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**Groundwater Monitoring Program
Final Annual Groundwater Monitoring Report for 1991**

Volume II of II

**September 18, 1992
Contract No. DAAA15-88-D-0021
Delivery Order 0006**

Harding Lawson Associates

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TECHNICAL SUPPORT FOR ROCKY MOUNTAIN ARSENAL



**Groundwater Monitoring Program
Final Annual Groundwater Monitoring Report for 1991**

Volume II of II

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PREPARED BY

Harding Lawson Associates

PREPARED FOR

PROGRAM MANAGER FOR ROCKY MOUNTAIN ARSENAL

**Rocky Mountain Arsenal
Information Center
Commerce City, Colorado**



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Table 1.1: Comprehensive Monitoring Program Groundwater Monitoring Programs

<u>Water Monitoring Year</u>	<u>Number of Water Levels Measured Quarterly^a</u>	<u>Number of Wells Sampled Annually^a</u>	<u>Number of Wells Sampled Semiannually^a</u>	<u>Number of Wells Sampled Quarterly^a</u>
1988	1119	466	307	46
1989	1013	488	388	101
1990	1210	621	61	65
1991	1265	282	N/A	70

^a The actual number of wells measured or sampled can vary from this number of proposed wells.

N/A = not applicable

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Table 1.2: Rocky Mountain Arsenal Comprehensive Monitoring Program
Target Analytes for the 1991 Water Monitoring Year

Organochlorine Pesticides

2,2'-bis(p-Chlorophenyl)-1,1-dichloroethane
2,2'-bis(p-Chlorophenyl)-1,1,1-trichloroethane
Aldrin
Chlordane
Endrin
Dieldrin
Isodrin
Hexachlorocyclopentadiene

Volatile Organohalogenes

1,1-Dichloroethane
1,2-Dichloroethane
1,1-Dichloroethene
1,2-Dichloroethene
1,1,1-Trichloroethane
1,1,2-Trichloroethane
Carbon tetrachloride
Chlorobenzene
Chloroform
Methylene chloride
Tetrachloroethene
Trichloroethene

Organosulfur Compounds

1,4-Dithiane
1,4-Oxithiane
Benzothiazole
Dimethyldisulfide
p-Chlorophenylmethylsulfide
p-Chlorophenylmethylsulfone
p-Chlorophenylmethylsulfoxide

Organophosphorus Compounds^a

Atrazine
Malathion
Parathion
Supona
Vapona

Volatile Organic Aromatic Compounds

Benzene
Ethylbenzene
Toluene
m-Xylene
o- and p-Xylene

Volatile Hydrocarbon Compounds

Bicycloheptadiene
Dicyclopentadiene (DCPD)
Methylisobutyl Ketone (MIBK)

Organophosphorus Compounds

Diisopropylmethylphosphonate (DIMP)
Dimethylmethylphosphonate (DMMP)

Dibromochloropropane (DBCP)

Metals

Arsenic
Cadium
Chromium
Copper
Lead
Mercury
Zinc

Cations

Calcium
Magnesium
Potassium
Sodium

Anions

Chloride
Fluoride
Nitrate+nitrite
Sulfate

Cyanide

^a In the 1988, 1989, and 1990 CMP analytical programs, only Parathion results were reported from the organophosphorous compounds.

Table 3.1: Winter 1990/91, Spring 1991, and Fall 1991
Water Quality Monitoring Networks
(Page 1 of 2)

Section Number	Total Wells	Well Number
<u>Winter 1990/91</u>		
Unconfined Flow System Wells		
01	2	027 ^a , 075
02	4	020, 023, 034, 505
22	5	008, 011, 043, 051, 053
23	28	047, 049, 057, 085, 095, 108 ^a , 118, 123, 142, 179, 188, 191, 197, 198, 202, 203, 204, 205, 220, 226, 231, 232, 235, 237, 238 ^a , 239, 241, 530
24	14	063, 101, 127, 135, 161, 163, 164, 166, 184, 185, 191, 199, 200, 201
26	32	011, 015, 017, 019, 020, 041, 065 ^a , 071, 073, 076, 083, 085, 127, 133, 145 ^a , 148, 157, 158, 160, 161, 162, 163, 164 ^a , 165 ^a , 166, 167 ^a , 168, 169, 170, 171, 173, 501, 503
27	20	003, 016, 037, 044, 053, 056, 057, 059, 062, 064, 071, 072, 073, 074, 076, 079, 082, 083, 085, 086
28	2	002, 023
33	5	048, 077, 078, 079, 581
35	3	505, 506 ^a , 507
Offpost	98	37304 ^a , 37307, 37308, 37309, 37312, 37313, 37320*, 37323, 37327, 37330, 37331, 37332*, 37333, 37334, 37335, 37336*, 37337, 37338, 37339, 37341*, 37342*, 37343, 37345, 37346*, 37347*, 37348*, 37349*, 37350*, 37351*, 37352*, 37353*, 37354*, 37355*, 37356*, 37357*, 37358, 37359*, 37360*, 37361*, 37363*, 37364*, 37366*, 37367*, 37368*, 37369, 37370, 37371, 37373, 37374, 37377, 37378, 37381, 37382, 37383*, 37385, 37386, 37389, 37391, 37392, 37395*, 37396, 37397*, 37402*, 37403*, 37404*, 37405*, 37406*, 37407, 37408*, 37409*, 37410*, 37418*, 37419*, 37420*, 37428*, 37429*, 37430*, 37433*, 37434*, 37435*, 37436*, 37437*, 37438, 37439, 37440*, 37441, 37442*, 37433*, 37444*, 005, 198-608*, 198-611*, 108-614*, DCGW01*, DCGW03*, SACMW03*, SACMW08*, SACMW11*
Total unconfined flow system wells = 213		
Confined Flow System Wells		
01	3	028, 029, 076
02	2	021, 025
22	6	023, 027, 028, 030, 031, 039
23	19	177, 180, 181, 183, 189, 190, 192, 193, 200, 201, 218, 219, 221, 222, 227, 230, 233, 234, 236

Table 3.1: Winter 1990/91, Spring 1991, and Fall 1991
Water Quality Monitoring Networks
(Page 2 of 2)

Section Number	Total Wells	Well Number
Confined Flow System Wells (continued)		
24	6	136, 168, 171, 172, 174, 175
26	15	066, 067, 072, 075, 084, 086, 129, 140, 142, 146, 149, 150, 153, 155, 156
27	3	054, 055, 058
28	1	025
Offpost	14	37316, 37317, 37318, 37319, 37321*, 37322*, 37365, 37372, 37376, 37379, 37380, 37387, 37388, 37390

Total confined flow system wells = 69

Spring 1991/Fall 1991

Unconfined Flow System Wells

23	13	049, 095, 108 ^{b,c} , 142, 179 ^c , 188, 191, 220, 237, 238 ^{b,c} , 239 ^c , 241, 530 ^c
26	31	015, 017, 019, 020, 041, 065 ^{b,c} , 071, 073, 083, 085, 127, 133, 145 ^{b,c} , 148, 157, 158 ^b , 160, 161, 162, 163, 164 ^{b,c} , 165 ^{b,c} , 166, 167 ^b , 168, 169, 170, 171, 173, 501, 503
27	1	016
35	2	505, 506 ^{b,c}

Total unconfined flow system wells = 47

Confined Flow System Wells

23	8	180 ^c , 181, 189, 190, 192, 193, 221, 222
26	15	066, 067, 072, 075, 084, 086, 129, 140, 142, 146 ^c , 149, 150, 153, 155, 156

Total confined flow system wells = 23

* Additional Offpost Remedial Investigation well sampled but not in proposed Comprehensive Monitoring Program Network.

^a No sample obtained in Winter 1990/91.

^b No sample obtained in Spring 1991.

^c No sample obtained in Fall 1991.

Table 3.2: Analytical Parameters for Non-Gas Chromatography/Mass Spectrometry Detection Methods
(Page 1 of 2)

Analyte	Analyte Detection Method	DataChem Laboratories		ESE Laboratories	
		PMRMA Method Designation	Certified Reporting Limit ($\mu\text{g/l}$)	PMRMA Method Designation	Certified Reporting Limit ($\mu\text{g/l}$)
Anions	IONCHROM				
Chloride		TT09	278	NN8	1590
Fluoride		TT09	153	NN8	1000
Nitrite, nitrate (nonspecific)		LL8	10	TF22	10
Sulfate		TT09	175	NN8	5000
Cyanide	Colorimetric				
Cyanide		TF34	5	CN1	8.0
Dibromochloropropane	GC/ECD				
Dibromochloropropane		AY8	0.195	Q8	0.13
Metals					
Arsenic	AA	AX8	2.35	R9D	25
Arsenic	AA	SS12	117	SD30	2
Arsenic	AA			VV8	2.5
Cadmium	ICP	SS12	6.78	R9D	5
Calcium	ICP	SS12	105	R9D	50
Chromium	ICP	SS12	16.8	R9D	22
Copper	ICP	SS12	18.8	R9D	10
Lead	ICP	SS12	43.4	R9D	52
Magnesium	ICP	SS12	135	R9D	89.2
Mercury	AA	CC8	0.1	WW8	0.5
Potassium	ICP	SS12	1240	XX8	590
Sodium	ICP	SS12	279	R9D	251
Zinc	ICP	SS12	18	R9D	20
Nitrogen-phosphorus Pesticides	GC/NPD				
Atrazine		UH11	4.03	UN07	0.512
Malathion		UH11	0.373	UN07	0.25
Parathion		UH11	0.647	UN07	0.25
Supona		UH11	0.787	UN07	0.25
Vapona		UN11	0.384	UN07	0.25
Organochlorine Pesticides	GC/ECD				
2,2-bis(p-Chlorophenyl)-1,1,1-trichloroethane		KK8	0.049	MM8A	0.059
2,2-bis(p-Chlorophenyl)-1,1-dichloroethene		KK8	0.054	MM8A	0.046
Aldrin		KK8	0.05	MM8A	0.083
Chlordane		KK8	0.095	MM8A	0.152
Dieldrin		KK8	0.05	MM8A	0.0539
Endrin		KK8	0.05	MM8A	0.06
Hexachlorocyclopentadiene		KK8	0.048	MM8A	0.083
Isodrin		KK8	0.051	MM8A	0.056
Organosulfur Compounds	GC/FPD				
1,4-Dithiane		AAA8	1.34	PP8A	3.34
1,4-Oxathiane		AAA8	2.38	PP8A	1.35
4-Chlorophenylmethyl sulfide		AAA8	5.69	PP8A	1.08
4-Chlorophenylmethyl sulfone		AAA8	7.46	PP8A	2.24
4-Chlorophenylmethyl sulfoxide		AAA8	11.5	PP8A	2.96

Table 3.2: Analytical Parameters for Non-Gas Chromatography/Mass Spectrometry Detection Methods
(Page 2 of 2)

Analyte	Analyte Detection Method	DataChem Laboratories		ESE Laboratories	
		PMRMA Method Designation	Certified Reporting Limit (µg/l)	PMRMA Method Designation	Certified Reporting Limit (µg/l)
Organosulfur Compounds (continued)					
Benzothiazole		AAA8	5	PP8A	1.14
Dimethyl disulfide		AAA8	0.55	PP8A	1.16
Phosphonates	GC/FPD				
Diisopropylmethylphosphonate		AT8	0.392	QQ8	10.1
Dimethylmethylphosphonate		AT8	0.188	QQ8	16.3
Volatile Halogenated Compounds	GC/CON				
1,1,1-Trichloroethane		N8	0.76	TT8	1.09
1,1,2-Trichloroethane		N8	0.78	TT8	1.63
1,1-Dichloroethane		N8	0.73	TT8	1.93
1,1-Dichloroethene		N8	1.7	TT8	1.85
1,2-Dichloroethane		N8	1.1	TT8	2.07
1,2-Dichloroethene (total of cis & trans)		N8	0.76	TT8	1.75
Carbon tetrachloride		N8	0.99	TT8	1.69
Chlorobenzene		N8	0.82	TT8	1.36
Chloroform		N8	0.5	TT8	1.88
Methylene chloride		N8	7.4	TT8	2.48
Tetrachloroethene		N8	0.75	TT8	2.76
Trichloroethene		N8	0.56	TT8	1.31
Volatile Hydrocarbons	GC/FID				
Bicyclo[2,2,1]hepta-2-5-diene		P8	5.9	R8	13.9
Dicyclopentadiene		P8	5	R8	9.31
Methylisobutyl ketone		P8	4.9	R8	12.9
Volatile Organic Aromatics	GC/PID				
Benzene		AV8	1.05	SS8	1.92
Ethylbenzene		AV8	1.37	SS8	0.62
Toluene		AV8	1.47	SS8	2.1
m-Xylene		AV8	1.32	SS8	1.04
o,p-Xylene		AV8	1.36	SS8	1.34

