REMEDIAL ACTION WORK PLAN

Bentley Mall
Fairbanks, Alaska

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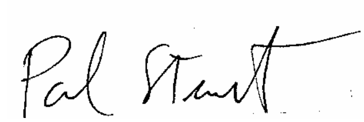

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1.0 INTRODUCTION

Alaska Resources and Environmental Services, LLC (ARES) prepared this work plan for the Bentley Mall located at 32 College Road in Fairbanks, Alaska (**Figure 1**, *subject site*). The work plan was prepared pursuant to a request from the Alaska Department of Environmental Conservation (ADEC) by letter dated May 3, 2006, *"Approval of Site Characterization and Corrective Action Reports, Bentley Mall East Satellite Building, Fairbanks, Alaska."* In the referenced letter, ADEC requested a work plan to implement the remedial alternative action selected in a recent corrective action plan prepared by ARES, *"Corrective Action Plan, Bentley Mall, Fairbanks, Alaska,"* dated January 2006.

The work plan proposes the implementation of remedial alternative No. 2, one of three (3) alternatives evaluated in the corrective action plan (ADEC, January 2006). The remedial alternative selected for the *subject site* consists of the installation and operation of a combined ozone sparging and vapor extraction system. The area targeted for remediation encompasses the south portion of the Bentley Mall where recent subsurface investigations identified concentrations of tetrachloroethene (PCE) and trichloroethene (TCE) in soil and groundwater near the East Satellite and Wells Fargo Buildings. A former dry cleaning establishment at the East Satellite Building was identified as a potential source of the halogenated volatile organic compounds (VOCs). Groundwater investigations since 2003 have outlined a plume of groundwater with PCE and TCE that extends from the East Satellite Building towards the west and off-site for more than one-thousand-and-five-hundred (1,500) feet down-gradient from the *subject site*. The identified contaminant plume lies within a mixed residential and commercial use area.

This work plan contains applicable elements of 18 AAC 75.360 cleanup operations requirements and is being submitted to ADEC for review.

2.0 BACKGROUND

A plan view of the Bentley Mall and vicinity is presented in **Figure 2**. The Bentley Mall includes the main mall building along the north side, and several satellite buildings along the south side of the property. A summary of the site history and background is presented in ARES (April 2006; January 2006; October 2005).

Since 2003, ARES has completed environmental investigations at the Bentley Mall:

- *Soil and Groundwater Sampling (March 2003)*: In March 2003, ARES collected soil samples from two (2) exploratory borings, and groundwater samples from eight (8) temporary wells installed in borings and three (3) groundwater monitoring wells. The investigation identified PCE and TCE in soil and groundwater samples collected near the satellite buildings in the south portion of the *subject site*. ARES reported up to 2,910 micrograms per liter (µg/L) of PCE and 97.5 µg/L of TCE in groundwater samples, above the ADEC (May 26, 2004) cleanup level of 5.0 µg/L for both PCE and TCE. Analytical results of two (2) soil samples taken at five (5) feet below ground surface (feet bgs) near the East Satellite Building indicated 0.242 and 0.292 milligrams per kilogram (mg/kg) of PCE, respectively, above the ADEC (May 26, 2004) cleanup level of 0.03 mg/kg. The investigation results were presented in a report by ARES dated March 2003. The soil and groundwater sampling locations are presented in **Figure 3**.

- *Soil-Gas Survey (August 2003)*: In August 2003, Beacon Environmental Services, Inc. (Beacon) of Bel Air, Maryland completed for ARES a soil-gas survey utilizing EMFLUX® passive soil-gas collectors. A utilities survey by ARES indicated the East Satellite Building is serviced by a wastewater line that extends from the building west along the north side of College Road and continues for approximately nine-hundred (900) feet where it discharges into the municipal sanitary sewer. The wastewater line is shown in **Figure 2**. The soil-gas survey identified PCE and TCE impacted soil below the East Satellite Building and near the wastewater line adjacent to College Road. ARES concluded that the historical dry cleaning operation at the East Satellite Building appeared to be a source of halogenated VOCs to the subsurface on the Bentley Mall property, and that the wastewater line leading from the East Satellite Building appears to have acted as a preferential pathway and/or secondary source. The soil-gas and utilities surveys were presented in a report by ARES dated November 2003.

- *Additional Soil-Gas Survey (June 2004):* In June 2004, additional soil-gas samples via EMFLUX® passive soil-gas collectors were taken by Beacon for ARES. The June 2004 and August 2003 soil-gas survey results were presented in a technical report by Beacon dated September 8, 2004 and included in a site characterization report by ARES dated April 2006. The soil-gas survey identified areas of elevated PCE and TCE concentrations in the vicinity of the East Satellite and Well Fargo Buildings, and spatially associated with the wastewater line on the north side of College Road.

- *Soil Sampling (November 2004):* In November 2004, soil samples were collected at five (5), ten (10) and fifteen (15) feet bgs from six (6) borings (BM-1 to BM-6) drilled in the south portion of the *subject site*. PCE concentrations up to 0.590 mg/kg, above the ADEC (May 26, 2004) soil cleanup level of 0.03 mg/kg, were reported in soil samples from five (5) to ten (10) feet bgs. The soil sampling results were presented in a report by ARES dated November 2004. Soil sampling locations are presented in **Figure 3**.

- *Groundwater Sampling (December 2004 – January 2005):* A groundwater investigation was conducted in December 2004 and January 2005 (ARES, February 2005). Sixty-six (66) grab groundwater samples were collected on-site and off-site from soil borings along transects perpendicular to the groundwater plume axis. Maximum concentrations of PCE (4,600 µg/L) and TCE (210 µg/L) were reported in those groundwater samples collected near the East Satellite Building. PCE and TCE concentrations in groundwater were reported at the top of the saturated zone in the fifteen (15) to twenty-five (25) feet depth interval. Vertical profiling indicated PCE and TCE concentrations in groundwater attenuated with depth in the saturated zone (ARES, April 2006). On-site groundwater sampling locations are shown in **Figure 3**.

