#7
NID

US EPA RECORDS CENTER REGION 5
465869

Groundwater Monitoring Plan

ACS NPL Site

Griffith, Indiana

History of Groundwater Sampling

- RI/FS -- Three rounds
  - August 89
  - May 1990
  - January 1991
- PreDesign Work Plan -- One round
  - December 1994
- Baseline Sampling - Five rounds
  - March, August, and November 1996
  - April/March 1997
  - June 1997
  - September 1997
  - December 1997

Sampling Objectives

- Upper Aquifer
  - Monitor Contaminated Areas: Are they constant, increasing, or decreasing?
  - Monitor any changes to groundwater flow cause by PGCS and BWES
  - Document Responses to Remediation
- Lower Aquifer
  - (Same as Upper Aquifer Objectives)
  - Monitor MW9 Area
  - Detection / Compliance Monitoring

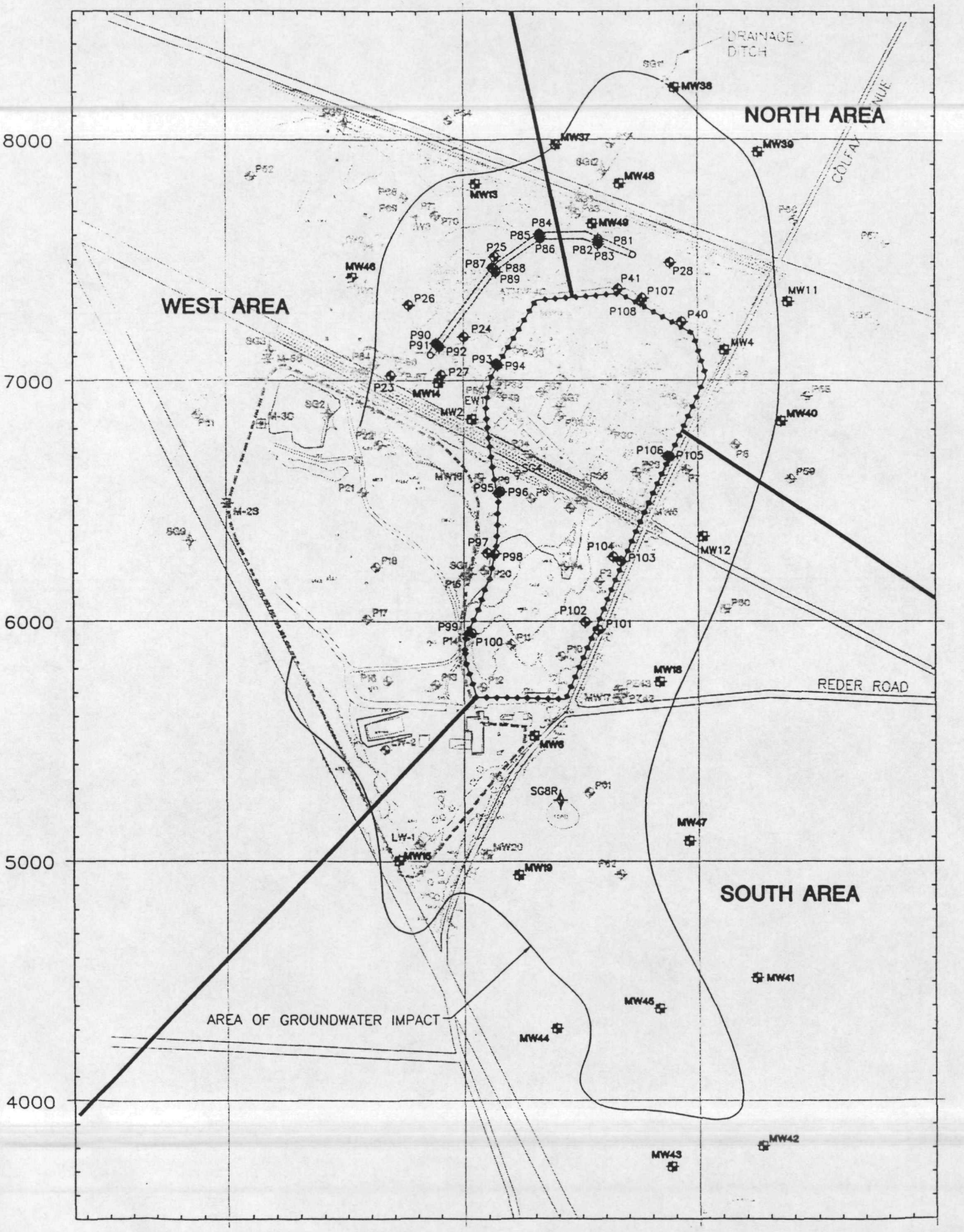

DRAINAGE DITCH
NORTH AREA
WEST AREA
SOUTH AREA
COLFAX AVENUE
REDER ROAD
AREA OF GROUNDWATER IMPACT
MW38
MW37
MW39
MW48
MW13
MW49
MW46
MW11
MW4
MW14
MW2
MW40
MW12
MW18
MW6
MW47
MW16
MW19
MW41
MW45
MW44
MW42
MW43
SG8R
LW-1
M-3C
M-23
EW1
P84
P85
P86
P81
P82
P83
P25
P87
P88
P89
P28
P41
P107
P108
P40
P26
P24
P90
P91
P92
P93
P94
P27
P23
P106
P105
P95
P96
P97
P98
P104
P103
P102
P101
P99
P100
8000
7000
6000
5000
4000
4000
5000
6000
7000