AA = atomic absorption spectrometry
 ESE = Environmental Science and Engineering, Inc.
 GC/CON = gas chromatography/conductivity detector
 GC/ECD = gas chromatography/electron capture detector
 GC/FID = gas chromatography/flame ionization detector
 GC/FPD = gas chromatography/flame photometric detector
 GC/MS = gas chromatography/mass spectrometry
 GC/NPD = gas chromatography/nitrogen phosphorus detector
 GC/PID = gas chromatography/photoionization detector
 HPLC = high performance liquid chromatography
 ICP = inductively coupled argon plasma screen
 IONCHROM = ion chromatography
 PMRMA = Program Manager for Rocky Mountain Arsenal
 $\mu\text{g/l}$ = micrograms per liter

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Table 3.3: Analytical Parameters for Gas Chromatography/Mass Spectrometry
Analysis and Certified Reporting Limits
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Analyte	DataChem Laboratories		ESE Laboratories	
	PMRMA Method Designation	Certified Reporting Limit ($\mu\text{g/l}$)	PMRMA Method Designation	Certified Reporting Limit ($\mu\text{g/l}$)
Semivolatile Organic Compounds				
1,2,3-Trichlorobenzene	UM25	5.8		
1,2,4-Trichlorobenzene	UM25	2.4	UM28	1.4
1,2-Dichlorobenzene	UM25	1.2	UM28	1.0
1,2-Diphenylhydrazine	UM25	13		
1,3-Dichlorobenzene	UM25	3.4	UM28	1.1
1,4-Dichlorobenzene	UM25	1.5	UM28	1.0
1,4-Dithiane	UM25	3.3		
1,4-Oxathiane	UM25	27		
2,2-bis (p-Chlorophenyl)-1,1,1-trichloroethane	UM25	18		
2,2-bis (p-Chlorophenyl)-1,1-dichloroethene	UM25	14		
2,2-bis (p-Chlorophenyl)-1,1-dichloroethane	UM25	18		
2,3,6-Trichlorophenol	UM25	1.7		
2,4,5-Trichlorophenol	UM25	2.8	UM28	4.6
2,4,6-Trichlorophenol	UM25	3.6	UM28	4.8
2,4-Dichlorophenol	UM25	8.4	UM28	5.8
2,4-Dimethylphenol	UM25	4.4	UM28	4.6
2,4-Dinitrophenol	UM25	176	UM28	33
2,4-Dinitrotoluene	UM25	5.8	UM28	9.7
2,6-Dinitroaniline	UM25	8.8		
2,6-Dinitrotoluene	UM25	6.7	UM28	5.0
2-Chloronaphthalene	UM25	2.6	UM28	1.6
2-Chlorophenol	UM25	2.8	UM28	2.4
2-Methylnaphthalene	UM25	1.3	UM28	1.9
2-Methylphenol	UM25	3.6	UM28	3.9
2-Nitroaniline			UM28	9.6
2-Nitrophenol	UM25	8.2	UM28	6.7
3,3'-Dichlorobenzidine	UM25	5.0	UM28	32
3-Dinitroaniline	UM25	21		
3-Menthyl-4-chlorophenol	UM25	8.5		
3-Nitroaniline	UM25	15	UM28	30
3-Nitrotoluene	UM25	2.9		
4-Bromophenylphenyl ether	UM25	22	UM28	1.4
4-Chloro-3-methylphenol			UM28	7.0
4-Chloroaniline			UM28	17
4-Chlorophenylmethyl sulfide	UM25	10		
4-Chlorophenylmethyl sulfone	UM25	5.3		
4-Chlorophenylmethyl sulfoxide	UM25	15		
4-Chlorophenylphenyl ether	UM25	23	UM28	4.0
4-Methylphenol	UM25	2.8	UM28	6.1
4-Nitroaniline			UM28	40
4-Nitrophenol	UM25	96	UM28	44

Table 3.3: Analytical Parameters for Gas Chromatography/Mass Spectrometry
Analysis and Certified Reporting Limits
(Page 2 of 4)

Analyte	DataChem Laboratories		ESE Laboratories	
	PMRMA Method Designation	Certified Reporting Limit ($\mu\text{g/l}$)	PMRMA Method Designation	Certified Reporting Limit ($\mu\text{g/l}$)
Semivolatile Organic Compounds (continued)				
Acenaphthene	UM25	5.8	UM28	3.4
Acenaphthylene	UM25	5.1	UM28	1.1
Aldrin	UM25	13		
Anthracene	UM25	5.2	UM28	1.0
Atrazine	UM25	5.9		
Benzo[A]anthracene	UM25	9.8	UM28	5.8
Benzo[A]pyrene			UM28	1.2
Benzo[B]fluoranthene	UM25	10	UM28	1.3
Benzo[B]pyrene	UM25	14		
Benzo[G,H,I]perylene	UM25	15	UM28	1.1
Benzo[K]fluoranthene	UM25	10	UM28	2.3
Benzoic acid			UM28	24
Benzyl alcohol	UM25	4.0	UM28	12
bis(2-Ethylhexyl) phthalate	UM25	7.7		
Bromacil	UM25	2.9		
Butylbenzylphthalate	UM25	28	UM28	1.1
Chlordane	UM25	37		
Chrysene	UM25	7.4	UM28	2.5
Di-N-butylphthalate	UM25	33	UM28	4.9
Di-N-octylphthalate	UM25	1.5	UM28	8.0
Dibenzo[A,H]anthracene	UM25	12	UM28	2.0
Dibenzofuran	UM25	5.1	UM28	2.6
Dibromochloropropane	UM25	12		
Dicyclopentadiene	UM25	5.5		
Dieldrin	UM25	26		
Diethylphthalate	UM25	5.9	UM28	2.2
Diisopropylmethylphosphonate	UM25	21		
Dimethylmethylphosphonate	UM25	130		
Dimethylphthalate	UM25	2.2	UM28	5.1
Endosulfan sulfate	UM25	50		
Endrin	UM25	18		
Endrin aldehyde	UM25	5.0		
Fluoranthene	UM25	24	UM28	1.0
Fluorene	UM25	9.2	UM28	1.3
Heptachlor	UM25	38		
Heptachlor epoxide	UM25	28		
Hexachlorobenzene	UM25	12	UM28	1.0
Hexachlorobutadiene	UM25	8.7	UM28	1.0
Hexachlorocyclopentadiene	UM25	54	UM28	7.6
Hexachloroethane	UM25	8.3	UM28	1.2
Indeno[1,2,3,-C,D]pyrene	UM25	21	UM28	4.4
Isodrin	UM25	7.8		

Table 3.3: Analytical Parameters for Gas Chromatography/Mass Spectrometry
Analysis and Certified Reporting Limits
(Page 3 of 4)

Analyte	DataChem Laboratories		ESE Laboratories	
	PMRMA Method Designation	Certified Reporting Limit ($\mu\text{g/l}$)	PMRMA Method Designation	Certified Reporting Limit ($\mu\text{g/l}$)
Semivolatile Organic Compounds (continued)				
Isophorone	UM25	2.4	UM28	1.1
Lindane	UM25	7.2		
Malathion	UM25	21		
Methoxychlor	UM25	11		
Mirex	UM25	24		
N-nitrosodi-N-propylamine	UM25	6.8	UM28	3.2
N-nitrosodimethylamine	UM25	9.7		
N-nitrosodiphenylamine	UM25	3.7	UM28	5.9
Naphthalene	UM25	0.5	UM28	3.8
Nitrobenzene	UM25	3.7	UM28	2.9
Parathion	UM25	37		
Pentachlorophenol	UM25	9.1	UM28	12
Phenanthrene	UM25	9.9	UM28	1.0
Phenol	UM25	2.2	UM28	6.2
Pyrene	UM25	17	UM28	1.0
Supona	UM25	19		
Vapona	UM25	8.5		
alpha-Benzenehexachloride	UM25	5.3		
alpha-Endosulfan	UM25	23		
beta-Benzenehexachloride	UM25	17		
beta-Endosulfan	UM25	42		
bis(2-Chloroethoxy)methane	UM25	6.8		
bis(2-Chloroethyl)ether	UM25	0.68		
bis(2-Chloroisopropyl)ether	UM25	5.0		
bis(2-Chloroethoxyl)methane			UM28	3.8
bis(2-Chloroethyl)ether			UM28	1.8
bis(2-Chloroisopropyl)ether			UM28	1.3
bis(2-Ethylexyl)phthalate			UM28	1.0
Volatile Organic Compounds				
1,1,1-Trichloroethane	UM21	1.0	UM27	3.6
1,1,2,2-Tetrachloroethane	UM21	1.5	UM27	2.0
1,1-Dichloroethane	UM21	1.0	UM27	2.0
1,1-Dichloroethene	UM21	1.0	UM27	21
1,2,3-Trichloropropane			UM27	2.0
1,2-Dichlorobenzene			UM27	17
1,2-Dichloroethane	UM21	1.0	UM27	6.7
1,2-Dichloroethene (total of cis and trans)	UM21	5.0		
1,2-Dichloropropane	UM21	1.0	UM27	2.0
1,3-Dichlorobenzene	UM21	1.0	UM27	10
1,3-Dichloropropane	UM21	4.8		
1,4-Dichlorobenzene			UM27	17

Table 3.3: Analytical Parameters for Gas Chromatography/Mass Spectrometry
Analysis and Certified Reporting Limits
(Page 4 of 4)

Analyte	DataChem Laboratories		ESE Laboratories	
	PMRMA Method Designation	Certified Reporting Limit ($\mu\text{g/l}$)	PMRMA Method Designation	Certified Reporting Limit ($\mu\text{g/l}$)
Volatile Organic Compounds (continued)				
2-Chloroethylvinyl ether	UM21	3.5	UM27	4.0
2-Hexanone			UM27	4.8
Acetone	UM21	8.0	UM27	17
Acrolein			UM27	20
Acrylonitril	UM21	8.4	UM27	2.3
Benzene	UM21	1.0	UM27	2.8
Bromodichloromethane	UM21	1.0	UM27	2.0
Bromoform	UM21	11	UM27	2.0
Bromomethane	UM21	14	UM27	36
Carbon disulfide			UM27	16
Carbon tetrachloride	UM21	1.0	UM27	4.4
Chlorobenzene	UM21	1.0	UM27	2.0
Chloroethane	UM21	8.0	UM27	8.0
Chloroform	UM21	1.0	UM27	2.0
Chloromethane	UM21	1.2	UM27	9.0
Dibromochloromethane	UM21	1.0	UM27	2.0
Dichlorobenzene (nonspecific)	UM21	2.0		
Dichlorodifluoromethane			UM27	17
Ethylbenzene	UM21	1.0	UM27	2.0
Ethylmethacrylate			UM27	2.0
Methylene bromide			UM27	2.0
Methylene chloride	UM21	1.0	UM27	19
Methylethyl ketone	UM21	10	UM27	6.2
Methylisobutyl ketone	UM21	1.4	UM27	2.0
Styrene			UM27	2.0
Tetrachloroethene	UM21	1.0	UM27	2.0
Toluene	UM21	1.0	UM27	2.0
Trichloroethene	UM21	1.0	UM27	2.2
Trichlorofluoromethane	UM21	1.0	UM27	11
Vinyl acetate			UM27	2.0
Vinyl chloride	UM21	12	UM27	2.0
cis-1,3-Dichloropropene			UM27	2.4
cis-1,4-Dichloro-2-butene			UM27	2.3
m-Xylene	UM21	1.0		
o,p-Xylene	UM21	2.0	UM27	11
trans-1,2-Dichloroethene			UM27	37
trans-1,3-Dichloropropene			UM27	1.6
trans-1,4-Dichloro-2-butene			UM27	3.6

ESE = Environmental Science and Engineering, Inc.
PMRMA = Program Manager for Rocky Mountain Arsenal
 $\mu\text{g/l}$ = micrograms per liter

Table 4.1: Comparison Between the 1991 Water Monitoring Network and Previous Water-level Well Networks

<u>Sampling Round</u>	<u>Number of CMP Water-level Measurement Wells</u>	<u>Number of Supplementary Wells^a</u>	<u>CMP Water-level Measurement Dates</u>
Winter 1987/88	1025	0	11/03/87 to 11/15/87
Spring 1988	916	0	04/20/88 to 05/01/88
Summer 1988	830	0	07/15/88 to 07/25/88
Fall 1988	922	0	10/11/88 to 10/19/88
Winter 1988/89	920	0	01/26/89 to 02/03/89
Spring 1989	984	0	04/24/89 to 05/02/89
Summer 1989	1008	0	07/24/89 to 07/31/89
Fall 1989	1210	0	10/09/89 to 10/19/89
Winter 1989/90	1200	0	02/12/90 to 02/21/90
Spring 1990	1210	0	05/07/90 to 05/15/90
Summer 1990	1216	0	08/06/90 to 08/14/90
Winter 1990/91	1216	135	01/23/91 to 02/04/91
Spring 1991	1171	129	04/01/91 to 04/09/91
Fall 1991	1177	178	09/16/91 to 09/27/91

^a Water-level data from supplementary wells were collected by Morrison-Knudson Engineers, Inc., Technical Operations Division of the Army, and the U.S. Geological Survey near the boundary systems.

