AIR QUALITY ANALYSIS
MR. C'S DRY CLEANERS SITE
September 2004

1 OBJECTIVE

The objective of this air quality analysis was to evaluate potential ambient air impacts that would result from operation of the air stripper/groundwater treatment system at the Mr. C's Dry Cleaners Site Remediation without vapor-phase carbon adsorber beds. These vapor-phase carbon beds are used to treat off-gas from the air stripper designed to remove volatile organic compounds (VOCs) from groundwater at the site. The principal VOC of concern is tetrachloroethene. However, the following VOCs have also been detected, at levels above and below analytical detection limits, in air samples from the system's exhaust air ductwork:

- benzene;
- bromomethane;
- cis-1,2-dichloroethene;
- trichloroethene; and
- trichlorofluoromethane.

The air quality analysis presents a comparison of the predicted air quality impacts caused by emissions of these contaminants without the use of the vapor-phase carbon beds to the short-term guideline concentrations (SGCs) and annual guideline concentrations (AGCs) outlined in New York State Department of Environmental Conservation's (NYSDEC's) *New York State Air Guide-1: Guidelines for the Control of Toxic Ambient Air Contaminants* (Air Guide-1) (NYSDEC 1991) and *DAR-1 AGC/SGC Tables* (NYSDEC 2003).

2 DESCRIPTION

NYSDEC currently operates a groundwater treatment system to treat contaminated groundwater at Mr. C's Dry Cleaners in East Aurora, New York. The system includes a direct-contact air stripper that is used to remove VOCs from groundwater pumped from the site. Two vapor-phase carbon adsorber beds, connected in series, are used to remove the VOCs contained in the exhaust air from the air stripper prior to release to the atmosphere.

Air samples are collected monthly from the exhaust air system at a point downstream of the air stripper and upstream of the vapor-phase carbon beds. Sampling is currently used to assess the loading rate to the carbon beds and the VOC control efficiency of the carbon beds. The samples are collected and analyzed for VOCs in accordance with the United States Environmental Protection Agency's (EPA's) TO-14 methodology.

3 ASSESSMENT APPROACH

Ambient air impacts at the site were evaluated using the procedures for conducting a screening level analysis outlined in *Appendix B of Air Guide-1: Ambient Air Quality Impact Screening Analysis* (NYSDEC 1995b). In accordance with this document, short-term and annual impacts were first evaluated using Air Guide-1 screening procedures. These screening procedures are used to predict short-term and annual impacts at discrete ambient locations and, as applicable, the cavity region of nearby buildings. Cavity impacts occur when the plume rise from a stack is not sufficient to escape a building's aerodynamic effects and the contaminant becomes entrained into the cavity region that develops downwind of the building. The Air Guide-1 screening procedures are considered to be very conservative in nature.

If results of the Air Guide-1 screening procedures indicate a possible exceedance of a guideline concentration, annual ambient air impacts are than evaluated using EPA's Industrial Source Complex-Long Term Version 2 model (ISCLT2) imbedded in NYSDEC's Air Guide-1 Software Program, Version 3.5 (AG1V35) (NYSDEC 2004). ISCLT2 evaluates annual impacts at discrete ambient locations only, but it does so in a more refined manner than the Air Guide-1 screening procedures because the model incorporates typical meteorological data for Buffalo, New York.

4 ASSESSMENT PARAMETERS

4.1 Stack

The groundwater treatment system's air exhaust system stack is a 8-inch inside diameter (ID) vertical vent located on the roof of the Mr. C's Building. The top of the stack is approximately 3 feet above the building roof and 18 feet above ground level. The volumetric discharge rate of the stack can vary; however, a review of the air flow rate measurements indicates that the maximum discharge rate is approximately 485 cubic feet per minute (cfm). Thus, the exit stack velocity is approximately 23 feet per second (ft/s). The stack temperature is roughly equal to ambient temperature, except in winter months when the inlet air to the air stripper is heated to prevent freezing. For analysis purposes, a temperature of 68°F was used for stack and ambient conditions to simulate a typical summer period with no buoyancy-induced plume rise.