- *Indoor-Air Sampling (March – May 2005):* Indoor air samples were collected in March 2005 from satellite buildings in south portion of the Bentley Mall (ARES, October 2005; April 2006). PCE and TCE concentrations in indoor air samples from the East Satellite and Wells Fargo Buildings were reported above indoor air target levels. Maximum concentrations were 290 micrograms per cubic meter (µg/m^3) of PCE and 6.8 µg/m^3 of TCE. The regulatory target levels for indoor air are 8.1 µg/m^3 for PCE and 0.22 µg/m^3 for TCE, as shown in Table 2b of the Environmental Protection Agency (November 29, 2002) guidance. To mitigate indoor air concerns, the HVAC systems in the buildings were adjusted to maintain a positive pressure inside the buildings. A subsequent round of indoor air samples collected in May 2005 indicated PCE and TCE concentrations had decreased to 15 µg/m^3 and 1.4 µg/m^3, respectfully (ARES, October 2005; April 2006).

- *Groundwater Monitoring (September to October 2005):* In September – October 2005, ARES installed, developed and sampled thirteen (13) groundwater monitoring wells including four (4) on-site (MW-1 to MW-4) and nine (9) off-site (MW-5 to MW-13). The wells were installed for purposes of monitoring the groundwater plume. The on-site groundwater monitoring well locations are shown in **Figure 3**.

  Groundwater monitoring results to date indicate groundwater flow direction is west with a gradient of approximately 0.0019 horizontal feet/vertical feet. The groundwater surface or water table was reported at approximately seventeen (17) feet bgs. The groundwater investigations to date have outlined a plume of groundwater impacted by PCE and TCE; the head or source area of the plume is inferred near the East Satellite Building. The plume extends west of the East Satellite Building below College Road and Tax Lot 221 (former Fred Moyers), and continues beyond Noyes Slough into the Charles Slater

Homestead Subdivision. The plume is at least five-hundred-and-twenty (520) feet wide and extends two-thousand (2,000) feet downgradient from the Bentley Mall property. The groundwater investigation results including a conceptual plume model were presented in a report by ARES dated April 2006.

- *Corrective Action Plan (January 2006):* Three (3) remedial alternatives for the Bentley Mall were evaluated and presented in a corrective action plan dated January 2006. The selected remedial alternative, ozone sparging and vapor extraction, received conditional approval for implementation by ADEC via a letter dated May 3, 2006.

3.0 CONCEPTUAL PLAN

This work plan is for the implementation of the remedial alternative selected in the corrective action plan: ozone sparging and vapor extraction (ARES, January 2006). The objective of the remediation technology is to mitigate subsurface soil and groundwater contaminants in the south portion of the Bentley Mall property.

Ozone sparging involves the injection of ozone via injection wells into the contaminated water-bearing zone. The injected air-ozone mixture traverses horizontally and vertically via interstitial channels through the soil column, creating an underground stripper that removes and degrades volatile contaminants in the saturated zone as well as in the overlying unsaturated zone. The three (3) main mechanisms responsible for contaminant removal during sparging are believed to be: 1) in-situ stripping of dissolved volatile organic compounds, 2) volatilization of dissolved and adsorbed contaminants below the water table and in the overlying soil, and 3) aerobic biodegradation of both dissolved and adsorbed contaminants enhanced by the injection of oxygen and ozone.

Vapor extraction will be used in conjunction with ozone sparging to mitigate soil vapors and treat the soils above the saturated zone. In vapor extraction, a vacuum in applied to the soil above the saturated zone along vertical or horizontal extraction points. The applied vacuum controls the subsurface flow of air and removes volatile contaminants. The extracted soil-gas is treated above-ground by an abatement unit and then discharged into the atmosphere.

4.0 SCOPE OF WORK

This work plan contains applicable elements of 18 AAC 75.360, Cleanup Operation Requirements in ADEC (May 26, 2004). The work plan was developed following applicable sections of the guidance published by the Interstate Technology Regulatory Council (ITRC), "*Technical and Regulatory Guidance for In Situ Chemical Oxidation of Contaminated Soil and Groundwater,*" dated January 2005. This work plan also made use of an air sparging guidance published by the United States Naval Facilities Engineering Service Center (NAVFAC), "*Final Air Sparging Guidance Document, Contract N47408-95-D-0730, Delivery Order No. 0090/0123,*" dated August 31, 2001.

The proposed scope of work is as follows:

- Short-term, ozone sparging and vapor extraction performance testing for the final design of a full-scale system.
- Installation of an ozone sparging system to treat the groundwater plume between the East Satellite and Wells Fargo Buildings.
- Installation of a vapor extraction system to treat soil contamination near the East Satellite and Wells Fargo Buildings.
- Operation and maintenance program.
- Preparation of a system installation and startup report followed by quarterly status reports.

5.0 OZONE SPARGING AND VAPOR EXTRACTION SYSTEM

The area targeted for remediation is the south portion of the Bentley Mall property between the East Satellite Building and Wells Fargo Building. **Figure 4** presents a schematic of the proposed ozone sparging and vapor extraction system. Groundwater remediation via ozone sparging is proposed along a line of injection wells traversing the source area of the groundwater plume. The characteristics of the groundwater plume were presented in a recent site characterization report by ARES dated April 2006.

Vapor extraction is proposed in conjunction with ozone sparging (**Figure 4**). Vapor extraction wells will be distributed around the perimeter of the East Satellite Building and Wells Fargo Building, and alongside the wastewater line on the north side of College Road. Those areas identified in the August 2003 and June 2004 soil-gas surveys (Beacon, September 8, 2004) to be underlain by elevated PCE and TCE concentrations will be targeted for soil vapor extraction. The characteristics of the soil-gas conditions were presented in the site characterization report by ARES (April 2006).

The area targeted for remediation is approximately three (300) feet long and encompasses the East Satellite Building and Wells Fargo Building. Based on the plume characterization to date, PCE and TCE in groundwater are concentrated in the fifteen (15) to twenty-five (25) feet depth interval. PCE and TCE concentrations in groundwater attenuate with depth below the top of the saturated zone. A radius of influence of thirty (30) feet was assumed and based on the sand and sandy gravel characterization of the saturated zone. Fourteen (14) injection wells (SW-1 to SW-14) are proposed in the area targeted for remediation (**Figure 4**).

The ozone sparging equipment will include an air filter, compressor, ozone generator and equipment panel and will incorporate flow and pressure gauges, and dedicated sparge control valves. The equipment panel will be programmable for pulsed injections to achieve greater distribution of the injected stream. The ozone sparging equipment will include a manifold panel with injection ports dedicated to each injection well. The injection wells will be connected to the control panel ports via dedicated, 3/8- to 1/2-inch outer diameter low-density tubing installed in shallow trenches. An air-tight fitting will be attached to the top of the well casings and the dedicated tubing will extend to the base of each injection well. The ozone sparging equipment will be housed in a portable compound to be installed in the parking lot area between the East Satellite and Wells Fargo Buildings (**Figure 4**) where utilities hookup is available to service the equipment.