Figure 8

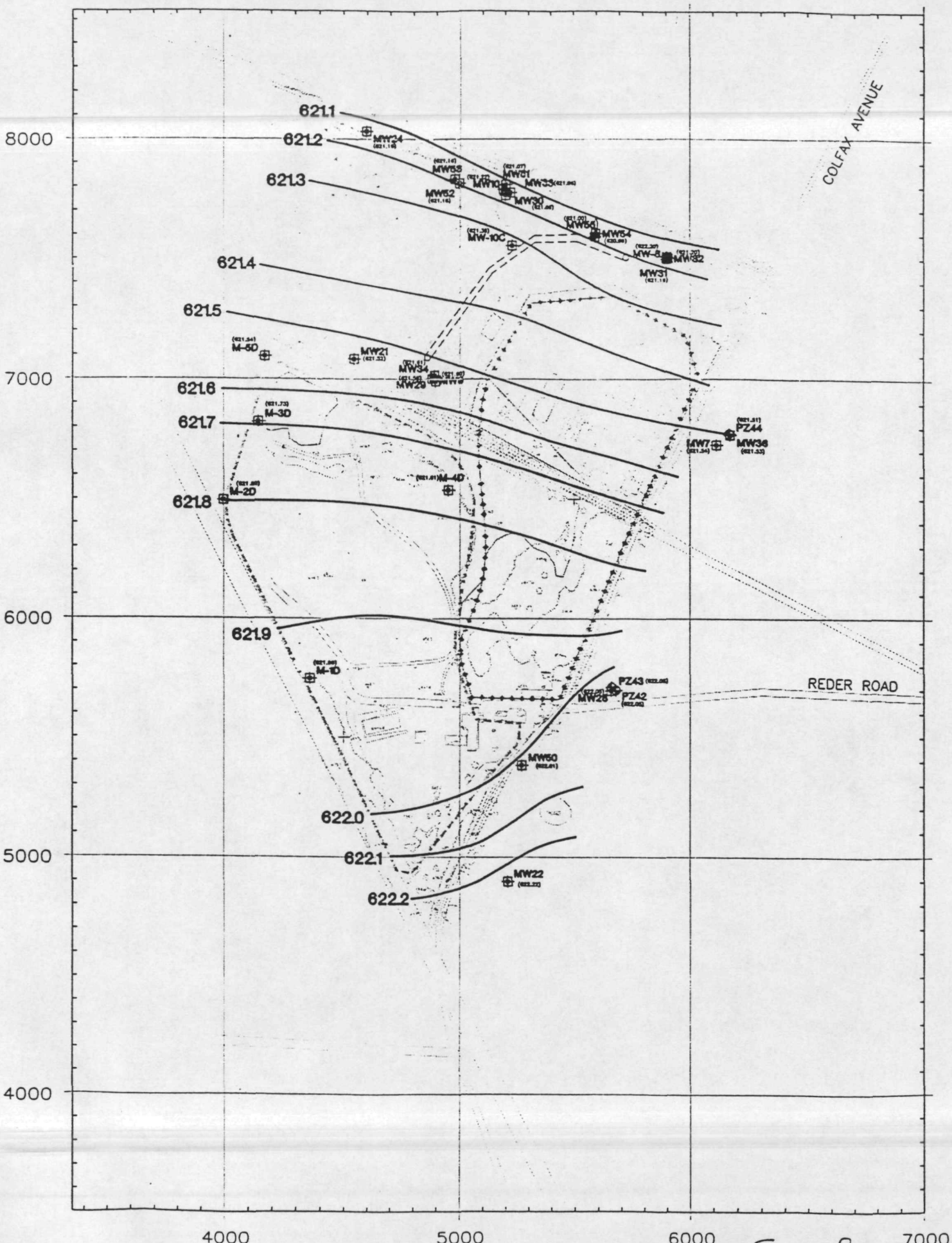

621.1
621.2
621.3
621.4
621.5
621.6
621.7
621.8
621.9
622.0
622.1
622.2
8000
7000
6000
5000
4000
4000
5000
6000
7000
COLFAX AVENUE
REDER ROAD
MW24
MW55
MW10
MW21
MW34
MW29
M-5D
M-3D
M-4D
M-2D
M-1D
MW-10C
MW31
PZ44
MW36
MW7
PZ43
PZ42
MW26
MW50
MW22

Figure 3

Sampling Plan Variables

- Sampling Frequency
- Analytical Parameters
- Sampling Locations
- Criteria to Modify Sampling Plan

Factors Affecting Frequency

- Groundwater Flow Rate
- Aquifer Homogeneity
- Consistency of Flow Patterns
- Complexity of Contaminant Distribution

Upper Aquifer

	Hydraulic Conductivity cm/sec	ft/year	Gradient ft/ft	Effective Porosity	GW Velocity
Min:	1.1E-03	1139	0.0025	0.3	9 feet/year
Max:	5.0E-03	5177	0.01	0.2	259 feet/year
Average:	2.0E-03	2118	0.005	0.25	42 feet/year

Lower Aquifer

	Hydraulic Conductivity cm/sec	ft/year	Gradient ft/ft	Effective Porosity	GW Velocity
Min:	2.1E-02	21742	0.00035	0.2	38 feet/year
Max:	2.3E-02	23813	0.0006	0.3	48 feet/year
Average:	2.2E-02	22778	0.0005	0.25	46 feet/year

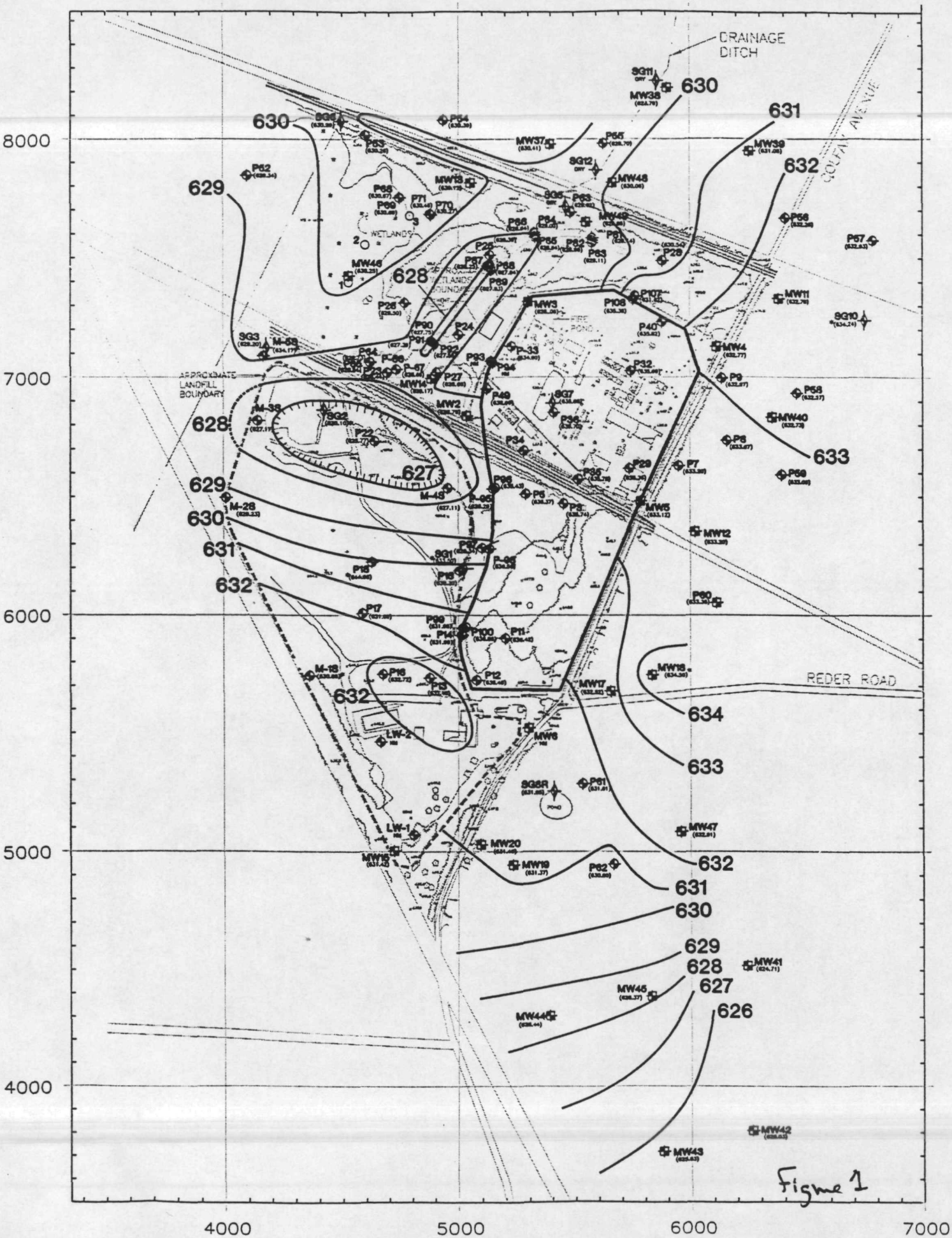

DRAINAGE DITCH
SOUTH AVENUE
REDER ROAD
WETLANDS
APPROXIMATE LANDFILL BOUNDARY
8000
7000
6000
5000
4000
4000
5000
6000
7000
630
631
632
633
634
629
628
627
626