CMP = Comprehensive Monitoring Program

Table 4.2: Summary of Analyses for the Winter 1990/91 Sampling Round
(Page 1 of 2)

Group/Analyte	Number of Analyses ^a	Number of Detections	Minimum Detection ($\mu\text{g/l}$)	Maximum Detection ($\mu\text{g/l}$)	Well Number of Maximum Detection
Volatile Aromatic Compounds					
Benzene	264	20	1.27	210	26133
Ethylbenzene	264	3	2.98	3.89	23049
Toluene	264	15	1.71	>400	26163
m-Xylene	264	5	1.35	7.10	26133
o- and p-Xylenes	264	8	1.50	31.8	26133
Volatile Organohalogen Compounds					
1,1,1-Trichloroethane	273	12	0.828	31.3	23189
1,1,2-Trichloroethane	273	1	6.79	6.79	23189
1,1-Dichloroethane	273	18	1.44	65.7	02505
1,1-Dichloroethene	266	5	2.03	46.9	23189
1,2-Dichloroethane	273	20	1.49	60.2	35507
1,2-Dichloroethene	273	16	1.29	580	26173
Carbon tetrachloride	273	5	1.21	37.3	23189
Chlorobenzene	273	19	0.950	12.6	23189
Chloroform	273	108	0.573	22,000	26148
Methylene chloride	273	6	3.41	430	26133
Tetrachloroethene	273	60	0.841	830	26133
Trichloroethene	273	58	0.793	500	26173
Volatile Hydrocarbon Compounds					
Bicycloheptadiene	205	9	12.0	740	26133
Dicyclopentadiene	261	28	9.84	2300	26133
Methylisobutylketone	256	3	19.3	210	26133
Dibromochloropropane	184	23	0.147	15.0	26157
Organochlorine Pesticides					
2,2-Bis(p-chlorophenyl)- 1,1,1-trichloroethane	173	17	0.0591	1.40	23530
2,2-Bis(p-chlorophenyl)- 1,1-dichloroethene	186	3	0.129	0.979	26163
Aldrin	175	16	0.0583	0.566	26085
Chlordane	186	2	2.10	2.20	02034
Dieldrin	168	31	0.0457 ^b	3.30	24101
Endrin	186	21	0.0433 ^b	3.80	23049
Hexachlorocyclopentadiene	156	6	0.148	5.30	23530
Isodrin	182	5	0.0825	1.10	23530
Organophosphorus Pesticides					
Atrazine	222	66	4.38	170	26163
Malathion	230	16	0.462	3.74	23530
Parathion	268	39	0.824	59.6	37313
Supona	230	3	0.929	1.93	26163
Vapona	220	4	0.627	5.69	26163

Table 4.2: Summary of Analyses for the Winter 1990/91 Sampling Round
(Page 2 of 2)

Group/Analyte	Number of Analyses ^a	Number of Detections	Minimum Detection (µg/l)	Maximum Detection (µg/l)	Well Number of Maximum Detection
Organophosphorus Compounds					
Diisopropylmethylphosphonate	248	151	0.443	3700	37418
Dimethylmethylphosphate	249	12	0.226	17,000	26041
Organosulfur Compounds					
1,4-Dithiane	272	46	1.63	200	35507
1,4-Oxathiane	233	23	2.00	43.0	26041
Benzothiazole	271	2	6.82	15.7	26163
Dimethyldisulfide	224	3	1.84	4.45	26163
p-Chlorophenylmethylsulfide	270	16	1.29	530	26133
p-Chlorophenylmethylsulfone	268	37	6.50	760	26168
p-Chlorophenylmethylsulfoxide	272	29	2.93	160	23220
Metals					
Arsenic	270	61	2.71	57.2	26163
Cadmium	270	1	15.9	15.9	23530
Chromium	270	24	17.2	151	23530
Copper	270	28	10.9	696	24127
Lead	270	4	44.6	79.0	23530
Mercury	271	76	0.102	3.60	37444
Zinc	270	65	20.5	278	SACMW08
Cations					
Calcium	230	230	2200	950,000	26066
Magnesium	230	224	294	510,000	26041
Potassium	271	259	1290	181,000	26041
Sodium	230	230	54,000	21,000,000	26041
Cyanide	220	12	5.33	16.5	26166
Anions					
Chloride	187	187	3560	11,000,000	26163
Fluoride	172	160	832	130,000	26163
Nitrate/nitrite	260	260	16.5	30,000	23095
Sulfate	214	211	2160	14,000,000	02023

^a There were 273 groundwater samples collected during the Winter 1990/91 sampling round. The number of analytical results in the final database is often less than 273 due primarily to their rejection. A summary of rejected results is presented in Table 4.7

^b The reported results are below the certified reporting limit because the method accuracy is above 100 percent.

µg/l = micrograms per liter

< = less than

> = greater than

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Table 4.3: Summary of Analyses for the Spring 1991 Sampling Round
(Page 1 of 2)

Group/Analyte	Number of Analyses ^a	Number of Detections	Minimum Detection ($\mu\text{g/l}$)	Maximum Detection ($\mu\text{g/l}$)	Well Number of Maximum Detection
Volatile Aromatic Compounds					
Benzene	61	17	1.26	200	26133
Ethylbenzene	61	1	11.3	11.3	23530
Toluene	61	6	11.2	1800	26163
m-Xylene	61	3	1.55	11.2	23530
o- and p-Xylenes	61	8	1.82	21.7	23530
Volatile Organohalogen Compounds					
1,1,1-Trichloroethane	61	0	-	-	-
1,1,2-Trichloroethane	61	0	-	-	-
1,1-Dichloroethane	61	6	0.935	3.73	26157
1,1-Dichloroethene	61	0	-	-	-
1,2-Dichloroethane	61	5	1.87	23.9	23049
1,2-Dichloroethene	61	2	6.81	470	26173
Carbon tetrachloride	61	2	2.23	4.63	26073
Chlorobenzene	61	6	1.47	9.55	26066
Chloroform	51	22	0.644	73,000	26133
Methylene chloride	61	5	18.3	190	26148
Tetrachloroethene	60	14	1.13	970	26133
Trichloroethene	59	19	0.678	600	26173
Volatile Hydrocarbon Compounds					
Bicycloheptadiene	40	7	12.7	310	26148
Dicyclopentadiene	58	13	22.7	5600	23049
Methylisobutylketone	58	4	9.23	110	26148
Dibromochloropropane	60	11	0.200	22.0	26133
Organochlorine Pesticides					
2,2-Bis(p-chlorophenyl)-1,1,1-trichloroethane	48	9	0.157	0.706	26148
2,2-Bis(p-chlorophenyl)-1,1-dichloroethene	48	3	0.106	0.161	26173
Aldrin	48	7	0.0682	0.964	26173
Chlordane	48	0	-	-	-
Dieldrin	48	20	0.0681	6.20	23241
Endrin	47	6	0.0589	0.248	26148
Hexachlorocyclopentadiene	9	0	-	-	-
Isodrin	48	4	0.0767	1.70	23241
Organophosphorus Pesticides					
Atrazine	31	19	5.57	240	26163
Malathion	31	15	0.559	7.09	23241
Parathion	49	7	0.966	6.10	26071
Supona	31	3	1.26	11.0	26041
Vapona	31	4	0.433	9.90	26041

Table 4.3: Summary of Analyses for the Spring 1991 Sampling Round
(Page 2 of 2)

Group/Analyte	Number of Analyses ^a	Number of Detections	Minimum Detection ($\mu\text{g/l}$)	Maximum Detection ($\mu\text{g/l}$)	Well Number of Maximum Detection
Organophosphorus Compounds					
Diisopropylmethylphosphonate	59	41	0.998	3200	26071
Dimethylmethylphosphate	59	10	0.272	8300	26041
Organosulfur Compounds					
1,4-Dithiane	53	28	1.76	160	26066
1,4-Oxathiane	52	25	1.65	67.0	26041
Benzothiazole	29	6	2.68	21.9	26041
Dimethyldisulfide	29	3	1.10	4.47	26041
p-Chlorophenylmethylsulfide	48	10	6.88	530	26133
p-Chlorophenylmethylsulfone	53	23	6.26	820	26168
p-Chlorophenylmethylsulfoxide	46	13	5.49	140	26148
Metals					
Arsenic	58	33	2.94	30.8	23049
Cadmium	58	0	-	-	-
Chromium	58	12	23.0	92.6	26133
Copper	58	9	10.5	93.0	23095
Lead	58	0	-	-	-
Mercury	59	22	0.101	1.79	26071
Zinc	58	8	21.4	42.6	26501
Cations					
Calcium	40	40	34,600	960,000	26066
Magnesium	40	40	2060	520,000	26041
Potassium	58	58	1240	142,000	26041
Sodium	40	40	120,000	20,000,000	26041
Cyanide	58	14	5.00	18.5	26168
Anions					
Chloride	60	60	16,000	10,000,000	26041
Fluoride	60	46	1250	250,000	26041
Nitrate/nitrite	58	58	13.4	31,000	23095
Sulfate	60	60	120,000	10,000,000	26041

^a There were 61 groundwater samples collected during the Spring 1991 sampling round. The number of analytical results in the final database is often less than 61 due primarily to their rejection. A summary of rejected results is presented in Table 4.7.

$\mu\text{g, l}$ = micrograms per liter

- = Because no detections were recorded, no value exists.

Table 4.4: Summary of Analyses for the Fall 1991 Sampling Round
(Page 1 of 2)

Group/Analyte	Number of Analyses ^a	Number of Detections	Minimum Detection ($\mu\text{g/l}$)	Maximum Detection ($\mu\text{g/l}$)	Well Number of Maximum Detection
Volatile Aromatic Compounds					
Benzene	58	11	3.08	140	26173
Ethylbenzene	58	6	1.15	11.3	26133
Toluene	58	5	3.09	690	26163
m-Xylene	58	3	1.21	7.37	26133
o- and p-Xylenes	58	5	3.65	20.7	26133
Volatile Organohalogen Compounds					
1,1,1-Trichloroethane	58	3	1.91	195	26133
1,1,2-Trichloroethane	33	0	-	-	-
1,1-Dichloroethane	58	5	2.83	9.40	26133
1,1-Dichloroethene	58	2	1.99	2.45	26171
1,2-Dichloroethane	58	2	4.67	46.0	23095
1,2-Dichloroethene	58	2	5.32	30.2	26133
Carbon tetrachloride	58	1	5.84	5.84	26073
Chlorobenzene	58	6	1.56	31.7	26148
Chloroform	58	18	2.25	55,000	26173
Methylene chloride	58	6	11.3	570	26173
Tetrachloroethene	58	12	2.71	196	23241
Trichloroethene	58	14	1.46	198	26133
Volatile Hydrocarbon Compounds					
Dicyclopentadiene	58	11	10.5	900	26133
Methylisobutylketone	58	3	17.3	98.2	26133
Dibromochloropropane	58	8	0.934	71.0	26173
Organochlorine Pesticides					
2,2-Bis(p-chlorophenyl)- 1,1,1-trichloroethane	58	3	0.193	1.90	26163
2,2-Bis(p-chlorophenyl)- 1,1-dichloroethene	58	2	0.174	0.270	23095
Aldrin	58	4	0.133	2.40	26127
Chlordane	58	0	-	-	-
Dieldrin	58	32	0.0529 ^b	7.40	26127
Endrin	58	8	0.0735	1.42	26127
Hexachlorocyclopentadiene	58	0	-	-	-
Isodrin	58	4	0.0887	0.181	35505
Organophosphorus Pesticides					
Parathion	56	0	-	-	-
Organophosphorus Compounds					
Diisopropylmethylphosphonate	57	34	14.5	5400	23095
Dimethylmethylphosphate	57	4	34.3	8000	26041

Table 4.4: Summary of Analyses for the Fall 1991 Sampling Round
(Page 2 of 2)

Group/Analyte	Number of Analyses ^a	Number of Detections	Minimum Detection (µg/l)	Maximum Detection (µg/l)	Well Number of Maximum Detection
Organosulfur Compounds					
1,4-Dithiane	58	24	4.35	200	26066
1,4-Oxathiane	58	27	2.01	28.2	26148
Benzothiazole	58	4	1.32	2.75	26066
Dimethyldisulfide	58	2	6.06	13.1	26173
p-Chlorophenylmethylsulfide	58	16	1.27	960	26173
p-Chlorophenylmethylsulfone	58	32	3.52	2900	26167
p-Chlorophenylmethylsulfoxide	58	13	3.81	350	26167
Metals					
Arsenic	55	26	2.04	130	26041
Cadmium	55	0	-	-	-
Chromium	55	0	-	-	-
Copper	55	0	-	-	-
Lead	55	0	-	-	-
Mercury	55	6	0.504	25.0	26019
Zinc	55	0	-	-	-
Cations					
Calcium	55	55	22,000	1,300,000	26167
Magnesium	55	51	1630	460,000	26041
Potassium	55	55	1280	130,000	26041
Sodium	55	55	130,000	17,000,000	26041
Cyanide	55	14	10.4	28.2	26020
Anions					
Chloride	58	58	17,100	22,000,000	26041
Fluoride	58	28	955	220,000	26041
Nitrate/nitrite	58	58	22.7	28,000	26020
Sulfate	58	58	120,000	9,000,000	26041

^a There were 58 groundwater samples collected during the Fall 1991 sampling round. The number of analytical results in the final database is often less than 58 due primarily to their rejection. A summary of rejected results is presented in Table 4.7

^b The reported results are below the certified reporting limit because the method accuracy is above 100 percent.