The following specifications are proposed for the ozone sparging system:

Ports:	Fourteen (14) injection ports with flow and pressure gauges and control valves;
Equipment Panel:	Programmable for pulsed injections;
Flow:	2 scfm to 10 scfm per injection port;
Cooling:	Water cooling or air conditioner
Ozone %:	1% to 10% ozone in injection stream
Generator:	12 to 15 scfm of compressed air per scmf of oxygen produced
Safety:	Automatic overheating shutdown, and ozone monitoring/alarm

The vapor extraction system will be designed to extract by vacuum soil-gas from the soils above the saturated zone, pass the extracted soil-gas through an abatement unit to remove halogenated VOCs, and then discharge the treated gas into the atmosphere. Soil-gas extraction will be accomplished via vertical extraction wells and horizontal extraction piping. The layout of extraction wells and piping presented in **Figure 4** was based in part on the results of the soil-gas surveys completed in 2003-2004 by ARES. The soil-gas survey identified three (3) main areas with elevated concentrations of PCE and TCE (ARES, April 2006): a) below the East Satellite Building, b) west-southwest of the East Satellite Building, and c) near the Wells Fargo Building. Assuming a radius of influence of approximately thirty (30) feet, nine (9) vapor extraction wells (VE-1 to VE-9) are proposed in the area targeted for remediation. The vapor extraction wells will consist of screened casing set at a depth of approximately ten (10) to fifteen (15) feet bgs. In addition, horizontal screened casing will be installed in shallow pits (5 feet bgs) at approximately sixty (60) feet intervals along the trenching for the system piping.

The vapor extraction equipment will include a water knockout tank, air filter, blower and abatement unit. The abatement unit will consist of three (3) granulated activated carbon (GAC) canisters in line. The equipment panel will include vacuum and pressures gauges, dedicated control valves, and sampling ports. Sampling ports will also be installed at the influent, inter-canister and effluent locations of the abatement unit for purposes of monitoring the treatment process. The system will be designed to operate twenty-four (24) hours per day, seven (7) days per week. The vapor extraction equipment will include a manifold panel with dedicated extraction ports. The control panel ports will be connected to the extraction points via dedicated, 3/8-inch outer diameter tubing installed in shallow trenches. The vapor extraction and treatment equipment will be housed in the same portable compound as the air sparging equipment, in the parking lot between the East Satellite and Wells Fargo Buildings (**Figure 4**).

The following specifications are proposed for the vapor extraction system:

Ports:	Nine (9) extraction ports with vacuum and pressure gauges, and control valves;
Equipment Panel:	Programmable for pulsed extractions;
Vacuum:	100 to 500 cfm capacity;
Cooling:	Water cooling or air conditioner;
Abatement:	Two (2) GAC canisters in line;
Safety:	Automatic overheating shut-down.

5.1 PRE-FIELD ACTIVITIES

Permits required from ADEC and local jurisdictions will be obtained for the installation of the ozone sparging and vapor extraction system. The installations will be coordinated with the management and tenants of the Bentley Mall to minimize disruptions to on-going commercial operations at the *subject site*. Traffic control measures will be arranged during the system installation activities. A site-specific health and safety plan will be prepared to protect the staff of ARES and its subcontractors, and tenants and visitors, during the system installation and operation. A utilities locating firm will survey the project area.

Other pre-field activities include selection of the equipment housing; evaluation of existing site conditions and access; review of available files and records pertaining to the *subject site* (well logs); review of utility drawings for the Bentley Mall and vicinity; and selection of the equipment manufacturers/suppliers.

5.2 PILOT PERFORMANCE TESTING

A short-term pilot test will be conducted to evaluate the performance of ozone sparging and vapor extraction at the *subject site*. The purpose of the performance testing is to obtain baseline conditions, evaluate the field response to air sparging and vapor extraction, and provide information for the final design, installation and operation of a full-scale system. The pilot testing will be performed in three (3) phases, each phase will be conducted for a minimum of twenty-four (24) to forty-eight (48) hours:

- *Vapor extraction performance testing without air sparging*: During this phase of the pilot test, a selection of extraction points will be connected to a rig-mounted vapor extraction with treatment equipment, and subjected to a vacuum under controlled conditions. The soil-gas extracted by vacuum will be treated through an abatement unit consisting of GAC canisters in line. Vadose and groundwater monitoring wells (or temporary wells) located in the vicinity of the extraction points will be monitored during the short-term performance testing.

- *Air sparging performance testing without vapor extraction*: A selection of injection points will be connected to rig-mounted air sparging equipment and subjected to pulsed injections of air (or a mixture of ozone-air). Groundwater monitoring wells (or temporary wells) located in the vicinity of the injection wells will be monitored during the short-term performance testing.

- *Combined air sparging and vapor extraction operating concurrently*: The rig-mounted ozone sparging and vapor extraction equipment will be operated concurrently to evaluate the combined effect in the subsurface. Groundwater and vadose monitoring wells (or temporary wells) will be monitored concurrently during the performance testing.

At the discretion of the project manager, the injection and extraction points to be used in the pilot test may be permanent wells (refer to Section 5.3 and Section 5.4 below), temporary wells constructed as per Section 5.3 and Section 5.4, or a combination of permanent and temporary wells. Permanent wells will be constructed as discussed in the below in Section 5.3 and Section 5.4. Temporary injection or extraction wells will be constructed as per Section 5.3 and Section 5.4, respectively, and only for the duration of the pilot test. Temporary points are to be permanently destroyed, or replaced with permanent installations, after the pilot test is completed.

The pilot test results will be used to evaluate the radius of influence of air sparging; number and placement of injection wells; flow, pressure and pulsation requirements for optimum sparging; whether hydraulic controls are needed to contain plume migration; vapor extraction radius of influence; number and placement of extraction points; vacuum, pressure and pulsation requirements for optimum treatment and capture of VOCs by vapor extraction. The pilot test results will also address permitting issues and best-available technology for abatement of the extracted soil-gas; and evaluate winterization and seasonal requirements for year-round operation.

