI/FS or remedial activities.	Field activities associated with the pilot tests will be conducted in accordance with the *Facility-Wide Health and Safety Plan* (HASP) and the task-specific HASP addenda.
ARM 17.74.101 ARM 17.74.102	Montana Occupational Health Act ARM Section 17.74.101, along with the similar federal standard in 29 CFR 1910.95, addresses occupational noise. ARM Section 17.74.102, along with the similar federal standard in 29 CFR 1910.1000 addresses occupational air contaminants.	
Sections 50-71-201, 202, and 203, MCA	Montana Safety Act Sections 50-71-201, 202 and 203, MCA, state that every employer must provide and maintain a safe place of employment, provide and require use of safety devices and safeguards, and ensure that operations and processes are reasonably adequate to render the place of employment safe.	Kennedy/Jenks Consultants has a comprehensive Injury and Illness Prevention Program designed to help ensure the health and safety of its employees and provide a safe and healthful work environment. In addition, Kennedy/Jenks Consultants has a Corporate Health and Safety Program and Hazardous Communication Program.
Section 50-78-201, 202, and 204, MCA	Employee and Community Hazardous Chemical Information Act Sections 50-78-201, 202, and 204, MCA, state that each employer must post notice of employee rights, maintain at the work place a list of chemical names of each chemical in the work place, and indicate the work area where the chemical is stored or used. Employees must be informed of the chemicals at the work place and trained in the proper handling of the chemicals.	
40 CFR Part 262 and ARM 17.53.601-604	Standards for Generators of Hazardous Waste The RCRA regulations at 40 CFR Part 262 and ARM 17.53.601-604 establish standards that apply to generators of hazardous waste. These standards include requirements for obtaining an EPA identification number and maintaining certain records and filing certain reports. These standards are applicable for any waste which will transported off-site.	Hazardous IDW generated during implementation of the pilot tests will be managed in accordance with Section 8.4 of the Facility-Wide SAP and will comply with these regulations.
40 CFR Part 263 and ARM 17.53.701-708	Standards for Transporters of Hazardous Waste The RCRA regulations at 40 CFR Part 263 and ARM 17.53.701-708 establish standards that apply to transporters of hazardous waste. These standards include requirements for immediate action for hazardous waste discharges. These standards are applicable for any off-site transportation.	
40 CFR 268 and ARM 17.53.1101-1102	RCRA Land Disposal Restrictions Since the wastes to be treated are listed and characteristic wastes, the RCRA Land Disposal Restrictions (LDRs) treatment levels set forth in 40 CFR Part 268 and ARM 17.53.1101-1102 are applicable requirements including the treatment levels for F001 and F002 listed wastes for the disposal of hazardous wastes generated at the site.	
49 CFR Chapter I, Subchapters B and C and ARM 23.5.101	Oil Transportation 49 CFR Chapter I, Subchapter B (Oil Transportation) and Subchapter C (Hazardous Materials) and ARM. 23.5.101 apply to transporters of oil and hazardous materials. These standards are applicable for any off-site transportation of oil meeting the quantity requirements set forth in Subchapter B or for the transportation of hazardous materials such as the transportation of asbestos-containing waste material.	Pilot test activities do not involve the use of oil and will not generate used oil.

ANALYSIS OF ENVIRONMENTAL REQUIREMENTS, CRITERIA, AND LIMITATIONS (ERCLS)[(a)] FOR ADDENDUM NO. 1 TO TASK F STAGE I - PART 2 PILOT TEST WORK PLAN
Burlington Northern Livingston Shop Complex