µg/l = micrograms per liter

- = Because no detections were recorded, no value exists.

Table 4.5: Summary of Specific Analyte Data for the 1991 Water Monitoring Year

Compound	Aquifer	Number of Samples	Number of Detections	Certified Reporting Limits (Number of Samples Analyzed)	Range of Detections
Diisopropylmethylphosphonate (DIMP)	Total	364	226	0.392(248), 10.1(116)	0.443 - 5400
	UFS	260	203		
	CFS	104	23		
Dibromochloropropane (DBCP)	Total	302	42	0.195(185), 0.130(117)	0.147 - 71.0
	UFS	218	39		
	CFS	84	3		
Chloroform (CHCL3)	Total	382	148	0.5(264), 1.8(118)	0.573 - 73,000
	UFS	270	132		
	CFS	112	16		
Dieldrin (DLDRN)	Total	276	85	0.0500(158), 0.0539(118)	0.0457 - 7.40
	UFS	191	76		
	CFS	85	9		
Fluoride (F)	Total	291	235	153(157), 1000(134)	832 - 250,000
	UFS	204	164		
	CFS	87	71		

CFS = confined flow system
UFS = unconfined flow system

Table 4.6: Tentatively Identified Compounds
Spring 1991 Sampling Round

<u>Compound</u>	<u>Number of Detections</u>	<u>Concentration ($\mu\text{g/l}$)^a</u>	<u>Well Identification</u>
1-Chloro-4-(methylsulfonyl)-benzene	2	4.8	26169
		45	26166
2-Chloro-5-methylphenol	1	130	26163
2-Chloro-6-methylphenol	1	81	26163
4-Dioxide-1,4-oxathiane	1	7.9	26129
4-Methyl-2-pentanone/methylisobutyl ketone ^b	1	69	26133
(Methylsulfonyl)-benzene	1	27	26166
Tetrachloroethene ^b	1	140	26133

^a Reported concentrations are estimated values.

^b CMP target analytes

$\mu\text{g/l}$ = micrograms per liter

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Table 4.7: Summary of Data Rejected for the 1991 Water Monitoring Year
(Page 1 of 2)

Method/Analyte	Number of Rejected Values*
Winter 1990/91	
Method: N8 Volatile Organohalogen Compounds	
1,1-Dichloroethene	7
Method: P8 Volatile Hydrocarbon Compounds	
Bicycloheptadiene	25
Dicyclopentadiene	2
Methylisobutylketone	16
Method: R8 Volatile Hydrocarbon Compounds	
Dicyclopentadiene	9
Method: AY8 Dibromochloropropane	
Dibromochloropropane	87
Method: KK8 Organochlorine Pesticides	
2,2-Bis(p-chlorophenyl)-1,1,1-trichloroethane	100
2,2-Bis(p-chlorophenyl)-1,1-dichloroethene	87
Aldrin	98
Chlordane	87
Dieldrin	116
Endrin	87
Hexachlorocyclopentadiene	100
Isodrin	91
Method: MM8A Organochlorine Pesticides	
Hexachlorocyclopentadiene	17
Method: UH11 Organophosphorus Pesticides	
Atrazine	9
Malathion	1
Parathion	3
Supona	1
Vapona	11
Method: AT8 Organophosphorus Compounds	
Diisopropylmethylphosphonate	25
Dimethylmethylphosphate	24
Method: AAA8 Organosulfur Compounds	
1,4-Oxathiane	36
Dimethyldisulfide	36
Method: PP8A Organosulfur Compounds	
1,4-Oxathiane	3
Dimethyldisulfide	12
p-Chlorophenylmethylsulfide	2
p-Chlorophenylmethylsulfone	4

Table 4.7: Summary of Data Rejected for the 1991 Water Monitoring Year
(Page 2 of 2)

Method/Analyte	Number of Rejected Values ^a
Winter 1990/91 (continued)	
Method: TF34 Cyanide	52
Method: LL8 Anions	
Nitrate/nitrite	13
Method: TT09 Anions	
Chloride	71
Fluoride	86
Sulfate	44
Spring 1991	
Method: N8 Volatile Organohalogen Compound	
Chloroform	10
Method: KK8 Organochlorine Pesticides	
Endrin	1
Hexachlorocyclopentadiene	23
Method: MM8A Organochlorine Pesticides	
Hexachlorocyclopentadiene	18
Method: AAA8 Organosulfur Compounds	
1,4-Oxathiane	8
Benzothiazole	31
Dimethyldisulfide	31
Dithiane	7
p-Chlorophenylmethylsulfide	12
p-Chlorophenylmethylsulfone	7
p-Chlorophenylmethylsulfoxide	14

^a Number of rejected values includes quality control samples.

Table 4.8: Quality Control Blank Artifact Summary, Volatile Organic Analyses
1991 Water Monitoring Year

Sampling Round	Blank Well Number ^a	Affected Well Number ^b	Chemical Abbreviation	Blank Artifact Concentration ($\mu\text{g/l}$)	Investigative Sample Concentration ^c ($\mu\text{g/l}$)	Affected Investigative Sample Concentration ^d ($\mu\text{g/l}$)
Rinse Blank Winter 1991	23232	23235	CH ₂ CL ₂	3.15	<2.48	<2.48
	33077	33078	CLC ₆ H ₅	1.20	<0.82	<0.82
			CHCL ₃	0.649	0.78	0.694
	37334	37337	CHCL ₃	1.83	2.78	<0.50
			CLC ₆ H ₅	1.64	2.35	<0.82
			DBCP	0.220	0.24	<0.195
Fall 1991	26157	26171	CHCL ₃	65.4	27,000	<1.88
			TCLEE	6.07	>196	3.45
Field Blank Winter 1991	26086		CHCL ₃	2.00	<0.50	
	33077		CLC ₆ H ₅	1.18	<0.82	
Spring 1991	26127		TCLEE	1.01	<0.75	

^a The well that was sampled before the blank sample was collected.

^b For rinse blanks, the well that was sampled with the same sampling equipment after the blank sample was collected.

^c For trip blanks and field blanks, this is the concentration detected in the investigative sample collected at the same time the blank was collected. For rinse blanks, this is the concentration detected in the investigative sample that was collected before the blank was collected.

^d For rinse blanks, the concentration in the well that was sampled with the same sampling equipment after the blank sample was collected.

< = less than

> = greater than

CH₂CL₂ = methylene chloride

CHCL₃ = chloroform

CLC₆H₅ = chlorobenzene

DBCP = dibrochloropropane

TCLEE = tetrachloroethene

$\mu\text{g/l}$ = micrograms per liter

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Table 4.9: Quality Control Blank Artifact Summary, Semivolatile Organic Compound and Pesticide Analyses, 1991 Water Monitoring Year

Sampling Round	Blank Well Number ^a	Affected Well Number ^b	Chemical Abbreviation	Blank Artifact Concentration (µg/l)	Investigative Sample Concentration ^c (µg/l)	Affected Investigative Sample Concentration ^d (µg/l)
Trip Blank Winter 1991	23204		DIMP	1.05	5.54	
	26086		ALDRN	0.0973	<0.05	
Rinse Blank Winter 1991	26086	26153	PPDDT	0.0770	0.589	<0.059
Fall 1991	26127	26075	ENDRN	0.0681	1.42	<0.060
			ALDRN	0.351	2.40	<0.083
			DLDRN	0.267	7.40	0.0692
			CPMS	1.30	<1.08	<1.08
Field Blank Winter 1991	23142		ALDRN	0.0942	<0.05	
	26086		ENDRN	0.261	0.0774	
			PPDDT	0.173	0.589	
	37368		ALDRN	0.0645	<0.05	

^a The well that was sampled before the blank sample was collected.

^b For rinse blanks, the well that was sampled with the same sampling equipment after the blank sample was collected.

^c For trip blanks and field blanks, this is the concentration detected in the investigative sample collected at the same time the blank was collected. For rinse blanks, this is the concentration detected in the investigative sample that was collected before the blank was collected.

^d For rinse blanks, the concentration in the well that was sampled with the same sampling equipment after the blank sample was collected.

< = less than

ALDRN = aldrin

CPMS = p-chlorophenylmethyl sulfide

DIMP = diisopropylmethyl phosphonate

DLDRN = dieldrin

ENDRN = endrin

PPDDT = 2,2-bis(para-chlorophenyl)-1,1,1-trichloroethane

µg/l = micrograms per liter

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Table 4 10: Quality Control Blank Artifact Summary, Trace Inorganic Constituent Analyses
1991 Water Monitoring Year
(Page 1 of 2)

Sampling Round	Well Number ^a	Affected Well Number ^b	Chemical Abbreviation	Blank Artifact Concentration ($\mu\text{g/l}$)	Investigative Sample Concentration ^c ($\mu\text{g/l}$)	Affected Investigative Sample Concentration ^d ($\mu\text{g/l}$)
Trip Blank						
Winter 1990/91						
	01075	01075	HG	0.124	<0.10	
	24166	24166	HG	0.136	<0.10	
	37353	37353	HG	1.08	1.02	
Spring 1991						
	23191	23191	HG	0.364	<0.10	
	26015	26015	AS	3.22	6.69	
	26127	26127	HG	0.447	<0.10	
Fall 1991						
	26127	26127	F	1560	<1000 ^a	
Rinse Blank						
Winter 1990/91						
	33077	33078	ZN	46.4	64.6 ^e	50.3 ^e
			ZN	22.9	42.3 ^e	39.5 ^e
			CU	26.6	<18.0 ^e	<18.8 ^e
			CU	29.9	<18.0 ^e	<18.8 ^e
			HG	0.212	0.818	0.401
	37334	37337	ZN	437	<18.0	24.5
			HG	0.879	280	0.687
	37353	37397	HG	0.508	1.02	0.741
	37368		HG	0.705	0.466	
	37408	37409 ^f	HG	0.605	1.22	0.771
			ZN	166	32.6	25.8
Spring 1991						
	36015	26161	ZN	33.2	<20.0	<20.0
	26127	26168	HG	1.10	<0.100	0.366
Fall 1991						
	26127	26075	CU	17.4	<1000 ^g	<500 ^g

Table 4.10: Quality Control Blank Artifact Summary, Trace Inorganic Compound Analyses
1991 Water Monitoring Year
(Page 2 of 2)

Sampling Round	Well Number ^a	Affected Well Number ^b	Chemical Abbreviation	Blank Artifact Concentration ($\mu\text{g/l}$)	Investigative Sample Concentration ^c ($\mu\text{g/l}$)	Affected Investigative Sample Concentration ^d ($\mu\text{g/l}$)
Field Blank						
Winter 1990/91						
	23232	23232	ZN	24.4	<20.0	
	24161	24161	ZN	120	<20.0	
	26086	26086	CR	18.0	<16.8	
	33077	33077	HG	0.363	0.818	
	37334	37334	HG	1.03	0.280	
	37368	37368	HG	0.323	0.466	
	37408	37408	HG	1.18	1.22	
Spring 1991						
	26127	26127	HG	1.26	<0.10	

^a The well that was sampled before the blank sample was collected.

