N61165.AR.003655
CNC CHARLESTON
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MONITORED NATURAL ATTENUATION OF SOLID WASTE MANAGEMENT 039 (SWMU 039)PRESENTATION CNC CHARLESTON SC
4/14/1998
ENSAFE

To: Charleston Project Team
From: Charles Vernoy and Todd Kafka
Subject: Monitored Natural Attenuation of SWMU 039
Date: April 14, 1998

The purpose of this presentation is to provide an overview of data collected to this point of contaminated wells at SWMU 039 and assess the possibility of monitored natural attenuation being a remedial alternative to an engineered remedy. As stated in the USEPA Region IV natural attenuation document, at a minimum, the following needs to demonstrated for the consideration of natural attenuation: 1) site characterization presented and supported, 2) remedial action for the source to be provided, 3) a long term monitoring plan provided, 4) a comparison of the natural attenuation remedy to an engineering remedy, 5) the enumeration of institutional controls that are currently operational and enforceable for the site and 6) determination of the carbon source and it's sustainability for chlorinated solvent degradation. Along with source treatment, natural attenuation of the groundwater may reduce the concentration of contaminants to the remediation goals/levels determined to be protective of human health and ecological environment in a reasonable time frame.

In the review of data collected at SWMU 039, two primary of contaminant plumes have been identified in the groundwater. One type is a fuel hydrocarbon plume composed of benzene, ethylbenzene, toluene and xylene (BETX) and the other type is chlorinated aliphtalic which includes tetrachlorethene, trichlorethene, dichloroethene and vinyl chloride (PCE, TCE, DCE,VC). Because it is more difficult to predict the long-term behavior of chlorinated hydrocarbon plumes than fuel hydrocarbon plumes, it is important to have a thorough understanding of the natural attenuation mechanisms. An understanding of the interaction between the chlorinated hydrocarbons, natural carbon present and inorganic electron acceptors (ie. dissolved oxygen, nitrate, sulfate) is needed for quantification of biodegradation.

In pursuit of that understanding, there are three points of evidence that can be used to support biological degradation of chlorinated solvents:
1. Observed reduction in contaminant concentrations along the flow path downgradient from the source of contamination.
2. Documented loss of contaminant mass at the field scale.
3. Microbiological laboratory or field data that support the occurrence of biodegradation and yield rates of biodegradation.

To determine that the three points of evidence exists, the nine step process, as outlined in the handout, is to be implemented and followed to completion. Step one (review available data, and develop a preliminary conceptual model) and step two (screen the site, and assess the potential for natural attenuation) have begun. Concurrently all past SWMU 039 monitoring well groundwater and DPT groundwater, geological cross sections and representative groundwater flow maps have been reviewed. Additionally, the first round of monitoring natural attenuation parameter data has been tabulated and plotted. We will begin to refine the monitoring natural attenuation data

collection parameters and processes while refining the preliminary conceptual model in an attempt to better demonstrate the potential for monitored natural attenuation at SWMU 039.

Monitored Natural Attenuation at SWMU 39

Objective of Presentation

- Overview of chemical and physical data collected to date to assess potential for MNA.
- Preliminary ranking of well locations for potential MNA.
- *Draft EPA Region 4 Suggested Practices for Evaluation of a Site for Natural Attenuation (Biological Degradation) of Chlorinated Solvents, November 1997*

Primary Groundwater contaminants at SWMU 39

Fuel Hydrocarbons and Chlorinated Aliphatic Hydrocarbons

- Fuel HCs:
  - Benzene
  - Ethylbenzene
  - Toluene
  - Xylene

- Chlorinated Aliphatic HCs:
  - Tetrachloroethene (PCE)
  - Trichloroethene (TCE)
  - Dichloroethene (DCE)
  - Vinyl Chloride (VC)

Biological Degradation of Chlorinated Solvents

Three lines of evidenced required for support:

- 1. Observed reduction in contaminant concentrations along the flow path downgradient from the source.
- 2. Document loss of contaminant mass at the field scale.
  - Chemical and geochemical analytical data
  - Estimate residence time along GW flowpath using conservative tracer.
  - Calculate biological decay rates.
- 3. Microbiological lab or field data to support occurrence of NA and yield biodegradation rates.

Reductive Dechlorination

Vinyl chloride oxidized to carbon dioxide

PCE ⇨ TCE ⇨ DCE ⇨ VC ⇨ CO_2

Reductive Dechlorination

Vinyl chloride reduced to ethene

PCE ⇨ TCE ⇨ DCE⇨ VC ⇨ Ethene

Ethene may be further reduced to Ethane or Methane.

Quantification of Contaminant Migration and Attenuation

9 step process: Steps 1 and 2 underway

- 1. Review available site data; develop preliminary conceptual model.
- 2. Screen the site; assess the potential for NA.
- (See packet for remaining 7 steps.)

From USEPA Doc, ver. 3.0

supports the natural reduction and removal of the dissolved contaminant plume.

Figure 2 outlines the steps involved in the natural attenuation demonstration. Figure 2 also shows the important regulatory decision points in the process of implementing natural attenuation. Predicting the fate of a contaminant plume requires the quantification of solute transport and transformation processes.

Quantification of contaminant migration and attenuation rates and successful implementation of the natural attenuation remedial option requires completion of the following steps:

1. Review available site data, and develop a preliminary conceptual model.
2. Screen the site, and assess the potential for natural attenuation.
3. Collect additional site characterization data to support natural attenuation, as required.
4. Refine the conceptual model, complete premodeling calculations, and document indicators of natural attenuation.
5. Simulate natural attenuation using analytical or numerical solute fate-and-transport models that allow incorporation of a biodegradation term, as necessary.
6. Identify current and future receptors, and conduct an exposure-pathway analysis.
7. Determine whether source treatment will be remediation, removal, containment or a combination of these.
8. If natural attenuation (after source treatment) is acceptable, prepare a long-term monitoring plan.
9. Present findings to regulatory agencies.

Review Available Site Data, and Develop a Preliminary Groundwater Flow and Transport Conceptual Model

Existing site characterization data should be reviewed and used to develop a site-specific conceptual model. The preliminary conceptual model will help identify any shortcomings in the data and will allow placement of additional data collection points in the most scientifically advantageous and cost-effective manner. A site-specific conceptual model is a three-dimensional representation of the ground-water flow and solute transport system based on available geological, biological, geochemical, hydrological, climatological, and analytical data. This type of conceptual model differs from the conceptual site models that risk assessors commonly use that qualitatively consider the location of contaminant sources, release mechanisms, transport pathways, exposure points, and receptors. The groundwater system conceptual model, however, facilitates identification of these risk-assessment elements for the exposure pathways analysis. After development, the conceptual model can be used to help determine optimal placement of additional data collection points (as necessary) to aid in the natural attenuation investigation and to develop the solute fate-and-transport model.

Contracting and management controls must be flexible enough to allow for the potential for revisions to the conceptual model and thus the data collection effort. In cases where little or questionable site-specific data are available, all future site characterization activities should be designed to collect the data necessary to screen the site to determine the potential for remediation by natural attenuation. The data collected in support of natural attenuation can be used to design and support other remedial measures.

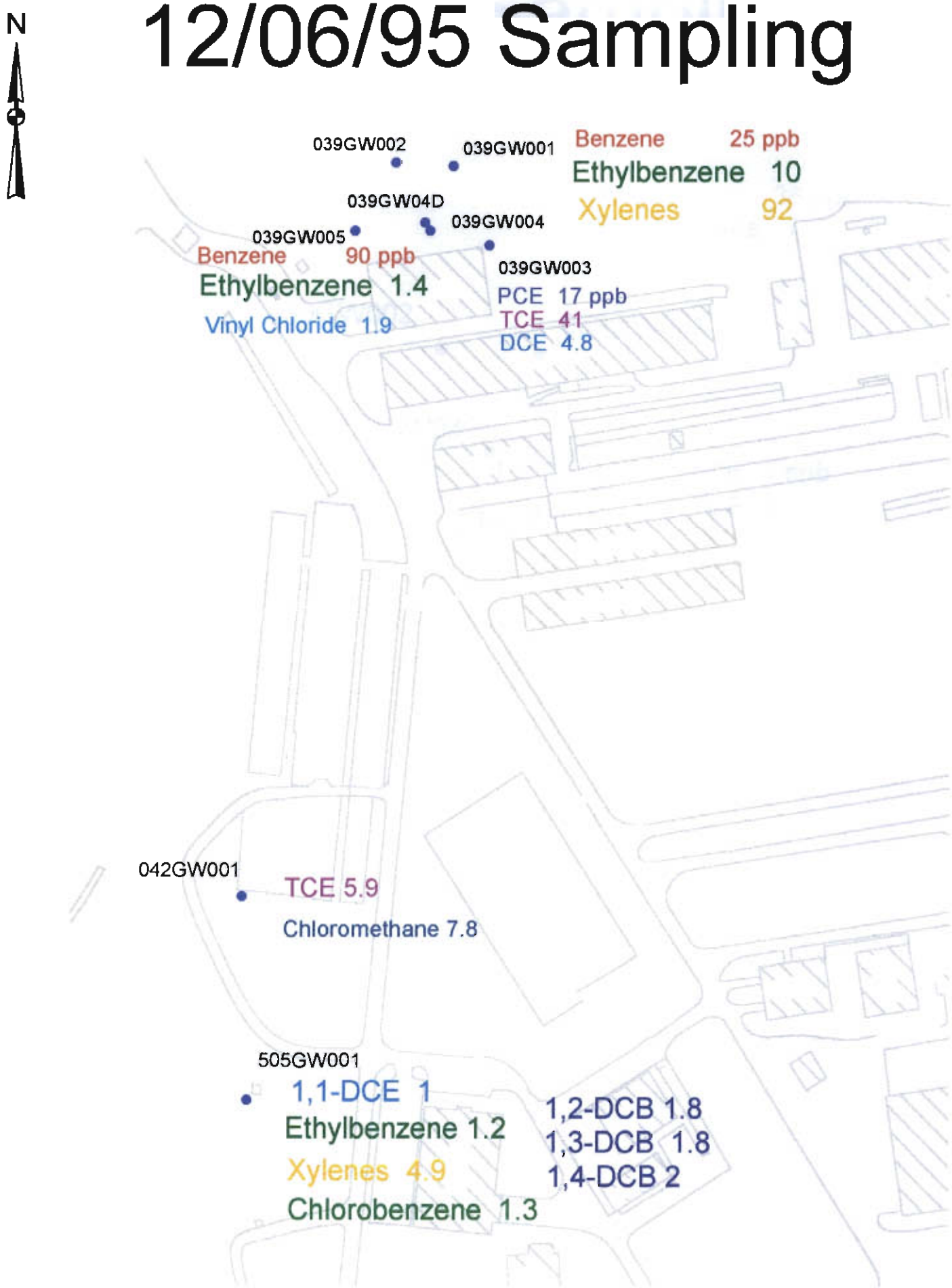
Table 1A. lists a standard set of methods, while Table 1B. lists methods that are under development and/or consideration for the soil and ground water analytical protocol for natural attenuation of chlorinated