4.2 Nearby Buildings

Buildings in proximity to the stack were identified to assess the potential for aerodynamic downwash and cavity impacts. In accordance with EPA guidance (EPA 1988), buildings with a potential to influence stack emissions are those within a distance of five times the lesser of the height or width of the building, but not greater than 0.5 miles from the stack. Based on a review of site drawings and maps (E & E 2003 and NYSDOT 1988), three buildings met this criteria: Mr. C's Building, Fitness Factory Building (located east of the site), and the Shoe Repair Building (located west of the site). The Mr.C's Building has two sections (North Side and South Side) with different roof configurations. Building dimensions are summarized in Table 1.

A comparison of the dimensions of these buildings compared to the stack height, indicate that the stack does not meet the criteria for a good engineering practice (GEP) stack. Therefore, building downwash and cavity impacts were addressed in this air quality analysis.

For the Air Guide-1 screening procedures, cavity impacts were calculated using the minimum building height (at the roof edge) for buildings with pitched roofs.

Actual maximum buildings heights were used during ISCLT2 model runs. In order to account for multiple buildings influencing the plumes, the "Air Guide-1 Worst-Case Crosswind Building Width Assignment Method" was selected for the ISCLT2 model runs as described in the *User's Guide for the Air Guide-1 Software Program* (NYSDEC 1995a). Under this option, a single worst-case crosswind building width is used to determine downwash impacts for all 16 wind sectors. The worst-case crosswind building width is based on a comparison of stack height to building height. For sources with stack height less than building height, the worst-case crosswind building width is set equal to the stack height. For sources with a stack height to building height ratio greater than 1 and less than 1.3, the worst-case crosswind building width is set equal to the building height.

Since three of the four identified buildings had equal maximum building heights, two ISCLT2 runs were performed as follows:

- Run 1: building height = 15 feet; worst-case crosswind building width = 15 ft;
- Run 2: building height = 40 feet; worst-case crosswind building width = 18 ft.

4.3 Air Contaminant Emission Rates

Hourly and annual emission rates of each air contaminant were calculated in order to compare ambient impacts to corresponding SGCs and AGCs. The emission rates of the air contaminants were calculated from air sampling results and a stack flowrate of 485 cfm. Example calculations for hourly emission rates and annual emissions are presented in Appendix A.

The maximum hourly emission rates of tetrachloroethene and trichloroethene were based on the highest concentrations found in air samples collected over the 12-month sampling period. Since none of the other contaminants were found above detection limits in the air samples, the hourly emission rates of these contaminants were based on a detection limit of 100 parts per billion by volume (ppbv), which corresponds to the highest minimum detection limit reported from all monthly sampling events over the entire sampling period.

Actual annual emissions of tetrachloroethene and trichloroethene were based on the average of the air sample concentrations found over the 12-month sampling period. The actual annual emissions of the other four contaminants were based on the average of the minimum detection limits reported for each monthly sampling event over the entire sampling period. The estimates of actual annual emissions are based on the assumption of continuous operation of 8,760 hours per year (24 hours/day x 365 days/year).

Potential annual emissions for each contaminant were calculated by multiplying the maximum hourly emission rate by 8,760 hours per year.

Air sampling results and corresponding minimum detection limits are summarized in Table 2. A summary of hourly and annual emission rates is presented in Table 3.

4.4 Meteorological Data

Air Guide-1 screening procedures do not utilize site-specific meteorological data.

ISCLT2 requires selection of a standard Stability Array (STAR) meteorological file. The meteorological data in a STAR file consists of a joint frequency distribution of wind speed and wind direction by stability category. AG1V35 contains 17 default STAR files that correspond to locations throughout New York State. The STAR file selected for this assessment was 1986 meteorological data from the Buffalo International Airport (Filename: BUF.MET).

4.5 Land Use

Air Guide-1 screening procedures are not influenced by land use type. For the ISCLT2 model runs, the land use type was selected as "Urban".

5 RESULTS

The air quality impacts for each contaminant based on Air Guide-1 screening procedures are summarized in Table 4. The results indicate that the predicted short-term impacts of all contaminants are less than the corresponding SGC. The results indicate that except for tetrachloroethene, the predicted annual impacts of all contaminants are less than the corresponding AGC. For tetrachloroethene, the annual cavity impact and the actual annual point impact (i.e., impact outside the cavity region based on actual emissions) was less than the AGC. However, the potential annual point impact (i.e., impact outside the cavity region based on potential emissions) was greater than the AGC. A sample calculation based on the Air Guide-1 screening procedures is presented in Appendix A.