Federal or State ERCL Citation	Description	Compliance
Sections 75-2-501 et seq., M	Montana Asbestos Control Act The Montana Asbestos Control Act, Sections 75-2-501 et seq., MCA, and implementing rules establish standards and procedures for accreditation of asbestos-related occupations and control of the work performed by persons in asbestos-related occupations.	Pilot test activities do not involve asbestos work.
Sections 75-2-502(4) and -511, MCA, and ARM 17.74.302(3)	A permit from DEQ is required before any person can conduct an asbestos project. The definition of "asbestos project" includes the encapsulation, enclosure, removal, transportation, or disposal of asbestos-containing waste. Section 75-2-502(4), MCA; ARM 17.74.302(3). In addition, a person who inspects, plans, designs, supervises, contracts for or works on an asbestos project must meet DEQ training and accreditation requirements. See also Section 75-2-511, MCA.	
ARM 17.74.314	ARM 17.74.314 states that no person may engage in an asbestos-type occupation unless accredited in that occupation or may employ or subcontract with nonaccredited individuals or contractors. No person may conduct an asbestos abatement project without a permit.	
ARM 17.74.335 29 CFR 1926.58 40 CFR 763.120-121 40 CFR Part 61, Subpart M	ARM 17.74.335 states that asbestos abatement projects require a DEQ permit. The permit conditions include but are not limited to: a. a requirement that all work performed be in accordance with 29 CFR 1926.58 (asbestos standards for the construction industry); and 40 CFR 763.120, 121 (requirements for asbestos abatement projects); b. a requirement that all asbestos be properly disposed in an approved asbestos disposal facility. "Approved asbestos disposal facility" is defined at ARM 17.54.302(1) as a properly operated and licensed class II landfill as described in ARM 17.50.504; c. a requirement that asbestos be disposed in accordance with 40 CFR Part 61, Subpart M. (National Emission Standard for Asbestos). See discussion above on National Emission Standard for Asbestos.	
ARM 17.74.338	ARM 17.74.338 requires an accredited asbestos abatement supervisor be physically present at all times at the work-site where a permitted asbestos abatement project is being performed and must be accessible to all workers. On-site air monitoring must be conducted by an accredited asbestos contractor/supervisor, an engineer or industrial hygienist.	
ARM 17.74.341	ARM 17.74.341 requires records of each asbestos abatement project be retained for a minimum of 30 years and must be made available to DEQ at any reasonable time. This section provides a noninclusive list of the records to be retained.	
40 CFR Part 92	Locomotive Emissions 40 CFR Part 92 establishes control of air pollution from locomotives and locomotive engines.	Pilot test activities do not involve the use of locomotives.

Notes:

(a) These ERCLs were developed by the Montana Department of Environmental Quality and were included in Appendix A of the *Record of Decision* (ROD) (DEQ 2001).
ERCLs pertinent to *Task F Stage I - Part 2 Pilot Test Work Plan for VOC-Containing Alluvial Aquifer Groundwater* are shaded in yellow. DEQ required compliance language is underlined.

[1] *Montana Maximum Contaminant Levels:*
Pursuant to the Public Water Safety Act, 75-6-101 et. seq., MCA and ARM 17.38.204, the MCLs specified in 40 CFR Part 141 (Primary Drinking Water Standards) are incorporated.

[2] *Montana Department of Environmental Quality, Planning, Prevention and Assistance Division, Circular WQB-7, Montana Numeric Water Quality Standards (September, 1999).*