^b For rinse blanks, the well that was sampled with the same sampling equipment after the sample was collected.

^c For trip blanks and field blanks, this is the concentration detected in the investigative sample collected at the same time the blank was collected. For rinse blanks, this is the concentration detected in the investigative sample that was collected before the blank was collected.

^d For rinse blanks, the concentration in the well that was sampled with the same sampling equipment after the blank sample was collected.

^e This sample was analyzed in two separate lots on different dates. Both values from the database are reported.

^f The well was sampled on the last day of the Winter 1990/91 monitoring round. Therefore, there is no affected investigative well associated with the rinse blank.

^g Elevated certified reporting limit.

< = less than

AS = arsenic

CR = chromium

CU = copper

F = fluoride

HG = mercury

ZN = zinc

$\mu\text{g/l}$ = micrograms per liter

Table 4.11: Statistical Summary for Duplicate Sample Analyses
1991 Water Monitoring Year
(Page 2 of 2)

Target Analyte	Number of Detection Pairs	Low RPD (Percent)	High RPD (Percent)	Average RPD (Percent)
Trace Inorganic Compounds (continued)				
Magnesium	34	0.0	170	9.7
Sodium	35	0.0	170	17
Nitrite-nitrate (nonspecific)	42	0.0	190	21
Sulfate	36	0.0	190	10
Zinc	9	6.6	87	41
Total of all analytes	325 ^a			16 ^b

^a Total number of detection pairs.

^b Geometric mean of the average RPDs.

RPD = relative percent difference

Table 4.12: Certified Reporting Limits for Different Analytical Methods
1991 Water Monitoring Year

Analyte	Method Designation		Certified Reporting Limit ($\mu\text{g/l}$)		Number of Detections Between Certified Reporting Limits ^a
	DataChem	ESE-Denver	DataChem	ESE-Denver	
Chloroform	N8	TT8	0.500	1.88	47
Dibromochloropropane	AY8	Q8	0.195	0.130	3
Diisopropylmethylphosphonate	AT8	QQ8	0.392	10.1	78
Dieldrin	KK8	MM8A	0.0500	0.0539	3
Fluoride	TT09	NN8	153	1000	4

^a Value of concentration reported is in between the values of Certified Reporting Limits.

ESE = Environmental Science and Engineering, Inc.

DataChem = DataChem Laboratories

$\mu\text{g/l}$ = micrograms per liter

Table 4.13: Dilution Differences for Certified Reporting Limits
1991 Water Monitoring Year

<u>Analyte</u>	<u>Laboratory</u>	<u>Method Designation</u>	<u>Dilution Factor</u>	<u>Certified Reporting Limit^a ($\mu\text{g/l}$)</u>	<u>Number of Analyses Reported below the Given CRL^b</u>
Dieldrin	DataChem	KK8	1	0.0500	171
			10	0.500	10
	ESE-Denver	MM8A	1	0.0539	104
			4	0.220	2
			5	0.270	2
Fluoride	DataChem	TT09	1	153	34
			32	4900	1
			104	16,000	1
	ESE-Denver	NN8	1	1000	34
			10	10,000	45
			25	25,000	7
			50	50,000	19
			100	100,000	3

^a CRL obtained through dilution factor calculations. A dilution factor of 1 corresponds to an undiluted sample.

^b The quantity listed is the number of results reported as less than the corresponding CRL.

CRL = Certified Reporting Limit

DataChem = DataChem Laboratories

ESE = Environmental Science and Engineering, Inc.

$\mu\text{g/l}$ = micrograms per liter

Table 4.14: Approximate Vertical Gradients Between Stratigraphically Adjacent Unconfined Flow System Wells and Confined Flow System Wells at Cluster Sites, 1991 Water Monitoring Year (Page 1 of 4)

Unconfined Flow System Well	Confined Flow System Well	Stratigraphic Unit of Confined Flow System Well	Number of Vertical Hydraulic Gradient Measurements ^a								Approximate Yearly Vertical Gradient	
			First Quarter		Second Quarter		Third Quarter		Fourth Quarter			
			Up	Down	Up	Down	Up	Down	Up	Down		
11002	11003	Denver B									2	0.047
12002	12003	Denver B									2	0.011
01014	01015	Denver AU									2	0.062
01021	01022	Denver AM									2	0.039
01024	01025	Denver AU									3	0.029
01038	01039	Denver AU									2	0.040
01049	01050	Denver A	2				2			3		-0.012
01075	01076	Denver						2		3		-0.010
01078	01079	Denver A						2			2	0.283
02003	02004	Denver A						2			2	0.304
02020	02021	Denver AL and AM						2			8	0.065
02023	02024	Denver AM						2		1	3	0.014
02026	02027	Denver AM						2		4	3	0.003
02034	02035	Denver AMU						2		4	2	-0.004
02037	02038	Denver AM						2		3	3	0.008
02040	02041	Denver AM						2		2	2	0.014
02058	02057	Denver A						2		4	2	0.094
02059	02060	Denver A						4				-0.151
06003	06004	Denver ASH								3		0.007
31005	31006	Denver AM						2		2		-0.007
31009	31010	Denver AL						2		2		-0.006
35026	35027	Denver ALSH										0.240
35061	35062	Denver AL						2		2	2	0.163
35065	35066	Denver AL						2				-0.013
35077	35008	Denver A						2		2		-0.153
36065	36066	Denver AL						2				0.092
36069	36105	Denver AM						2		2	2	0.292

Table 4.14: Approximate Vertical Gradients Between Stratigraphically Adjacent Unconfined Flow System Wells and Confined Flow System Wells at Cluster Sites, 1991 Water Monitoring Year
(Page 2 of 4)

Unconfined Flow System Well	Confined Flow System Well	Stratigraphic Unit of Confined Flow System Well	Number of Vertical Hydraulic Gradient Measurements ^a						Approximate Yearly Vertical Gradient
			First Quarter Up	First Quarter Down	Second Quarter Up	Second Quarter Down	Third Quarter Up	Third Quarter Down	
36077	36078	Denver ASH				2	2	2	0.021
36109	36110	Denver A				2	2	2	0.101
36141	36140	Denver A				2	2	2	0.299
02011	02012	Denver IU			2		2	2	-0.001
25038	25039	Denver IU			2		2	2	-0.008
25042	25049	Denver IU				2	2	2	0.002
25044	25050	Denver IU				2	2	2	0.099
25047	25051	Denver IU				2	2	2	0.001
26063	26057	Denver IU				2	2	2	0.017
26073	26074	Denver IU	3			2	2	2	0.018
35020	35021	Denver IU				2	2	2	0.434
35058	35059	Denver IU				2	2	2	-0.006
35069	35070	Denver IU			2		2	2	0.109
35079	35081	Denver IU				2	2	2	0.082
35088	35089	Denver IU	6			2	2	2	0.250
36146	36147	Denver IUSH				2	2	2	0.265
25011	25012	Denver I			2		2	2	-0.013
25028	25029	Denver ISH				2	2	2	0.468
26065	26066	Denver I				2	2	2	0.008
26085	26086	Denver I				2	2	2	0.187
26127	26128	Denver I			2		2	2	-0.012
26143	26144	Denver I				2	2	2	0.157
35031	35032	Denver I				2	2	2	0.151
35037	35038	Denver I				2	2	2	0.047
09002	09003	Denver 2				2	2	1	0.099
23122	23227	Denver 2				2	2	1	0.009
23123	23233	Denver 2	1	17	1	11	1	13	0.005

Table 4.14: Approximate Vertical Gradients Between Stratigraphically Adjacent Unconfined Flow System Wells and Confined Flow System Wells at Cluster Sites, 1991 Water Monitoring Year
(Page 3 of 4)

Unconfined Flow System Well	Confined Flow System Well	Stratigraphic Unit of Confined Flow System Well	Number of Vertical Hydraulic Gradient Measurements ^a								Approximate Yearly Vertical Gradient
			First Quarter		Second Quarter		Third Quarter		Fourth Quarter		
			Up	Down	Up	Down	Up	Down	Up	Down	
23178	23176	Denver 2	11	14	9	13	20	6	12	14	-0.005
23179	23180	Denver 2			2		2		3		-0.007
23185	23186	Denver 2				2		2		2	0.337
23188	23189	Denver 2				2		2	2		0.003
24192	24167	Denver 2		26		15		26		27	0.114
25015	25016	Denver 2				2		2		2	0.188
25018	25019	Denver 2				2		2		2	0.045
26068	26069	Denver 2				2		2		2	0.176
26071	26072	Denver 2				2		2		2	0.091
26076	26077	Denver 2				2		2		2	0.015
26081	26082	Denver 2				2		2		2	0.049
26088	26089	Denver 2				2		2		2	0.002
03002	03003	Denver 3	1		3		3		19		-0.017
23191	23192	Denver 3				2		2		2	0.019
23226	23236	Denver 3		8		2		2		2	0.072
24135	24136	Denver 3				2		2		2	0.008
24177	24206	Denver 3	5	7		13		12		1	0.017
24178	24203	Denver 3	13	36		14	12	3	16		-0.004
24179	24205	Denver 3	15	32	8	6	4	10	9	7	0.007
24193	24202	Denver 3	4	42		14		14		14	0.030
24194	24204	Denver 3	10	21		13		14		15	0.029
37338	37376	Denver 3			2			2	2		0.058
37374	37379	Denver 3				2		1		2	0.034
22021	22023	Denver 4				3		2		5	0.045
27053	27054	Denver 4				3		1		7	0.020
27057	27058	Denver 4				2		2		2	0.010
28027	28028	Denver 4	1			5		15		7	0.007

Table 4.14: Approximate Vertical Gradients Between Stratigraphically Adjacent Unconfined Flow System Wells and Confined Flow System Wells at Cluster Sites, 1991 Water Monitoring Year
(Page 4 of 4)

Unconfined Flow System Well	Confined Flow System Well	Stratigraphic Unit of Confined Flow System Well	Number of Vertical Hydraulic Gradient Measurements ^a								Approximate Yearly Vertical Gradient
			First Quarter		Second Quarter		Third Quarter		Fourth Quarter		
			Up	Down	Up	Down	Up	Down	Up	Down	
33033	33034	Denver 4		3		7		15		7	0.154
34008	34010	Denver 4	1		2	1	2	1	2		-0.001
37320	37321	Denver 4				2		2		2	0.043
37343	37365	Denver 4				2		2		2	0.010

^a The total number of times either of the wells in the cluster was measured.

Table 5.1: Direction of Vertical Hydraulic Gradients at Well Clusters
Near the North Boundary Containment/Treatment System
September 1991

Well Cluster ^a	Aquifer Designation (zone)	Direction of Vertical Hydraulic Gradient
North of NBS		
24511, 24512/24172	UFS/CFS(2)	Down
24511, 24512/24171	UFS/CFS(5)	Down
24172/24171	CFS(2)/CFS(5)	Up
24503, 24192/24167	UFS/CFS(2)	Down
24503, 24192/24168	UFS/CFS(3)	Down
24194/24204	UFS/CFS(3)	Down
South of NBS		
24179/24205	UFS/CFS(3)	Up
23178/23176	UFS/CFS(2)	Up
23178/23177	UFS/CFS(2)	Up
24178/24203	UFS/CFS(3)	Up

^a A cluster is defined as a set of wells completed at different depth intervals within the confined and unconfined systems that are close to one another.