Step 1

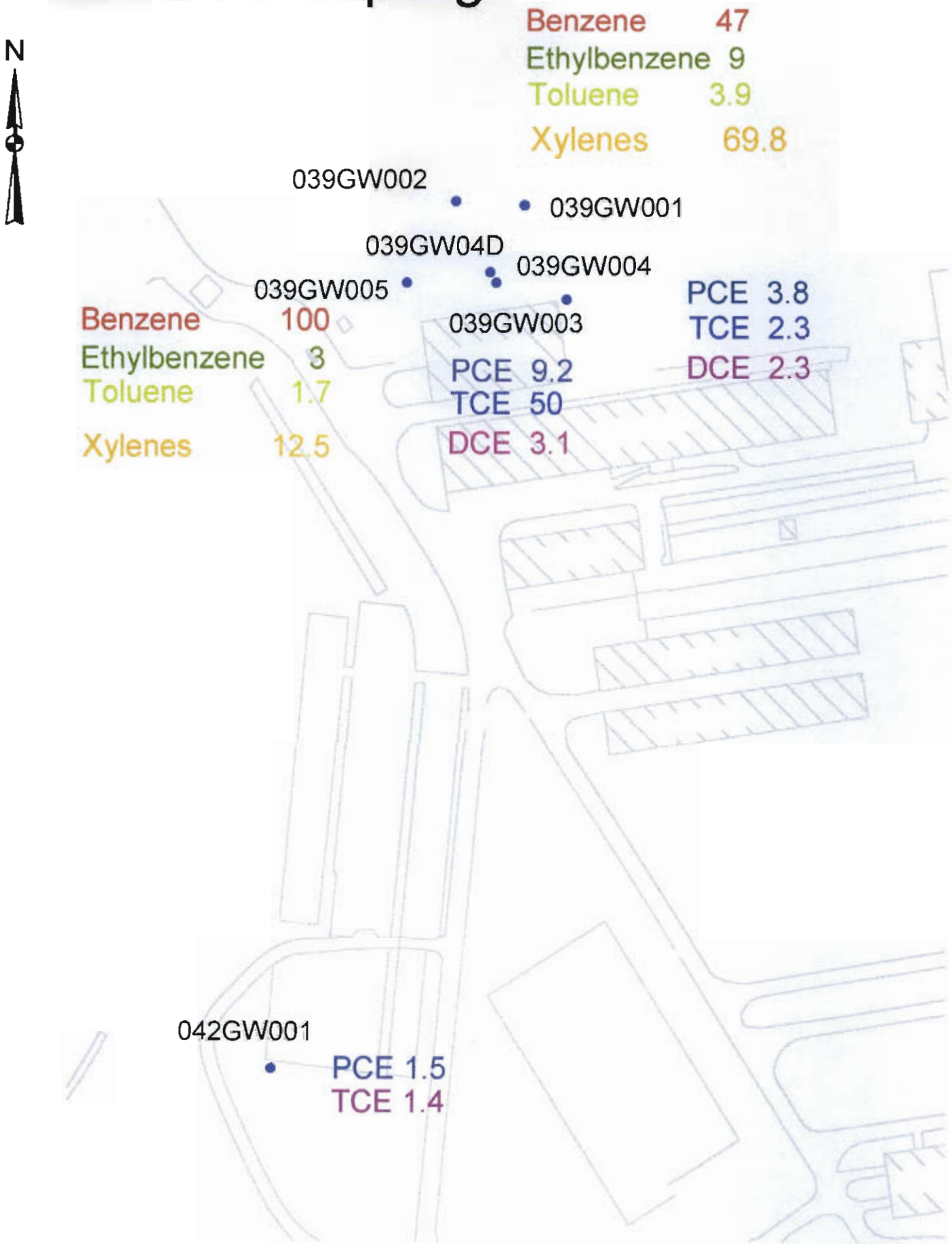
Review Site Data

- Sampling Events Results (handouts)
  - Due to multiple well installation phases, majority of data not coincident.
- Geoprobe Sample Results (June 1996)
  - First synoptic event
  - Used to assist in siting additional wells
  - Two separate areas of PCE contamination approx. 450 ft apart. Well and DPT locations in between reveal other chlorinated compounds but no PCE.