During the pilot testing, the following parameters will be monitored to evaluate performance:

- System operation schedule and downtime;

- Pressure, vacuum and flow gauge readings in the equipment panels;

- Air quality monitoring for ozone and VOCs in and around the work area for health and safety purposes, and with the use of field instrumentation;

- Depth-to-groundwater and groundwater-quality parameters including dissolved oxygen (DO) and oxidation reactivity potential (ORP) utilizing field instrumentation;

- Total-volatile-organic concentrations (TVOs) in subsurface soil-gas with the use of a portable photo-ionization detector (PID).

- Pressure, flow rate and TVOs in the influent stream, inter-canister stream, and effluent stream of the GAC abatement unit;

Groundwater samples will be collected from groundwater monitoring and injection wells in the treatment area before and after the pilot test. The groundwater sampling will follow standard groundwater sampling protocol, such as those included in the Environmental Protection Agency (EPA) advisory, "*Technical Protocol for Evaluating Natural Attenuation of Chlorinated Solvents in Ground Water,"* dated September 1998. The groundwater samples will be analyzed for halogenated VOCs by EPA Method 8260B or equivalent method. Additional testing to be performed includes chemical parameters for monitoring oxidation state and natural attenuation as discussed in ARES (April 2006): total chromium and hexavalent chromium by EPA Methods 7000 Series; total iron by EPA Method 7000 Series and ferrous/ferric iron by SM 3500; total nitrogen, nitrate and nitrite by EPA Method 300.0; and sulfate and sulfide by EPA Methods 300.0/376.2.

Soil-gas samples will be collected from the extraction wells, as well as from vadose monitoring wells, before and after the pilot test. The soil-gas sampling protocol will follow industry standards for the collection of soil-gas samples, sampling protocols are found in the Department of Toxic Substances Control, State of California Environmental Protection Agency (DTSC, February 7, 2004), "*Guidance for the Evaluation and Mitigation of Subsurface Vapor Intrusion to Indoor Air;*" and in EPA (November 29. 2002), "*Draft Guidance for Evaluating the Vapor Intrusion to Indoor Air Pathway from Groundwater and Soils (Subsurface Vapor Intrusion Guidance)*." The soil-gas samples will be analyzed for halogenated VOCs by EPA Method T015 or equivalent method.

In addition, influent and effluent air samples will be collected from the GAC abatement unit of the vapor extraction equipment. The air samples will be collected from sampling ports and analyzed for halogenated VOCs by EPA Method T015 or equivalent method. The sampling will be performed to confirm GAC treatment of the soil-gas.

The project manager may opt to modify or augment the pilot test duration and the monitoring and sampling plan presented above based on new information and site conditions.

5.3 INJECTION WELL INSTALLATIONS

The conceptual layout for the full-scale system includes fourteen (14) injection wells distributed in lines across the groundwater plume between the East Satellite and Wells Fargo Buildings (**Figure 4**). The fourteen (14) injection wells, designated SW-1 to SW-14, respectively, will be spaced approximately fifty (50) feet apart. A thirty (30) feet radius of influence was assumed. The wells will be constructed by a licensed driller using continuous flight, hollow stem auger equipment under the direction of a professional geologist. The well borings will be drilled to the base of the contaminated saturated zone targeted for sparging. During the drilling, the geologist will log the soil lithology and field screen with a portable PID. At the discretion of the project manager, soil samples may be collected submitted for laboratory analyses for halogenated VOCs to augment the site characterization data.

The injection wells will be constructed with well casing of approximately two (2) inch diameter. The bottom three (3) to five (5) feet of casing will consist of screened casing with a bottom cap. Annular space around the screened casing will be filled with a sand filter pack. The sand pack will extend no more than one foot above the screened casing and be followed above by a thin layer of bentonite. The rest of annular space above the screened casing will be sealed with cement grout placed by tremie pipe up to grade. The top of the well casing will be completed with the appropriate sparge fitting. A traffic rated well box will be constructed around the wellhead and set in concrete. The injection wells will be developed using a well development rig. The well construction shall comply with ADEC requirements.

The project manager may modify the construction details of individual wells based on the results of the performance testing and field conditions encountered during the drilling and well installation. Well construction should ensure that short-circuiting of air is unlikely to occur across the seal and surface grout. Well casing material must be selected to be durable and compatible with ozone contact.

The existing groundwater monitoring wells in or near the area targeted for remediation will be used to monitor groundwater conditions. There are four (4) groundwater monitoring wells (MW-1 to MW-4) available on-site, and two (2) wells (MW-12 and MW-13) located off-site and downgradient of the *subject site*. If as a result of pilot testing and evaluation, the project manager decides that additional groundwater monitoring locations are needed, then additional groundwater monitoring wells will be installed and constructed similar to the existing wells, e.g. set at a depth of approximately twenty-five (25) feet bgs and screened in the fifteen (15) to twenty-five (25) feet depth interval.

5.4 EXTRACTION WELL INSTALLATIONS

The conceptual layout of the vapor extraction points is presented in **Figure 4**. The vapor extraction wells will be concentrated around the periphery of the air sparing well field near the East Satellite and Wells Fargo Buildings. The vapor extraction wells will be constructed by a licensed driller using continuous flight, hollow stem augers under the direction of a professional geologist. The well borings will be drilled to approximately ten (10) to fifteen

(15) feet bgs in the unsaturated zone. During drilling, the geologist will log the soils and field screen with a portable PID. At the discretion of the project manager, soil samples may be submitted for laboratory analyses for halogenated VOCs via EPA Method 8260B.

The vapor extraction wells will be constructed with well casing of approximately two (2) inch diameter. The bottom five (5) to ten (10) feet of the well casing will consist of screened casing with an annular space filled with a sand filter pack. The annular space atop the sand pack and bentonite layer will be filled with cement grout up to grade. The top of the well casing will be completed with an air-tight fitting and a traffic rated well box will be constructed around the wellhead set in concrete. Well construction shall comply with ADEC requirements. The project manager may modify the construction details of individual wells based on the results of the performance testing and field conditions encountered during the drilling and well installation.

In addition, five (5) foot long segments of screened well casing will be placed horizontally in shallow pits excavated to approximately five (5) feet depth and spaced at approximately sixty (60) feet apart along the trenching for the ozone sparging and vapor extraction piping. The horizontal screened casing will be enclosed by sand pack up to the base of the piping trench. One end of the casings will have a cap and the other will be attached to a riser with an air-tight fitting for the vapor extraction piping. The vertical riser will be set in a utility box within the piping trench. The horizontal piping risers and vapor extraction wells will be connected via dedicated tubing to the vapor extraction equipment panel. The number and locations of the horizontal casings will be based on field monitoring and PID reading of soils during the trenching for the system piping.