Since the potential annual point impact was greater than the AGC, a more refined analysis with ISCLT2 was used to predict the annual point impacts due to tetrachloroethene emissions. The air quality impacts for tetrachloroethene based on the two ISCLT2 model runs are summarized in Table 5. The actual maximum annual air quality impact and potential maximum annual air quality impact for tetrachloroethene using ISCLT2 were predicted as 0.41 $\mu g/m^3$ and 0.87 $\mu g/m^3$, respectively. These values are less than the tetrachloroethene AGC of 1.0 $\mu g/m^3$.

6 DISCUSSION

The standard point source method for assessing impacts in the Air Guide-1 screening procedures and the ISCLT2 model (as used) did not consider terrain effects or elevated receptors. With the exception of a raised railroad bed to the east of the site, the immediate area around the stack (~ ½ mile radius) is flat. Given the relatively short height of the stack (18 feet), it was anticipated that maximum ambient impacts would occur well within this immediate area. The maximum impacts predicted by ISCLT2 occurred at a location less than 100 feet from the stack.

A survey of building air intakes was not conducted as part of this analysis. Air intakes located within cavity regions would be considered to be in areas where results indicate that air contaminant concentrations are less than corresponding SGCs and AGCs.

7 REFERENCES

Ecology and Environment Engineering, P.C. (E & E). 2003. Location Map: Mr. C's Dry Cleaners Site.

__________. 2004. Unpublished Air Sampling Data from Mr. C's Dry Cleaners Site.

New York State Department of Environmental Conservation (NYSDEC). 1991. *Air Guide-1: Guidelines for the Control of Toxic Ambient Air Contaminants, 1991 Edition.*

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__________. 1995b. *Appendix B of Air-Guide-1: Ambient Air Quality Impact Screening Analysis, 1995 Edition.*

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__________. 2004. Air Guide-1 Software Program Version 3.5 (Draft).

New York State Department of Transportation (NYSDOT). 1988. Raster Quadrangle.

United States Environmental Protection Agency (EPA). 1988. *Screening Procedures for Estimating the Air Quality Impact of Stationary Sources.* EPA-450/4-88-010.

Table 1
Building Parameters

Building Name	Roof Type	Maximum Height (ft)	Minimum Height (ft)	Width (ft)	Length (ft)
Mr. C's Building – North Side	Pitched	15	12	95	105
Mr. C's Building – South Side	Flat	15	15	40	115
Fitness Factory Building	Flat	15	15	70	140
Shoe Repair Building	Pitched	40	30	70	110

Source: Ecology & Environment Engineering, P.C., 2003

Table 2
Air Sampling Results

Sampling Period	Minimum Detection Limit (ppbv)	Sample Result for Tetrachloroethene (ppbv)	Sample Result for Trichloroethene (ppbv)
October 2003	10	144	10(1)
November 2003	5	192	5.52
December 2003	50	1400	127
January 2004	50	713	50(1)
February 2004	25	1100	68.8
March 2004	25	727	25.8
April 2004	50	695	50(1)
May 2004	50	681	50(1)
June 2004	50	726	50(1)
July 2004	100	1810	100(1)
August 2004	25	1080	46.7
September 2004	50	1100	52.7
Annual Average	**41**	**864**	**53**

Notes:
(1) Based on minimum detection limit.

Source: Ecology & Environment Engineering, P.C., 2004

Table 3
Air Contaminant Emission Rates

Air Contaminant	Hourly Emission Rate (lb/hr)	Actual Annual Emission Rate (lb/yr)	Potential Annual Emission Rate (lb/yr)
Benzene	0.00059	2.1	5.2
Bromomethane	0.00072	2.6	6.3
cis-1,2-Dichloroethene	0.00073	2.6	6.4
Tetrachloroethene	0.0227	95	199
Trichloroethene	0.00126	4.6	11
Trichlorofluoromethane	0.00104	3.7	9.1