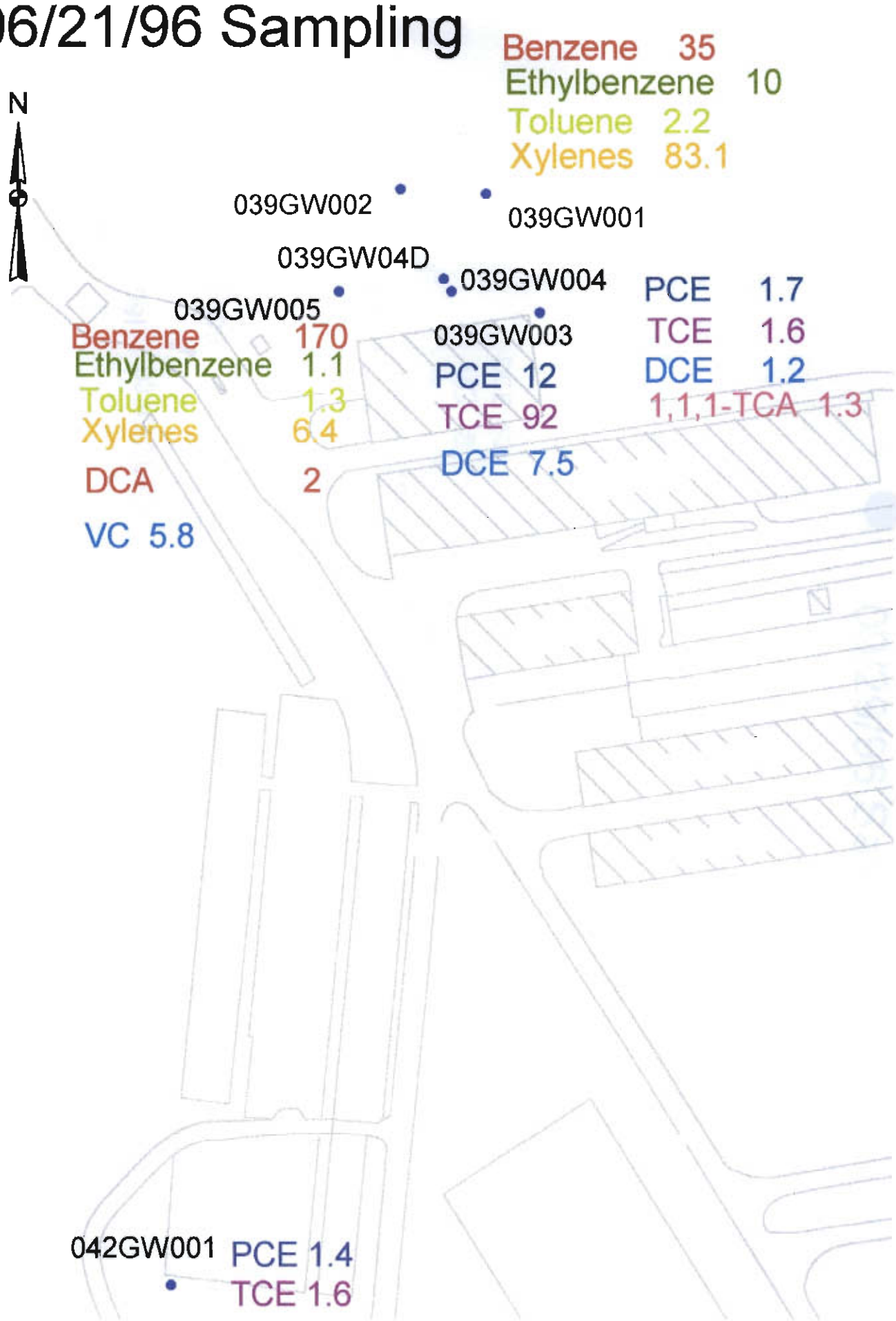
12/06/95 Sampling

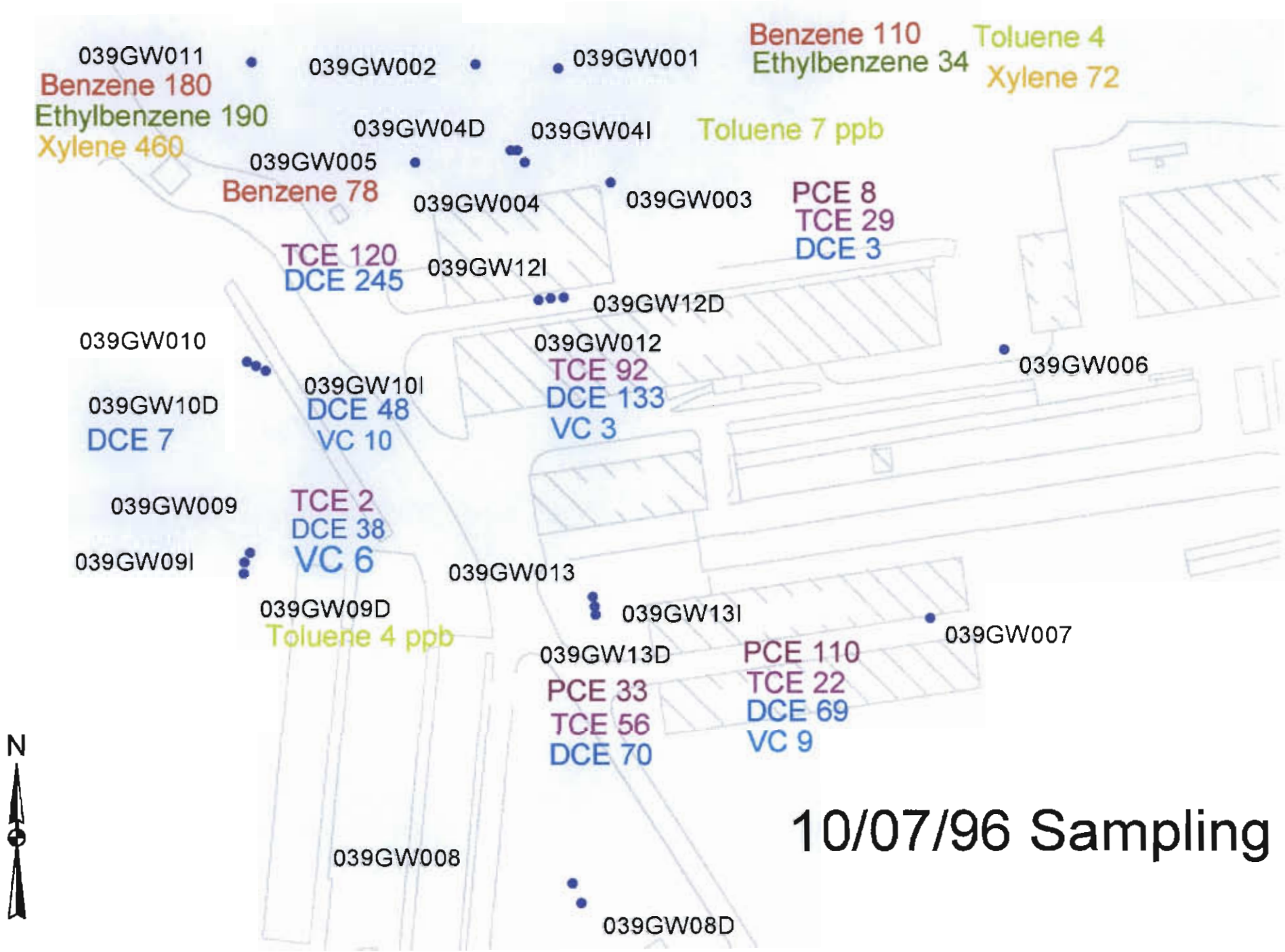


04/23/96 Sampling



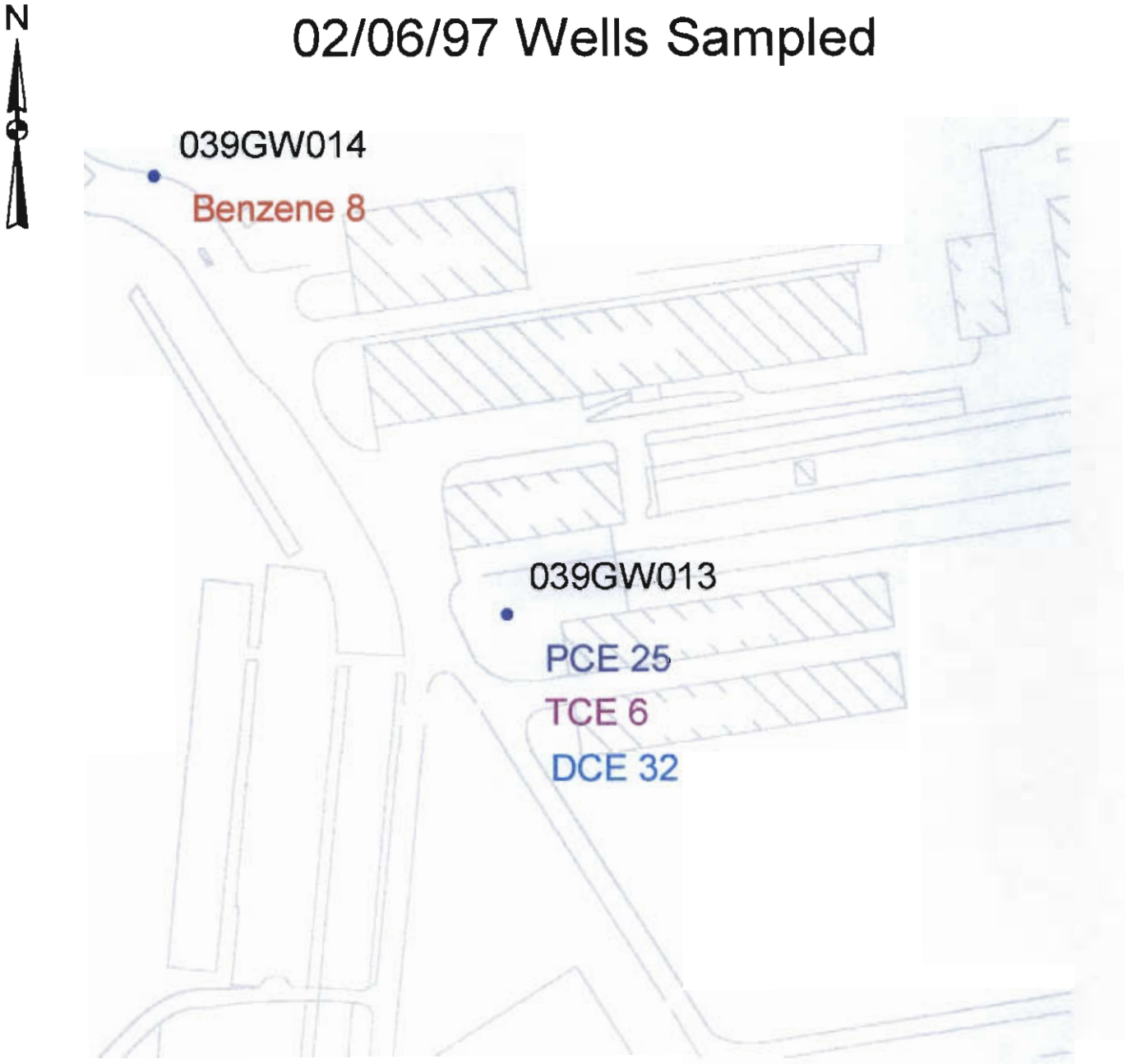
06/21/96 Sampling



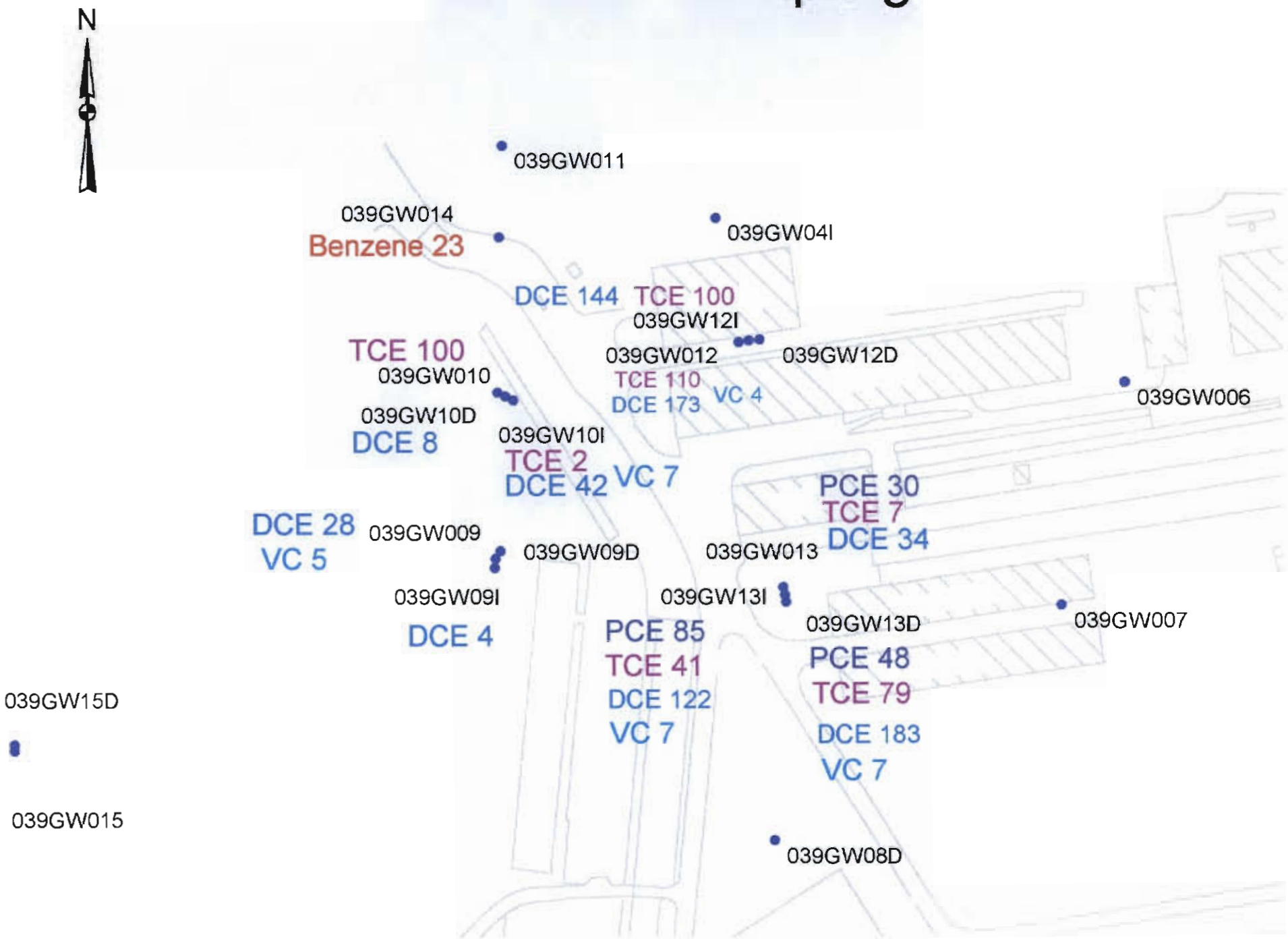


10/07/96 Sampling

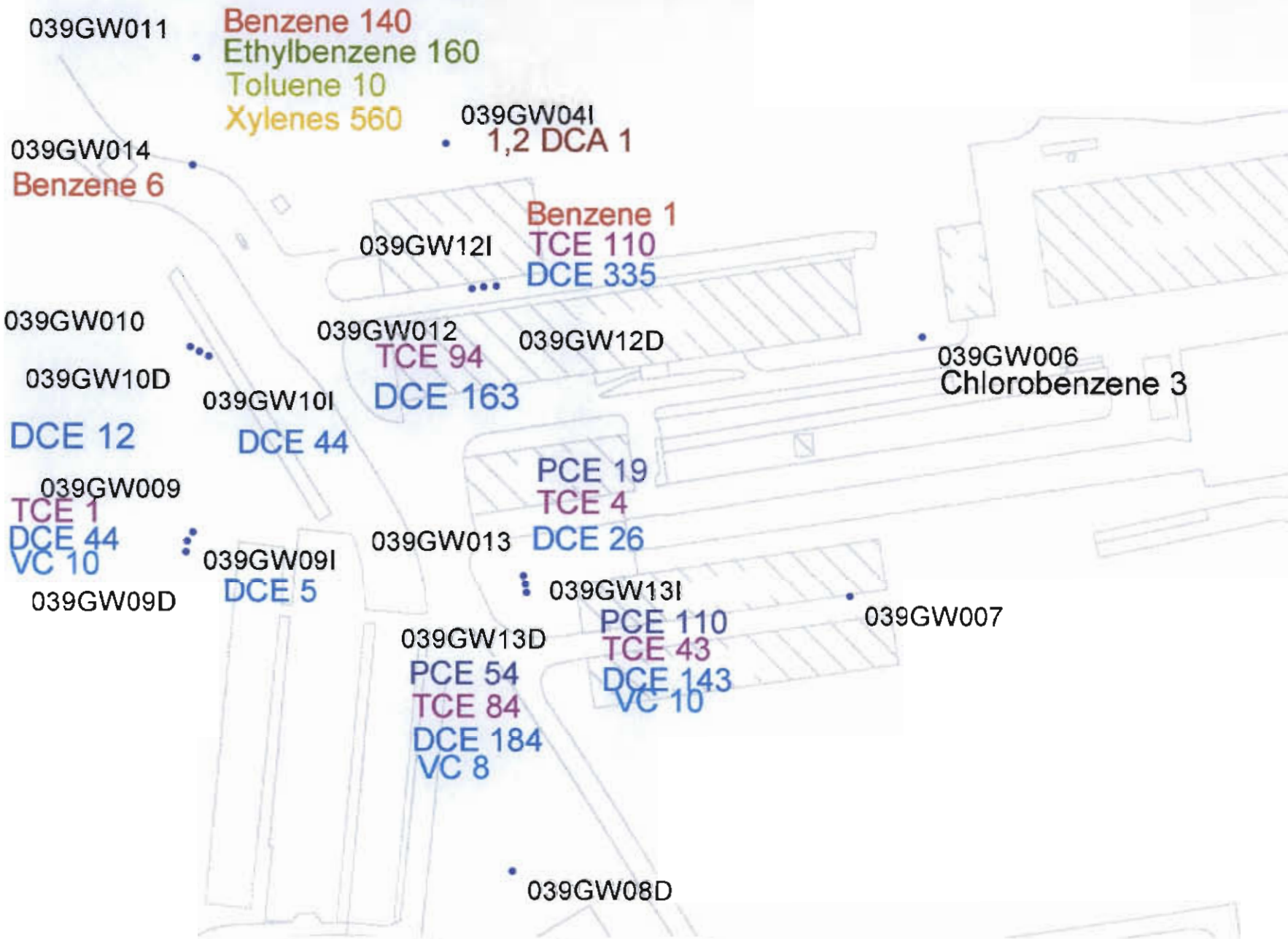
02/06/97 Wells Sampled

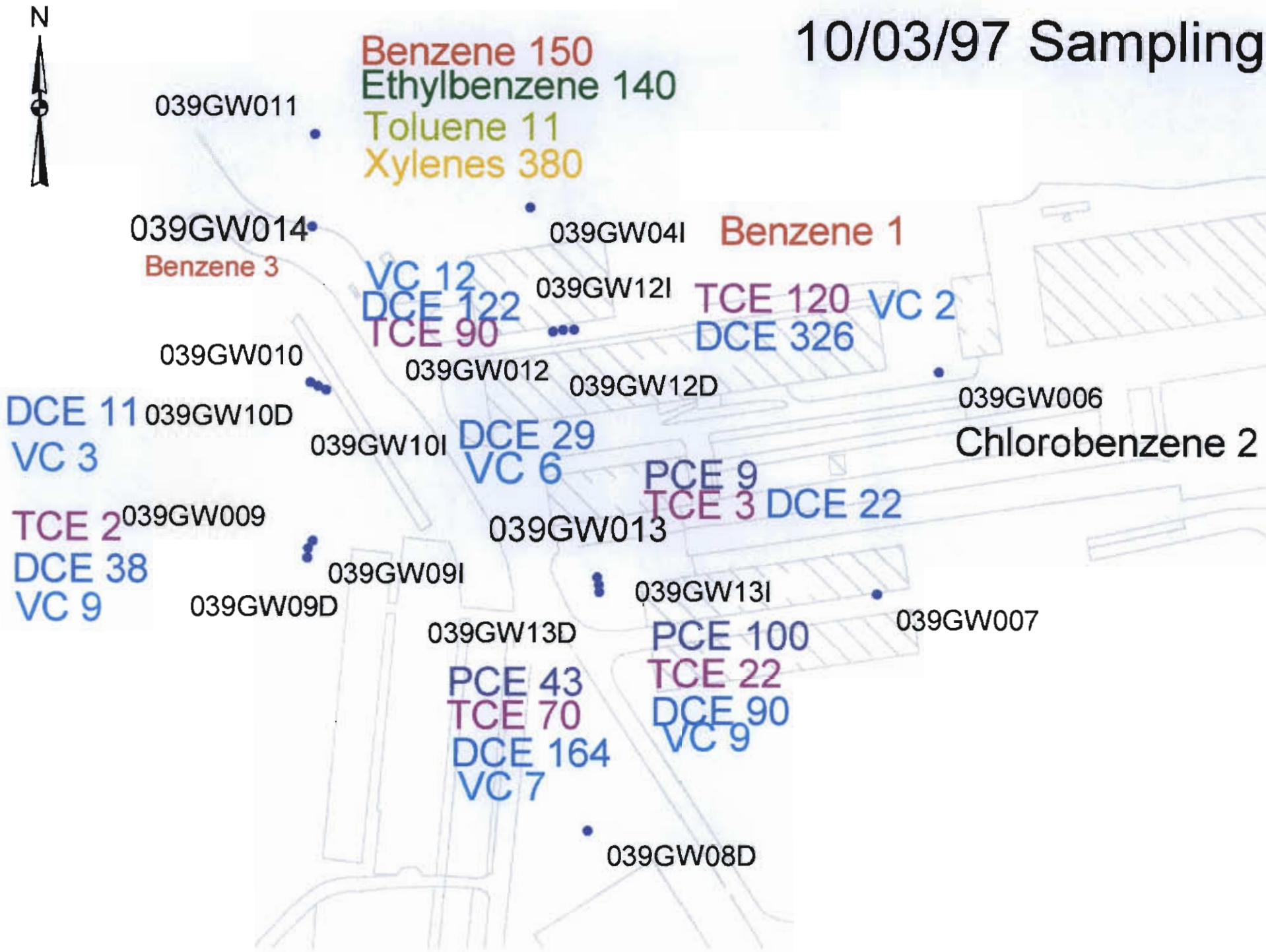


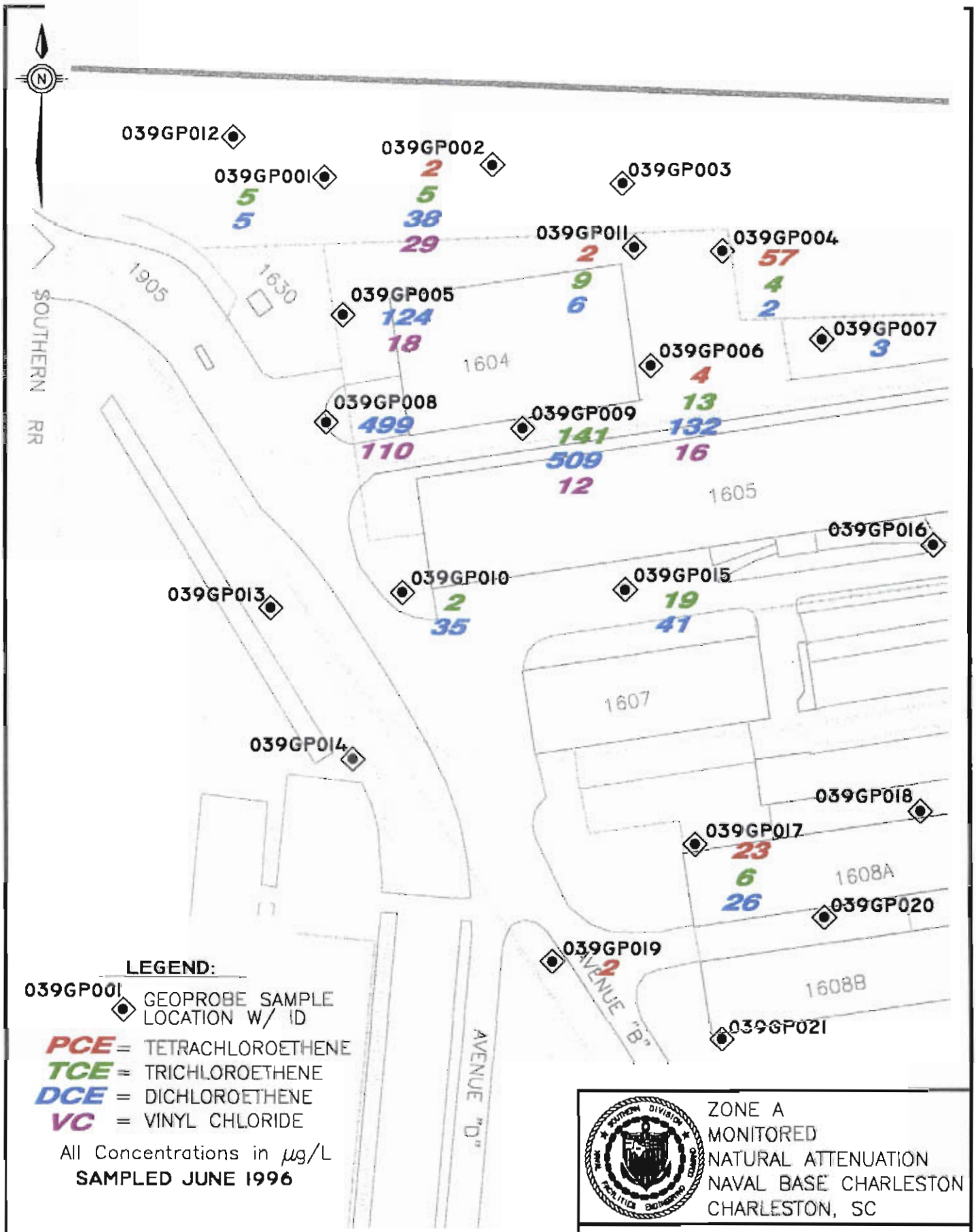
03/10/97 Sampling



07/07/97 Sampling




N
10/03/97 Sampling
Benzene 150
Ethylbenzene 140
Toluene 11
Xylenes 380
039GW011
039GW014
Benzene 3
039GW04I
Benzene 1
VC 12
DCE 122
TCE 90
039GW12I
TCE 120
DCE 326
VC 2
039GW010
039GW012
039GW12D
039GW006
DCE 11
039GW10D
VC 3
039GW10I
DCE 29
VC 6
Chlorobenzene 2
PCE 9
TCE 3
DCE 22
TCE 2
039GW009
DCE 38
VC 9
039GW013
039GW09I
039GW09D
039GW13I
039GW007
039GW13D
PCE 100
TCE 22
DCE 90
VC 9
PCE 43
TCE 70
DCE 164
VC 7
039GW08D