[3] *For vinyl chloride, the WQB-7 standard was 0.15 ug/l; the MCL is 2 ug/l.*

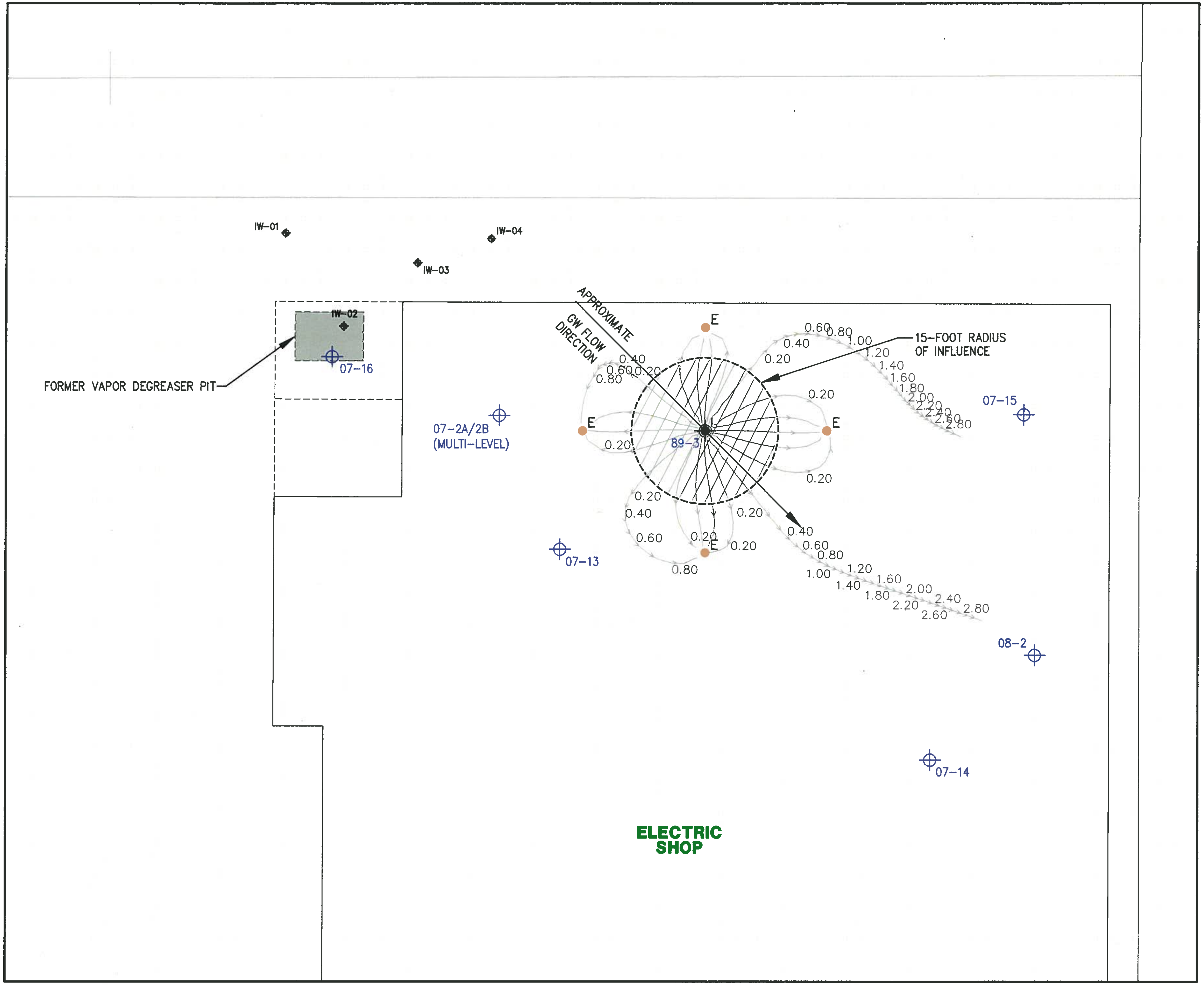
[4] *Each of the ambient air quality standards includes in its terms specific requirements and methodologies for monitoring and determining levels. Such requirements are also applicable requirements. In addition, ARM 17.8.204 and 17.8.206, Ambient Air Monitoring; Methods and Data, respectively (Applicable), require that all ambient air monitoring, sampling and data collection, recording, analysis and transmittal shall be in compliance with the Montana Quality Assurance Manual except when more stringent requirements are determined by DEQ to be necessary.*

[5] *ARM 17.50.530(1)(b) allows the department to approve an alternative final cover design if it achieves the reduction in infiltration and protection from erosion to a level at least as equivalent as the stated criteria.*

[6] *If a temporary controlled ground water area is granted, the statute requires DNRC to commence studies to determine the designation or modification of a permanent controlled ground water area.*

Appendix B

Modeling - Supporting Information



LEGEND

IW-01 — 2008 PERMANGANATE INJECTION BORING
89-3 — EXISTING MONITORING WELL LOCATION
I — PROPOSED INJECTION WELL
E — PROPOSED EXTRACTION WELL
MODELED GROUNDWATER FLOW PATH AND DIRECTION
1.60 — GROUNDWATER FLOW TIME (DAYS)

NOTE:
1) ALL LOCATIONS ARE APPROXIMATE

N

0 10 20
APPROXIMATE SCALE IN FEET

BASEMAP SOURCE:
HORIZONS, INC. RAPID CITY, SD (1989)