Figure 1

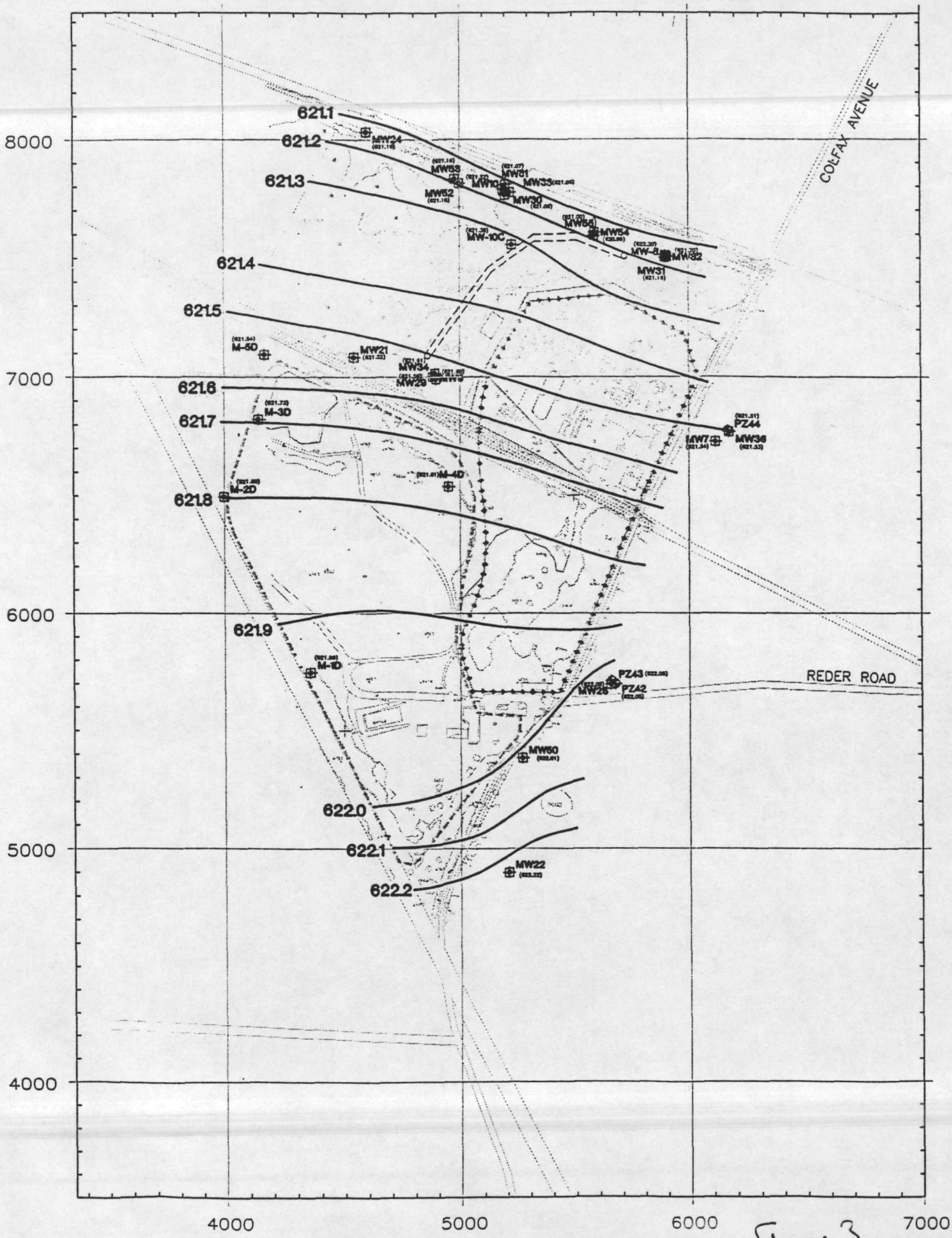

8000
7000
6000
5000
4000
4000
5000
6000
7000
621.1
621.2
621.3
621.4
621.5
621.6
621.7
621.8
621.9
622.0
622.1
622.2
COLFAX AVENUE
REDER ROAD
MW24
MW53
MW52
MW10
MW51
MW33
MW30
MW54
MW64
MW-10C
MW-8
MW32
MW31
M-5D
MW21
MW34
MW29
M-3D
PZ44
MW7
MW36
M-4D
M-2D
M-1D
PZ43
PZ42
MW26
MW60
MW22

Figure 3

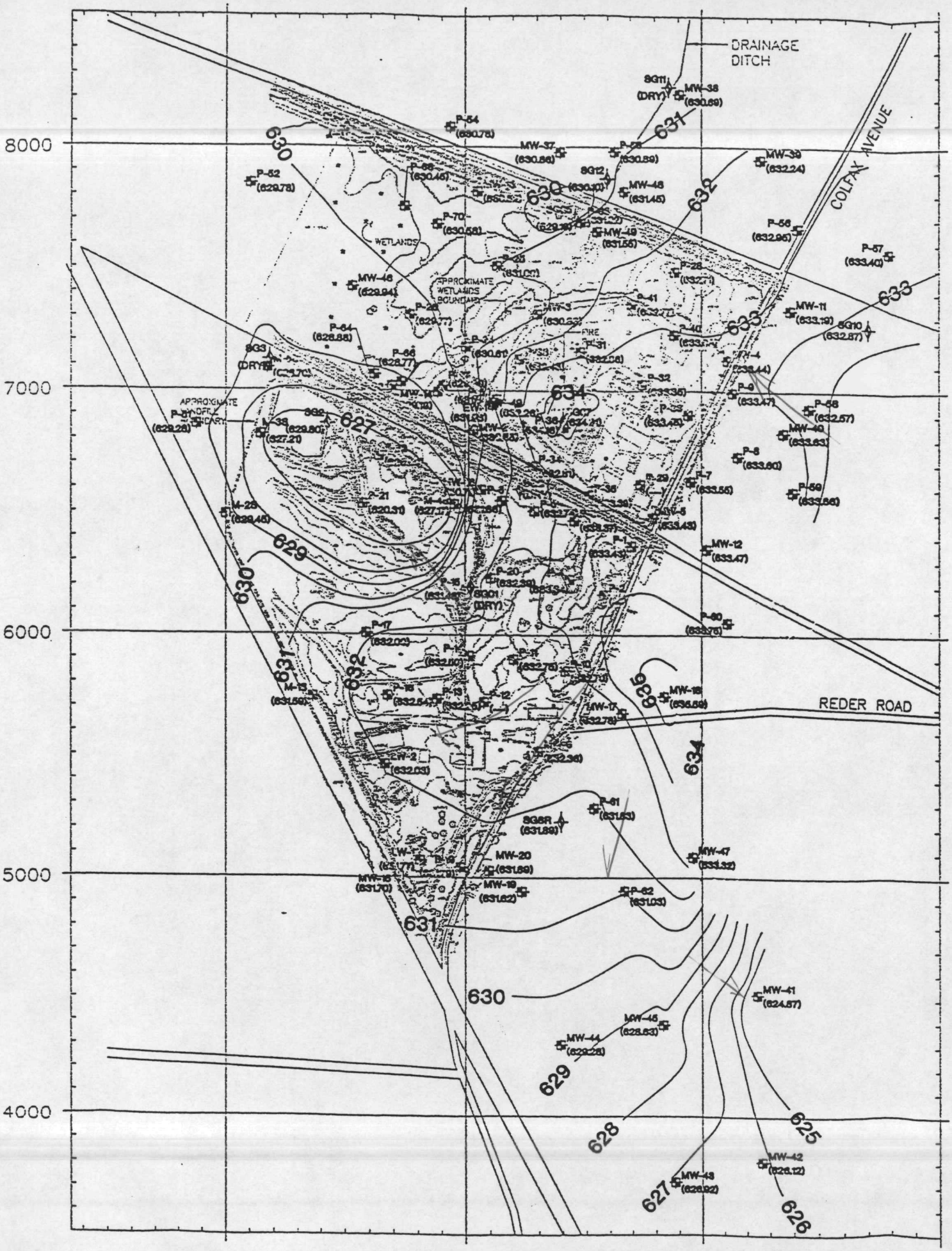

DRAINAGE DITCH
COLFAX AVENUE
REDER ROAD
WETLANDS
APPROXIMATE WETLANDS BOUNDARY
APPROXIMATE RUNOFF BOUNDARY
FIRE
8000
7000
6000
5000
4000
4000
5000
6000
7000
630
631
632
633
634
629
628
627
626
625