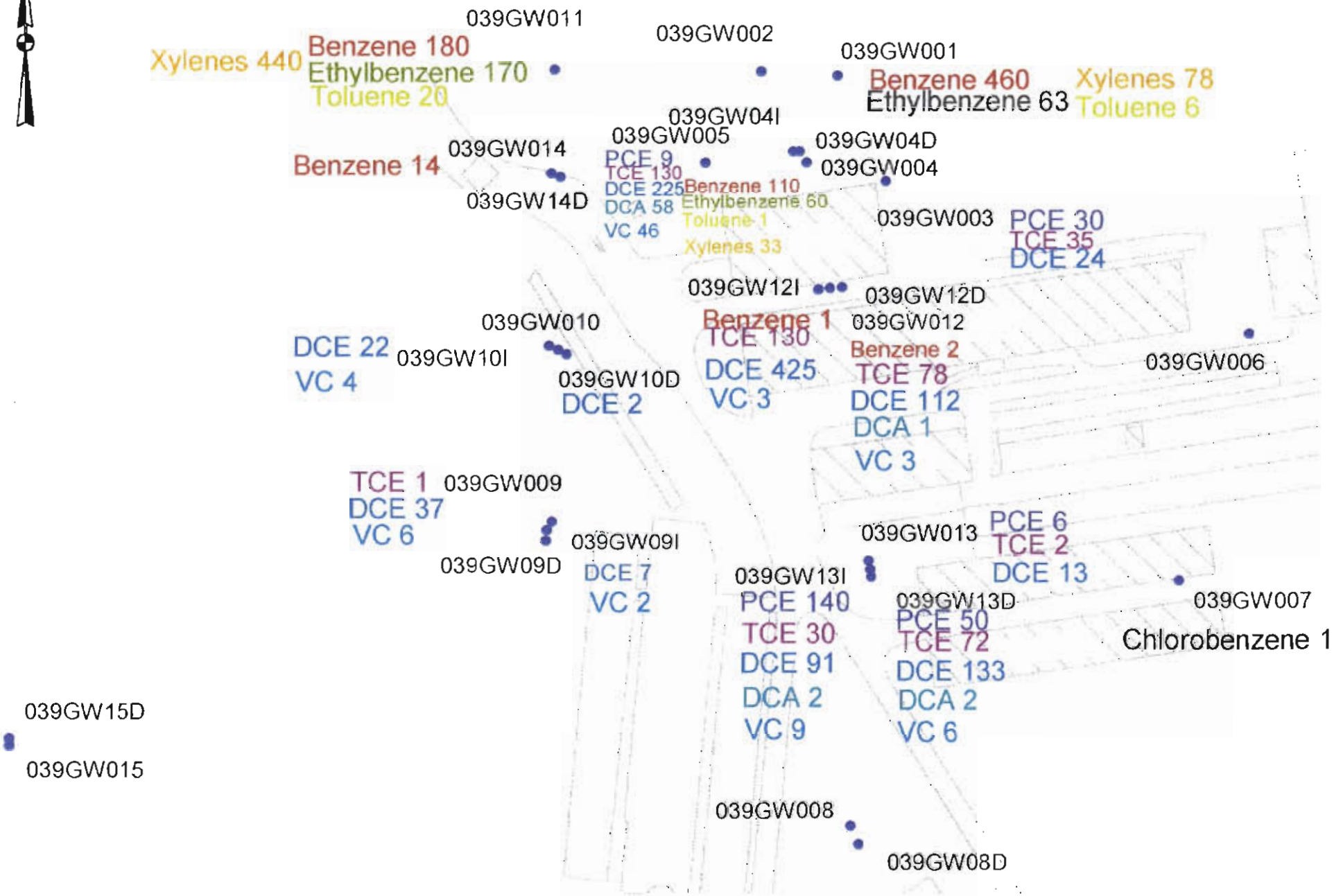

N
039GP012
039GP001
5
5
039GP002
2
5
38
29
039GP003
039GP011
2
9
6
039GP004
57
4
2
039GP005
124
18
039GP007
3
039GP006
4
13
132
16
039GP008
499
110
039GP009
141
509
12
039GP016
039GP010
2
35
039GP015
19
41
039GP013
039GP014
039GP018
039GP017
23
6
26
039GP020
039GP019
2
039GP021
1905
1630
1604
1605
1607
1608A
1608B
SOUTHERN RR
AVENUE "B"
AVENUE "D"
LEGEND:
039GP001 GEOPROBE SAMPLE LOCATION W/ ID
PCE = TETRACHLOROETHENE
TCE = TRICHLOROETHENE
DCE = DICHLOROETHENE
VC = VINYL CHLORIDE
All Concentrations in µg/L
SAMPLED JUNE 1996
0 50 100 200 300
SCALE IN FEET
ZONE A
MONITORED
NATURAL ATTENUATION
NAVAL BASE CHARLESTON
CHARLESTON, SC
SWMU 39 GEOPROBE SAMPLE
CONCENTRATION LEVELS
Date: 04/10/98
DWG Name: NATATT-A

Step 2

Screen site and assess potential for natural attenuation

- 1st rd MNA results (Feb 98)
  - 2nd synoptic event
  - BETX in northern portion of SWMU 39
  - PCE detected at suspected source area north of Bldg. 1604 and at wells 039013/13I/13D.
  - TCE, DCE and VC extensive at:
    - 039005
    - 039003
    - Wells 039012/12I
    - Wells 039013/13I/13D
  - No VOCs detected at downgradient well pair (039008/08D).

Monitored Natural Attenuation



Step 2

Assess potential for natural attenuation

- 1st rd of MNA chemical data
  - Calculated preliminary ranking of well locations for potential MNA.
  - Points awarded according to EPA Guidance Document
    - Total points between 0-5 ⇨ INADEQUATE EVIDENCE
    - Total points between 6-14 ⇨LIMITED EVIDENCE
    - Total points between 15-20 ⇨ ADEQUATE EVIDENCE
    - Total points greater than 20 ⇨ STRONG EVIDENCE
  - 9 locations LIMITED; 10 locations ADEQUATE; and 7 locations STRONG. Somewhat subjective and likely to be refined as more data becomes available.

SWMU 39 MONITORING NATURAL ATTENUATION PRELIMINARY RANKING

	Analyte	units	039001	039002	039003	039004	03904D	03904I	039005	039006	039007	039008	03908D	039009	03909D	03909I0	039010	03910D	03910I
VOCs	PCE	ug/l			30				9										
	TCE	ug/l			35				130					1					
	1,1-DCA	ug/l							58										
	1,1-DCE	ug/l							5										
	1,2-DCE tot	ug/l			24				220					37		7		2	22
	Vinyl Chl	ug/l							46					6		2			4
	Benzene	ug/l	460						110										
	Ethylbenzene	ug/l	63						60										
	Toluene	ug/l	6						1										
	Xylene	ug/l	78						33										
Natural Attenuation Parameters	Alkalinity	ppm	64	42	52	82	39	48	53	75	68	86	12	44	38	54	25	72	68
	Spec Cond	mmho/cm	0.19	0.20	0.23	0.23	0.30	-147	0.15	0.24	0.67	0.42	0.23	0.08	0.69	0.12	0.01	0.10	0.11
	Ethane	ng/l	2516	ND	174	115	ND	9	1071	126	ND	ND	6	36	8	9	3	59	25
	Ethene	ng/l	ND	ND	13	ND	ND	41.1	10901	ND	ND	ND	6	538	17	120	10	11	60
	H_2 (gas)	nm/l	0.440	0.260	0.390	0.510	0.570	1.060	0.460	0.350	1.040	0.267	0.400	0.415	0.340	0.270	0.610	0.830	1.060
	Fe^{2+}	mg/l	33	14	0.5	2	0.5	0.5	36	10	16	14	17	0.5	0.5	1	0.5	0.5	10
	CH_4	mg/l	ND	0.034	ND	ND	ND	0.0002	ND	6688	8218	11366	ND	800	973	1096	3	416	348
	DO	mg/l	NA	0.2	0.1	1.1	0.0	0.1	0.3	1.4	0.5	0.3	0.2	0.2	0.4	0.6	1.1	0.4	1.4
	ORP	mV	-150	-57	70	-104	-215	0.37	-136	-118	-138	-55	40	-73	-83	-110	134	-136	-58
	Temp	°C	15.8	16.6	18.2	15.6	20.2	20.0	17.2	20.5	18.5	18.2	20.7	20.5	18.7	20.2	16.8	22.5	21.6
	pH		6.66	6.43	6.40	6.97	7.59	7.25	6.74	6.51	6.39	6.31	5.49	6.26	7.45	6.87	6.80	7.06	6.26
	Cl	mg/l	8	8	13	12	16	6	10	387	265	69	14	4	15	9	ND	7	5
	SO_4	mg/l	5520	35	5710	13	6	35	1	5620	5340	997	123	11	3	5	4490	5700	5510
	TOC	mg/l	10	4	ND	4	ND	3	5	10	10	12	ND	7	ND	ND	ND	ND	3
	NO_3 as N	mg/l	ND	ND	ND	ND	0.3	0.1	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Preliminary Screening Points & Ranking	DO	POINTS	0	3	3	-3	3	3	3	-3	3	3	3	3	3	0	-3	3	-3
	NO_3		0	0	0	0	2	2	0	0	0	0	0	0	0	0	0	0	0
	Fe II		3	3	0	3	0	0	3	3	3	3	3	0	0	3	0	0	3
	SO_4		0	0	0	2	2	0	2	0	0	0	0	2	2	2	0	0	0
	CH_4		0	0	0	0	0	0	0	3	3	3	0	3	3	3	3	3	3
	Redox		2	1	0	2	2	1	2	2	2	1	1	1	1	2	0	2	1
	pH		0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	TOC		0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	Temp		0	0	0	0	1	0	0	1	0	0	1	1	0	1	0	1	1
	CO_2*		0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	Alk*		1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
	Cl*		0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	H_2		0	0	0	0	0	3	0	0	3	0	0	0	0	0	0	0	3
	VFA		0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	BTEX		2	0	0	0	0	0	2	0	0	0	0	0	0	0	0	0	0
	PCE		0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	TCE		0	0	2	0	0	0	2	0	0	0	0	2	0	0	0	0	0
	DCE		0	0	2	0	0	0	2	0	0	0	0	2	0	2	0	2	2
	VC		0	0	0	0	0	0	2	0	0	0	0	2	0	2	0	0	2
	Ethene		0	0	3	0	0	3	3	0	0	0	3	3	3	3	3	3	3
	Ethane		3	0	3	3	0	3	3	3	0	0	3	3	3	3	3	3	3
	DCA		0	0	0	0	0	0	2	0	0	0	0	0	0	0	0	0	0
	CA		0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	Tot Pts		**11**	**8**	**14**	**8**	**11**	**16**	**27**	**10**	**15**	**11**	**15**	**23**	**16**	**22**	**7**	**18**	**19**
	NA evidence?		limited	limited	limited	limited	limited	adequate	strong	limited	adequate	limited	adequate	strong	adequate	strong	limited	adequate	adequate

SWMU 39 MONITORING NATURAL ATTENUATION PRELIMINARY RANKING

	Analyte	039011	039012	03912D	03912I	039013	03913I	03913D	039014	03914D	039015	03915D
VOCs	PCE					6	140	50				
	TCE		78		130	2	30	72				
	1,1-DCA		1				2	2				
	1,1-DCE		2		5		2	3				
	1,2-DCE tot		110		420	13	88	130				
	Vinyl Chl		3		3		9	6				
	Benzene	180	2		1				14			
	Ethylbenzene	170										
	Toluene	20										
	Xylene	440										
Natural Attenuation Parameters	Alkalinity	34	63	68	51	10	52	40	52	40	82	76
	Spec Cond	0.24	0.30	0.32	0.17	88	0.24	0.14	0.13	0.09	3.7	0.57
	Ethane	405	606	58	112	2	106	67	82	42	1628	10
	Ethene	ND	244	53	344	11	193	99	ND	13	ND	12
	H_2 (gas)	3.550	0.250	0.170	0.110	0.360	0.625	0.290	0.500	0.500	0.515	0.795
	Fe^{2+}	48	37	10	0.6	0.5	0.5	0.5	28	0.5	0.5	0.5
	CH_4	130025	ND	ND	ND	ND	1442	438	2753	401	67003	430
	DO	0.3	NA	0.0	0.1	0.8	0.4	0.3	0.9	0.3	0.3	0.3
	ORP	-154	-128	-162	-112	63	113	75	-131	-138	-21	-201
	Temp	17.6	16.7	20.0	20.0	16.7	21.4	20.7	17.9	21.1	18.8	21.2
	pH	6.21	6.73	7.80	6.94	5.47	5.93	5.99	6.76	7.47	7.62	7.41
	Cl	6	ND	ND	12	4	7	14	17	6	1800	153
	SO_4	ND	5090	4930	5210	34	20	27	7	28	79	50
	TOC	29	3	ND	ND	ND	ND	ND	6	ND	17	ND
	NO_3 as N	ND	ND	ND	ND	0.34	ND	ND	ND	ND	ND	ND
Preliminary Screening Points & Ranking	DO	3	0	3	3	0	3	3	0	3	3	3
	NO_3	0	0	0	0	2	0	0	0	0	0	0
	Fe II	3	3	3	0	0	0	0	3	0	0	0
	SO_4	0	0	0	0	0	2	0	2	0	0	0
	CH_4	3	0	0	0	0	3	3	3	3	3	3
	Redox	2	2	2	2	0	0	0	2	2	1	2
	pH	0	0	0	0	0	0	0	0	0	0	0
	TOC	2	0	0	0	0	0	0	0	0	0	0
	Temp	0	0	0	0	0	1	1	0	1	0	1
	CO_2*	0	0	0	0	0	0	0	0	0	0	0
	Alk*	1	1	1	1	1	1	1	1	1	1	1
	Cl*	0	0	0	0	0	0	0	0	0	0	0
	H_2	3	0	0	0	0	0	0	0	0	0	0
	VFA	0	0	0	0	0	0	0	0	0	0	0
	BTEX	2	2	0	2	0	0	0	2	0	0	0
	PCE	0	0	0	0	0	0	0	0	0	0	0
	TCE	0	2	0	2	2	2	2	0	0	0	0
	DCE	0	2	0	2	2	2	2	0	0	0	0
	VC	0	2	0	2	0	2	2	0	0	0	0
	Ethene	0	3	3	3	3	3	3	0	3	0	3
	Ethane	3	3	3	3	3	3	3	3	3	3	3
	DCA	0	2	0	0	0	2	2	0	0	0	0
	CA	0	0	0	0	0	0	0	0	0	0	0
	Tot Pts	**22**	**22**	**15**	**20**	**13**	**24**	**22**	**16**	**16**	**11**	**16**
	NA evidence?	**strong**	**strong**	**adequate**	**adequate**	**limited**	**strong**	**strong**	**adequate**	**adequate**	**limited**	**adequate**