Table 4
Results of Air Guide-1 Screening Procedures Analysis

	Short-Term			Annual			
Air Contaminant	**Cavity Impact (µg/m³)**	**Point Impact (µg/m³)**	**SGC (µg/m³)**	**Cavity Impact (µg/m³)**	**Actual Point Impact (µg/m³)**	**Potential Point Impact (µg/m³)**	**AGC (µg/m³)**
Benzene	2	3	1,300	0.02	0.02	0.05	0.13
Bromomethane	3	4	3,900	0.02	0.02	0.06	5
cis-1,2-Dichloroethene	3	4	-	0.02	0.02	0.06	1,900
Tetrachloroethene	91	116	1,000	0.72	0.85	1.8	1.0
Trichloroethene	5	6	54,000	0.04	0.04	0.10	0.50
Trichlorofluoromethane	4	5	560,000	0.03	0.03	0.08	-

Key:
AGC = Annual Guideline Concentration
SGC = Short-Term Guideline Concentration

Table 5
Results of ISCLT2 Analysis

Air Contaminant	Run 1 Building Height = 15 ft Crosswind Building Width = 15 ft		Run 2 Building Height = 40 ft Crosswind Building Width = 18 ft	
	Maximum Actual Annual Impact ($\mu g/m^3$)	Maximum Potential Annual Impact ($\mu g/m^3$)	Maximum Actual Annual Impact ($\mu g/m^3$)	Maximum Potential Annual Impact ($\mu g/m^3$)
Tetrachloroethene	0.24	0.51	0.41	0.87

Appendix A
Calculations
Air Quality Analysis - Mr. C's Dry Cleaners Site

1. Building Parameters

<u>Mr. C's – North Side</u>
Minimum Building Height, h_b = 12 ft
Building Minimum Length, L_{min} = 95 ft
Building Maximum Length, L_{max} = 105 ft

<u>Mr. C's – South Side</u>
h_b = 15 ft
L_{min} = 40 ft
L_{max} = 115 ft

<u>Fitness Factory</u>
h_b = 15 ft
L_{min} = 70 ft
L_{max} = 140 ft

<u>Shoe Repair</u>
h_b = 30 ft
L_{min} = 70 ft
L_{max} = 110 ft

2. Stack Parameters

Stack Height, h_s = 18 ft
Stack Inside Diameter, D = 8 in (0.667 ft)
Stack Inside Radius, R = 4 in (0.333 ft)
Stack Inside Cross Sectional Area, A_s = 50.2 in^2 (0.349 ft^2)
Stack Temperature = 68 F (20 C) (293 K)
Stack Flowrate, W = 485 acfm
Stack Velocity = 23.2 ft/s

3. Emissions - Tetrachloroethene

Max Conc Fraction, $MaxC_{ppmv}$ = 1.81 ppmv (1810 ppbv)
Avg. Conc Fraction, $AvgC_{ppmv}$ = 0.864 ppmv (864 ppbv)

Max Conc, $MaxC_{\mu g/m3} = (MaxC_{ppmv})(P)(M)/(R)(T)$
Avg Conc, $AvgC_{\mu g/m3} = (AvgC_{ppmv})(P)(M)/(R)(T)$

Where,
Pressure, P = 1013 mb (1 atm)
Molecular Weight, M = 165.8 g/mol
Gas Constant, R = 0.08314 mb-m^3-K^{-1}-mol^{-1}
Temperature, T = 293 K (20 C)

$MaxC_{\mu g/m3}$ = (1.81)(1013)(165.8)/(0.08314)(293)
= 12,480 $\mu g/m^3$

$AvgC_{\mu g/m3}$ $= (0.864)(1013)(165.8)/(0.08314)(293)$
$= 5{,}960\ \mu g/m^3$

Hourly Emission Rate, $Q = (MaxC_{\mu g/m3})(W)(2.205 \times 10^{-9}\ lb/\mu g)(0.0283\ m^3/cf)(60\ min/hr)$

Q $= (12{,}480)(485)(2.205 \times 10^{-9})(0.0283)(60)$
$= 0.0227\ lb/hr$

Actual Annual Emission Rate, $Q_a = (AvgC_{\mu g/m3})(W)(2.205 \times 10^{-9}\ lb/\mu g)(0.0283\ m^3/cf)(60\ min/hr)(8760\ hr/yr)$