CFS = confined flow system

NBS = North Boundary Containment/Treatment System

UFS = unconfined flow system

11793,600 - GMP

0613092492

Table 5.2: Contaminant Concentrations in Samples From the Confined Flow System Near the North Boundary Containment/Treatment System, Fall 1989 and Winter 1990/91

Well Number (Zone)	DIMP		Dieldrin		DBCP		Chloroform	
	Fall 1989	Winter 1990/91	Fall 1989	Winter 1990/91	Fall 1989	Winter 1990/91	Fall 1989	Winter 1990/91
23177(2)	LT	0.475	LT	LT	LT	LT	1.34	1.55
23200(3)	LT	LT	LT	LT	LT	LT	LT	LT
23201(4)	LT	LT	LT	LT	LT	LT	LT	LT
23218(2)	0.559	LT	LT	NA	LT	LT	LT	LT
23219(3)	LT	LT	LT	LT	LT	NA	LT	LT
23227(2)	LT	LT	0.176	LT	LT	LT	LT	LT
23233(2)	LT	LT	LT	LT	LT	LT	LT	LT
23234(3)	LT	LT	LT	LT	LT	NA	LT	LT
23236(3)	LT	LT	LT	LT	LT	NA	LT	LT
24136(2)	LT	LT	LT	LT	LT	LT	LT	LT
24168(3)	LT	LT	LT	LT	2.81	LT	10.8	LT
24171(3)	LT	LT	0.179	LT	LT	0.283	LT	6.06
24172(5)	LT	LT	LT	LT	LT	LT	15.2	0.585
24174(3)	LT	LT	0.101	LT	LT	LT	LT	LT
24175(4)	LT	LT	LT	LT	2.99	LT	8.08	LT
37316(5)	20.4	4.74	LT	NA	LT	NA	LT	LT
37317(4)	LT	.443	LT	NA	LT	NA	LT	LT
37318(3)	10.3	16.9	LT	NA	LT	NA	LT	LT
37319(6)	NS	11.7	NS	NA	NS	LT	NS	LT
37321(4)	0.451	1.37	LT	LT	LT	LT	LT	LT
37322(5)	LT	LT	LT	LT	LT	LT	NA	LT
37365(4)	17.6	46.0	LT	NA	LT	NA	LT	0.889
37372(4)	0.705	LT	LT	LT	0.274	0.199	LT	LT
37376(3)	LT	LT	LT	NA	LT	NA	LT	LT
37379(3)	50.0	31.7	0.0533	NA	LT	LT	1.41	1.51
37380(4)	5.35	4.27	LT	LT	LT	NA	0.675	LT
37388(4)	0.496	LT	LT	NA	LT	LT	LT	0.631
37390(3)	NS	9.06	NS	NA	NS	LT	NS	1.30

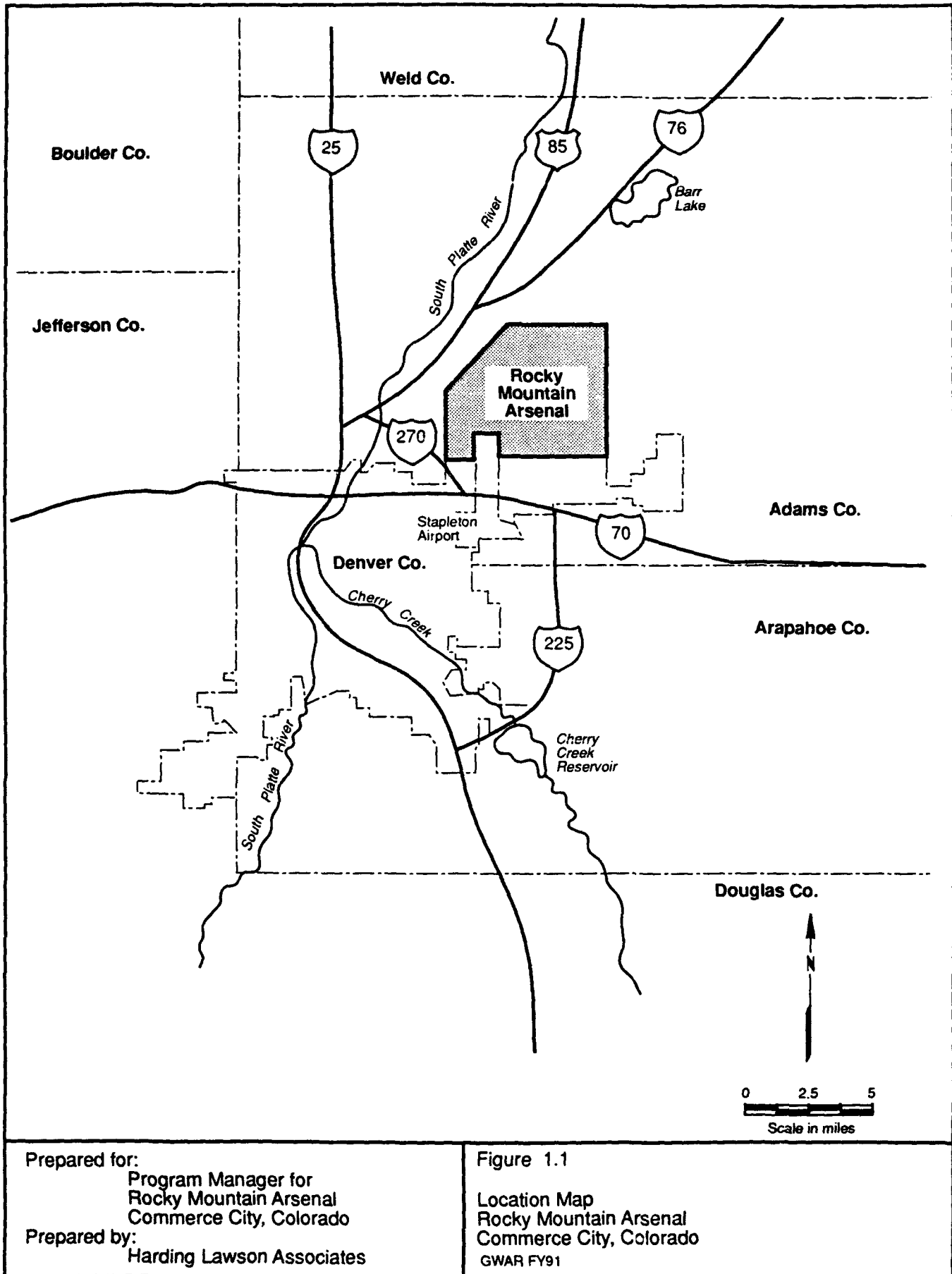
DBCP = dibromochloropropane

DIMP = diisopropylmethylphosphonate

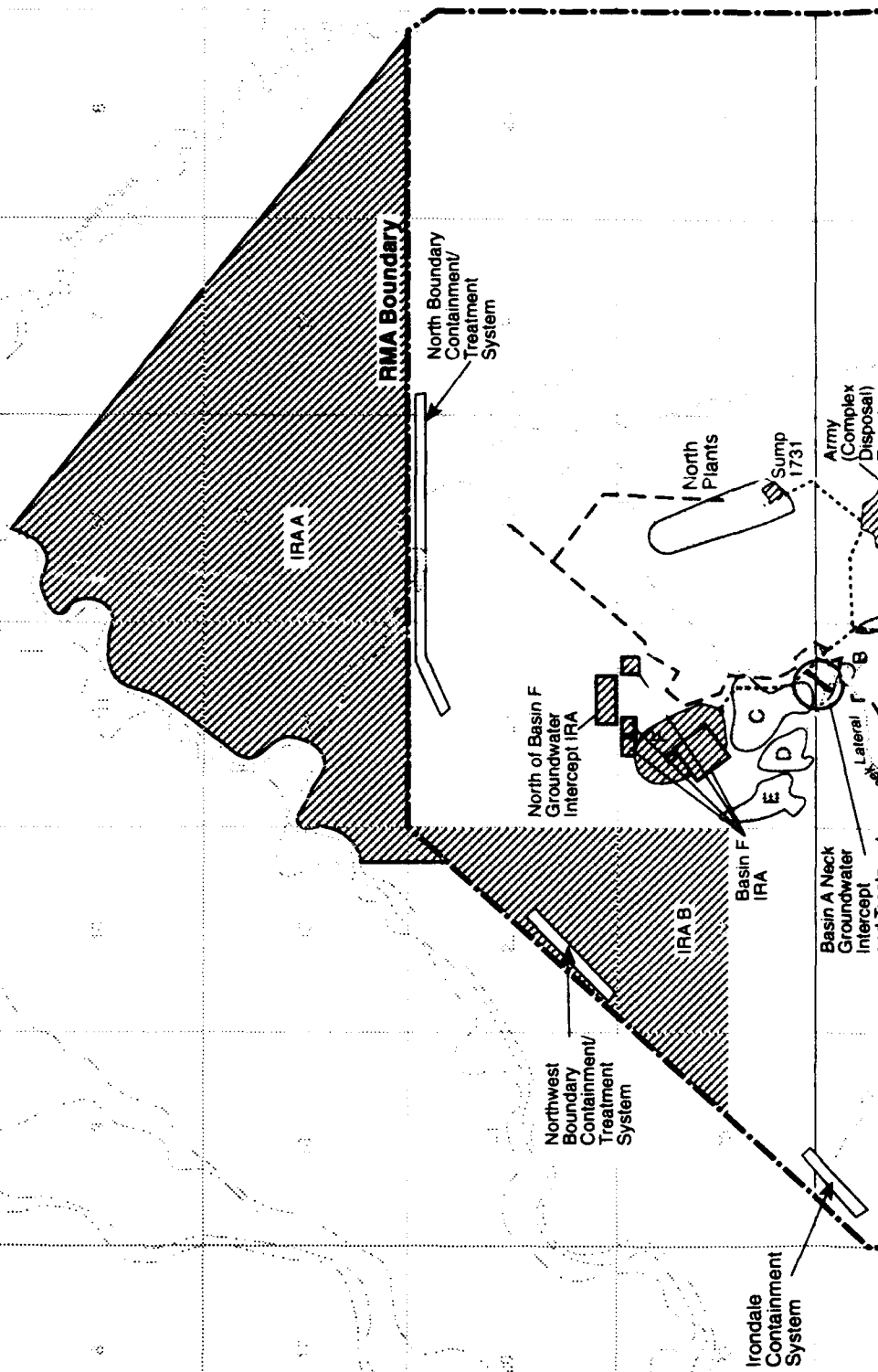
LT = less than Certified Reporting Limit

NS = well was not sampled

NA = well was sampled but results are not available because analyses were cancelled or results were rejected.