SWMU 39 MONITORING NATURAL ATTENUATION PRELIMINARY RANKING

Notes:	* =	parameters must exceed 2X background			
"Background" locations:			Avg of results from "background" locations		
Shallow wells:	002001		Cl =	2276	mg/l
	002002		Alk =	5	ppm
	002003		CO_2 =	no values	
	GDA002				
	GDA001				
	039015				
Deep wells:	GDA02D		Cl =	8304	mg/l
	GDA01D		Alk =	5	ppm
	03915D		CO_2 =	no values	

Table 2: Analytical Parameters and Weighting for Preliminary Screening

Analyte	Concentration in Most Contaminated zone	Interpretation	Points Awarded
Oxygen[a]	< 0.5 mg/L	Tolerated; suppresses reductive dechlorination at higher concentrations	3
Oxygen[a]	> 1 mg/L	Vinyl chloride may be oxidized aerobically, but reductive dechlorination will not occur	-3
Nitrate[a]	< 1 mg/L	At higher concentrations may compete with reductive pathway at higher concentrations	2
Iron (II)[a]	> 1 mg/L	Reductive pathway possible; vinyl chloride may be oxidized under Fe(III)-reducing conditions	3
Sulfate[a]	< 20 mg/L	At higher concentrations may compete with reductive pathway	2
Sulfide[a]	> 1 mg/L	Reductive pathway possible	3
Methane[a]	<0.5 mg/L	vinyl chloride oxidizes	0
Methane[a]	> 0.5 mg/L	Ultimate reductive daughter product, vinyl chloride accumulates	3
Oxidation reduction potential[a] (ORP)	< 50 mV <-100 mV	Reductive pathway possible Reductive pathway likely	1 2
pH[a]	5 < pH < 9 (5 > pH> 9	Optimal range for reductive pathway Outside optimal range for reductive pathway	0 -2
TOC (total organic carbon)	> 20 mg/L	Carbon and energy source; drives dechlorination; can be natural or anthropogenic	2
Temperature	> 20°C	At T > 20°C, biochemical process is accelerated	1
Carbon Dioxide[a]	> 2 times background	Ultimate oxidative daughter product	1
Alkalinity	> 2 times background	Results from interaction of carbon dioxide with aquifer minerals	1
Chloride[a]	> 2 times background	Daughter product of organic chlorine	2
Hydrogen	> 1 nM	Reductive pathway possible; vinyl chloride may accumulate	3
Hydrogen	< 1 nm	Vinyl chloride oxidized	0
Volatile fatty acids	> 0.1 mg/L	Intermediates resulting from biodegradation of aromatic compounds; carbon and energy source	2
BTEX[a]	> 0.1 mg/L	Carbon and energy source; drives dechlorination	2
Perchloroethene		Material Released	0
Trichloroethene[a]		Material released Daughter product of perchloroethene	0 2[b]
Dichloroethene[a]		Material released or daughter product of trichloroethene Daughter product of trichloroethene *if amount of cis-12-dichloroethene is greater than 80% of total* dichloroethene, it is likely a daughter product of trichloroethene; 1,1-DCE can be chemical reaction product of TCA	0 2[a]
Vinyl chloride[a]		Material released Daughter product of dichloroethene	0 2[b]
Ethene/Ethane	> 0.01 mg/L > 0.1 mg/L	Daughter product of vinyl chloride/ethene	2 3
Dichloroethane		Daughter product of trichloroethene	2
Chloroethane[a]		Daughter product of vinyl chloride under reducing conditions	2

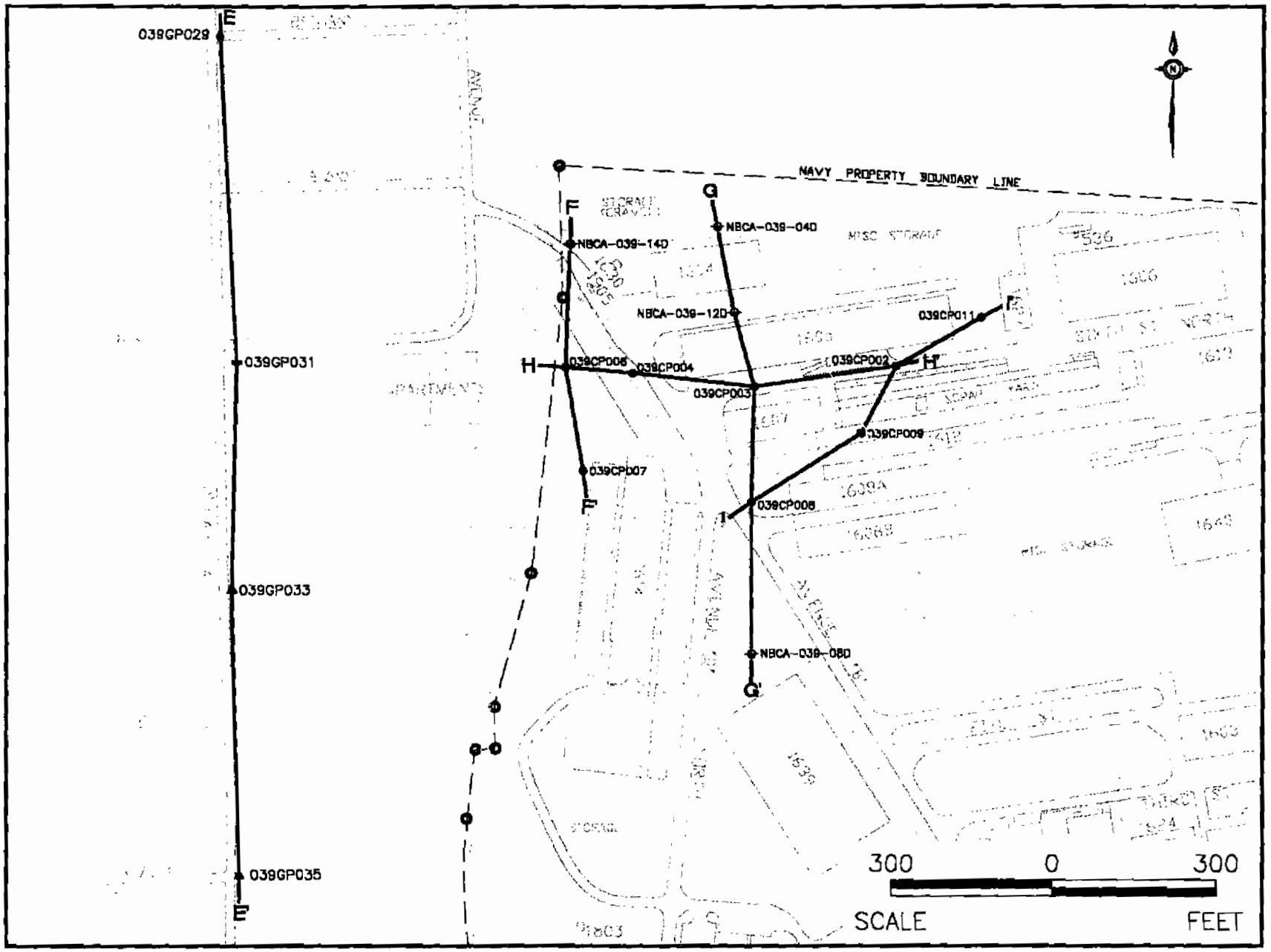
Analyte	Concentration in Most Contaminated zone	Interpretation	Points Awarded
1,1,1-Trichloroethane[a]		Material Released	0
Chloroform		Material Released Daughter product of Carbon Tetrachloride	0 2
Carbon Tetrachloride		Material Released	0
Dichloromethane		Material Released Daughter product of chloroform	0 2

[a] Required Analysis
[b] Points awarded only if it can be shown that the compound is a daughter product (i.e., not a constituent of the source NAPL).

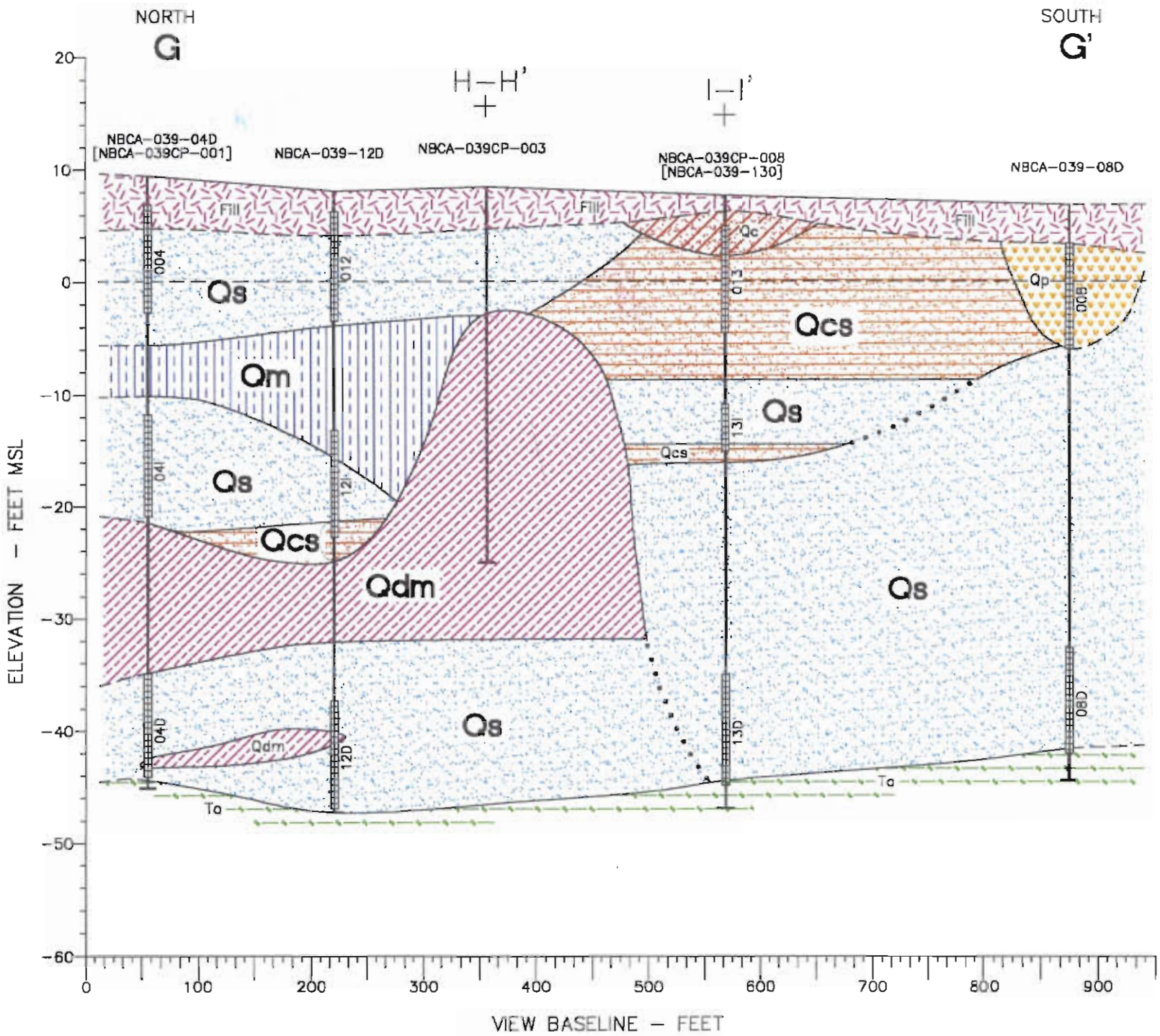
Step 1 and 2

Preliminary Conceptual Model

- Complex site geology
  - Isolated sand bodies and clay lenses
  - No clay lenses evident south of well cluster 13
- Hydrogeology
  - Shallow GW flow primarily N⇨S with components to SE and SW as dictated by recharge zone near wetland.
  - Intermediate and deep GW flow to S-SE
- BETX source(s) in northern portion of site
- Possibly more than one chlorinated solvent source area

