Health Consultation

Whiteway Cleaners Site

City of Minneapolis, Hennepin County, Minnesota

EPA Facility ID: MND981094485

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Prepared by

The Minnesota Department of Health
Under Cooperative Agreement with the
Agency for Toxic Substances and Disease Registry

FOREWORD

This document summarizes public health concerns at a hazardous waste site in Minnesota. It is based on a formal site evaluation prepared by the Minnesota Department of Health (MDH). For a formal site evaluation, a number of steps are necessary:

! *Evaluating exposure:* MDH scientists begin by reviewing available information about environmental conditions at the site. The first task is to find out how much contamination is present, where it is found on the site, and how people might be exposed to it. Usually, MDH does not collect its own environmental sampling data. Rather, MDH relies on information provided by the Minnesota Pollution Control Agency (MPCA), the US Environmental Protection Agency (EPA), and other government agencies, private businesses, and the general public.

! *Evaluating health effects:* If there is evidence that people are being exposed—or could be exposed—to hazardous substances, MDH scientists will take steps to determine whether that exposure could be harmful to human health. MDH's report focuses on public health— that is, the health impact on the community as a whole. The report is based on existing scientific information.

! *Developing recommendations:* In the evaluation report, MDH outlines its conclusions regarding any potential health threat posed by a site and offers recommendations for reducing or eliminating human exposure to contaminants. The role of MDH in dealing with hazardous waste sites is primarily advisory. For that reason, the evaluation report will typically recommend actions to be taken by other agencies—including EPA and MPCA. If, however, an immediate health threat exists, MDH will issue a public health advisory to warn people of the danger and will work to resolve the problem.

! *Soliciting community input*: The evaluation process is interactive. MDH starts by soliciting and evaluating information from various government agencies, the individuals or organizations responsible for cleaning up the site, and community members living near the site. Any conclusions about the site are shared with the individuals, groups, and organizations that provided the information. Once an evaluation report has been prepared, MDH seeks feedback from the public. *If you have questions or comments about this report, we encourage you to contact us.*

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I. Summary of Background and History

The Whiteway Cleaners (a.k.a. Despatch Laundry) site is located at the southwest corner of 26th Street East and Stevens Avenue in Minneapolis, Minnesota. The site is located in a mixed commercial and residential neighborhood (the Whittier neighborhood), with both single-family and multi-family homes and apartments. The site currently consists of 0.65-acre gravel surfaced vacant lot used for neighborhood parking. The property was occupied by a large dry cleaning and laundry operation from approximately 1900 until 1986. The property was also occupied by an auto service station in the 1930's and 1940's; a house once stood on the southern end of the site. The buildings on the site were vacated after dry cleaning operations ceased in 1986 and were demolished in 1994. The site is on tax-forfeited land and is currently administered by Hennepin County (Bay West 2003a). The location of the site is shown in Figure 1, and the original site features are shown in Figure 2.

A release at the site was first identified in 1983 when neighbors complained of an oily substance running out from beneath the garage doors of the dry cleaning facility (Bay West 2003a). The initial investigation at the site was conducted by the site owners in 1987 under the direction of the city of Minneapolis Pollution Control Division and contaminated soil and groundwater were found. The site was listed on the federal Comprehensive Environmental Response, Compensation, and Liability Information System (CERCLIS), a list of potential Superfund sites, in May of 1989. In early 1990, the site entered the Minnesota Pollution Control Agency's (MPCA) Property Transfer Program (now the Voluntary Investigation and Cleanup (VIC) Program). The VIC Program provides technical assistance to site owners and potential developers. In 1993, the site was also entered into the MPCA's Leaking Underground Storage Tank (LUST) Program; six underground storage tanks (USTs) were subsequently removed from the site. The USTs were used variously for gasoline, fuel oil, and dry cleaning solvent storage. The MPCA LUST Program closed the site file in 1996. Because of a lack of activity on the part of the site owners, and the eventual tax-forfeiture of the site, it was listed on the Minnesota Permanent List of Priorities, the state Superfund list, in 1998.

Investigations at the site indicate that soils at the site and groundwater across a wide area in the vicinity of the site are contaminated with high levels of tetrachloroethylene (also known as perchloroethylene, or PCE) and other chlorinated volatile organic compounds (VOCs). Some areas of the site are also contaminated with petroleum products. PCE is a common dry cleaning solvent; petroleum products (specifically Stoddard solvent, a petroleum distillate) were also used for dry cleaning. The sources of the contamination appear to be primarily from spillage or disposal of dry cleaning wastes in the basement of the former facility, and leakage from the former USTs. A "perc room" was identified in the basement of the former dry cleaning facility (see Figure 2).

Given the extent of PCE contamination remaining in soil and groundwater at the site, the MPCA Superfund Program has been overseeing investigation and cleanup activities. Due to recent interest in the redevelopment of the site by Hennepin County, the City of Minneapolis, and area residents, the site also remains active in the MPCA VIC Program. The MPCA staff requested that MDH review site documents prepared to date, the results of indoor air monitoring conducted

in nearby buildings, and the proposed redevelopment plans in order to develop conclusions and recommendations regarding potential public health impacts from the site.

Geology/Hydrogeology

In general, the surface soils at the site consist of up to 12 feet of fill materials; buried foundations from the former site buildings are also present in some areas of the site. Beneath the fill materials lie sand deposits, which extend to 90-100 feet below grade. Intermittent layers of less-permeable materials (silts and clays) are present within the sand deposits such as a 5 to 10 foot layer of sandy clay found between 14 and 25 feet below grade, and a discontinuous silt layer between 28 and 38 feet below grade (Bay West 2003a). Below the sand deposits are the Platteville formation (a limestone bedrock), the Glenwood formation, and the St. Peter Sandstone.

The uppermost groundwater is approximately 60 feet below grade in the sand unit, and flows to the east-southeast. Groundwater in the bedrock aquifers also likely flows to the east, towards the Mississippi River. Small areas of discontinuous or "perched" groundwater associated with the less permeable clay soils may be found at shallower depths in some locations on the site (Bay West 2003c).

Soil Data

Since 1988, several parties have conducted limited investigations to determine the extent and magnitude of contamination at the site. In addition to the six USTs that were removed from the site, an abandoned water supply well was also sealed. The most thorough investigation of soil contamination at the site to date was conducted by Bay West in 2002, and involved 56 push-probe borings (Bay West 2003b). The borings were centered around the former loading dock area and "perc room," where previous investigations had shown the contamination to have likely originated. PCE was found in soil at concentrations as high as 17,000 milligrams per kilogram (mg/kg) of soil, or 1.7%, at a depth of 30 feet below grade near the former "perc room." Soil samples from various depths in each boring were also screened for the presence of organic vapors using a photoionization detector (PID). Very high concentrations of organic vapors, up to 9,040 parts per million (ppm), were found in some borings. The locations of the 2002 soil borings, along with the PCE concentrations at various depths, can be seen in Figure 3.

Much lower concentrations of other chlorinated VOCs, such as trichloroethylene (TCE), 1,2-dichloroethylene and vinyl chloride were also detected in various samples. The concentrations of these other chlorinated VOCs, which may be breakdown products of PCE, are essentially negligible when compared to the extensive PCE contamination. Petroleum contamination, as measured by a separate analysis in previous soil borings for gasoline range organics (GRO) and diesel range organics (DRO), is also present at high levels in some areas. The maximum GRO concentration found was 16,000 mg/kg (boring ST-7), and the maximum DRO concentration was 2,000 mg/kg (boring ST-5). The DRO and GRO concentrations found in soil are shown in Figure 4. High levels of some petroleum related VOCs, such as the trimethylbenzene compounds, were also found in some of the 2002 push-probe borings.

The horizontal extent of the PCE and petroleum contamination in soil does not appear to be large, especially at shallow depths and in the fill materials, and is centered beneath and immediately around the former loading dock area and "perc room." It may extend under Stevens Avenue on the east side of the site, and low levels of PCE may be present on the western edge of the site, near the alley. That the highest levels of PCE contamination are found at significant depth (typically 15 to 30 feet below grade) is likely because the contamination was the result of leakage from USTs and from leakage or disposal of PCE wastes through the basement floor of the "perc room." Only low levels of PCE were found in the shallow soils, mainly in the former loading dock area. None of the PCE results in the shallow soils (0-2 feet below grade) exceeded the applicable MPCA Tier I (residential) Soil Reference Value (SRV) for PCE of 72 mg/kg, so exposure to contaminants in shallow soils is unlikely to represent a human health risk. The SRV is a soil evaluation criterion based on the protection of human health from direct contact with contaminated soil through ingestion, skin contact, and inhalation of vapors and/or contaminated dust particles. There are no specific SRVs for the petroleum products.

Groundwater Data

Since investigation activities at the site began, a total of 14 permanent monitoring wells have been installed at and around the site to evaluate groundwater quality. Two groups of nested wells (a shallow aquifer and a bedrock well located in the same location) make up 4 of the 14 monitoring wells. The monitoring well identifications, screen intervals (depth), and general locations are as follows:

Well ID	Screen Interval (feet)	Monitoring Well Location
MW-1	58 – 73	NE corner of site
MW-2	58 – 73	East-central boundary of site
MW-3	58 – 73	West side of site
MW-4	55 – 70	SE corner of site
MW-5	126 – 131	NE corner of site
MW-6	85 – 90	Approx. 200' NE of site
MW-7	82 – 87	NW corner of site
MW-7a	228 – 233	Approx. 200' NE of site
MW-8	82 – 87	NE corner of site
MW-8a	145 – 150	Approx. 500' NE of site
MW-9	82 – 87	SE corner of site
MW-10	78 – 83	Southern boundary of site
MW-11	218 – 223	Approx. 200' east of site
MW-12	60 – 75	Approx. 200' east of site

The locations of the monitoring wells and the most recent available groundwater monitoring data (from December 2002) for PCE and TCE are shown in Figure 5. During the December 2002 sampling event, PCE was detected in all the site monitoring wells at concentrations ranging from 2.9 µg/l (MW-11) to 14,000 µg/l (MW-2). Two of the monitoring wells (MW-8 and MW-9) were not sampled due to their proximity and similar depth to MW-1 and MW-4, respectively.