Q_a $= (5{,}960)(485)(2.205 \times 10^{-9})(0.0283)(60)(8760)$
$= 95\ lb/yr$

Potential Annual Emission Rate, $Q_p = (Q)(8760\ hr/yr)$

Q_p $= (0.0227)(8760)$
$= 199\ lb/yr$

4. Air Guide-1 Screening Procedures - Tetrachloroethene

4.1 Basic Cavity Method

For all buildings, the cavity height, h_c $(1.5\ h_b) > hs$

Worst Case Annual Cavity Impact, $C_c = (1.72)(Q_a)/(h_b)^2$

For Mr. C's North Side Building:
C_C $= (1.72)(95)/(12)^2$
$= 1.13\ \mu g/m^3$

For Mr. C's South Side and Fitness Factory Buildings:
C_C $= (1.72)(95)/(15)^2$
$= 0.72\ \mu g/m^3$

For Shoe Repair Building:
C_C $= (1.72)(95)/(30)^2$
$= 0.18\ \mu g/m^3$

Worst Case Short-Term Cavity Impact, $C_{CST} = (904{,}000)(Q)/(h_b)^2$

For Mr. C's North Side Building:
C_{CST} $= (904{,}000)(0.0227)/(12)^2$
$= 143\ \mu g/m^3$

For Mr. C's South Side and Fitness Factory Buildings:
C_{CST} $= (904{,}000)(0.0227)/(15)^2$
$= 91\ \mu g/m^3$

For Shoe Repair Building:
C_{CST} $= (904{,}000)(0.0227)/(30)^2$
$= 23\ \mu g/m^3$

4.2 Refined Cavity Method

Performed only for Mr. C's North Side Building.

Primary Method

Since h_b is less than ½ L_{min}, $h_c = h_b$ = 12 feet

Since $h_s > h_c$, no annual or short-term cavity impacts occur.

Alternative method for calculating hc (included in Air Guide-1 software):

$h_c = h_b\,[1 + (1.6)(e^{(-1.3Lmin/hb)}]$

$$hc = (12)\,[1 + (1.6)(e^{(-1.3(95/12)}]$$
$$= 12 \text{ ft}$$

Since $h_s > h_c$, no annual or short-term cavity impacts occur.

4.3 Standard Point Source Method

For all buildings, h_s/h_b is less than or equal to 1.5.

Maximum Actual Annual Impact, $C_a = (6.0)(Q_a)/(h_s)^{2.25}$

$$C_a = (6.0)(95)/(18)^{2.25}$$
$$= 0.85\ \mu g/m^3$$

Maximum Potential Annual Impact, $C_p = (52{,}500)(Q)/(h_s)^{2.25}$

$$C_p = (52{,}500)(0.0227)/(18)^{2.25}$$
$$= 1.78\ \mu g/m^3$$

Maximum Short-Term Impact, $C_{ST} = (65)(C_p)$

$$C_{ST} = (65)(1.78)$$
$$= 116\ \mu g/m^3$$

5. Results

See Table A-1 for results for all contaminants.

Table A-1
Summary of Air Guide-1 Screening Procedures

Parameter	Unit	Air Contaminant					
		Benzene	Bromomethane	cis-1,2-Dichloro - ethene	Tetrachloroethene	Trichloroethene	Trichlorofluoro - methane
Molecular Weight	(g/mol)	78.11	94.95	96.94	165.83	131.4	137.38
Maximum Concentration	(ppbv)	100	100	100	1810	127	100
	(ppmv)	0.100	0.100	0.100	1.810	0.127	0.100
	(μg/m^3)	325	395	403	12482	694	571
Average Concentration	(ppbv)	41	41	41	864	53	41
	(ppmv)	0.041	0.041	0.041	0.864	0.053	0.041
	(μg/m^3)	133	162	165	5958	290	234
Hourly Emission Rate	(lb/hr)	0.000590	0.000717	0.000732	0.0227	0.00126	0.00104
Actual Annual Emission Rate	(lb/yr)	2.1	2.6	2.6	95	4.6	3.7
Potential Annual Emission Rate	(lb/yr)	5.2	6.3	6.4	199	11	9.1
Worst Case Annual Cavity Impact	(μg/m^3)	0.02	0.02	0.02	0.72	0.04	0.03
Worst Case Short-Term Cavity Impact	(μg/m^3)	2	3	3	91	5	4
Maximum Actual Annual Impact	(μg/m^3)	0.02	0.02	0.02	0.85	0.04	0.03
Maximum Potential Annual Impact	(μg/m^3)	0.05	0.06	0.06	1.78	0.10	0.08
Maximum Short-Term Impact	(μg/m^3)	3	4	4	116	6	5