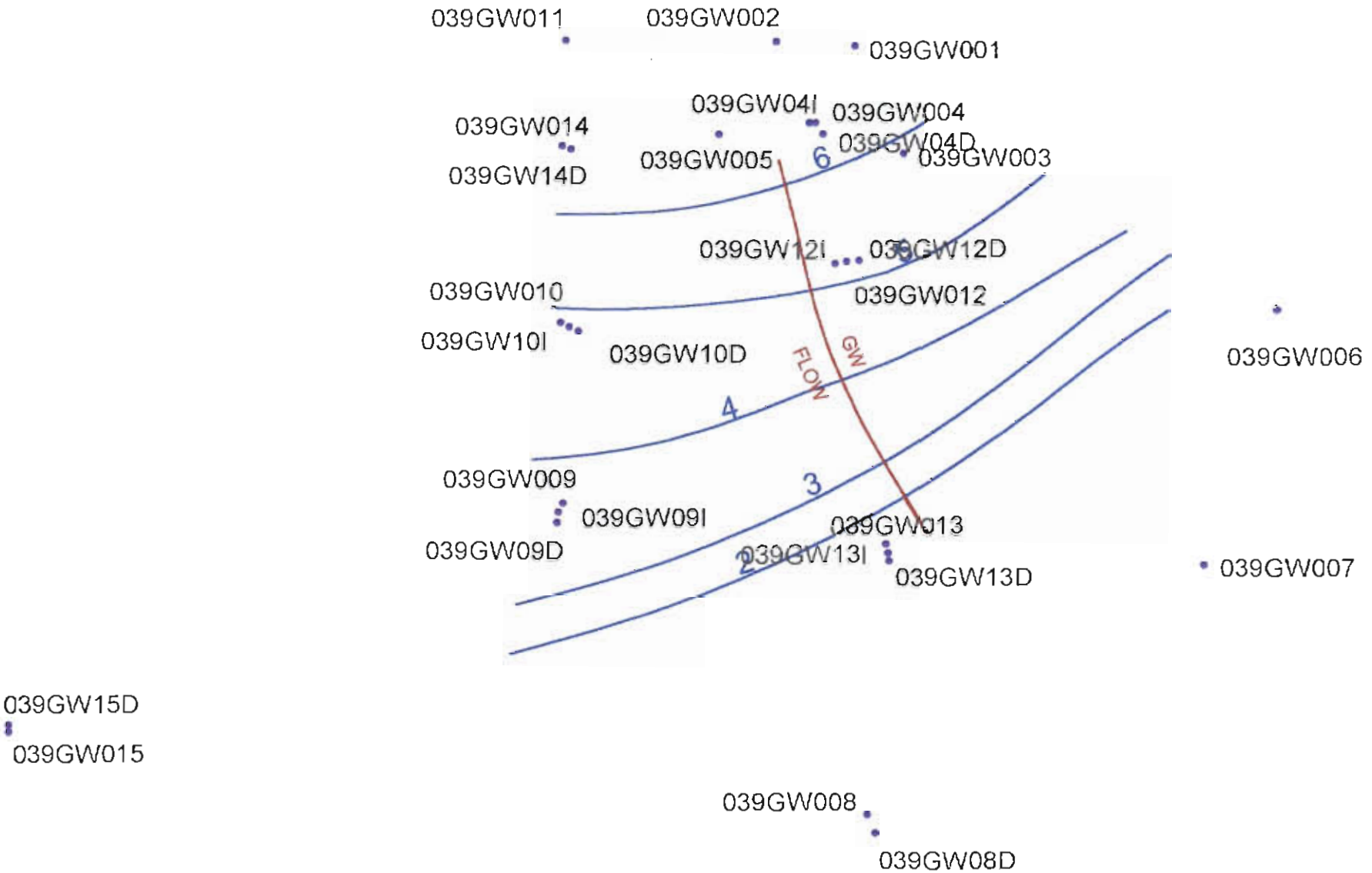


039GP029
E
039GP031
039GP033
039GP035
E'
NAVY PROPERTY BOUNDARY LINE
F
NBCA-039-14D
G
NBCA-039-04D
NBCA-039-12D
H
039CP006
039CP004
039CP003
039CP002
H'
039CP011
039CP009
039CP007
F'
039CP008
I
NBCA-039-08D
G'
300
0
300
SCALE
FEET

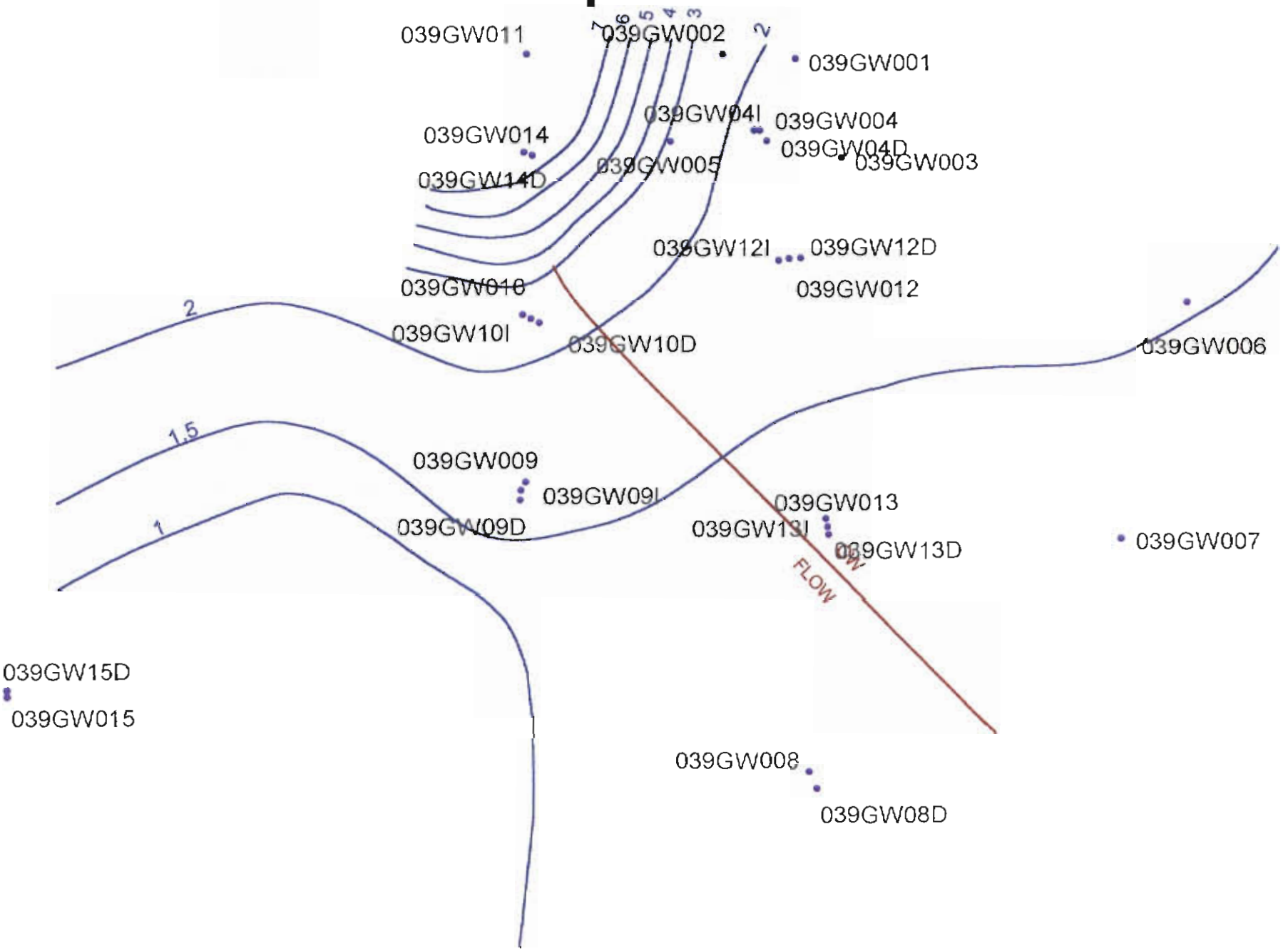


CROSS-SECTION G-G'