Figure 2

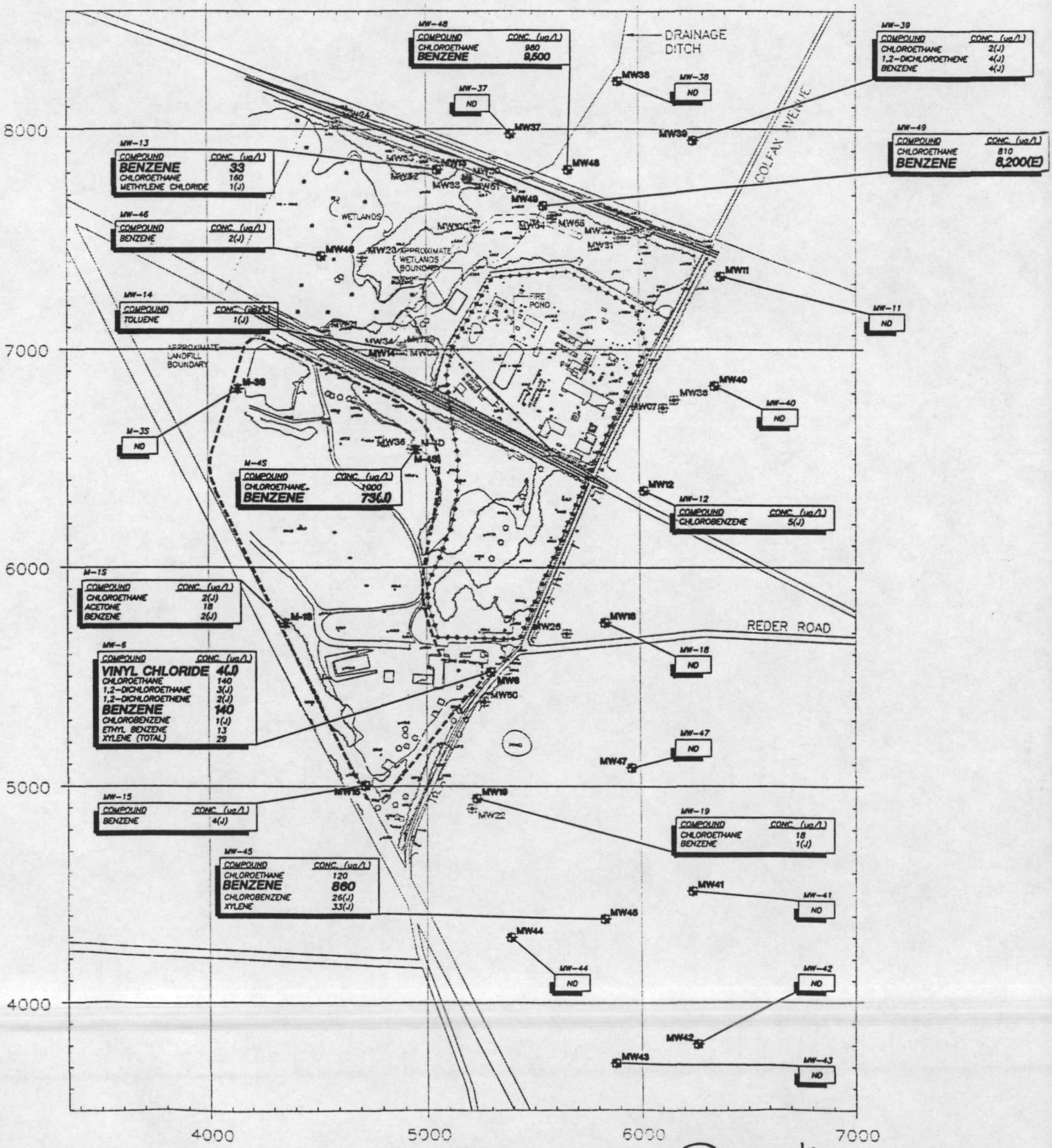

MW-48
COMPOUND CONC. (ug/l)
CHLOROETHANE 980
BENZENE 9,500
DRAINAGE DITCH
MW-39
COMPOUND CONC. (ug/l)
CHLOROETHANE 2(J)
1,2-DICHLOROETHENE 4(J)
BENZENE 4(J)
MW-38
ND
MW-37
ND
MW-49
COMPOUND CONC. (ug/l)
CHLOROETHANE 810
BENZENE 8,200(E)
MW-13
COMPOUND CONC. (ug/l)
BENZENE 33
CHLOROETHANE 160
METHYLENE CHLORIDE 1(J)
MW-46
COMPOUND CONC. (ug/l)
BENZENE 2(J)
WETLANDS
APPROXIMATE WETLANDS BOUNDARY
FIRE POND
MW-11
ND
MW-14
COMPOUND CONC. (ug/l)
TOLUENE 1(J)
APPROXIMATE LANDFILL BOUNDARY
M-3S
ND
MW-40
ND
M-4S
COMPOUND CONC. (ug/l)
CHLOROETHANE 1000
BENZENE 7300
MW-12
COMPOUND CONC. (ug/l)
CHLOROBENZENE 5(J)
M-1S
COMPOUND CONC. (ug/l)
CHLOROETHANE 2(J)
ACETONE 18
BENZENE 2(J)
REDER ROAD
MW-18
ND
MW-6
COMPOUND CONC. (ug/l)
VINYL CHLORIDE 400
CHLOROETHANE 140
1,2-DICHLOROETHANE 3(J)
1,2-DICHLOROETHENE 2(J)
BENZENE 140
CHLOROBENZENE 1(J)
ETHYL BENZENE 13
XYLENE (TOTAL) 29
MW-47
ND
MW-15
COMPOUND CONC. (ug/l)
BENZENE 4(J)
MW-19
COMPOUND CONC. (ug/l)
CHLOROETHANE 18
BENZENE 1(J)
MW-45
COMPOUND CONC. (ug/l)
CHLOROETHANE 120
BENZENE 860
CHLOROBENZENE 26(J)
XYLENE 33(J)
MW-41
ND
MW-44
ND
MW-42
ND
MW-43
ND
COLFAX AVENUE
8000
7000
6000
5000
4000
4000
5000
6000
7000

Figure 4

Selection of Analytical Parameters

- The Use of Indicators
- Selection of Indicators
- Elimination of Analytes from Routine Monitoring

Indicators for Routine Monitoring

- During Baseline Sampling, Samples were Analyzed for All Target Chemicals
  - Target Compound List (TCL) Organics
  - Target Analyte List (TAL) Inorganics
  - Pesticides & PCBs
- Long Term Monitoring is streamlined to provide sufficient information to achieve Monitoring Objectives
  - Deterimining: Has Something Changed?
    What Has Changed?

UCLP -- Upper Confidence Limit of the Prediction Interval

- Description of Statistical Tool
- EPA acceptance
  - Guidance
  - Provides Objective Decision
- Current Values based on 4 events

Organic Indicator Compounds

- Based on Representativeness of Contamination of Site Groundwater
  - Frequency of Detection
  - Relative Concentration Levels
  - Persistence
  - Solubility in Water
- Selected Indicators for Organic Contamination
  - Benzene (representing non-halogenated organics)
  - Chloroethane (representing halogenated organics)

Excluded Organic Compounds

- PCBs, Pesticides, and SVOCs
- Basis for elimination from routine sampling
  - No significant detections
  - Compounds with only sporadic detections, in location and time
  - Evidence that compounds are naturally occurring at detected concentrations
  - Related to Laboratory effects rather than Site conditions
- Compounds could be added if Indicators show increasing range of contaminants