R 67 W R 66 W

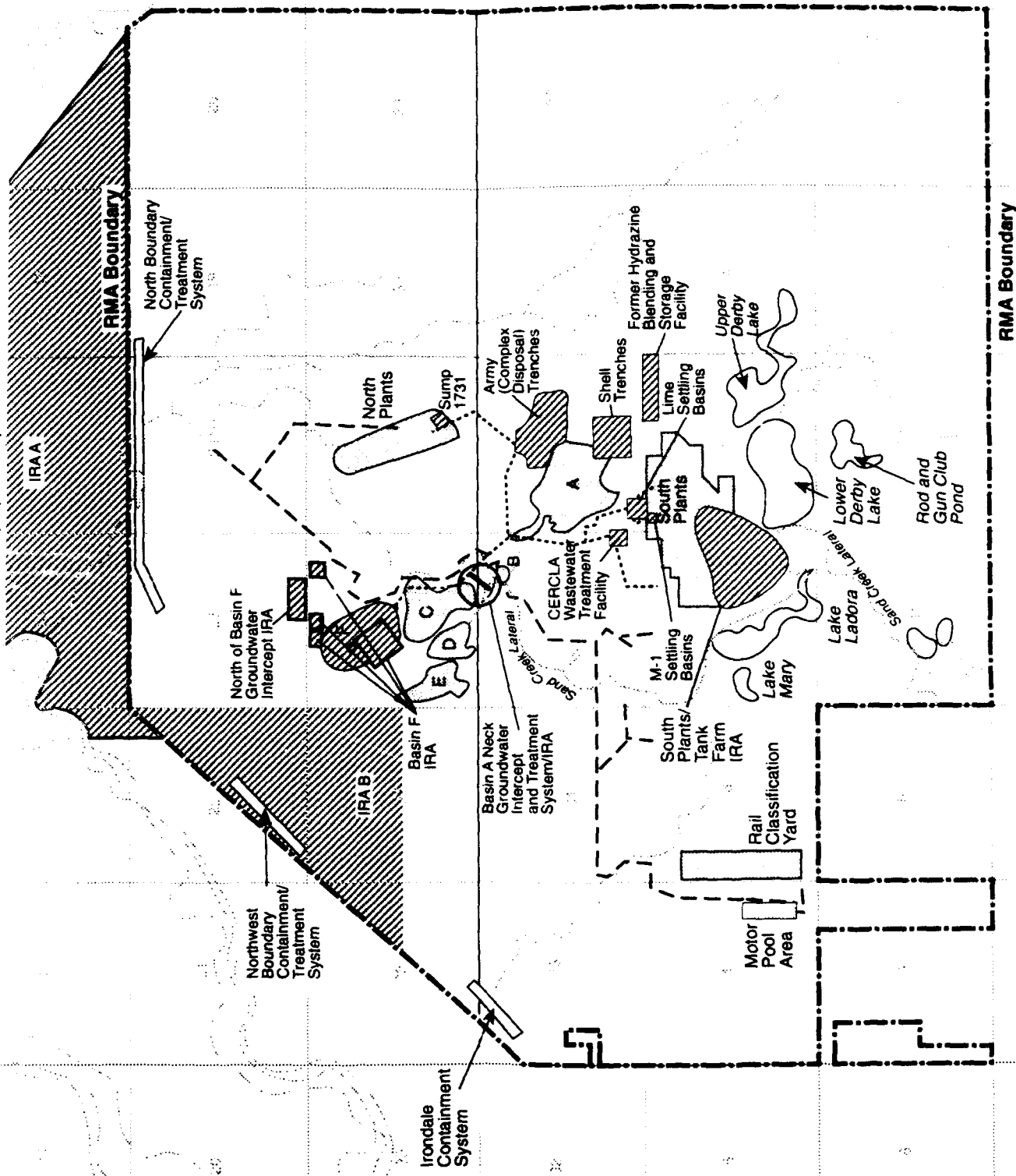


Wastewater Treatment

A

1-1

Sheet



T2S
T3S

T2S
T3S

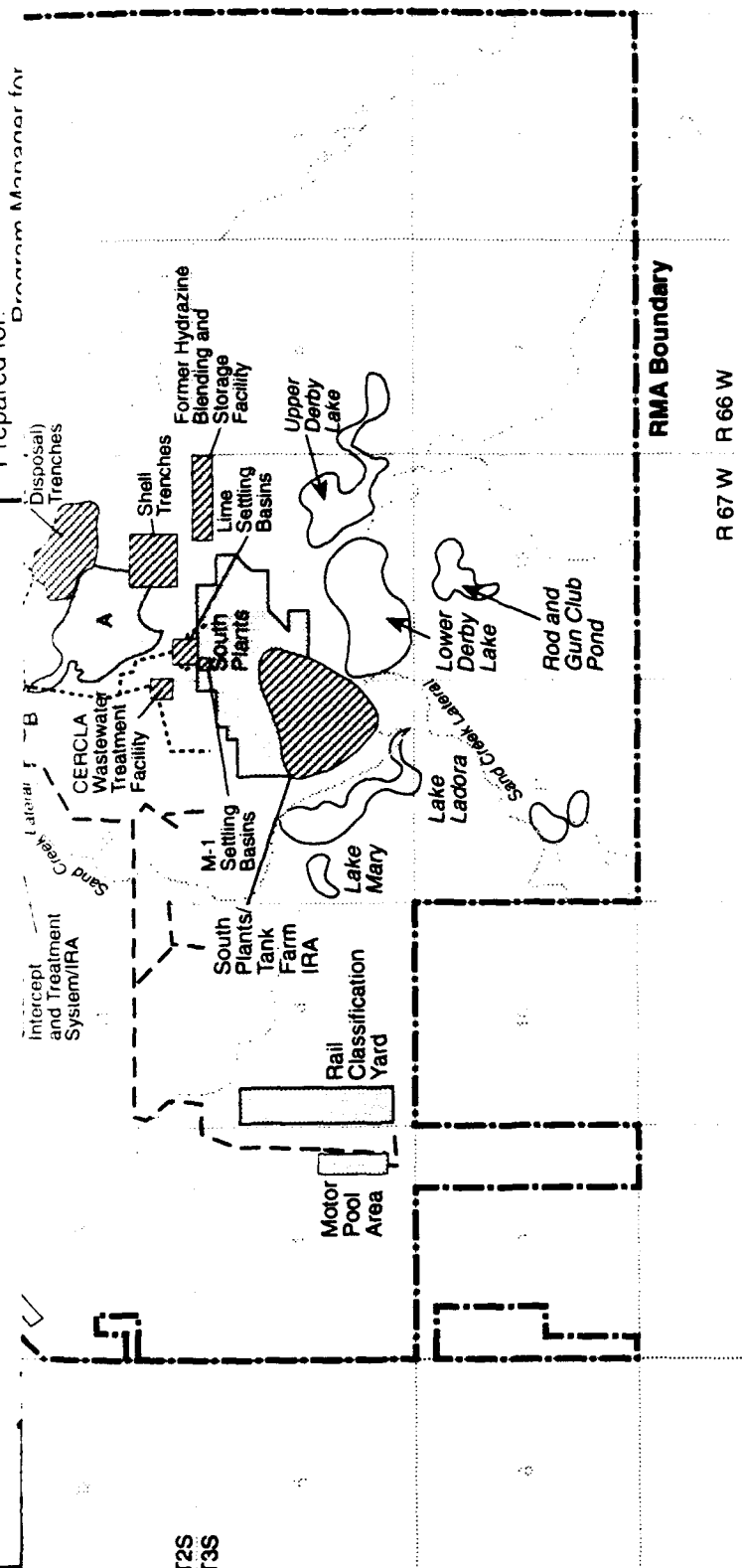
2

RAA Boundary

R 67 W R 66 W

T2S
T3S

T2S
T3S



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Program Manager for
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Commerce City, Colorado

Prepared by:
Harding Lawson Associates

Figure 1.2

Locations of Major Potential Contamination Sites,
Lakes, Containment Systems, and Interim Response
Action Areas

GWAR FY91

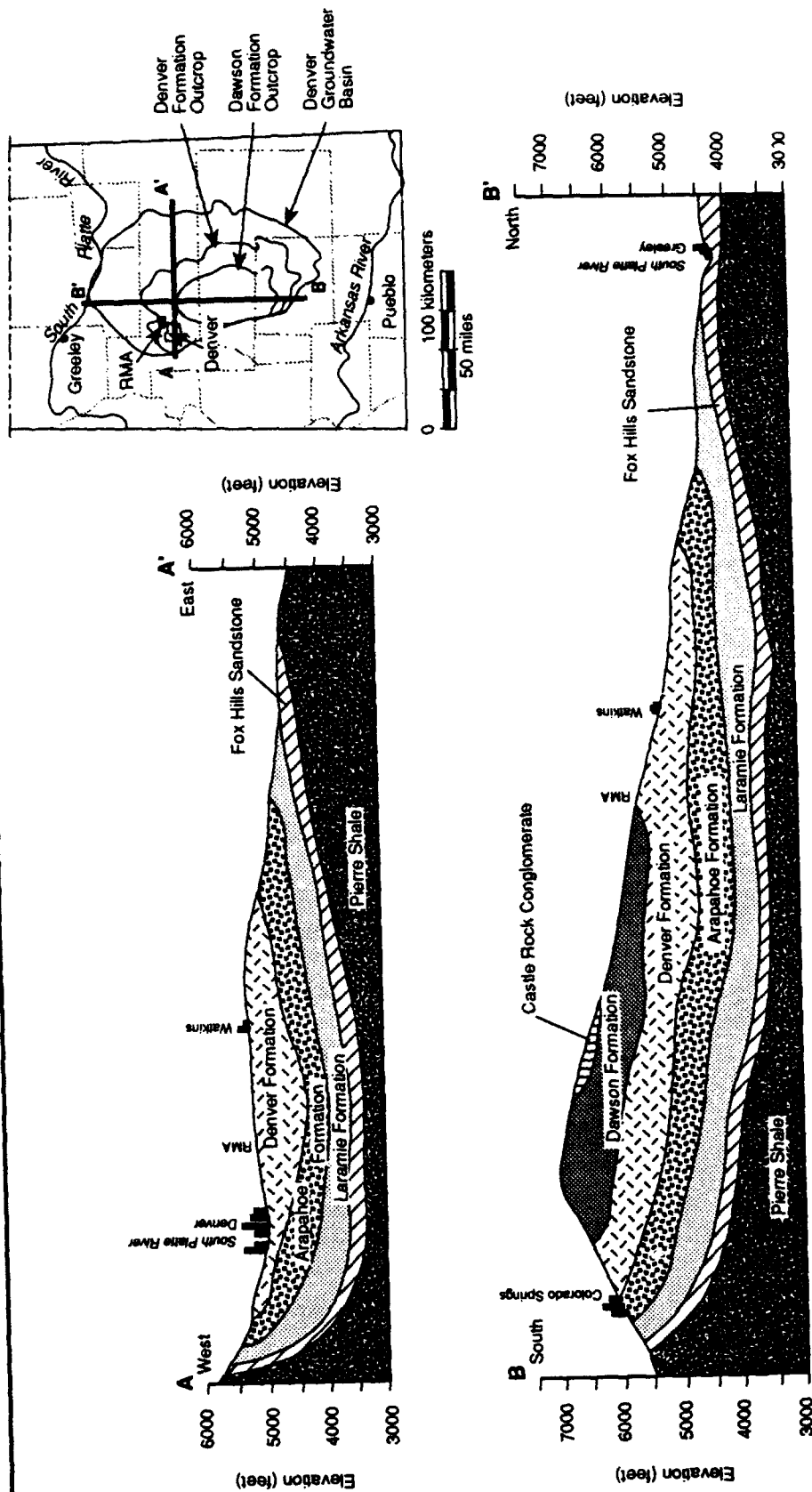
EXPLANATION

- Major potential contamination site
- Interim response action (IRA) area
- Sanitary sewer system
- Chemical sewer system



(2)

(3)



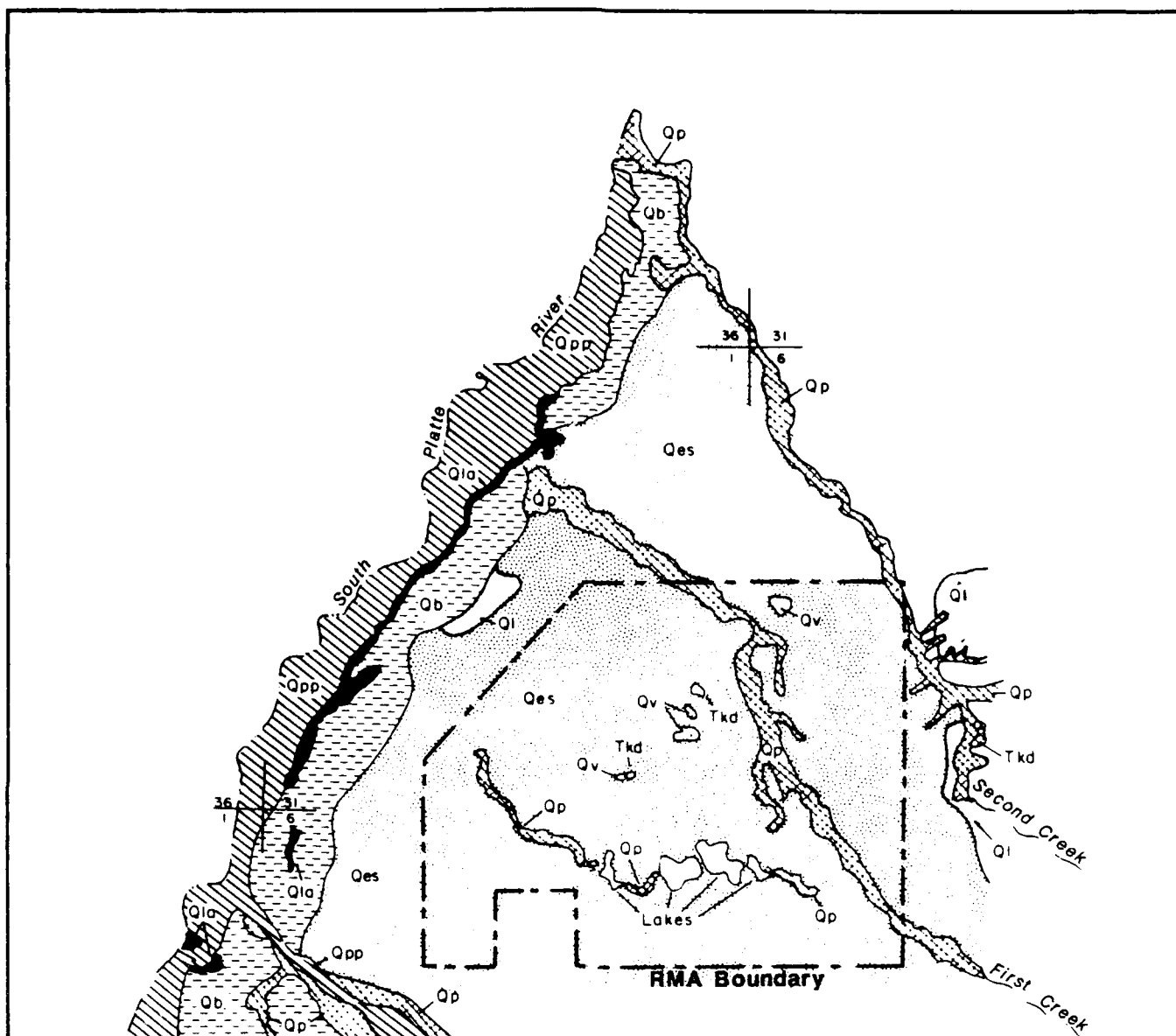
Source: Robson and Romero, 1981

Figure 2.1
Upper Stratigraphic Sections of the Denver Basin

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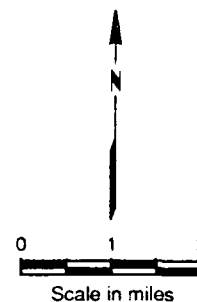
GWAR FY91