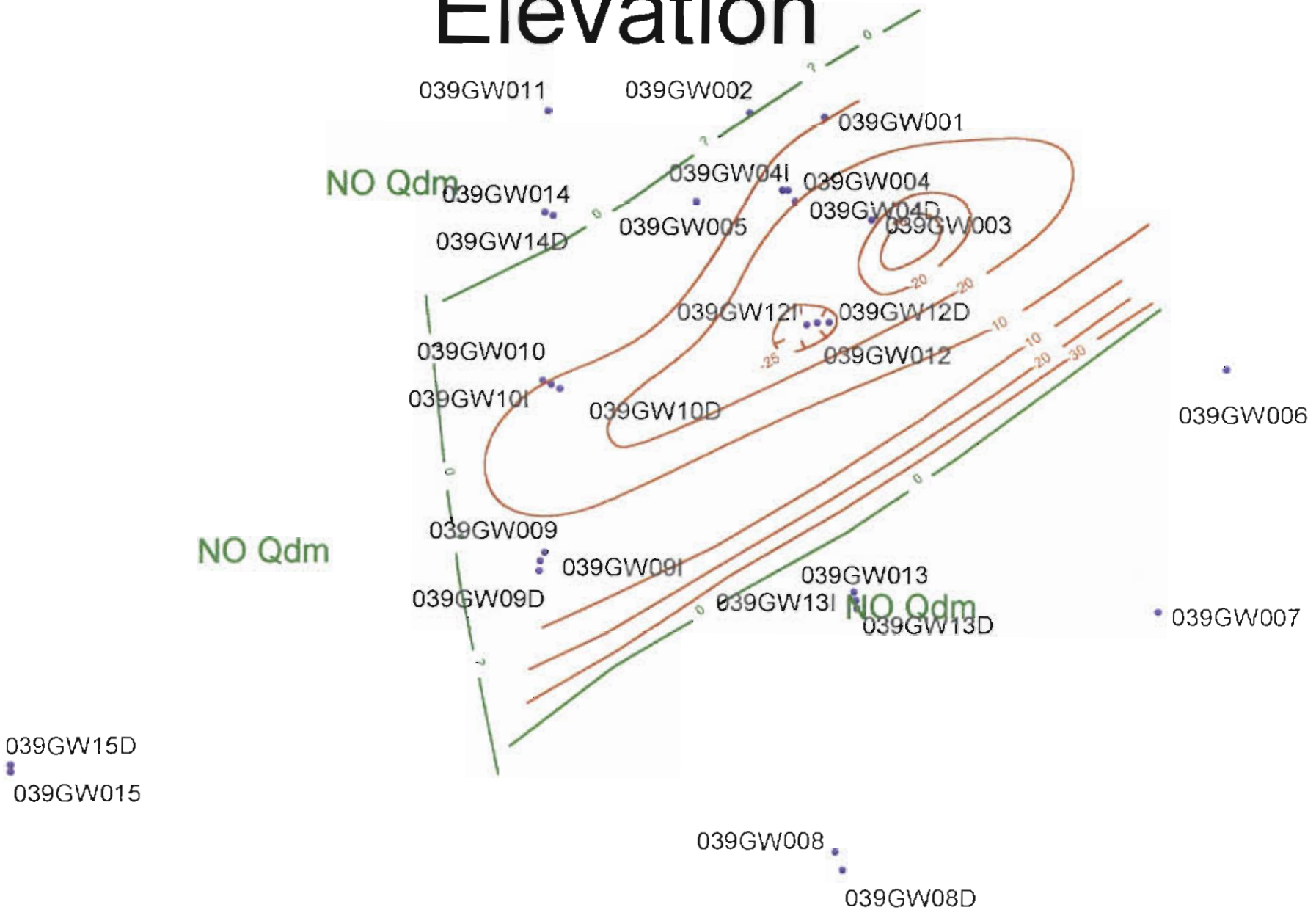
Intermediate Flow



Deep Flow


039GW011
7
6
5
4
3
039GW002
2
039GW001
039GW04I
039GW004
039GW014
039GW04D
039GW005
039GW003
039GW14D
039GW12I
039GW12D
039GW016
039GW012
2
039GW10I
039GW10D
039GW006
1.5
039GW009
039GW09I
039GW013
1
039GW09D
039GW13I
039GW13D
039GW007
FLOW
039GW15D
039GW015
039GW008
039GW08D

Elevation

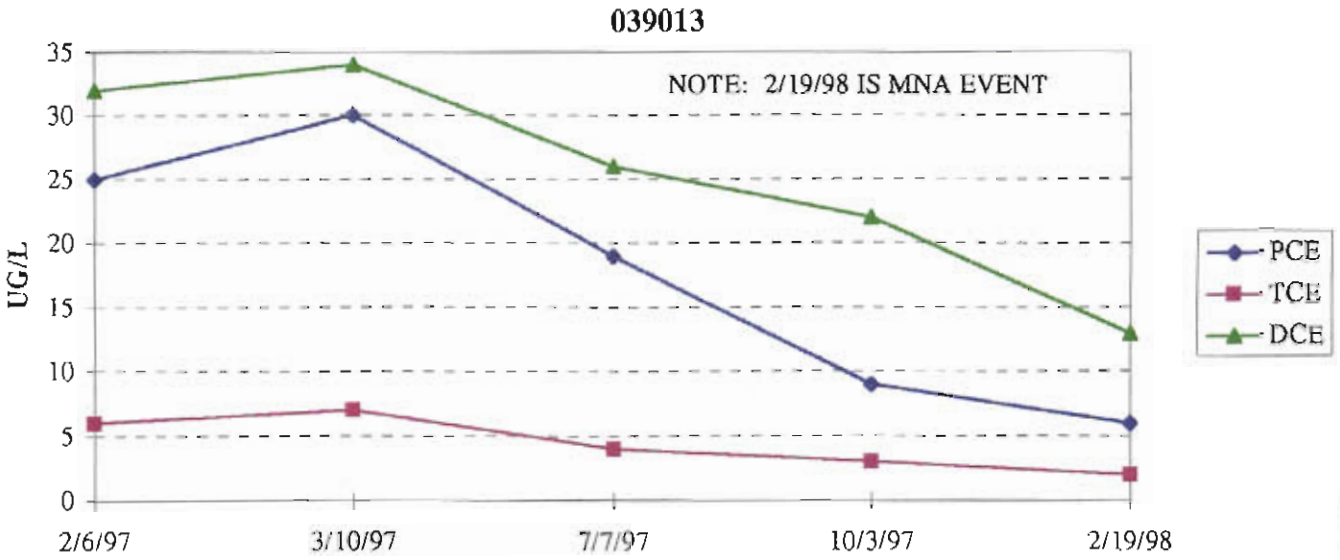
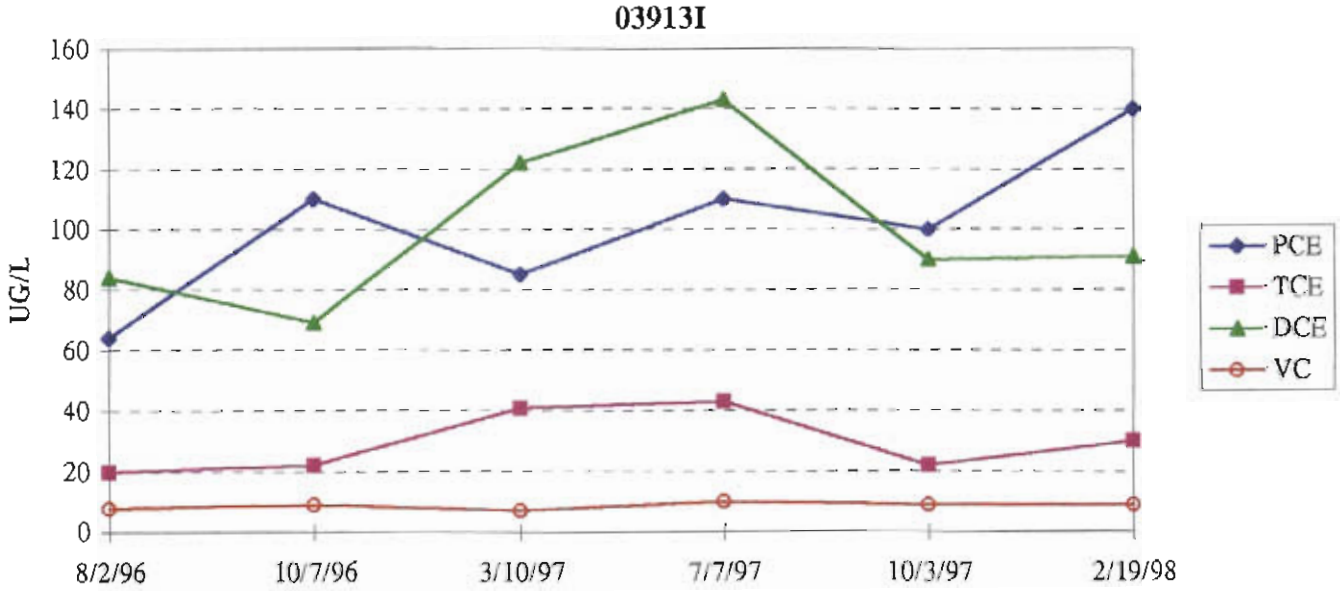
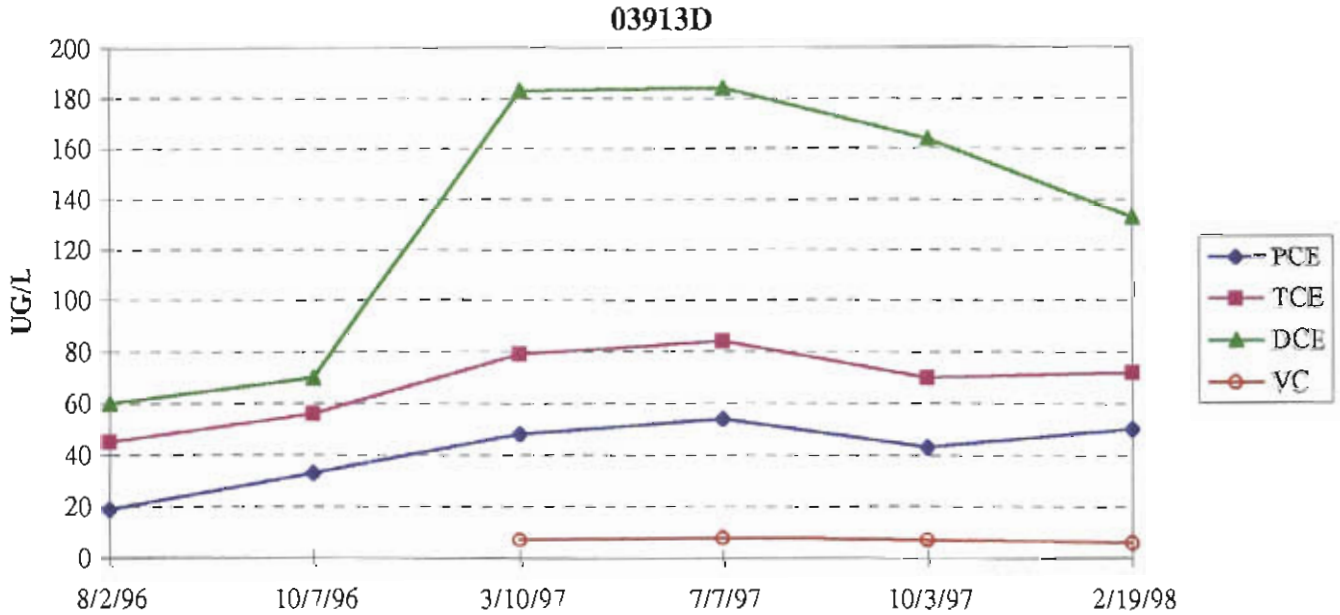

039GW011
039GW002
039GW001
NO Qdm
039GW014
039GW04I
039GW004
039GW04D
039GW005
039GW003
039GW14D
039GW12I
039GW12D
039GW010
039GW012
039GW10I
039GW10D
039GW006
039GW009
NO Qdm
039GW09I
039GW013
039GW09D
039GW13I
NO Qdm
039GW13D
039GW007
039GW15D
039GW015
039GW008
039GW08D

Thickness

039GW011
039GW002
039GW001
NO Qdm
039GW014
039GW04I
039GW004
039GW04D
039GW005
039GW003
039GW14D
039GW12I
039GW12D
039GW010
039GW012
039GW10I
039GW10D
039GW006
039GW009
NO Qdm
039GW09I
039GW013
039GW09D
039GW13I
NO Qdm
039GW13D
039GW007
039GW15D
039GW015
039GW008
039GW08D
0
10
20
30

Steps 3-9

To be addressed

- Additional rounds of MNA to be scoped (i.e., well locations, parameters).
- Continue potential biodegradation data evaluation, conceptual model refinement, source area(s) resolution, contaminant mass balance.

SAMPLING EVENT RESULTS