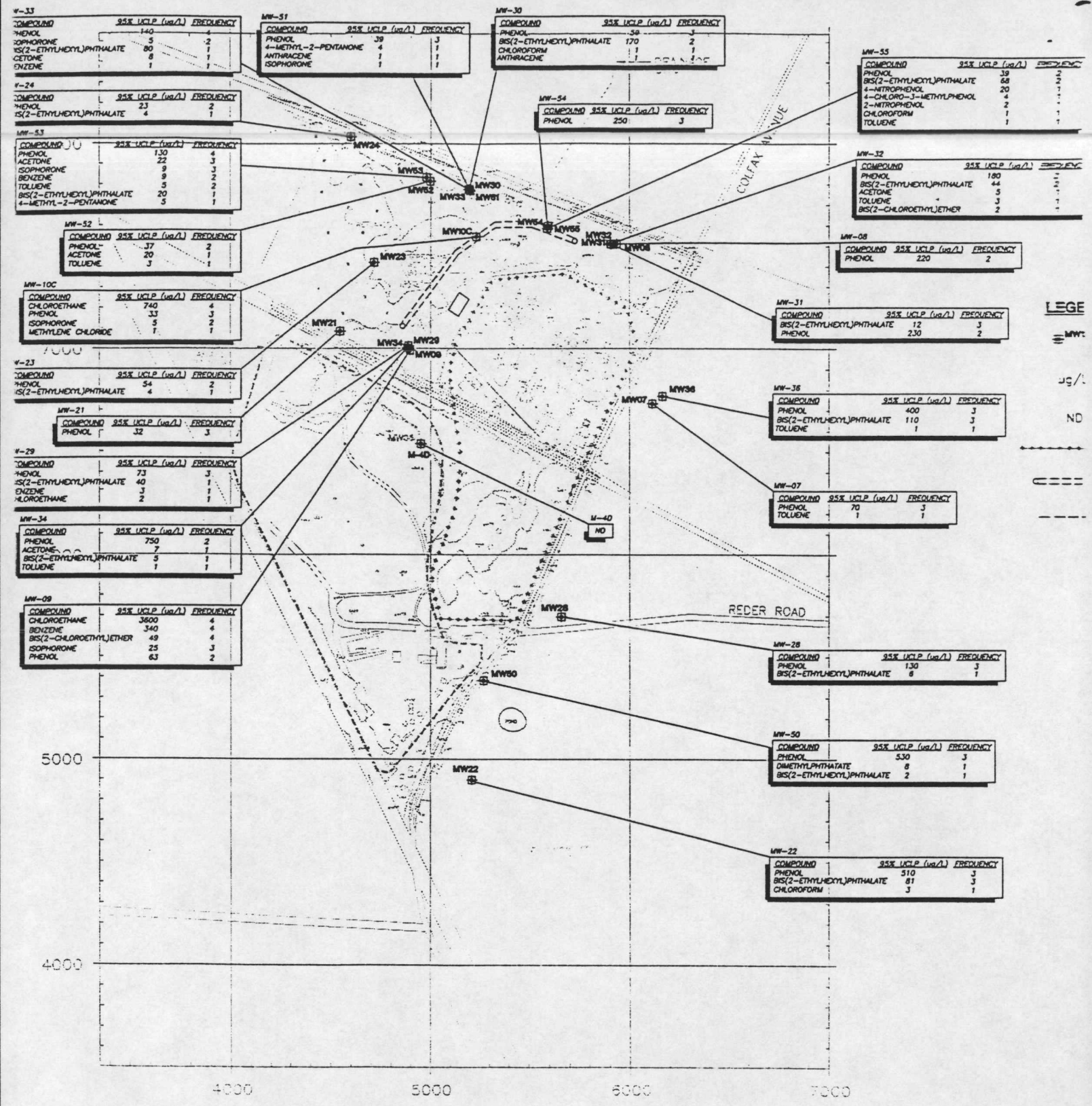

MW-33
COMPOUND 95% UCLP (ug/L) FREQUENCY
PHENOL 140 4
ISOPHORONE 5 2
BIS(2-ETHYLHEXYL)PHTHALATE 80 1
ACETONE 8 1
BENZENE 1 1
MW-24
COMPOUND 95% UCLP (ug/L) FREQUENCY
PHENOL 23 2
BIS(2-ETHYLHEXYL)PHTHALATE 4 1
MW-53
COMPOUND 95% UCLP (ug/L) FREQUENCY
PHENOL 130 4
ACETONE 22 3
ISOPHORONE 9 3
BENZENE 9 2
TOLUENE 5 2
BIS(2-ETHYLHEXYL)PHTHALATE 20 1
4-METHYL-2-PENTANONE 5 1
MW-52
COMPOUND 95% UCLP (ug/L) FREQUENCY
PHENOL 37 2
ACETONE 20 1
TOLUENE 3 1
MW-10C
COMPOUND 95% UCLP (ug/L) FREQUENCY
CHLOROETHANE 740 4
PHENOL 33 3
ISOPHORONE 5 2
METHYLENE CHLORIDE 1 1
MW-23
COMPOUND 95% UCLP (ug/L) FREQUENCY
PHENOL 54 2
BIS(2-ETHYLHEXYL)PHTHALATE 4 1
MW-21
COMPOUND 95% UCLP (ug/L) FREQUENCY
PHENOL 32 3
MW-29
COMPOUND 95% UCLP (ug/L) FREQUENCY
PHENOL 73 3
BIS(2-ETHYLHEXYL)PHTHALATE 40 1
BENZENE 3 1
CHLOROETHANE 2 1
MW-34
COMPOUND 95% UCLP (ug/L) FREQUENCY
PHENOL 750 2
ACETONE 7 1
BIS(2-ETHYLHEXYL)PHTHALATE 5 1
TOLUENE 1 1
MW-09
COMPOUND 95% UCLP (ug/L) FREQUENCY
CHLOROETHANE 3600 4
BENZENE 340 4
BIS(2-CHLOROETHYL)ETHER 49 4
ISOPHORONE 25 3
PHENOL 63 2
MW-51
COMPOUND 95% UCLP (ug/L) FREQUENCY
PHENOL 39 3
4-METHYL-2-PENTANONE 4 1
ANTHRACENE 1 1
ISOPHORONE 1 1
MW-30
COMPOUND 95% UCLP (ug/L) FREQUENCY
PHENOL 59 3
BIS(2-ETHYLHEXYL)PHTHALATE 170 2
CHLOROFORM 1 1
ANTHRACENE 1 1
MW-54
COMPOUND 95% UCLP (ug/L) FREQUENCY
PHENOL 250 3
MW-55
COMPOUND 95% UCLP (ug/L) FREQUENCY
PHENOL 39 2
BIS(2-ETHYLHEXYL)PHTHALATE 68 2
4-NITROPHENOL 20 1
4-CHLORO-3-METHYLPHENOL 4 1
2-NITROPHENOL 2 1
CHLOROFORM 1 1
TOLUENE 1 1
MW-32
COMPOUND 95% UCLP (ug/L) FREQUENCY
PHENOL 180 2
BIS(2-ETHYLHEXYL)PHTHALATE 44 2
ACETONE 5 1
TOLUENE 3 1
BIS(2-CHLOROETHYL)ETHER 2 1
MW-08
COMPOUND 95% UCLP (ug/L) FREQUENCY
PHENOL 220 2
MW-31
COMPOUND 95% UCLP (ug/L) FREQUENCY
BIS(2-ETHYLHEXYL)PHTHALATE 12 3
PHENOL 230 2
MW-36
COMPOUND 95% UCLP (ug/L) FREQUENCY
PHENOL 400 3
BIS(2-ETHYLHEXYL)PHTHALATE 110 3
TOLUENE 1 1
MW-07
COMPOUND 95% UCLP (ug/L) FREQUENCY
PHENOL 70 3
TOLUENE 1 1
M-4D
ND
MW-28
COMPOUND 95% UCLP (ug/L) FREQUENCY
PHENOL 130 3
BIS(2-ETHYLHEXYL)PHTHALATE 6 1
MW-50
COMPOUND 95% UCLP (ug/L) FREQUENCY
PHENOL 530 3
DIMETHYLPHTHATATE 8 1
BIS(2-ETHYLHEXYL)PHTHALATE 2 1
MW-22
COMPOUND 95% UCLP (ug/L) FREQUENCY
PHENOL 510 3
BIS(2-ETHYLHEXYL)PHTHALATE 81 3
CHLOROFORM 3 1
MW24
MW65
MW62
MW30
MW33
MW61
MW10C
MW64
MW66
MW32
MW31
MW08
MW23
MW21
MW34
MW29
MW09
MW36
MW07
MW35
M-4D
MW28
MW50
MW22
COLFAX AVENUE
REDER ROAD
5000
4000
4000
5000
6000
7000