5.5 Equipment Installation and Startup

The results of the ozone sparging and vapor extraction performance testing will be used to confirm the number and placement of injection and extraction points needed to achieve the required zone of influence and coverage. The blower, compressor, piping and other system components and the equipment manufacturers/suppliers will be selected.

Power panel and amenities and utility service for the full-scale equipment will be installed by licensed contractors following the specifications of the ozone sparging and vapor extraction equipment manufacturers. Winterization provisions will be implemented for continuous year-round operation. Other factors to evaluate include the need to install a discharge muffler to the blower if a noise nuisance condition arises, the need to protect the blower from suction of water and particulates by the use of in-line filters and moisture knockouts, and the air conditioning requirements for year-round operation. Adjustments to the pulse sparging sequence and sparging frequency will be made to maximize efficiency and benefits.

Process and instrumentation schematics showing process flow diagrams and identification of system components and direction of flow through system; size and type of blower/vacuum pump including range of operating flow rates, manufacturers performance curves, and vacuum levels; piping specifications including sizing and compatibility with contaminants; maximum flow ratings for GAC canisters, oil-water separators, or other treatment units proposed; and specifications of measuring instruments including vacuum and flow gauges will be defined for the full-scale system.

The equipment compound will be constructed at the designated location. The equipment will be housed in a weather tight and secure enclosure and be provided with utilities hook-up for automatic and continuous operation. Performance testing may demonstrate that the installation of two (2) smaller systems, one at the Wells Fargo Building and the other at the East Satellite Building, may be more efficient and cost-effective. The option to install two (2) systems, one for the west side and the other for the east side of the treatment area (as opposed to one large system to treat the whole area) may be exercised at the discretion of the project manager in conjunction with the owners.

Ozone Sparging System

The ozone sparging equipment will be transported and installed following the directions of the manufacturer/supplier. The system equipment will include an ozone generator, air compressor, programmable timer/controller, and control panel with flow and pressure gauges. The injection wells will be connected to the equipment control panel via dedicated, 3/8- to 1-/2-inch outer diameter low-density tubing installed in shallow trenches. The trenches will be backfilled with compacted fill and covered with pavement. The ozone sparging layout is presented in **Figure 4**.

Groundwater monitoring will be performed during startup testing at approximately two (2) to six (8) hour intervals, and include the measurement in the field with portable instrumentation of depth-to-water, DO and ORP. Startup testing will be performed and include monitoring of the sparge rate, pressure, operation hours, sparge order, and injection frequency. The schedule will be initially set to cycle through the injection wells for ten (10) to thirty (30) minutes per well per cycle.

An ozone detector will be employed on-site to check for leaks, and to monitor and detect for the presence of ozone in the breathing zone of on-site personnel as well as in the equipment compound. An automatic ozone monitoring unit with emergency shut-down and alarm capabilities will be installed if needed in the equipment compound. Leak testing will also be performed with the use of a leak detection solution. Leak testing will be performed in the equipment connections, housing perimeter, along the tubing, and at the wellheads.

Vapor Extraction System

The vapor extraction system including the abatement device, blower, and water knockout tank will be delivered to the site. The system will be installed in the equipment compound and connected to the vapor extraction wells and trenches following supplier directions. The vapor extraction points will be connected to the equipment control panel via 3/8-inch outer diameter piping installed in trenches. The power panel and utilities service for the equipment will be installed by licensed contractors following the manufacturer specifications. The vapor extraction layout is presented in **Figure 4**.

The required source testing will be performed to ensure compliance with permitted emissions. Field soil-gas monitoring will be performed on the vadose monitoring and extraction wells during system startup and troubleshooting. The vacuum pressures and flow rates will be monitored at approximately two (2)- to eight (8)-hours frequency. Equipment parameters such as vacuum, extraction rates, operation hours, gauge readings and status will be monitored. Leak testing will also be performed with the use of a leak detection solution applied to external connection, joints and other points in the system. Leak testing for TVOs will be performed with the portable PID at equipment connections, housing perimeter, along the tubing, and at the extraction points.

5.6 Operation and Maintenance

The following will be prepared for the operation and maintenance of the full-scale system:

- *Health and safety Plan (H&S Plan):* A H&S Plan to protect the safety of contractors, tenants and visitors, and meet applicable requirements of the Division of Occupational Health and Safety (OSHA).

- *Spill Prevention, Control and Countermeasures Plan (SPCC Plan):* A project specific SPCC Plan to prevent accidental spills and stormwater runoff impact.

- *Operation and Maintenance Manual (O&M Manual):* The O&M Plan will describe the optimum operational conditions. The manual will identify the equipment gauges to be monitored and inspected, and the groundwater and vadose monitoring requirements.

The following maintenance schedule for the proposed full-scale system may be modified as-needed by the project manager based on the results of the pilot and startup testing. Site visits and maintenance schedule will be performed daily during the first one (1) month of operation following system startup. The routine maintenance frequency will be gradually reduced from daily to twice-weekly to weekly as improvements and adjustments are made and system operation and gauges stabilize.

The routine maintenance schedule will document the following:

- System operation schedule and downtime;

- Pressure and flow gauge readings in the equipment panels;

- Air quality monitoring for VOCs in and around the work area for health and safety purposes using field instrumentation;

- Depth-to-water, DO and ORP readings in groundwater monitoring wells;
- TVOs readings in vadose monitoring wells;
- Pressure, flow rate and TVOs in the influent stream, inter-canister stream, and effluent stream of the GAC abatement unit for the vapor extraction system;
- Routine leak testing with the use of leak detection equipment;
- System troubleshooting and other significant events.

The sampling of the groundwater monitoring wells will be performed on a quarterly frequency. The groundwater sampling will follow standard groundwater sampling protocol, such as presented in ARES (April 2006) and following EPA (September 1998) guidance. The groundwater samples will be analyzed for halogenated VOCs by EPA Method 8260B or equivalent method.

Soil-gas samples will be collected from vadose monitoring wells in laboratory-designated containers and submitted with chain of custodies. Soil-gas samples will be collected from the vadose monitoring wells on a quarterly frequency and follow industry standards, such as DTSC (February 15, 2004) and EPA (November 29, 2002). The soil-gas samples will be analyzed for halogenated VOCs by EPA Method T015 or equivalent method.