PCE concentrations in those two wells would presumably be similar. TCE was also detected in nearly all monitoring wells, at concentrations ranging from 11µg/l to 120 µg/l. Much lower concentrations of other VOCs that are common breakdown products of PCE and TCE, such as 1,2-dichloroethylene, were also found in the most recent samples. Vinyl chloride, the most toxic breakdown product of PCE, was not found. The laboratory detection limits for vinyl chloride were quite high for some samples, however, due to interference from the high levels of PCE.

PCE and TCE were detected at high concentrations in both the surficial and bedrock aquifers, at levels well in excess of their Health Risk Limits (HRLs). The HRL for PCE is 7 µg/l; MDH uses an interim recommended exposure limit for TCE of 5 µg/l pending formal revision of the HRL. The HRLs represent levels of contamination in drinking water that MDH considers safe for daily (about 2 liters per day) human consumption over a lifetime. Levels of PCE contamination have historically been highest in monitoring well MW-2, which is located nearest to the suspected contamination source areas.

The results of the groundwater monitoring confirm that the contamination plume is sinking into the bedrock aquifer as it moves downgradient. The full extent of the groundwater contamination, both vertically and horizontally, is unknown. A well receptor survey was conducted by Bay West in 2003, and selected wells located downgradient of the site were sampled for VOCs (Bay West 2003f). Both PCE (19 µg/l) and TCE (8.2 µg/l) were detected in a sample from a surficial aquifer monitoring well owned by Hennepin County and located approximately 2,000 feet east of the site. No other detections of site contaminants were found in the monitoring and water supply wells sampled to the east of the site, so no known drinking water wells have been impacted.

Contaminants possibly related to the site have also been detected in shallow monitoring wells located on the former corporate campus of Honeywell, Inc., approximately 1,000 feet southeast of the site. It is difficult to sort out the possible contribution from the Whiteway Cleaners site to the contamination found at Honeywell because several potential sources of similar VOCs were also identified at the Honeywell facility.

Indoor Air Samples

Due to the presence of high levels of PCE in soil and groundwater at the site, sampling for VOC vapors in nearby storm and sanitary sewers and in indoor air in the basements of several nearby buildings was conducted beginning in the spring and summer of 2002. VOCs are capable of migrating in the vapor state through porous soil and into adjacent structures, where they can contaminate indoor air. Exposure to low concentrations of some VOCs in indoor air, including PCE and TCE, at concentrations well below the odor threshold may be of long-term health concern.

This sampling was conducted using Summa canisters (non-reactive, coated stainless steel canisters placed under a vacuum), which are portable and can be used to collect air samples instantaneously. A low-flow restrictor valve can also be used with a Summa canister to collect air samples over a period of as long as 24 hours. Air samples are then analyzed for VOCs using

EPA Method TO-14. Detection limits below one part-per-billion (generally less than 10 micrograms per cubic meter ($\mu g/m^3$) for most compounds) are possible using this method.

Two instantaneous (grab) air samples were collected from bottom of the sanitary sewer and storm sewer on Stevens Avenue, along the east side of the site, in May of 2002. The samples were analyzed for VOCs; PCE was detected at a concentration of 27 $\mu g/m^3$ in the sanitary sewer sample and at a concentration of 6.8 $\mu g/m^3$ in the storm sewer sample. Low levels of toluene and styrene were also detected in these samples. No other VOCs were detected. The results indicate that PCE vapors from the contaminated soil, which lies very close to (and perhaps even beneath) the buried sewer lines, may be penetrating the sewer lines through cracks or joints. It is possible that the PCE vapors could be coming from other sources, such as urban runoff or improper disposal through the sanitary sewer. However, this is unlikely because PCE is highly volatile (it evaporates quickly) and would not travel for any great distance through the sewer, and its use and disposal are now closely regulated.

24-hour air samples have also been collected using Summa canisters in four off-site buildings adjacent to the site. Three of the four buildings have been sampled on multiple occasions, with samples collected from both the basement and first floor. The results of the sampling are presented in Table 1, and the sample locations and PCE concentrations are shown in Figure 6. Applicable long-term (or chronic) screening air criteria are also shown in Table 1 for comparison.

As can be seen in Table 1, only one common VOC (toluene) was detected in the basement of Building A, so further monitoring was deemed unnecessary. Multiple VOCs were detected in all of the samples collected from the other three buildings, including benzene, ethylbenzene, methylene chloride, toluene, PCE, TCE, trimethylbenzenes, and xylenes. When possible, their concentrations were compared against MDH chronic Health Risk Values (HRVs) for air, EPA reference concentrations (RfCs) for non-carcinogens, or criteria known as Interim Screening Criteria (ISCs) that have been developed by MDH for carcinogenic compounds for which there are no chronic HRVs. Levels of PCE and TCE consistently exceeded their respective ISCs, as did levels of benzene and 1,2,4-trimethylbenzene. The HRVs, RfCs, and ISCs are health-based criteria and represent levels considered by MDH to be safe exposure levels for the general population, including sensitive sub-populations. In the spring of 2003, letters were sent to the building owners and residents informing them of the results of the indoor air sampling and explaining the potential health risks.

Proposed Response Actions and Site Development

Once the extent of the PCE contamination in soil, groundwater, and indoor air at and around the site became apparent through the investigations described above, the MPCA determined that remediation of the site was necessary to address the potential human health risks and instructed Bay West to prepare an analysis of potential remedial actions. This analysis, known as a Focused Feasibility Study (FFS), presented a detailed evaluation of the feasibility and effectiveness of various alternative response actions designed to address human health risks (Bay West 2003a). The main human health risk identified was exposure to VOC vapors in indoor air.

Direct exposure to contaminants in groundwater is not occurring because area residents are served by the municipal water supply, and exposure to contaminated soils is minimal because the site has been covered with gravel and the majority of the contaminated soils are found at depth.

The potential remedial actions evaluated by Bay West in the FFS included (Bay West 2003a):

- No further action
- Institutional controls
- Monitoring
- In-situ Soil Vapor Extraction (SVE)
- In-situ chemical oxidation using potassium permanganate
- Excavation and thermal desorption
- Excavation and incineration

The above remedial actions were evaluated based on their estimated short and long-term effectiveness in addressing the contamination, their technical feasibility and implementability, potential community acceptance, and their estimated cost. After a detailed comparative analysis, Bay West determined that the response action that would best meet the evaluation criteria was in-situ SVE. This response action involves the placement of soil vapor extraction points (similar to dry wells) across the site, to which a vacuum is applied for extraction of VOC vapors from the pore spaces between soil particles below the ground. This is a proven technology that has been successfully applied at many other VOC and petroleum contaminated sites in Minnesota, and the MPCA agreed with Bay West's recommendation.

After completing the FFS, the MPCA authorized Bay West to conduct a pilot study of an in-situ SVE system at the site (Bay West 2003c). The objectives of the SVE pilot study were to establish the relationship between the applied vacuum and the resulting soil vapor flow rate, determine the radius of influence at various applied vacuums, determine the effects of the applied vacuum on the sand and clay units, and estimate VOC emission rates from a full-scale SVE system. The SVE pilot study consisted of the installation of two soil vapor extraction wells, four vacuum monitoring points, associated piping and vacuum equipment, and the operation and monitoring of the pilot system at various levels of vacuum. One of the soil vapor extraction wells was installed in the shallow sand unit (the SEP), and one in the deeper sandy clay unit (the CEP). Both the SEP and CEP were installed just west of the former "perc room" location. At each of the four vapor monitoring points, one monitoring point was installed in the sand unit and one in the clay unit.

The SVE pilot study was complicated by the fact that the bottom of the CEP became submerged in a layer of groundwater perched atop the clay unit. Efforts to bail out the CEP proved fruitless, because groundwater refilled the CEP within a short time. One of the four vacuum monitoring points completed in the clay layer was also submerged. Eventually, the SVE pilot test of the clay layer was conducted by testing each of the three dry clay vacuum monitoring points

individually, and monitoring system performance using the remaining clay monitoring points and the sand layer monitoring points.

The results of the SVE pilot test showed that SVE is a viable remedial alternative, and would be very effective at removing VOCs from the sand deposits beneath the site. The pilot study also showed that applying a vacuum to the sand deposits results in a vacuum in the clay layer (and vice verse), indicating that VOCs could be removed from the clay as well, albeit more slowly. The study indicated that the likely radius of influence of the soil vapor extraction wells is between 24 and 60 feet.

The successful pilot study demonstrated that SVE is a viable technology to clean up the VOC contamination in the subsurface soils (Bay West 2003c). Emissions from a full-scale SVE system would be high, however, given the high concentrations of PCE in the soil. An exhaust sample collected during the SVE pilot study using a Summa canister and analyzed for VOCs using EPA Method TO-14 contained 11,000 parts per million (or 79,790 $\mu g/m^3$) of PCE, plus low levels of TCE and three other VOCs. Using this measured concentration, an estimated 2,111,372 micrograms of PCE per cubic foot of air ($\mu g/ft^3$) would be emitted from a full-scale SVE system. At this concentration, the allowable emissions rates for VOCs to air established by the MPCA (known as Significant Emission Rates, or SERs) would be exceeded at a system flow rate of only 2.2 cubic feet of air per minute (cfm). At this very low flow rate, cleanup of the site would take many years, if not decades, and the system would likely fail to prevent off-site migration of PCE vapors. To prevent emissions of VOCs above the SERs and achieve cleanup of the site in a relatively short time frame will require the use of emission controls on the SVE system.

The response action approved for the site (in-situ SVE) will be implemented in conjunction with the redevelopment of the site. A response action plan (RAP) for the site has been developed by Bay West, on behalf of the MPCA, Hennepin County, and the proposed developers of the site (Bay West 2003b). The RAP is designed to address soil contamination only, and does not include remediation of groundwater. Over the long-term, however, the SVE system will also have a positive effect on groundwater quality as the contamination source is removed from the soil. The intention of the RAP is to treat soils containing greater than 1 mg/kg of PCE in and above the sandy clay layer, and soils containing greater than 5 mg/kg below the sandy clay layer. These concentrations are well below the SRVs for PCE, and should also eliminate the contaminated soils as a source of sub-surface vapor migration.