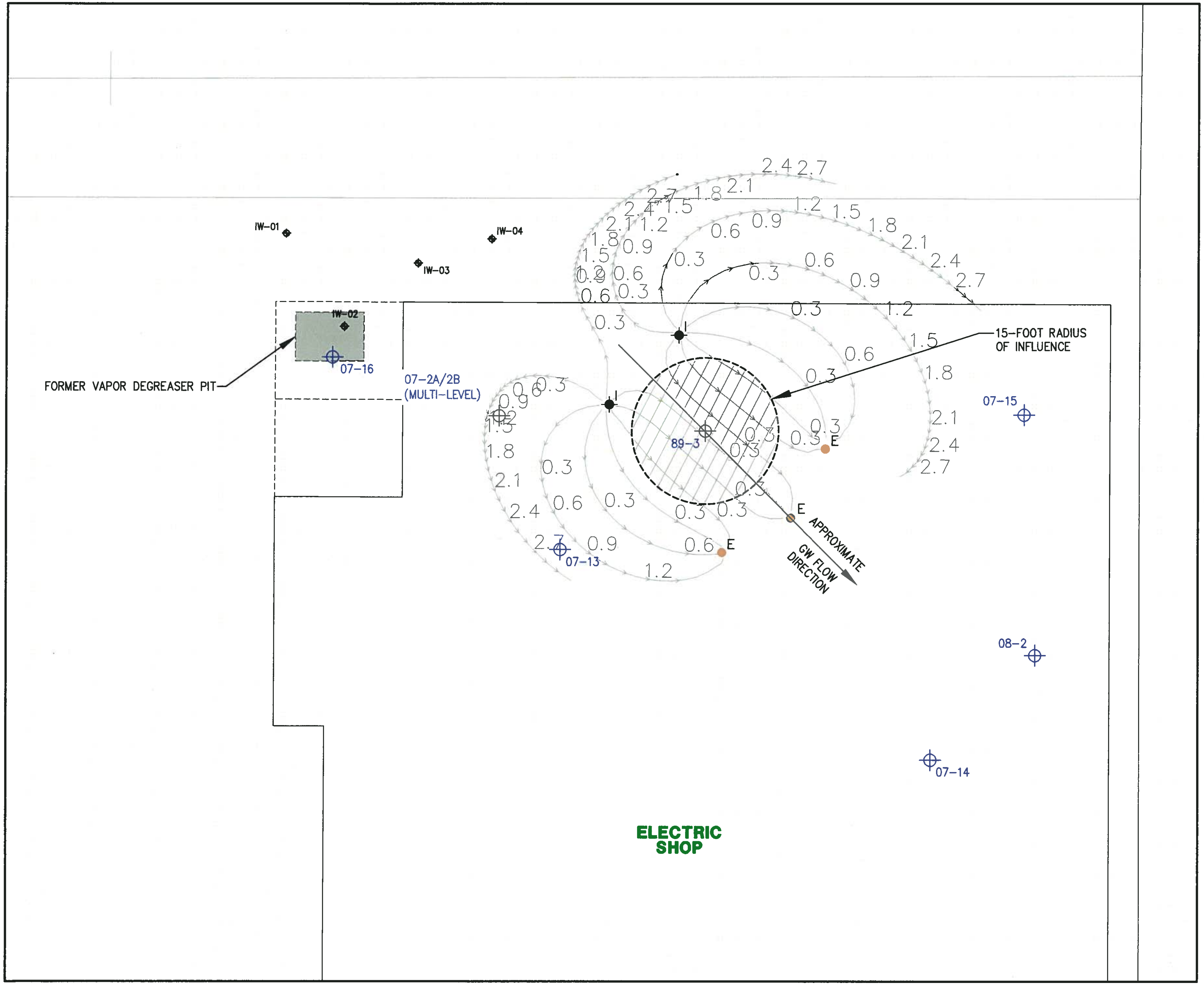
Kennedy/Jenks Consultants

BURLINGTON NORTHERN LIVINGSTON SHOP COMPLEX – LIVINGSTON, MT

RECIRCULATION (SCENARIO #1 - 5-SPOT)

0996021.16/Task F/PIWP/P09SK00B1r1

11/09 (Revision No. 1) **FIGURE B-1**

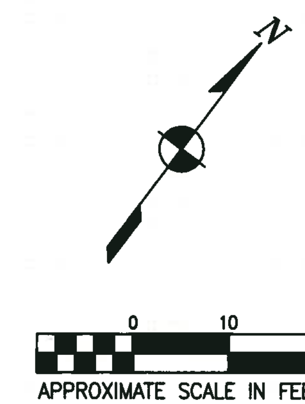


LEGEND

IW-01	2008 PERMANGANATE INJECTION BORING
89-3	EXISTING MONITORING WELL LOCATION
I	PROPOSED INJECTION WELL
E	PROPOSED EXTRACTION WELL
	MODELED GROUNDWATER FLOW PATH AND DIRECTION
1.60	GROUNDWATER FLOW TIME (DAYS)

NOTE:

1) ALL LOCATIONS ARE APPROXIMATE



BASEMAP SOURCE:
HORIZONS, INC. RAPID CITY, SD (1989)

Kennedy/Jenks Consultants

BURLINGTON NORTHERN LIVINGSTON SHOP COMPLEX – LIVINGSTON, MT

RECIRCULATION (SCENARIO #2 - LINE-DRIVE)

0996021.16/Task F/PIWP/P09SK00B2r1

11/09 (Revision No. 1) **FIGURE B-2**