Air samples will be collected from inside buildings to evaluate indoor air quality at the East Satellite Building and Wells Fargo Building. Indoor air sampling will be performed following air sampling advisories, such as DTSC (February 7, 2005). At a minimum, indoor air samples will be analyzed for halogenated VOCs by EPA Method T015 or equivalent method. Other testing may be performed on soil-gas and air samples including atmospheric gases (oxygen, nitrogen, carbon dioxide) and methane by appropriate analytical methods having low detection limits.

In addition, the sampling events will include a selection of samples and analyzes for quality assurance and quality control (QA/QC) following QA/QC advisories (e.g., DTSC, February 7, 2005; EPA, November 29, 2002; EPA, September 1998).

Air samples for laboratory analyses will also be collected from the abatement unit of the vapor extraction equipment. The purpose of the sampling is to identify breakthrough in the GAC canisters and ensure the abatement system operates properly. The air sample will be collected from sampling ports located at the influent stream, inter-GAC canister stream locations, and effluent stream. Abatement unit air samples will be analyzed for halogenated VOCs by EPA Method T015 or equivalent method.

The project manager may opt to modify the maintenance and sampling frequency and analytical plan during the course of the operation and maintenance program based on new information and data from quarterly monitoring.

5.7 Project Management and Status Reports

A system installation and startup report will be prepared after three (3) months of full-scale operation. This report will include permits, system as-built drawings, field and analytical data; results of pilot and performance testing; and discuss system startup and operation and maintenance. Subsequent status reports will be prepared on a quarterly schedule. After eighteen (18) months of operation, a comprehensive report will be prepared and evaluate system effectiveness and remediation progress. Recommendations will be made regarding system operation and maintenance, risk assessment, and attainment of cleanup goals.

6.0 REFERENCES

Alaska Department of Environmental Conservation (ADEC, May 3, 2006): *"Approval of Site Characterization and Corrective Action Reports, Bentley Mall East Satellite Building, Fairbanks, Alaska,"* letter to Bentley Mall LLC.

Alaska Department of Environmental Conservation (ADEC, April 2006): *"Bentley Mall East Satellite Building Site Characterization Report Tax Lot 217 Section 2, Township 1 South, Range 1 West, Fairbanks, Alaska."*

Alaska Department of Environmental Conservation (ADEC, May 26, 2004): *"18 AAC 75, Oil and Other Hazardous Substances Pollution Control,"* amended through May 26, 2004.

Alaska Department of Environmental Conservation (ADEC, June 26, 2003): *"Water Quality Standards 18 AAC 70,"* amended through June 26, 2003.

Alaska Department of Environmental Conservation (ADEC, January 2000): *"The Selection of Natural Attenuation as a Cleanup Alternative for the Restoration of Soil and Ground Water at Contaminated Sites."*

Alaska Resources and Environmental Services, LLC (ARES, April 2006): *"Bentley Mall Site Characterization Report, Tax Lot 217, Section 2, Township 2 South, Range 1 West, Fairbanks Meridian, Fairbanks, Alaska."*

Alaska Resources and Environmental Services, LLC (ARES, January 2006): *"Corrective Action Plan, Bentley Mall, Fairbanks Meridian, Fairbanks, Alaska."*

Alaska Resources and Environmental Services, LLC (ARES, October 2005): *"Bentley Mall Project Summary, Tax Lot 217, Section 2, Township 1 South, Range 1 West, Fairbanks Meridian, Fairbanks, Alaska."*

Alaska Resources and Environmental Services, LLC (ARES, February 2005): *"Bentley Mall Groundwater Sample Results Summary, Tax Lot 217, Section 2, Township 1 South, Range 1 West Fairbanks Meridian, Fairbanks, Alaska."*

Alaska Resources and Environmental Services, LLC (ARES, November 2004): *"Bentley Mall Soil Sample Results Summary Tax Lot 217, Section 2, Township 1 South, Range 1 West Fairbanks Meridian Fairbanks, Alaska."*

Alaska Resources and Environmental Services, LLC (ARES, April 2004): *"Bentley Mall Site Characterization Work Plan, Tax Lot 217, Section 2, Township 1 South, Range 1 West Fairbanks Meridian, Fairbanks, Alaska."*

Alaska Resources and Environmental Services, LLC (ARES, November 2003): *"Phase II Addendum I, Environmental Site Assessment Report, Bentley Mall Complex, Fairbanks, Alaska."*

Alaska Resources and Environmental Services, LLC (ARES, March 2003): *"Phase II Environmental Site Assessment Report, Bentley Mall Complex, Fairbanks, Alaska."*

Department of Toxic Substances Control, California Environmental Protection Agency (DTSC, February 7, 2005): *"Guidance for the Evaluation and Mitigation of Subsurface Vapor Intrusion to Indoor Air, Interim Final,"* December 15, 2004, revised February 7, 2005.

Environmental Protection Agency (EPA, November 29, 2002): *"Draft Guidance for Evaluating the Vapor Intrusion to Indoor Air Pathway from Groundwater and Soils (Subsurface Vapor Intrusion Guidance),"* Office of Solid Waste and Emergency Response.

Environmental Protection Agency (EPA, September 1998): *"Technical Protocol for Evaluating Natural Attenuation of Chlorinated Solvents in Ground Water,"* EPA/600/R-98/12B, National Risk Management Research Laboratory, Office of Research and Development, USEPA, Cincinnati, Ohio.

Interstate Technology and Regulatory Council (ITRC, January 2005): *"Technical and Regulatory Guidance for In Situ Chemical Oxidation of Contaminated Soil and Groundwater,"* Second Edition, In Situ Chemical Oxidation Team, ITRC Technical / Regulatory Guideline. Available on the Internet at http://www.itrcweb.org.

United States Naval Facilities Engineering Service Center (NAVFAC, August 31, 2001): *"Final Air Sparging Guidance Document, Contract N47408-95-D-0730, Delivery Order No. 0090/0123,"* NFESC Technical Report TR-2193-ENV, prepared by Battelle for the United States Naval Facilities Engineering Service Center, Port Hueneme, California.