Due to the instability of the fill soils on the site, and the fact that the basement floor slab of the original site building was left in place after demolition, the site developer is proposing to excavate up to 12 feet of fill material beneath the proposed building and garage footprints, including the basement slab. Contaminant concentrations in the fill soils are relatively low. The fill materials from the bottom six feet of the deeper excavations will be screened and re-used on site where possible; clean fill may be brought in to backfill the upper portions of the excavation as needed. Any heavily contaminated soils that are encountered will be removed from the site. Due to the potential for this excavation to release VOC vapors from the heavily contaminated

soil that lies beneath the fill, Hennepin County is proposing to install a temporary SVE system in the fill materials and sandy soil above the clay layer to remove a significant amount of the VOCs prior to the excavation. This is intended to reduce the likelihood for significant VOC vapor emissions during the excavation and backfilling of the site. Temporary vapor monitoring points will be installed in and just below the fill materials to monitor the performance of the temporary SVE system.

Once the temporary SVE system has reduced VOC vapor concentrations in the soil to acceptable levels and the fill materials have been excavated, backfilled, and compacted, the final SVE system will be installed. A generalized schematic of the proposed SVE system is shown in Figure 7. The individual soil vapor extraction points will be connected through a manifold, and routed through a tank to remove excess moisture before treatment with granular activated carbon (GAC) to remove the VOCs. Excess moisture interferes with the efficiency of GAC treatment (Miyake et al 2003). The perched groundwater on the top of the clay layer will be pumped out through a recovery well, and treated using GAC before discharge to the sanitary sewer. Removing the perched groundwater will increase the effectiveness of the SVE system. The blowers and associated treatment vessels will be located in a garage on the west side of the site.

The current layout of the proposed residential/commercial development, including the locations of the SVE points and the proposed fill excavation areas and depths, is shown in Figure 8. Because the development will be completed and occupied before the final site cleanup standards for PCE in soil are achieved, several precautions will be taken during construction to prevent the migration of vapors into the overlying structures. Significantly contaminated soil encountered during excavation for footings, utilities, and the SVE system will be removed for off-site disposal (with possible treatment to reduce contaminant concentrations beforehand), although the potential for encountering contaminated soil will be minimized by the initial excavation to remove the unstable fill on the site. After the SVE system is operating, a synthetic membrane will be installed beneath the footings to minimize upward vapor migration. A secondary vapor extraction system (such as slotted pipes) will also be installed directly beneath the building slabs (the buildings will not have basements) to channel any vapors that penetrate the membrane safely away. This secondary venting system will have the capability of being actively pumped by the addition of a vacuum pump if necessary. Indoor air monitoring will also be conducted in all new structures to verify that the systems are operating effectively. A conceptual design for the construction of the footings and sub-slab vapor migration systems is shown in Figure 9.

Site Visit

On May 12, 2003 MDH staff conducted a site visit to the Whiteway Cleaners Site, located at the intersection of Stevens Avenue South and 26th Street East in Minneapolis. The primary purpose of the site visit was to become familiar with the location and layout of the site, especially the locations of monitoring wells and potential soil gas extraction wells and the locations where indoor air samples have been collected. A technician from Bay West, the consultant conducting the indoor air sampling on behalf of the MPCA, was also present.

The Whiteway Cleaners site itself is a gravel contract parking lot dotted with monitoring and test

wells. Several drums of residual investigation wastes remained to be disposed (note: these drums of investigation wastes were properly disposed on June 5, 2003; John Evans, Hennepin County, personal communication, 2004). The site buildings (including one house) were demolished about 10 years ago. The site is currently owned by Hennepin County, which is pursuing a mixed commercial/residential redevelopment of the site as described above.

As a result of soil and groundwater contamination at the site, the MPCA collected indoor air samples in the basements and first floors of four buildings surrounding the site. These four buildings (Buildings A, B, C, and D; see Figure 6) are the closest to the areas of highest contamination. An initial sample collected in the basement of Building A showed no VOCs related to the site. The building to the south of Building C is a multi-unit, split-level apartment building with only a shallow basement, and is not expected to be as susceptible to soil gas intrusion. Multiple VOCs believed related to the PCE contamination at the site have been found in previous air samples collected from Buildings B, C, and D.

The Bay West technician prepared the Summa canisters used for the sampling by attaching the low-flow regulator valves, noting the pressure inside the canister at the start of the sampling, and recording the starting time and location of the sample. The sample time was 24 hours. The Summa canisters were placed in the same locations used for the previous samples. The sampling locations were inspected and the following observations made:

Building A:
This building is used for commercial purposes only. Indoor air monitoring did not indicate the presence of site-related VOCs, so the interior of the building was not inspected.

Building B:
First floor: The building is a two-story side-by-side duplex. The first floors of these units are interconnected and appear to be used as a community meeting/art center or perhaps a youth center. Much of the space appeared to be infrequently used, although there was a slight odor of paint in the air. The Summa canister was set up about 10 feet in from the door.

Basement: The basements of the two units are also interconnected, and appear to be used for music practice, meeting space, and storage. The floor is painted concrete, and the walls painted flat fieldstone. The Summa canister was placed against the west wall of the basement, at the bottom of the stairs, in the same area that the utility pipes (for natural gas and water) penetrate the floor and basement wall.

Building C:
First floor: The first floor of the north unit is residential and was not viewed. The first floor of the south unit is operated as a woodworking shop, with lumber, woodworking equipment, various supplies and a small office present. Several chemical products were observed including spray lubricant, spray paints, paint stripper, solvents, etc on shelves but it was not clear if any are frequently used. The Summa canister was set up in the south unit, near the center wall about 1/3 of the way into the building from the front door.

Basement: The basements of the two units are interconnected, and appear to be used for some woodworking, but mostly for storage. There are natural gas fired boilers for heat and hot water, and some chemical storage including paint. The walls are flat fieldstone, and are mostly unpainted. The floor is concrete, although a dirt floor was observed in part of the south side. The Summa canister was set up against the west wall of the south unit, near the location of a bricked up doorway that may at one time been a street entrance to the basement.

Building D:
This building is a two-story, single-family house used as a rental property. One Summa canister was set up on the first floor on the north wall, in the kitchen/laundry area. The second was set up in the unfinished basement, which is of crumbling flat fieldstone construction and has a dirt floor. The door to the basement is normally locked so that the residents cannot access it.

II. Discussion

Tetrachloroethylene (PCE) is a synthetic solvent widely used for fabric cleaning and degreasing of metal. It has been the solvent of choice for dry cleaning operators for a number of years because it is nonflammable and volatilizes (evaporates) quickly. In dry cleaning operations, PCE is used as a scouring solvent to remove oils, greases, waxes, and fats from both natural and man-made fabrics (ATSDR 1997). PCE is also used in water repellents, silicone lubricants, spot removers, adhesives, and wood cleaners.

PCE at high concentrations in air can cause dizziness, headache, nausea, and in some cases, unconsciousness. These effects are primarily seen in cases of extreme occupational or intentional exposure. Skin irritation can also result from repeated contact. Although it has not been conclusively demonstrated to cause cancer in people, the U.S. Department of Health and Human Services has determined that PCE may reasonably be considered a potential human carcinogen, or cancer causing agent, based on animal studies (ATSDR 1997). Once it enters the body, PCE is presumed to be metabolized by the liver through a saturable enzymatic path (Bogen and McKone 1988). Concentrations typically observed in indoor air at the site are far below that which would result in saturation of the enzymatic pathway. This indicates that PCE in potentially exposed individuals should be fully metabolized.

Based on its volatility and the behavior of PCE in the environment, inhalation is usually the most common exposure pathway (over ingestion or dermal exposure from water and soil) (McKone and Daniels 1991). Once released into the environment, PCE easily volatilizes from soil and water. Factors that can affect the rate of volatilization from soil include soil type, organic matter content of soil, moisture content of soil, and the type of release (e.g. how large of a spill). Volatilization will tend to be higher in sandy soils and lower in denser, more organic soils such as clays where PCE may be adsorbed onto organic carbon particles. PCE also tends to move rapidly through soil, and can easily contaminate shallow groundwater. PCE is denser than water, and, if present in sufficient concentrations in groundwater, it may sink to form a pool at the base

of the groundwater aquifer. This pool of dense, non-aqueous phase liquid (or DNAPL) can serve as a continuing source of groundwater contamination.

People are commonly exposed to PCE and other VOCs found at the site through a number of pathways and in a number of situations. They are present in the environment (in ambient air and water), and in our homes and workplaces (in products and building materials). Levels of PCE measured in ambient air have ranged from less than 1 $\mu g/m^3$ to as high as 9.0 $\mu g/m^3$, while levels above 100 $\mu g/m^3$ have been measured in some industrialized areas (ATSDR 1997). Levels of PCE measured in indoor air in homes in Minnesota ranged from non-detect to 120 $\mu g/m^3$ in a recent study conducted in part by MDH (Stroebel et al 1997), indicating it is a contaminant that can be found at high levels in indoor air. The health-based criterion for PCE developed by MDH (the ISC) for screening purposes is 3.33 $\mu g/m^3$. Lifetime estimates of excess cancer risk from exposure to PCE in indoor air have been estimated to be as high as 1.4×10^{-2} based on measured concentrations in homes (Tancrede et al 1987). VOCs in indoor air may also contribute to respiratory hypersensitivity and be capable of triggering asthmatic symptoms, although this relationship is not well established (Becher et al 1996).

Soil Contamination

There are areas of highly contaminated soil at the site. Maximum levels of PCE in soil exceed the MPCA Tier I (residential) Soil Reference Value (SRV) by a factor of several hundred. The SRV is a soil evaluation criterion based on the protection of human health from direct contact with contaminated soil through ingestion, skin contact, and inhalation of vapors and/or contaminated dust particles. Because all of the PCE detections which exceed the SRV of 72 mg/kg are found at significant depth (more than 2 feet below ground), there is little possibility of regular direct contact with the soil by local residents or those who park their cars at the site. The same is true for the high levels of residual petroleum contamination found in soils at the site. There is the potential for exposure when the contaminated soil is excavated for redevelopment. Such activities should only be conducted under an approved site safety and health plan, as has been proposed by Hennepin County. The contaminated soil also serves as a continuing source of groundwater contamination, and is the likely source of vapors in indoor air in adjacent structures.