Figure 7

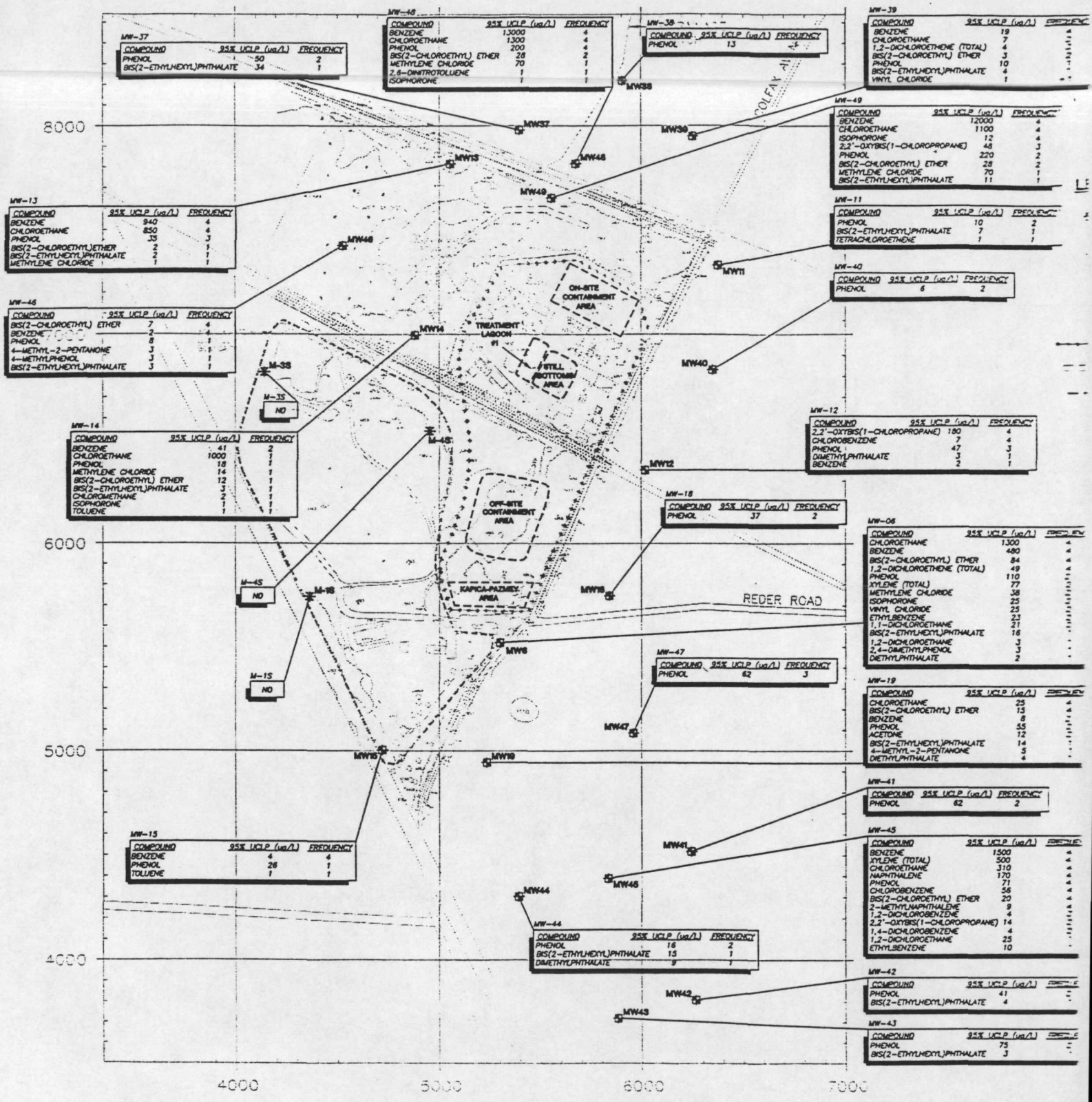

MW-37
COMPOUND 95% UCLP (ug/L) FREQUENCY
PHENOL 50 2
BIS(2-ETHYLHEXYL)PHTHALATE 34 1
MW-48
COMPOUND 95% UCLP (ug/L) FREQUENCY
BENZENE 13000 4
CHLOROETHANE 1300 4
PHENOL 200 4
BIS(2-CHLOROETHYL) ETHER 28 2
METHYLENE CHLORIDE 70 1
2,6-DINITROTOLUENE 1 1
ISOPHORONE 1 1
MW-38
COMPOUND 95% UCLP (ug/L) FREQUENCY
PHENOL 13 1
MW-39
COMPOUND 95% UCLP (ug/L) FREQUENCY
BENZENE 19 4
CHLOROETHANE 7 1
1,2-DICHLOROETHENE (TOTAL) 4 1
BIS(2-CHLOROETHYL) ETHER 3 1
PHENOL 10 1
BIS(2-ETHYLHEXYL)PHTHALATE 4 1
VINYL CHLORIDE 1 1
MW-49
COMPOUND 95% UCLP (ug/L) FREQUENCY
BENZENE 12000 4
CHLOROETHANE 1100 4
ISOPHORONE 12 4
2,2'-OXYBIS(1-CHLOROPROPANE) 48 3
PHENOL 220 2
BIS(2-CHLOROETHYL) ETHER 28 2
METHYLENE CHLORIDE 70 1
BIS(2-ETHYLHEXYL)PHTHALATE 11 1
MW-13
COMPOUND 95% UCLP (ug/L) FREQUENCY
BENZENE 940 4
CHLOROETHANE 850 4
PHENOL 35 3
BIS(2-CHLOROETHYL)ETHER 2 1
BIS(2-ETHYLHEXYL)PHTHALATE 2 1
METHYLENE CHLORIDE 1 1
MW-11
COMPOUND 95% UCLP (ug/L) FREQUENCY
PHENOL 10 2
BIS(2-ETHYLHEXYL)PHTHALATE 7 1
TETRACHLOROETHENE 1 1
MW-40
COMPOUND 95% UCLP (ug/L) FREQUENCY
PHENOL 6 2
MW-46
COMPOUND 95% UCLP (ug/L) FREQUENCY
BIS(2-CHLOROETHYL) ETHER 7 4
BENZENE 2 4
PHENOL 8 1
4-METHYL-2-PENTANONE 3 1
4-METHYLPHENOL 3 1
BIS(2-ETHYLHEXYL)PHTHALATE 3 1
ON-SITE CONTAINMENT AREA
TREATMENT LAGOON
STILL BOTTOMS AREA
M-3S
M-3S
ND
MW-14
COMPOUND 95% UCLP (ug/L) FREQUENCY
BENZENE 41 2
CHLOROETHANE 1000 1
PHENOL 18 1
METHYLENE CHLORIDE 14 1
BIS(2-CHLOROETHYL) ETHER 12 1
BIS(2-ETHYLHEXYL)PHTHALATE 3 1
CHLOROMETHANE 2 1
ISOPHORONE 1 1
TOLUENE 1 1
M-4S
MW-12
COMPOUND 95% UCLP (ug/L) FREQUENCY
2,2'-OXYBIS(1-CHLOROPROPANE) 180 4
CHLOROBENZENE 7 4
PHENOL 47 3
DIMETHYLPHTHALATE 3 1
BENZENE 2 1
MW-18
COMPOUND 95% UCLP (ug/L) FREQUENCY
PHENOL 37 2
OFF-SITE CONTAINMENT AREA
MW-06
COMPOUND 95% UCLP (ug/L) FREQUENCY
CHLOROETHANE 1300 4
BENZENE 480 4
BIS(2-CHLOROETHYL) ETHER 84 4
1,2-DICHLOROETHENE (TOTAL) 49 4
PHENOL 110 3
XYLENE (TOTAL) 77 3
METHYLENE CHLORIDE 38 3
ISOPHORONE 25 3
VINYL CHLORIDE 25 3
ETHYLBENZENE 23 3
1,1-DICHLOROETHANE 21 3
BIS(2-ETHYLHEXYL)PHTHALATE 16 3
1,2-DICHLOROETHANE 3 1
2,4-DIMETHYLPHENOL 3 1
DIETHYLPHTHALATE 2 1
M-4S
ND
M-1S
KAPICA-PAZIMEX AREA
REDER ROAD
MW-47
COMPOUND 95% UCLP (ug/L) FREQUENCY
PHENOL 62 3
MW-19
COMPOUND 95% UCLP (ug/L) FREQUENCY
CHLOROETHANE 25 4
BIS(2-CHLOROETHYL) ETHER 15 4
BENZENE 8 4
PHENOL 55 3
ACETONE 12 3
BIS(2-ETHYLHEXYL)PHTHALATE 14 3
4-METHYL-2-PENTANONE 5 1
DIETHYLPHTHALATE 4 1
M-1S
ND
MW-41
COMPOUND 95% UCLP (ug/L) FREQUENCY
PHENOL 62 2
MW-15
COMPOUND 95% UCLP (ug/L) FREQUENCY
BENZENE 4 4
PHENOL 26 1
TOLUENE 1 1
MW-45
COMPOUND 95% UCLP (ug/L) FREQUENCY
BENZENE 1500 4
XYLENE (TOTAL) 500 4
CHLOROETHANE 310 4
NAPHTHALENE 170 4
PHENOL 71 4
CHLOROBENZENE 56 4
BIS(2-CHLOROETHYL) ETHER 20 4
2-METHYLNAPHTHALENE 9 4
1,2-DICHLOROBENZENE 4 4
2,2'-OXYBIS(1-CHLOROPROPANE) 14 3
1,4-DICHLOROBENZENE 4 3
1,2-DICHLOROETHANE 25 3
ETHYLBENZENE 10 3
MW-44
COMPOUND 95% UCLP (ug/L) FREQUENCY
PHENOL 16 2
BIS(2-ETHYLHEXYL)PHTHALATE 13 1
DIMETHYLPHTHALATE 9 1
MW-42
COMPOUND 95% UCLP (ug/L) FREQUENCY
PHENOL 41 2
BIS(2-ETHYLHEXYL)PHTHALATE 4 1
MW-43
COMPOUND 95% UCLP (ug/L) FREQUENCY
PHENOL 75 2
BIS(2-ETHYLHEXYL)PHTHALATE 3 1
8000
6000
5000
4000
4000
5000
6000
7000

Figure 6

Inorganic Indicator Analytes

- Based on Representativeness of Contamination of Site Groundwater
  - At least 4 detections in baseline (>1% occurrence)
  - UCLP of Interior Monitoring Well exceeds MCL or ROD Remediation Level
  - Significant UCLP difference between upgradient, interior, and downgradient monitoring wells
- Selected Inorganic Indicators:

Aluminum, Arsenic, Lead, Iron, Manganese

Inorganic Selection
North and West

UP

Analyte	MCL	ROD	95% UCLP (ug/L)			
			Internal	Sidegradient	Upgradient	Downgradient
Aluminum	**50**	**NP**	**14,000**	**1,200**	**3,600**	**2,300**
Antimony	6	NP	2	4	8	8
Arsenic	**50**	**8.8**	**37**	**5**	**2**	**2**
Barium	2000	NP	164	150	29	43
Cadmium	5	NP	3	3	7	7
Calcium	NP	NP	170,000	130,000	49,000	130,000
Chromium	100	NP	36	10	7	11
Cobalt	NP	NP	12	7	5	8
Copper	1300	NP	26	14	21	19
Iron	**300**	**NP**	**33,000**	**25,000**	**10,000**	**16,000**
Lead	**15**	**NP**	**19**	**8**	**7**	**5**
Magnesium	NP	NP	36,000	35,000	20,000	27,000
Manganese	**50**	**3300 - 275**	**2,300**	**1,700**	**1,200**	**970**
Nickel	100	NP	20	710	10	21
Vanadium	NP	NP	34	14	19	5
Zinc	5000	NP	68	25	31	27

Inorganic Selection
South

Analyte	MCL	ROD	95% UCLP (ug/L)			
			Internal	Sidegradient	Upgradient	Downgradient
Aluminum	50	NP	740	1,700	46	13,000
Antimony	6	NP	1	3	8	5
Arsenic	50	8.8	62	59	9	84
Barium	2000	NP	950	2,600	43	130
Cadmium	5	NP	3	3	7	1
Calcium	NP	NP	230,000	94,000	110,000	150,000
Chromium	100	NP	27	30	120	51
Cobalt	NP	NP	6	5	1	16
Copper	1300	NP	52	27	26	69
Iron	300	NP	18,000	15,000	440	48,000
Lead	**15**	**NP**	**38**	**23**	**21**	**31**
Magnesium	NP	NP	74,000	100,000	37,000	63,000
Manganese	**50**	**3300 - 275**	**2,700**	**500**	**1,200**	**1,000**
Nickel	100	NP	40	24	10	37
Vanadium	NP	NP	10	10	3	32
Zinc	5000	NP	29	19	35	33

Sampling Locations

- Upper Aquifer
  - South Area
  - North Area
  - West Area
- Lower Aquifer
  - Background
  - MW9 Area
  - Downgradient Boundary

How define these areas?

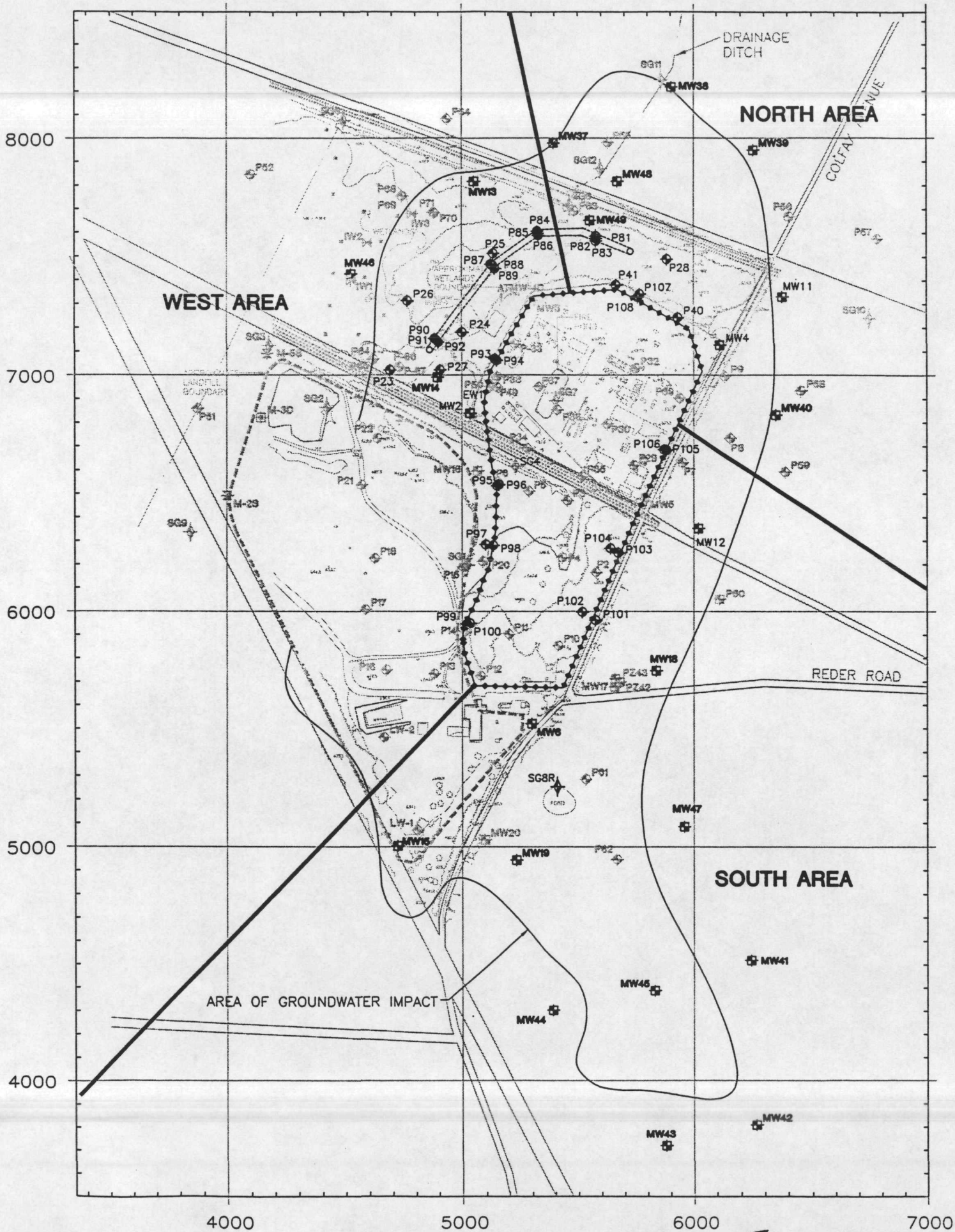

DRAINAGE DITCH
NORTH AREA
WEST AREA
SOUTH AREA
COLFAX AVENUE
REDER ROAD
AREA OF GROUNDWATER IMPACT
LANDFILL BOUNDARY
8000
7000
6000
5000
4000
4000
5000
6000
7000
MW38
MW37
MW39
MW48
MW13
MW49
MW46
MW11
MW4
MW14
MW2
MW40
MW12
MW18
MW6
MW47
MW16
MW19
MW41
MW45
MW44
MW42
MW43
SG8R
P84
P85
P86
P82
P83
P81
P25
P87
P88
P89
P28
P41
P107
P108
P40
P26
P24
P90
P91
P92
P93
P94
P27
P23
P106
P105
P95
P96
P97
P98
P104
P103
P102
P101
P99
P100
P61