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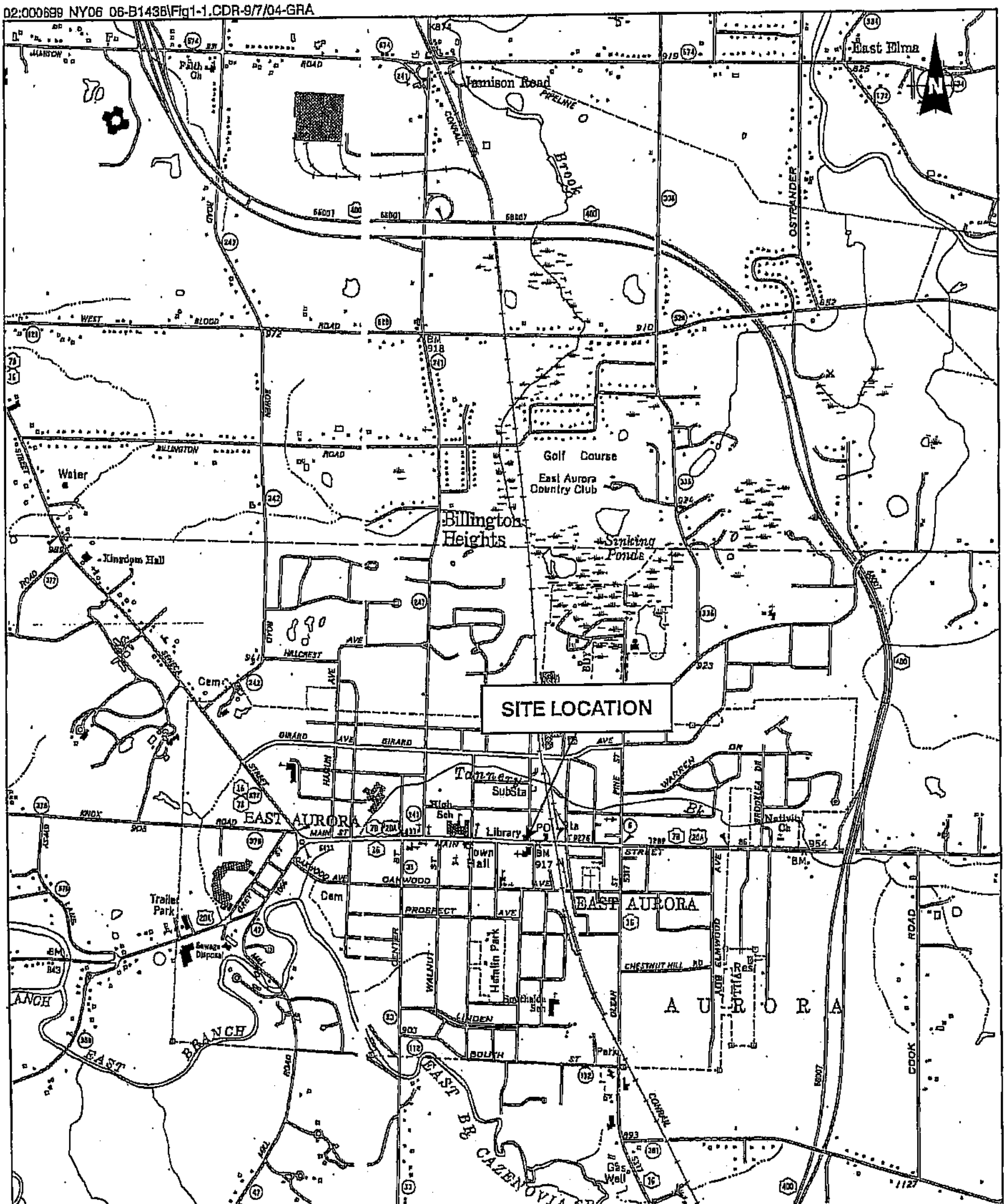

SOURCE: NYS Department of Transportation Raster Quadrangle, 1988.