The MPCA's consultant has evaluated various options for further remediation of the contaminated soil, and has concluded that the installation of an in-situ SVE system will be the most effective long-term remedy (Bay West 2003a). The predominantly sandy soils at the site, which will facilitate volatilization and removal of the PCE from the soils, are ideal for an SVE system.

Groundwater Contamination

Maximum levels of PCE in the uppermost groundwater on the site (14,000 µg/l in monitoring well MW-2 in December of 2002) exceed the HRL of 7 µg/l by a factor of 2,000. The HRLs represent levels of contamination in drinking water that MDH considers safe for daily (about 2 liters per day) human consumption over a lifetime. The uppermost groundwater is found at a depth in excess of 60 feet below ground. Concentrations of TCE above its interim recommended exposure limit of 5 µg/l are also present on the site; the highest level of TCE detected in December 2002 was in an off-site well (MW-12). PCE and TCE have also been found at concentrations well in excess of their health-based criteria in the bedrock aquifer on site and to

the east of the site, indicating that the contamination is sinking. The full extent of the groundwater contamination, both vertically and horizontally, is unknown. Both PCE and TCE were detected, however in a sample from a surficial aquifer monitoring well owned by Hennepin County and located approximately 2,000 feet east of the site. As determined by groundwater elevation measurements, groundwater in the two aquifers appears to be moving in an east or northeast direction, toward the Mississippi River.

Detectable levels of the breakdown products of PCE and TCE, primarily 1,2-dichloroethylene, have also been detected in monitoring wells on and off the site. Vinyl chloride, perhaps the most toxic breakdown product of PCE, has not been detected at levels above the laboratory reporting limit in samples collected at the site. Detection limits have been high for some samples, so the possibility of vinyl chloride in the groundwater cannot be ruled out. PCE typically dissolves into the groundwater as it moves downgradient from the source of the contamination. Dissolved PCE has been shown to be easily degraded under anaerobic conditions in the environment by microbes through a process known as reductive dehalogenation (ATSDR 1997).

Currently, direct exposure to PCE and its breakdown products in groundwater is unlikely. A well receptor survey was conducted by Bay West, and selected wells located downgradient of the site were sampled. No detections of site contaminants were found in the water supply wells sampled to the east of the site.

The groundwater plume extends under residential neighborhoods to the east and northeast of the site. While PCE and TCE concentrations in the shallow groundwater (60 feet below grade) are quite high (in excess of 900 µg/l for PCE), given the depth to groundwater vapor migration would not be expected to result in a health risk for people in homes in this area of the plume.

Indoor Air Quality

The detection of VOCs in the indoor air in the three buildings closest to the site represents the primary exposure pathway of concern at the site. Based on a review of the literature and the site soil and groundwater data, the only VOCs detected in indoor air that are likely the result of soil vapor intrusion as opposed to other sources are TCE and PCE, and possibly some portion of the petroleum-related VOCs which include benzene, toluene, ethylbenzene, xylenes, and the trimethylbenzenes. Concentrations of the petroleum-related VOCs are within typical reported background ranges, however, and their concentrations were generally higher in samples collected from the main level than they were in the basements in all three homes. This suggests a background source within the main living spaces (or outdoors) as opposed to a below-ground environmental source outside of the structure. Many of these VOCs are common household contaminants, found in fuel oil, cigarette smoke, cleaners, etc., and in vehicle emissions. The opposite is true for TCE and PCE, which were found at levels well above typical background ranges in all three buildings, and were generally at higher concentrations in basement spaces than in main floor samples. This does suggest a below ground environmental source, such as the heavily contaminated soil located very near the three buildings in which PCE and TCE were detected in indoor air. Potential sources of TCE or PCE were also not observed in the three buildings during a site visit. The basement construction of the three buildings (fieldstone walls, with two having partial dirt floors) would also contribute to vapor intrusion.

The ISCs used for comparison to levels of PCE and TCE found inside the nearby structures were developed using the most recently available toxicological information, and are consistent with HRV methodology. The ISCs were developed using common risk assessment parameters. The excess lifetime cancer risk level used was 1×10^{-5}, or 1 in 100,000, which is the default limit used in Minnesota. Estimated excess lifetime cancer risks below this level are considered to be negligible. The ISCs are intended for simple screening for the identification of potential problem situations and not as actual, long-term health standards. The derivation of the ISCs is shown in Appendix 1.

The fact that concentrations of PCE and TCE in indoor air have consistently exceeded their respective health-based ISCs indicates that an excess lifetime incremental cancer risk exists for residents or others who essentially spend all or a majority of their time at the three buildings, in the sampled areas, over a lifetime. To put it another way, if a person spent all day, every day at Building B, based on the average concentrations of PCE and TCE detected their estimated excess lifetime cancer risk from exposure to the PCE and TCE at these concentrations would be approximately 38 in 100,000. Note that as an incremental risk, this estimate is in addition to the reported lifetime cancer incidence rate of Minnesota citizens, which is approximately 40% (or 40,000 in 100,000).

The ISCs and associated risk estimates were developed using conservative exposure assumptions. The assumptions used may not reflect the actual exposures that may occur at the buildings, and in fact likely overestimate them. The true health risks are probably lower. Exposures to PCE and TCE vapors in Building B are likely limited, because the basement and first floor uses are non-residential. Exposures in Building C may be higher, because part of the first floor appears to be a residence. The other part of the first floor is used as a woodworking shop, and is frequently occupied. The consistent detection of methylene chloride (a common ingredient in paint stripper and some other commercial products) in air in Building C at levels in excess of the HRV is probably related to the woodworking operation. The basement of Building D is not currently usable for living space, and the first floor residence is no longer being rented out and is now occupied by the building owner (B. Lundeen, personal communication, 2003). While the three buildings apparently lack forced-air central heating systems, they are of a vintage and construction that should allow for substantial air exchange to the outside, reducing contaminant levels in indoor air in the occupied spaces. Air samples have not been collected on the upper, residential floors of any of the buildings. Because the upper floors are located farthest away from the contamination source, simple dilution and natural ventilation should reduce PCE and TCE concentrations to lower levels.

Contaminant concentrations in indoor air as a result of soil vapor intrusion can vary substantially over time due to changes in air pressure, soil moisture, wind speed and direction, and ventilation (EPA 2002). Levels of PCE and TCE have been relatively consistent in the monitoring events conducted to date. The sampling events have been conducted in three seasons, and in all types of weather, and so far it is not clear if there is a seasonal variation in the levels of VOCs entering the building. The presence of frost in the winter months can greatly influence the migration of subsurface gases and vapors. Frost can act as a “cap,” preventing VOCs from volatilizing from

the soil surface and into the atmosphere, thus increasing migration into buildings through such routes as foundation cracks, pipe entries or simple diffusion. This diffusion is driven by pressure differences between the building and the surrounding soil. The pressure differential is caused by differences in temperature, wind loading on the building and soil, and unbalanced ventilation systems (Hodgson et al 1992). Also, during winter months windows are typically closed, and basement spaces tend to be underpressurized. These factors can lead to a seasonal increase in VOC concentrations.

The use of Summa canisters has been shown to be an effective method for the collection of ambient air samples for analysis of low levels of VOCs. The stability of collected mixtures of ambient gases can be affected by physical adsorption or absorption processes with the collection vessel, reactions with the chemicals in the collected sample, or instability of the compounds. The stainless steel construction of the Summa canisters minimizes physical adsorption and absorption processes. A study of the accuracy, precision, and storage stability of 194 VOCs collected in Summa canisters demonstrated percent mean recovery rates of 93.7% and 103.5% for the primary VOCs (PCE and TCE) found in indoor air (Brymer et al 1996). Other potential VOCs of concern fall in the same range.

The proposed in-situ SVE system to be installed at the site should quickly reduce VOC vapor concentrations in the heavily contaminated soils, reducing (or even reversing) the migration of VOC vapors towards the surrounding buildings. As shown in Figure 9, the conceptual design of the proposed buildings to be constructed on the site includes several safeguards in addition to the SVE system to prevent the infiltration of soil gases, such as a synthetic membrane and passive (with the potential to become active) secondary soil gas extraction system. This design should be adequate to prevent the migration of PCE, TCE, and petroleum vapors into the buildings until the site is remediated by the SVE system. The use of a GAC filter system on the exhaust from the SVE system will prevent exposure to VOCs in the outdoor air at the site.

Child Health Considerations

ATSDR and MDH recognize that the unique vulnerabilities of infants and children make them of special concern to communities faced with contamination of their water, soil, air, or food. Children are at greater risk than adults from certain kinds of exposures to hazardous substances at waste disposal sites. They are more likely to be exposed because they play outdoors and they often bring food into contaminated areas. They are smaller than adults, which means they breathe dust, soil, and heavy vapors close to the ground. Children also weigh less, resulting in higher doses of chemical exposure per body weight. The developing body systems of children can sustain permanent damage if toxic exposures occur during critical growth stages. Most importantly, children depend completely on adults for risk identification and management decisions, housing decisions, and access to medical care.

Children may have been exposed to VOC vapors from the infiltration of soil gas into buildings near the site, and exposures may be ongoing. Since the highest levels of PCE and TCE have been found in the basements of the nearby buildings where it does not appear children spend a large amount of time, such exposures may not represent a long-term health concern for children. The proposed SVE system should reduce or eliminate the potential for exposure in the near

future.

III. Conclusions

The Whiteway Cleaners site in the City of Minneapolis was the location of a dry cleaning operation for much of the 20th century, and also a service station. Significant spillage or outright disposal of petroleum products and dry cleaning wastes occurred at the site. Levels of VOCs in soil significantly exceed the MPCA's soil evaluation criteria for direct human contact. However, the contaminated soil is at a depth where the likelihood of human contact is minimal given the sites current use as a parking lot. The uppermost groundwater and the bedrock groundwater aquifers beneath the site are grossly contaminated with PCE and TCE, at levels significantly in excess of the HRLs. A well survey in the area has not shown any drinking water wells to be impacted, however. The full extent of the groundwater plume has not been identified.

Indoor air samples collected on multiple occasions using Summa canisters in three buildings adjacent to the site show detectable levels of PCE and TCE. The levels detected consistently exceed health-based screening criteria developed by MDH, and indicate that people in or using the buildings may be exposed tat levels associated with an excess lifetime incremental cancer risk that exceeds the criteria used in Minnesota of 1 in 100,000. For this reason, the site currently represents a public health hazard. Exposure to these levels of PCE and TCE may not be occurring on a constant basis, and the risk may be overestimated.