Figure 8

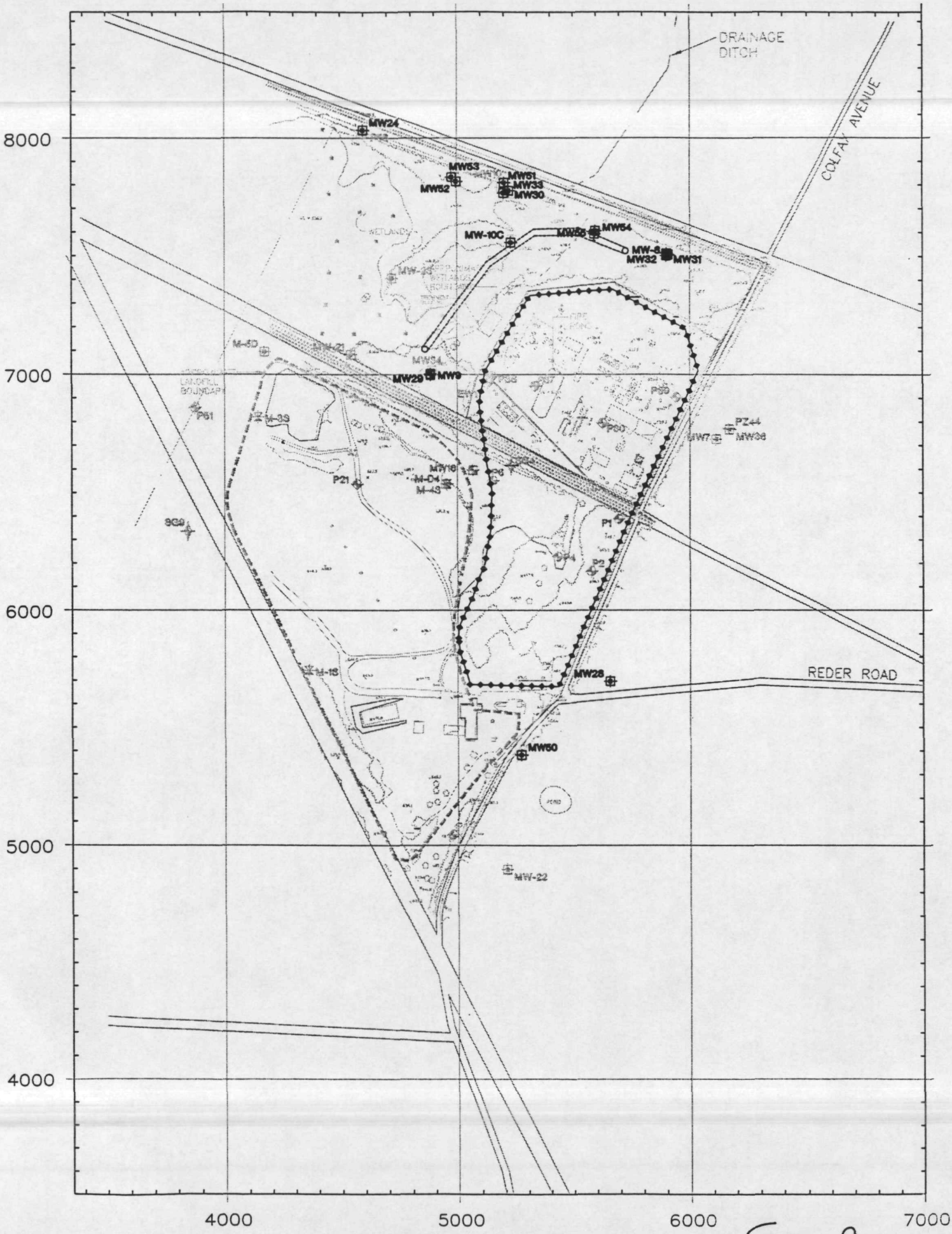

DRAINAGE DITCH
COLFAX AVENUE
REDER ROAD
8000
7000
6000
5000
4000
4000
5000
6000
7000
MW24
MW53
MW52
MW51
MW33
MW30
MW-10C
MW55
MW54
MW-8
MW32
MW31
MW-23
M-5D
MW-21
MW34
MW29
MW9
LANDFILL BOUNDARY
P61
M-3S
P58
P59
P60
PZ44
MW7
MW36
M7/16
M-D4
M-4S
P21
P26
P1
P4
P2
SG9
M-1S
MW28
MW60
MW-22

Figure 9

When to Modify the Groundwater Monitoring Plan

- Evidence that contaminant concentration or distribution has changed
  - Increase frequency, parameters, and/or locations
  - Decrease frequency, parameters, and/or locations

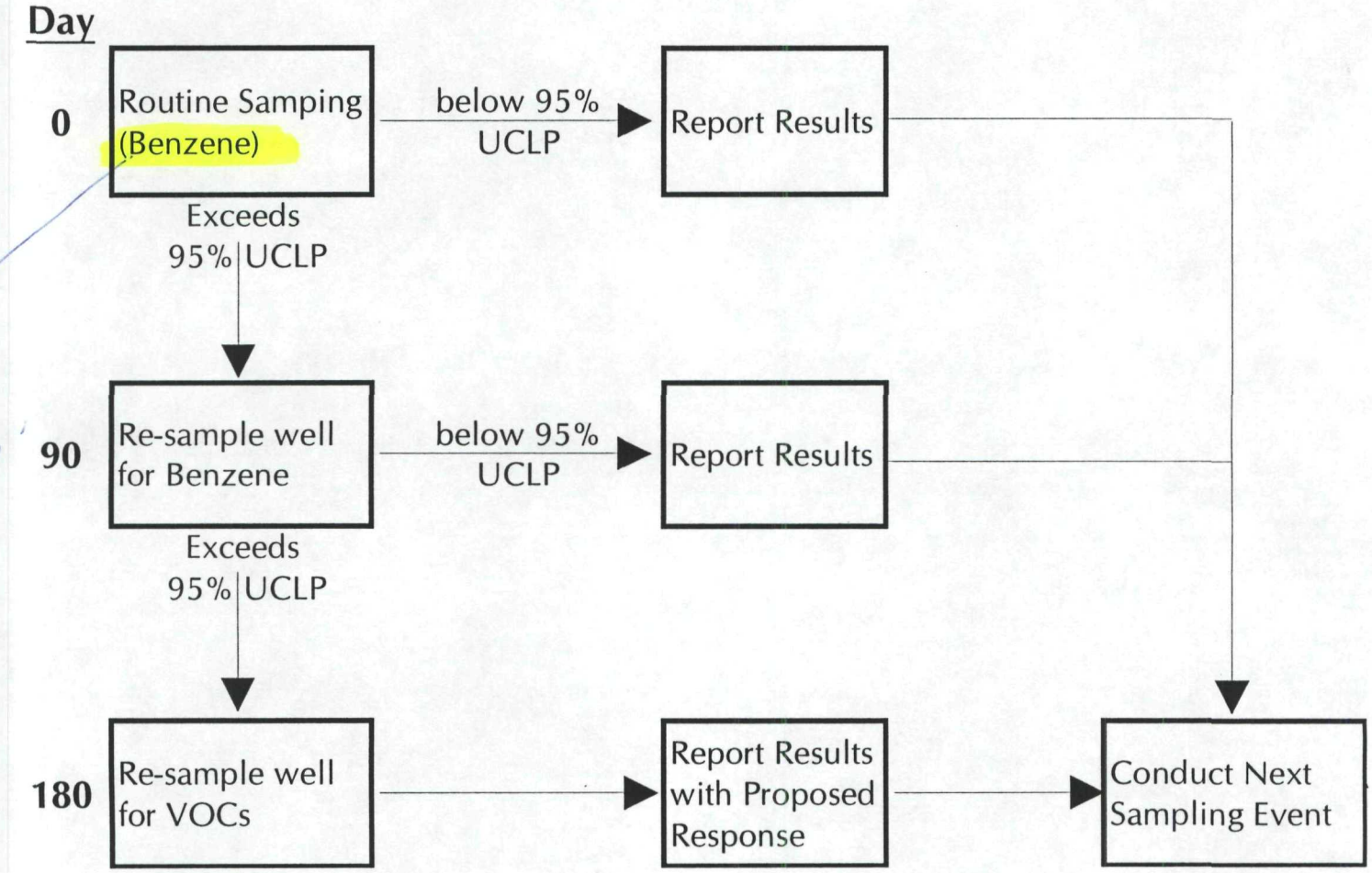
Propose Modifications to U.S. EPA by Area

- If there is evidence that contaminant concentrations are increasing, and/or area of contamination is expanding:
  - Propose to increase frequency, parameters, and/or locations
- If the groundwater quality in an Area improves to below MCLs or ROD remediation or Background level:
  - Propose to eliminate wells in that Area from Monitoring Plan

Proposed Response to Indicator Exceedance

Sequence to evaluate Exceedance of Groundwater Criteria

(Assuming benzene exceedance)



could be inorganic or semi-vola

Summary of Sampling Plan

Factors	Current Requirement	Proposed
Sampling Frequency	Quarterly	Annually, with seasonal off-set
Analytical Parameters	Full Scan TCL/TAL	Indicators: Benzene & chloroethane Al, As, Pb, Fe, & Mn
Sampling Locations	24 Upper Aquifer Wells 23 Lower Aquifer Wells	19 Upper Aquifer Wells 17 Lower Aquifer Wells
Criteria to Change Sampling	No Protocol Established	Parameter Exceeds 95% UCLP or Achieve ROD Rem/Background Level