Approximate Scale in Miles:

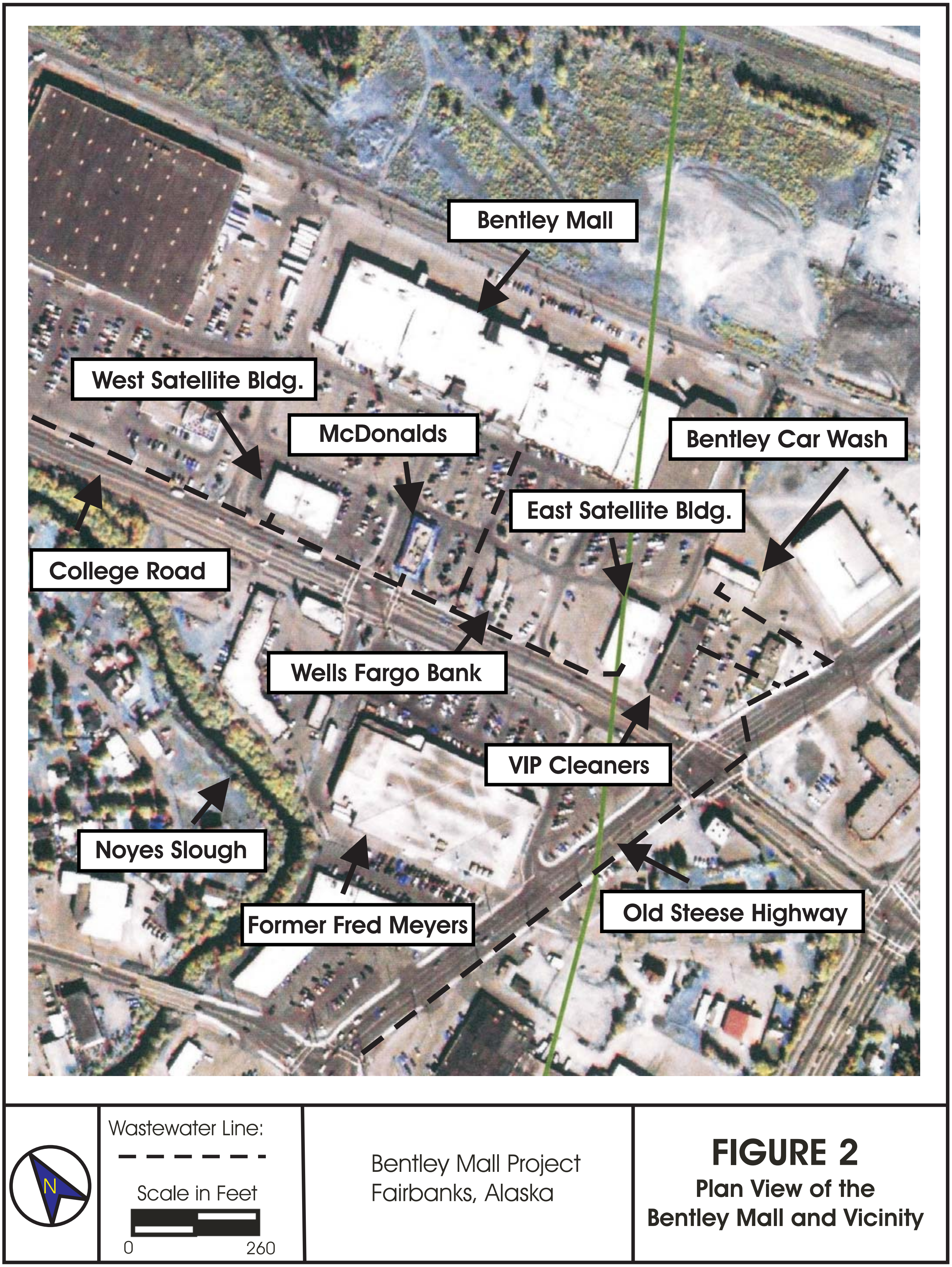
0 1

N

ERG
Environmental Resource Group

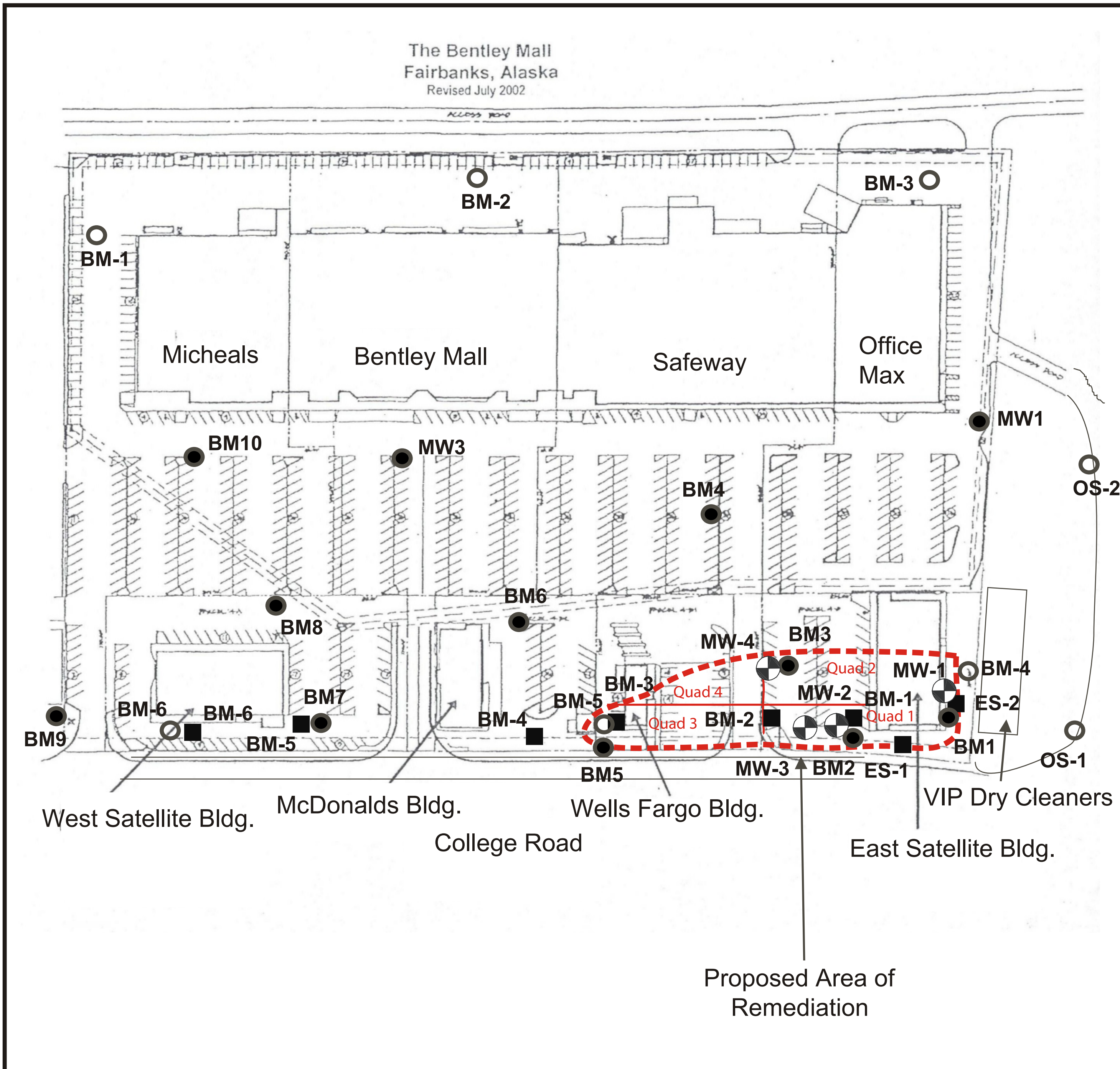
Bentley Mall Project
Fairbanks, Alaska

Figure 1
Site Location



Bentley Mall Project
Fairbanks, Alaska

FIGURE 2
Plan View of the Bentley Mall and Vicinity



BM-1 — Soil Sample Location (ARES, November 2004)

BM1 — Grab Groundwater Sampling Location (ARES, December 2004)

MW-1 — Groundwater Monitoring Well (ARES, September 2005)

ES-1 — Soil Sample Location (ARES, March 2003)

OS-1 — Grab Groundwater Sampling Location (ARES, March 2003)

N