The proposed in-situ SVE system should be effective in cleaning up the site, and preventing exposure to PCE and TCE in indoor air in the surrounding buildings. The conceptual design of the proposed development on the site incorporates several safeguards that also should prevent infiltration of VOC and petroleum vapors into the proposed buildings. Emissions from the SVE system will be controlled by the use of a GAC filter system.

IV. Recommendations

1. Occupants of the three buildings impacted by PCE and TCE vapors should ensure that their heating and any ventilation systems (especially fresh air intakes) are operating properly to prevent the buildup of vapors, and should take any possible steps to reduce the infiltration of soil gases through sealing of cracks and joints in basement areas wherever possible.
2. To mitigate the primary public health concern at the site, exposure to VOC vapors in indoor air, the proposed SVE system should be installed at the site as soon as possible.
3. Two additional indoor air monitoring events should be conducted in the three impacted buildings adjacent to the site after the in-situ SVE system has been installed to determine its effect on PCE and TCE concentrations in indoor air. At least one of the sample events should occur during the winter months.
4. At least one indoor air sample (using a Summa canister) should be collected on the first floor

of each completed structure on the site to verify that VOC vapors from the contaminated soil (primarily PCE) are not entering the structures.

5. Remediation of any residual contaminated soil at the site during redevelopment should be conducted only under a comprehensive Site Safety and Health Plan, as well as an MPCA-approved Response Action Plan and Construction Contingency Plan.
6. Local residents and workers should be informed of the schedule for the redevelopment in advance of the start of any excavation or remediation activities, and any precautions that need to be taken by area residents or workers while the cleanup is in progress.
7. Occupants of the proposed buildings on the site should be given information on the cleanup of the site before purchase, and on a regular basis afterwards until the site remediation goals are achieved.
8. To help determine long-term trends in groundwater quality, groundwater samples should be collected from the permanent monitoring wells installed at and around the site on a regular basis. The full extent of the groundwater plume should also be determined.
9. Any monitoring wells destroyed by the site development should be replaced as necessary.
10. Land use restrictions should be considered to ensure that future exposure to any residual VOCs in soil and groundwater at the site is limited.

V. Public Health Action Plan

MDH's Public Health Action Plan for the site consists of continued consultation with MPCA staff on air and groundwater monitoring and redevelopment issues, communication of the results to the various property owners and occupants near the site, and participation in any planned public outreach activities.

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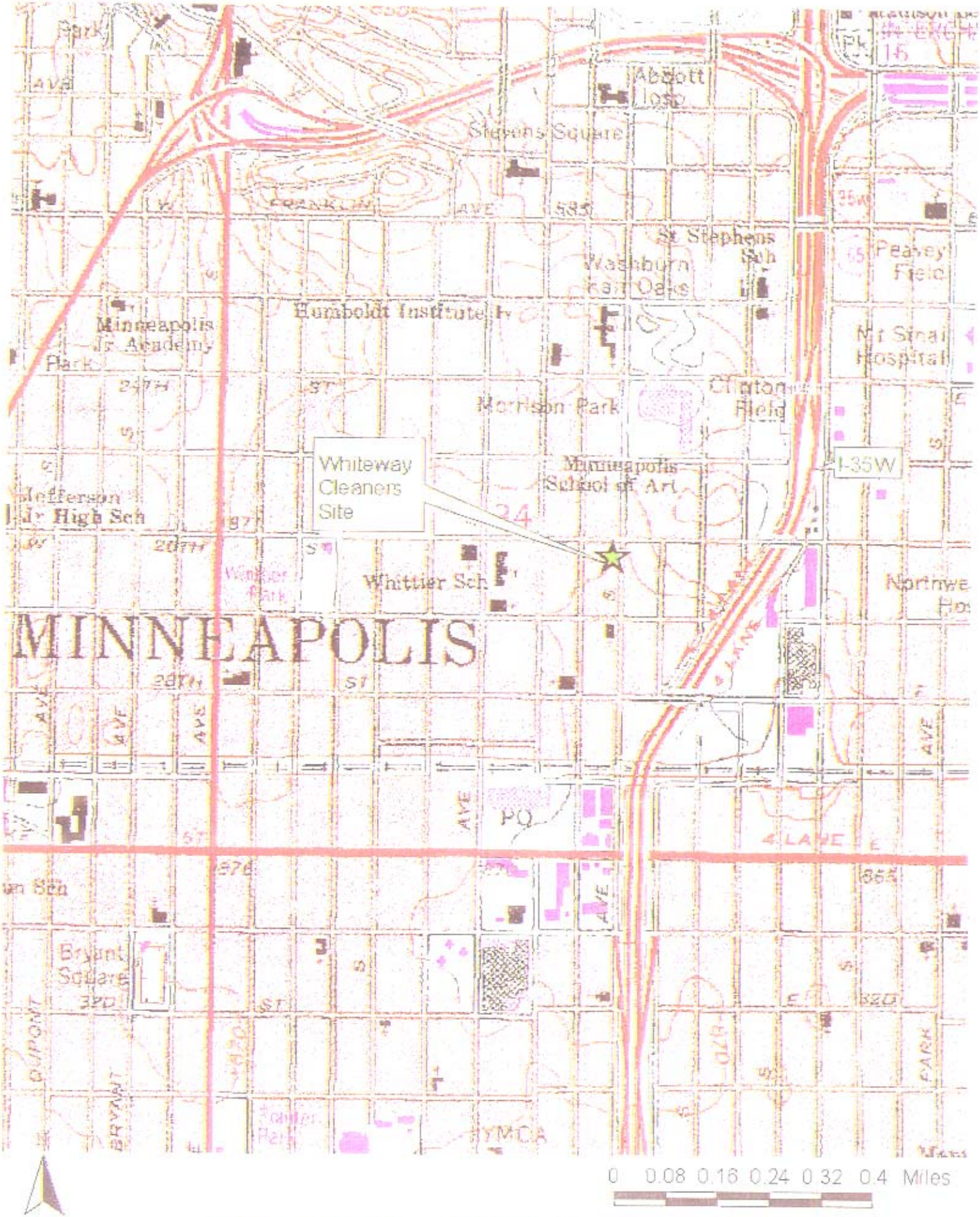
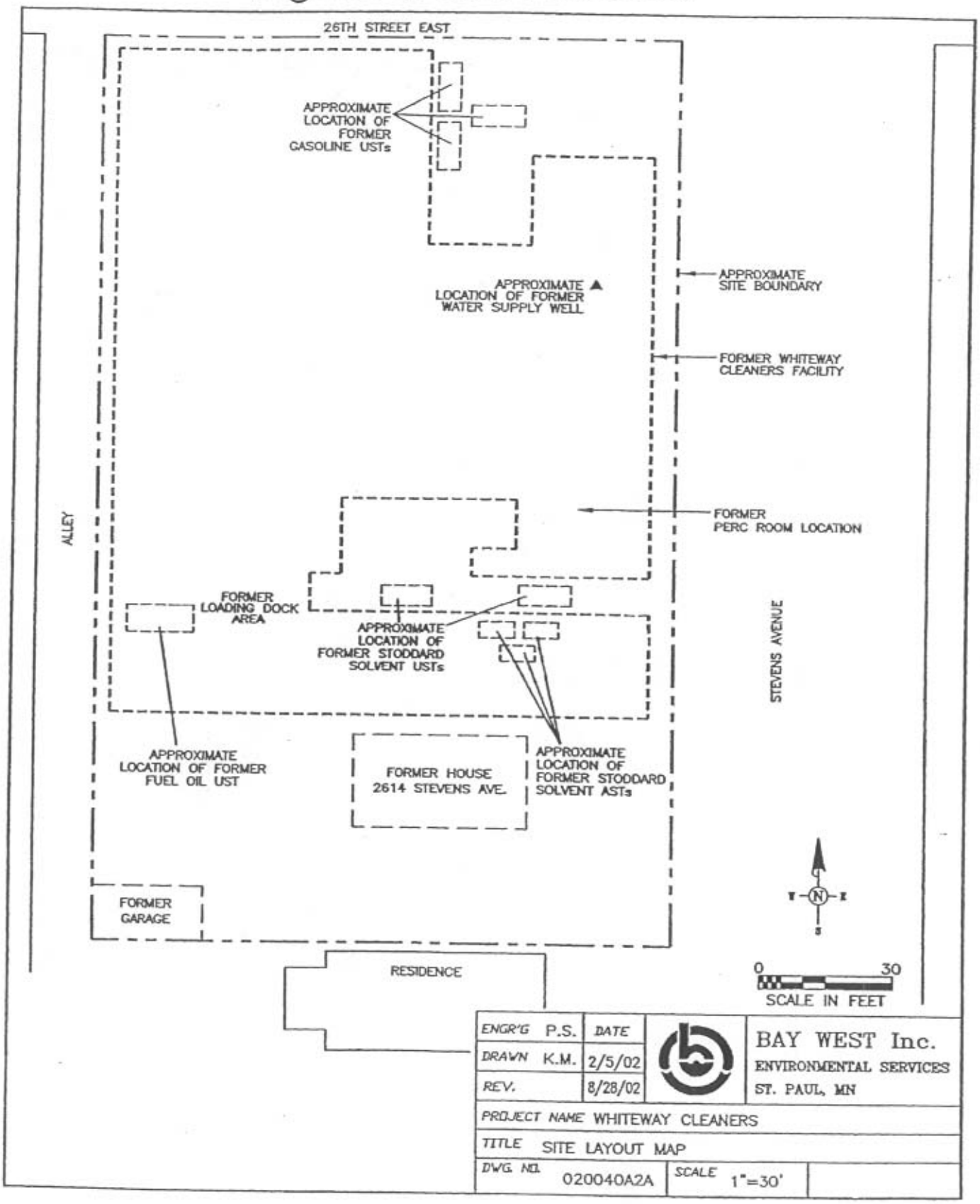