SCALE

0 2,000 4,000 Feet

Figure 1-1 Mr. C's Dry Cleaners NYSDEC Standby Contract Site Location Map

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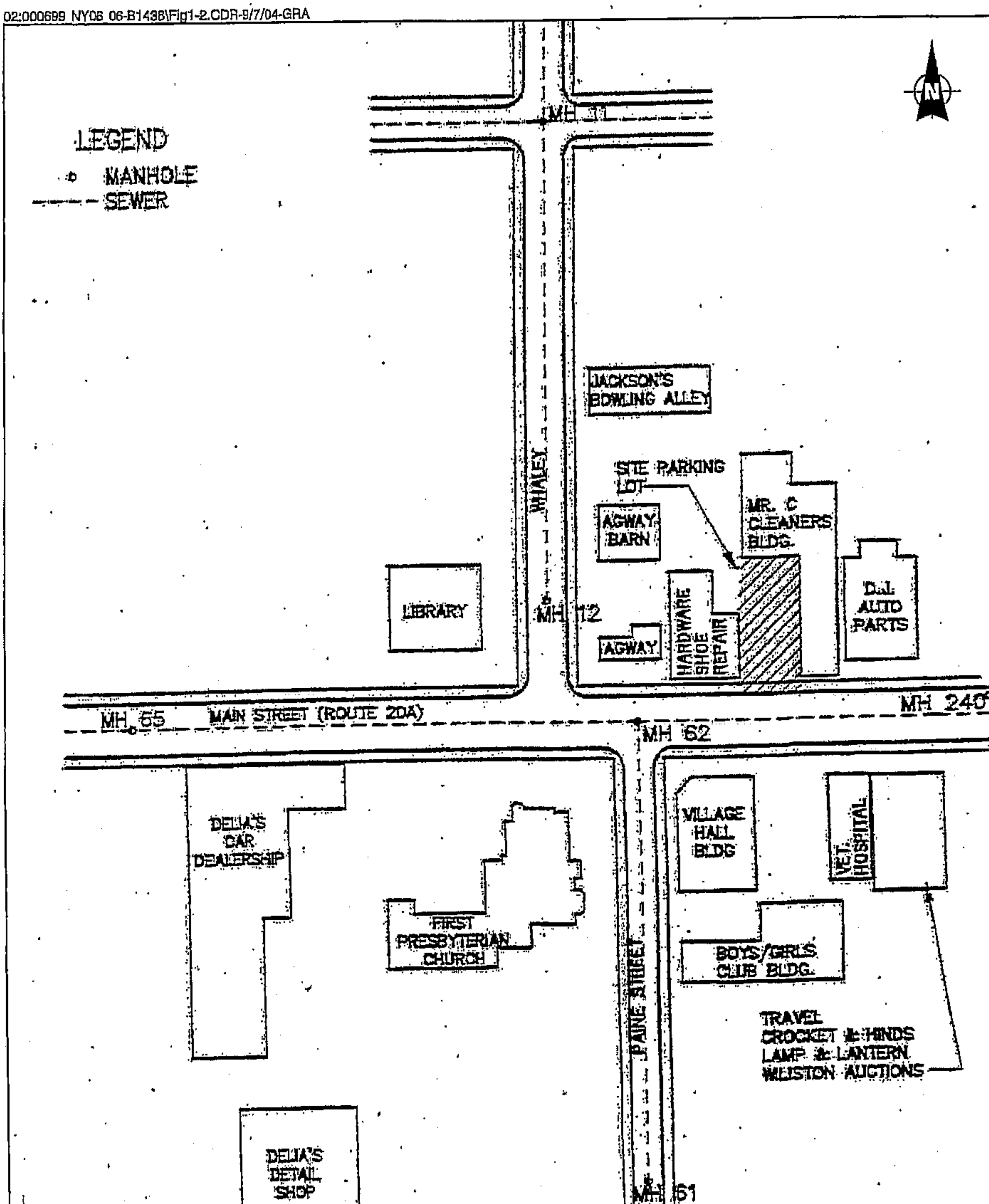

SOURCE: Malcolm Pirnie, Figure 3-2, July 1994.

SCALE

0 100 200 Feet

Figure 1-2 Mr. C's Dry Cleaners Remedial Investigation Report
Site Vicinity Map