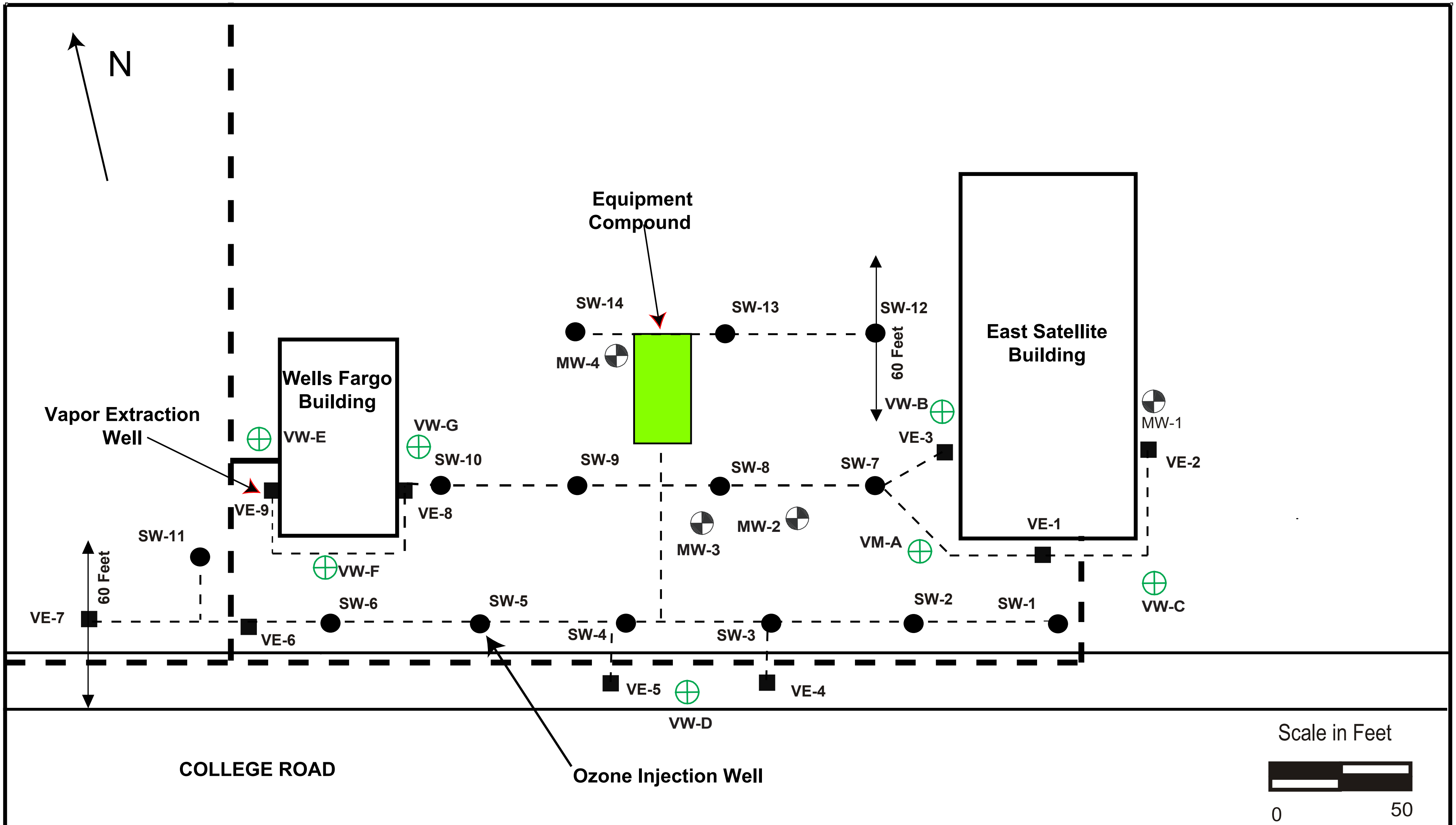
Scale in Feet

0 75 150

Bentley Mall Project
Fairbanks, Alaska

FIGURE 3

Bentley Mall Site Map



Ozone Injection Well
SW-1

Vapor Extraction Point
VE-1

Vadose Monitoring Point
VM-A

Ozone Injection and Vapor Extraction Piping Trench

Wastewater Line, estimated

Groundwater Monitoring Well (ARES, September 2005)
MW-1

NOTE: This is a preliminary layout of the system. Final layout of the system will be determined based on the results of design and testing and site condtions.

Figure 4

Schematic of Ozone Sparging and Vapor Extraction System, Bentley Mall Project, Fairbanks, Alaska