Figure 1: Site Location

Figure 2: Site Features



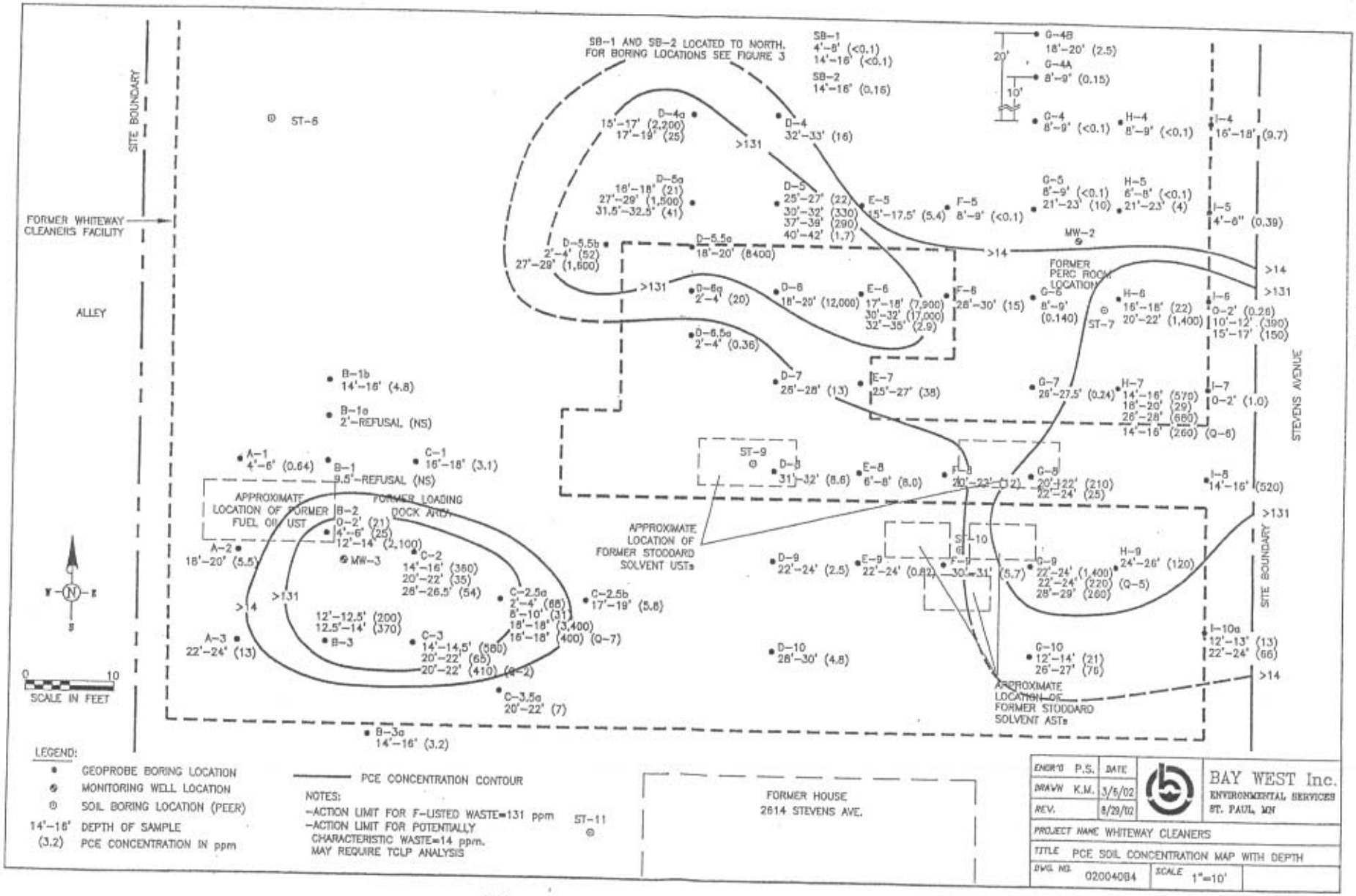


Figure 3: PCE Concentrations in Soil

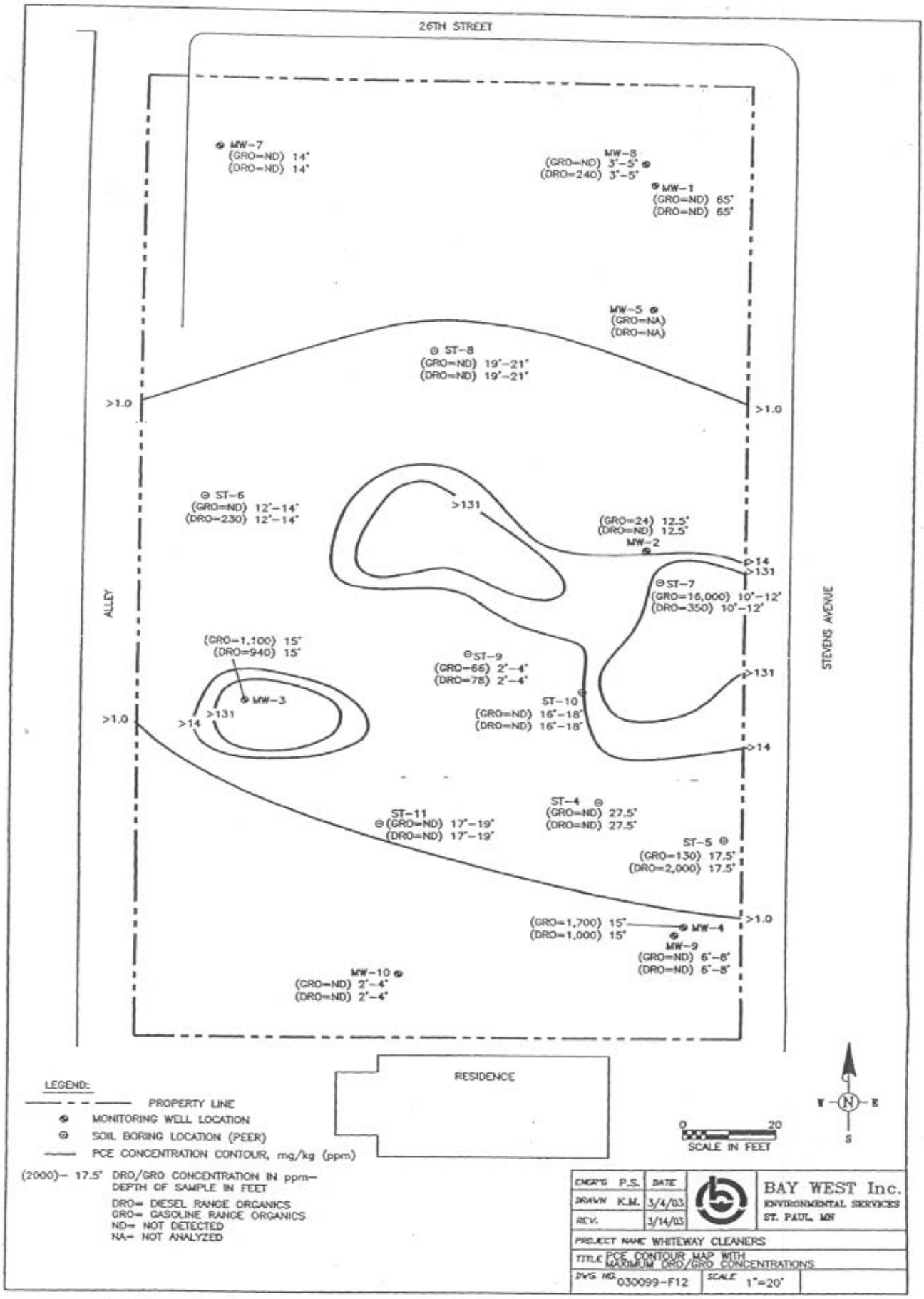


Figure 4: DRO/GRO Concentrations in Soil

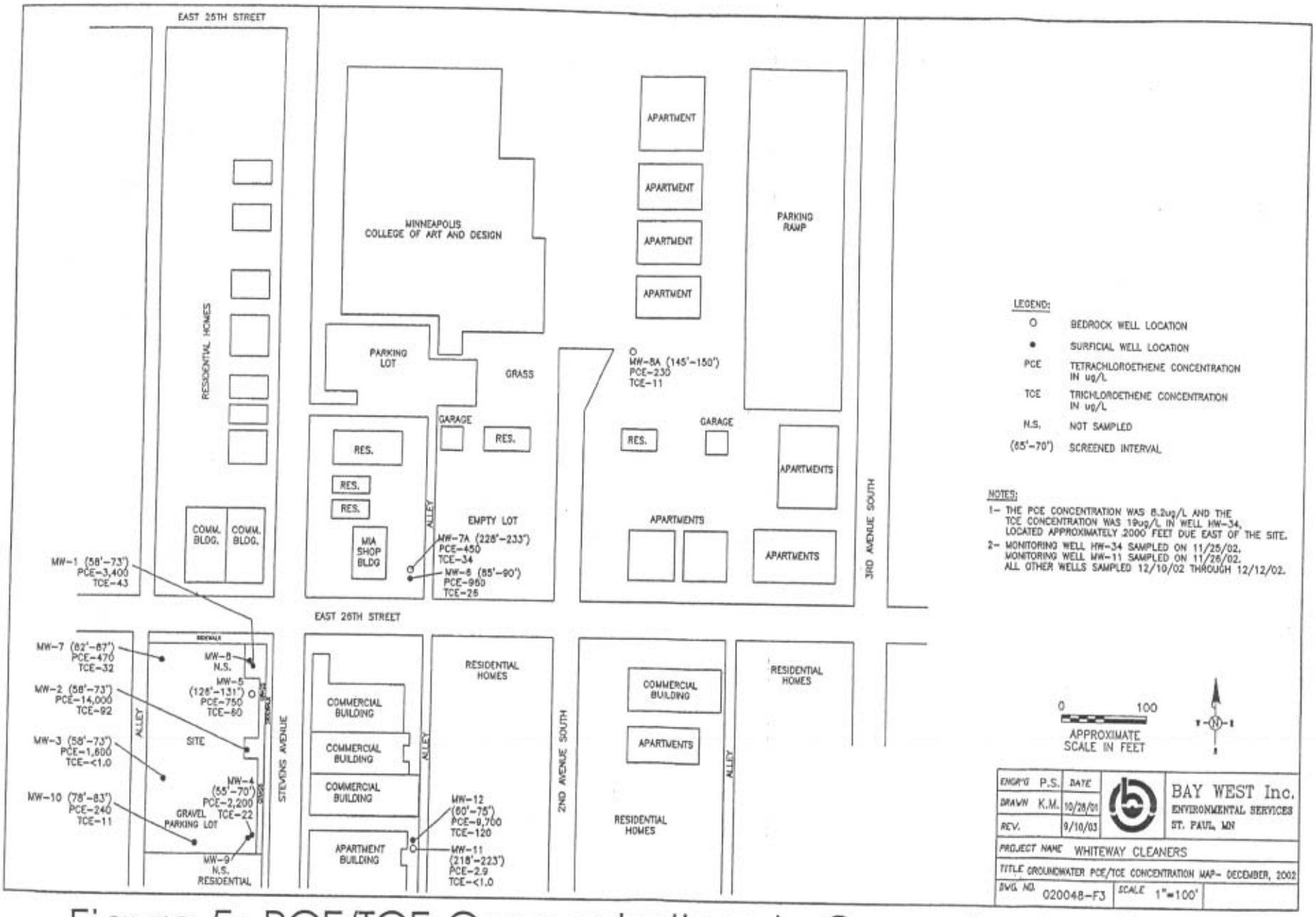


Figure 5: PCE/TCE Concentrations in Groundwater, Dec. 2002

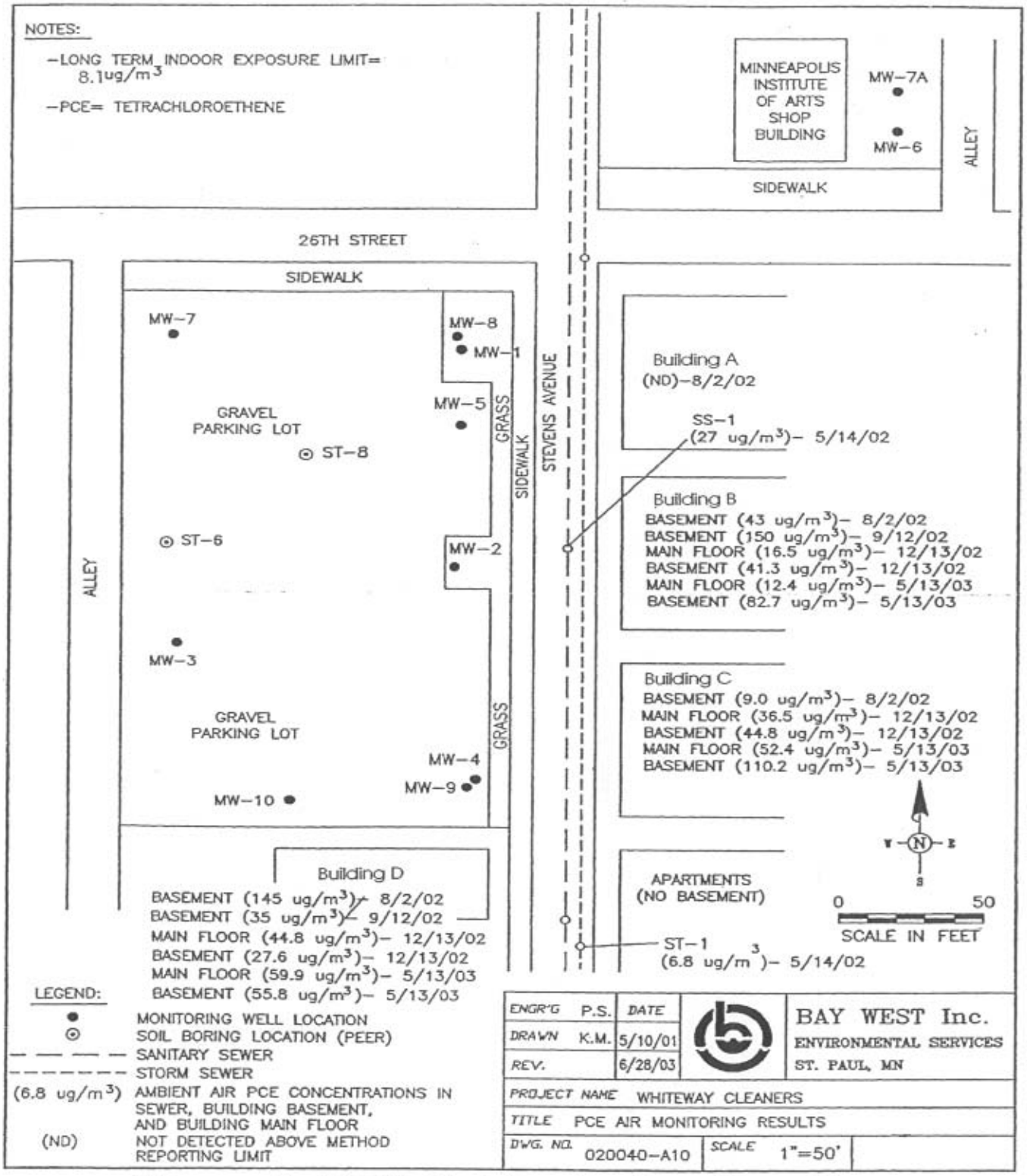


Figure 6: PCE Air Monitoring Results

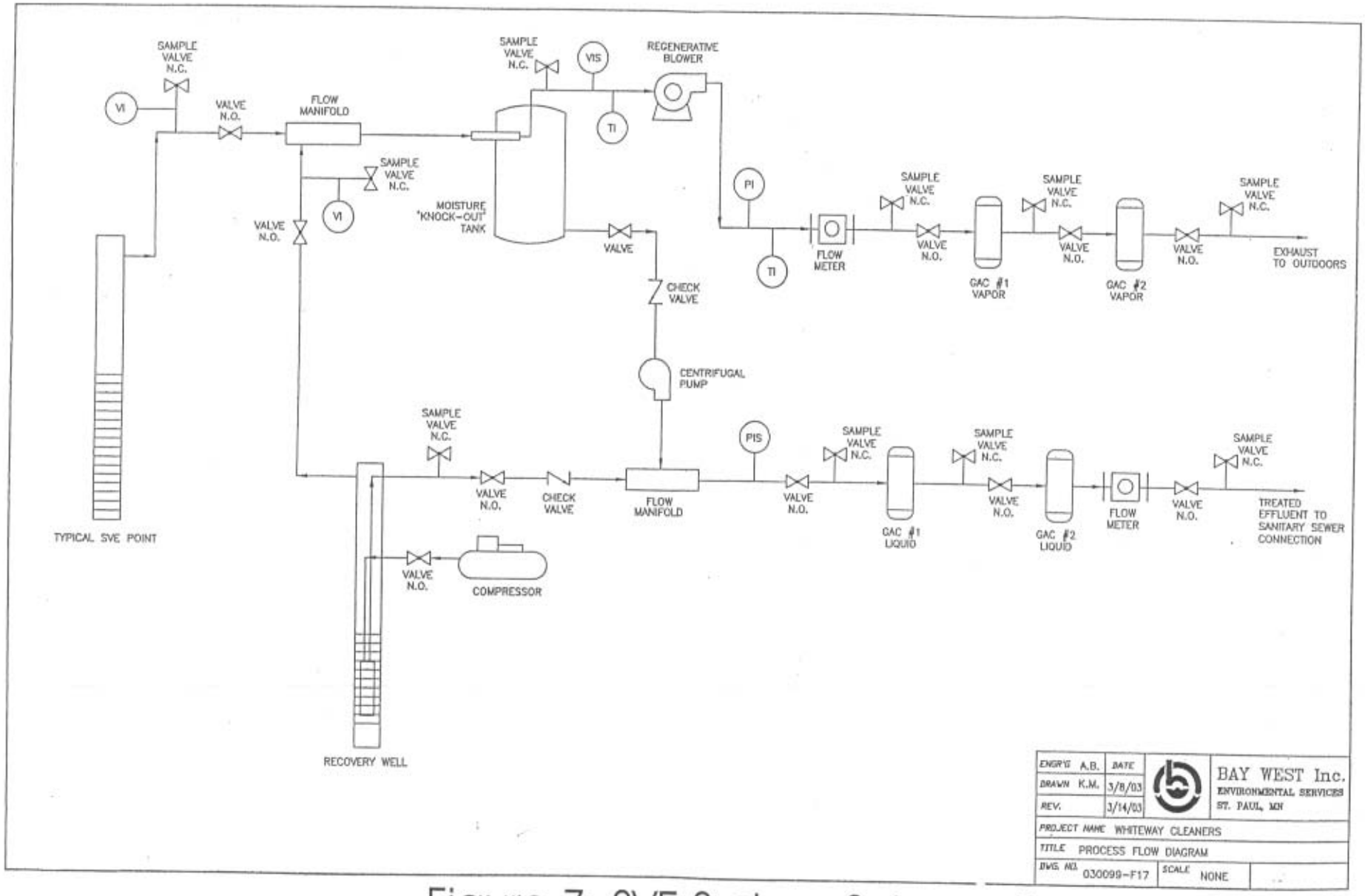


Figure 7: SVE System Schematic

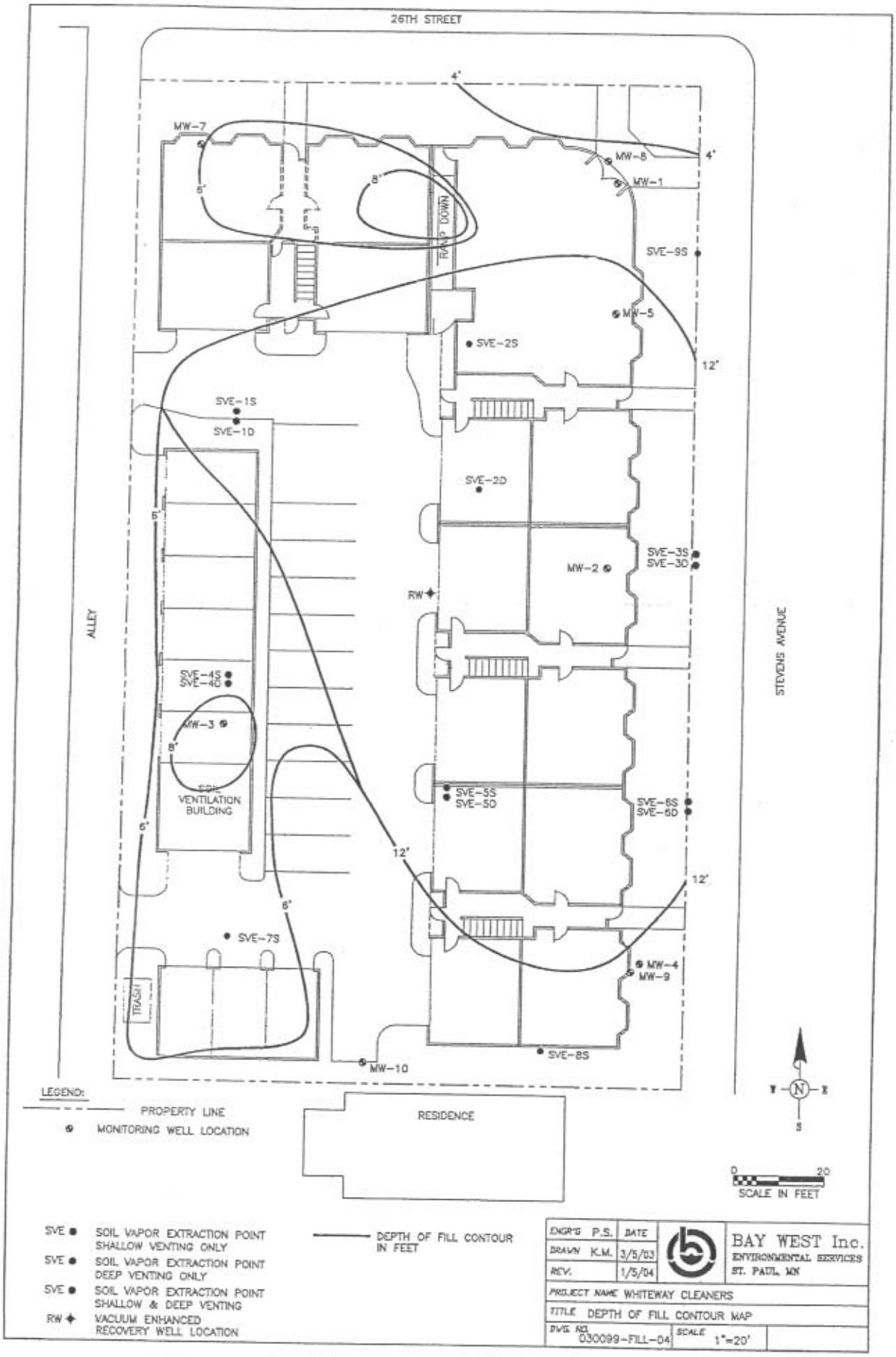


Figure 8: Proposed Development & Fill Depth

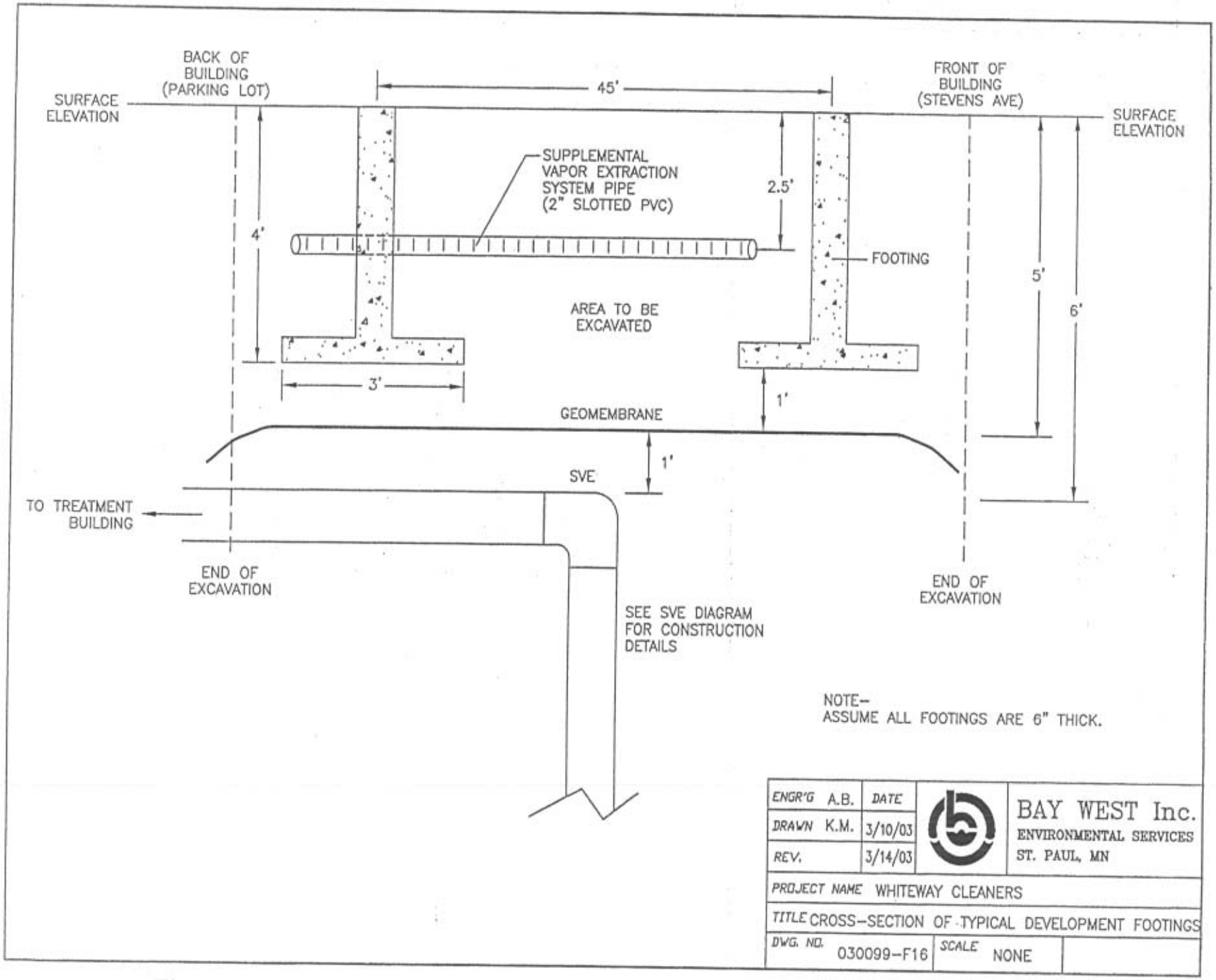


Figure 9: Conceptual Footing System Design

Table 1

Indoor Air Sample Analytical Results
Whiteway Cleaners Site

Results in ug/m^3

Compound	Building A Basement 8/2/2002	Building B Basement 8/2/2002	9/12/2002	12/13/2002	4/3/2003	5/13/2003	Building B 1st Floor 12/13/2002	4/3/2003	5/13/2003	Chronic Screening Criteria	Source
Dichlorodifluoromethane	5								4.0	800	RfC
Chloromethane										90	RfC
Bromomethane										5	HRV
Trichlorofluoromethane		42								700	RfC
Methylene chloride		**590**	6.9	6.7		3.5	4.2		5.3	20	HRV
1,1,1-Trichloroethane		390								2200	RfC
1,2-Dichloroethane			**2.8**							0.38	ISC
Benzene			2.7	**4.8**		3.5	**8.3**		**6.4**	1.3-4.5	HRV
Trichloroethene (TCE)		**7.5**	**26**	**10.4**	**5.0**	**7.6**	**6**		**5.4**	0.4	ISC
Toluene	7.2	140	57	71.6	82.9	135.7	79.1	94.3	192.3	400	HRV
Tetrachloroethene (PCE)		**43**	**150**	**40.7**	**27.8**	**81.4**	**16.3**	**6.4**	**12.2**	3.33	ISC
Ethylbenzene		6.1	4.8	3.2		16.9	4.8		11.7	1000	RfC
m&p Xylenes		24	18	7.8	9.1	56.4	14.8	10.4	38.2	700	RfC
o-Xylene		6.5	7.8	3.7		14.3	5.6		10.0	700	RfC
Styrene			11							1000	HRV
1,3,5-Trimethylbenzene		4.9	5.9			4.5				6	RfC
1,2,4-Trimethylbenzene		**17**	**13**	**6.9**		**13.3**	**12.3**	4.9	**9.8**	6	RfC
1,4-Dichlorobenzene		18	7.2							110	RfC

Bold indicates exceedence of chronic screening criteria

Appendix 1

Calculation of Interim Screening Concentrations (ISCs) for Potential Carcinogens

Inhalation Unit Risk (risk per ug/m^3) : Slope Factor x 1 / BW x IR x 10^{-3} (mg/ug)

where: BW = Body Weight, Adult (70 kg)
IR = Inhalation Rate, Adult (20 m^3/day)
Slope Factor = Cancer Slope Factor, (mg/kg/day)$^{-1}$

Interim Screening Concentration = (ISC, in ug/m^3) $\frac{\text{TR}}{\text{Unit Risk}}$

where: TR = Target Risk (1 x 10^{-5})

Compound	Conv. Factor (ug/m^3/ppb)	Cancer Slope Factor	Source	Unit Risk (per ug/m^3)	ISC (ug/m^3)
Carbon Tetrachloride	6.39	0.0525	IRIS	0.000015	0.67
1,2-Dichloroethane	4.12	0.091	IRIS	0.000026	0.38
Tetrachloroethylene	6.89	0.0105	EPA*	0.000003	3.33
Trichloroethylene	5.46	0.089	EPA**	0.000025	0.40
Vinyl Chloride	2.6	0.0308	IRIS	0.0000088	1.14

* Provisional EPA-NCEA value
** Geometric mean of EPA-NCEA proposed cancer slope factor range, 8/01

CERTIFICATION

This Whiteway Cleaners Site Health Consultation was prepared by the Minnesota Department of Health under a cooperative agreement with the Agency for Toxic Substances and Disease Registry (ATSDR). It is in accordance with approved methodology and procedures existing at the time the health consultation was begun.

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ATSDR

The Division of Health Assessment and Consultation, ATSDR, has reviewed this public health consultation and concurs with the findings.

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Roberta Erlwein
Chief, State Program Section, SSAB, DHAC, ATSDR