EXPLANATION

- | | |
|--|--|
| | Post Piney Creek Alluvium (Quaternary) |
| | Piney Creek Alluvium (Quaternary) |
| | Eolian Sand (Quaternary) |
| | Loess (Quaternary) |
| | Broadway Alluvium (Quaternary) |
| | Louviers Alluvium (Quaternary) |
| | Verdos Alluvium (Quaternary) |
| | Denver Formation (Upper Cretaceous & Tertiary) |

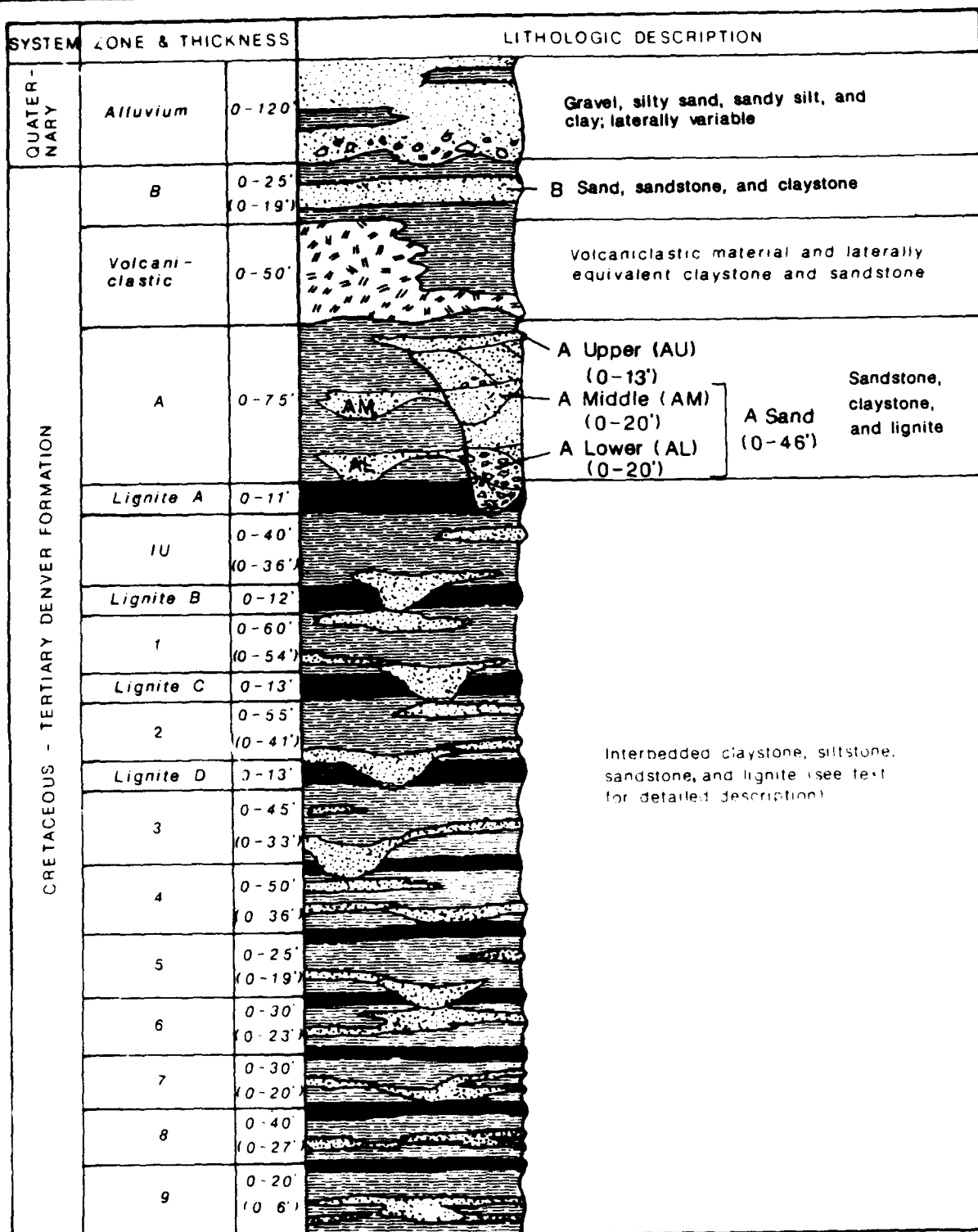
Source: Lindvall, 1980



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Figure 2.2
Surficial Geologic Map of the Rocky Mountain
Arsenal Area
GWAR FY91



Note: Thickness not to scale; net sandstone thickness shown in parentheses.

Source: Environmental Science and Engineering, 1988

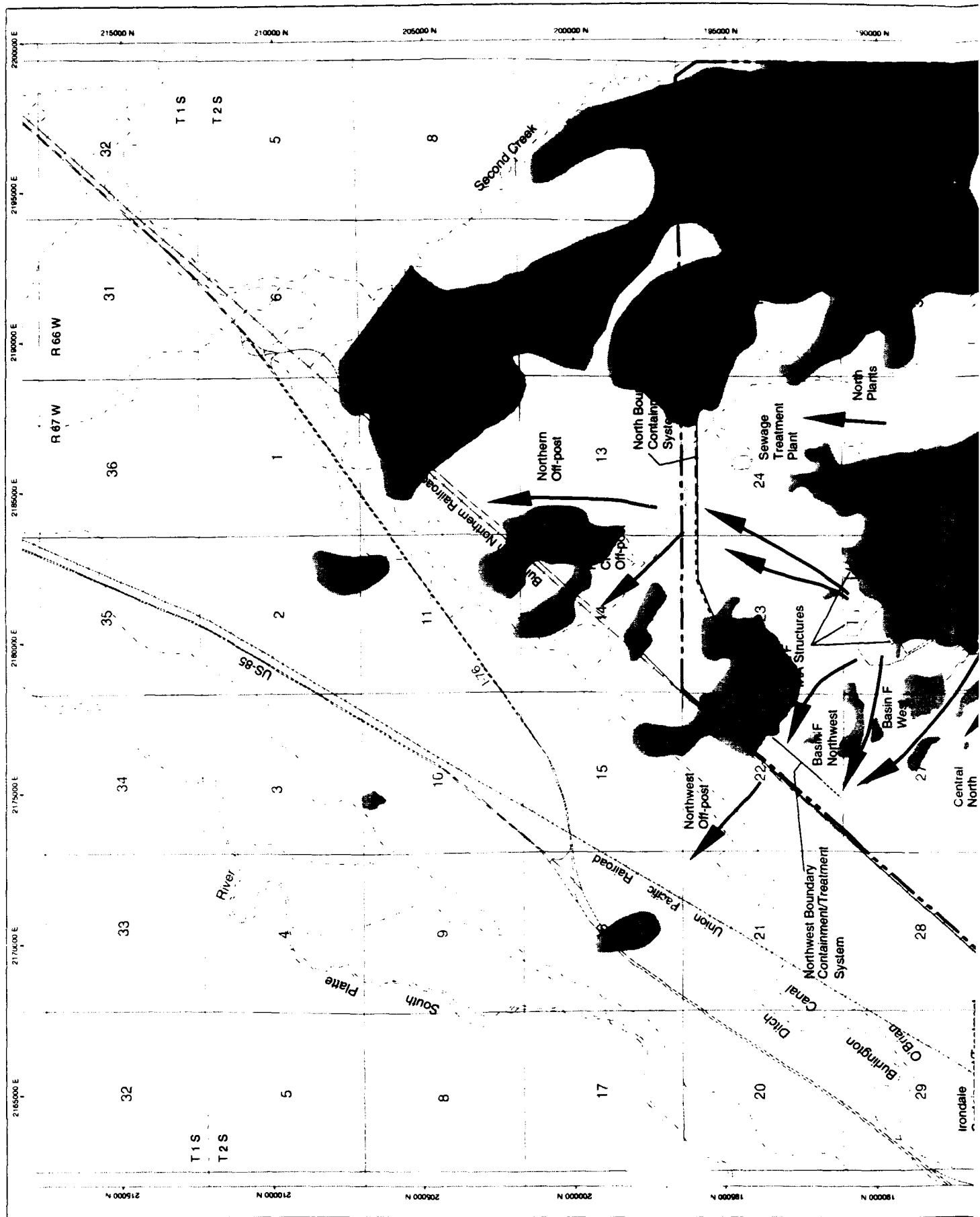
Prepared for:
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Figure 2.3

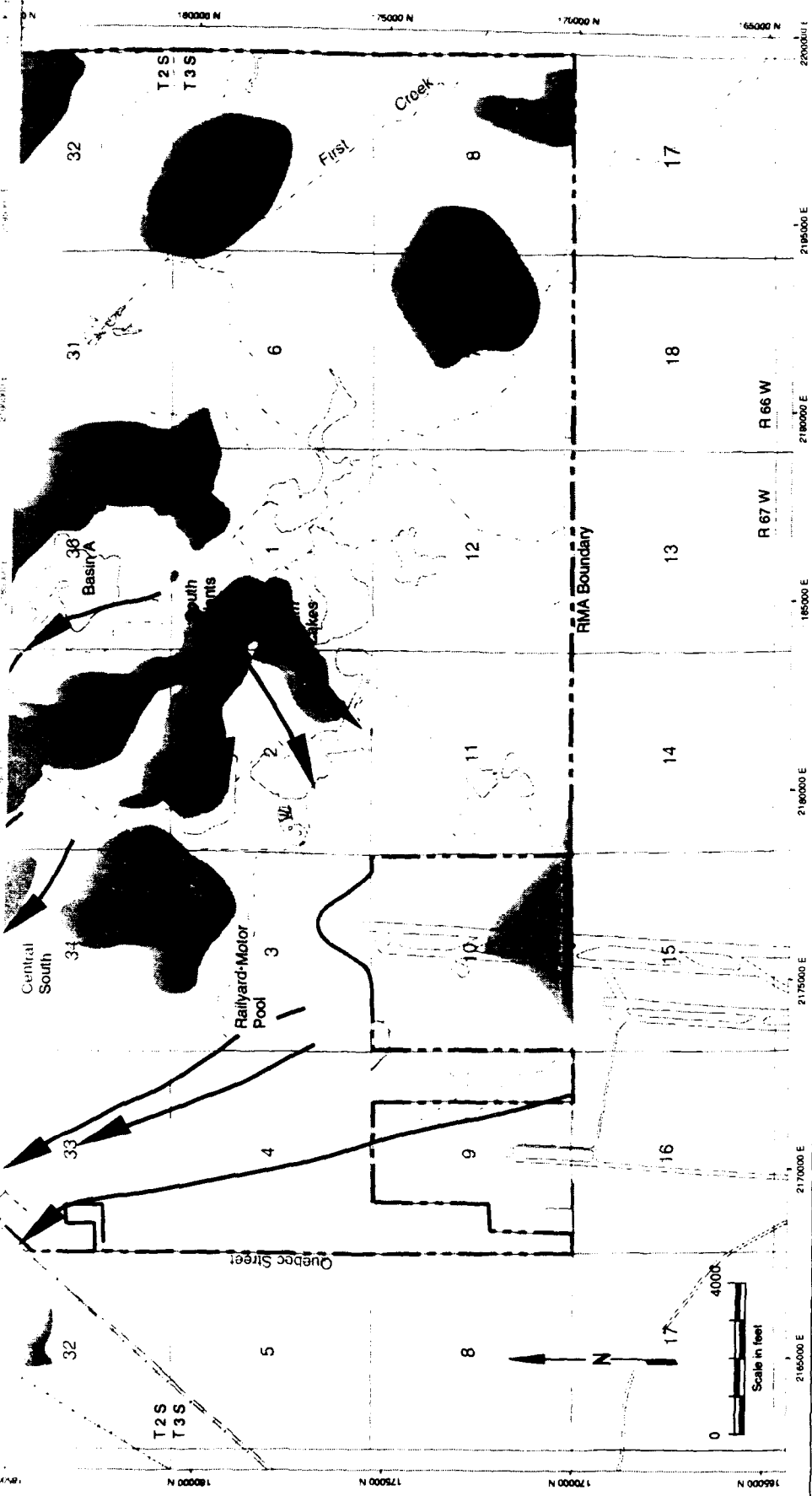
Denver Formation Stratigraphic Column

GWAR FY91

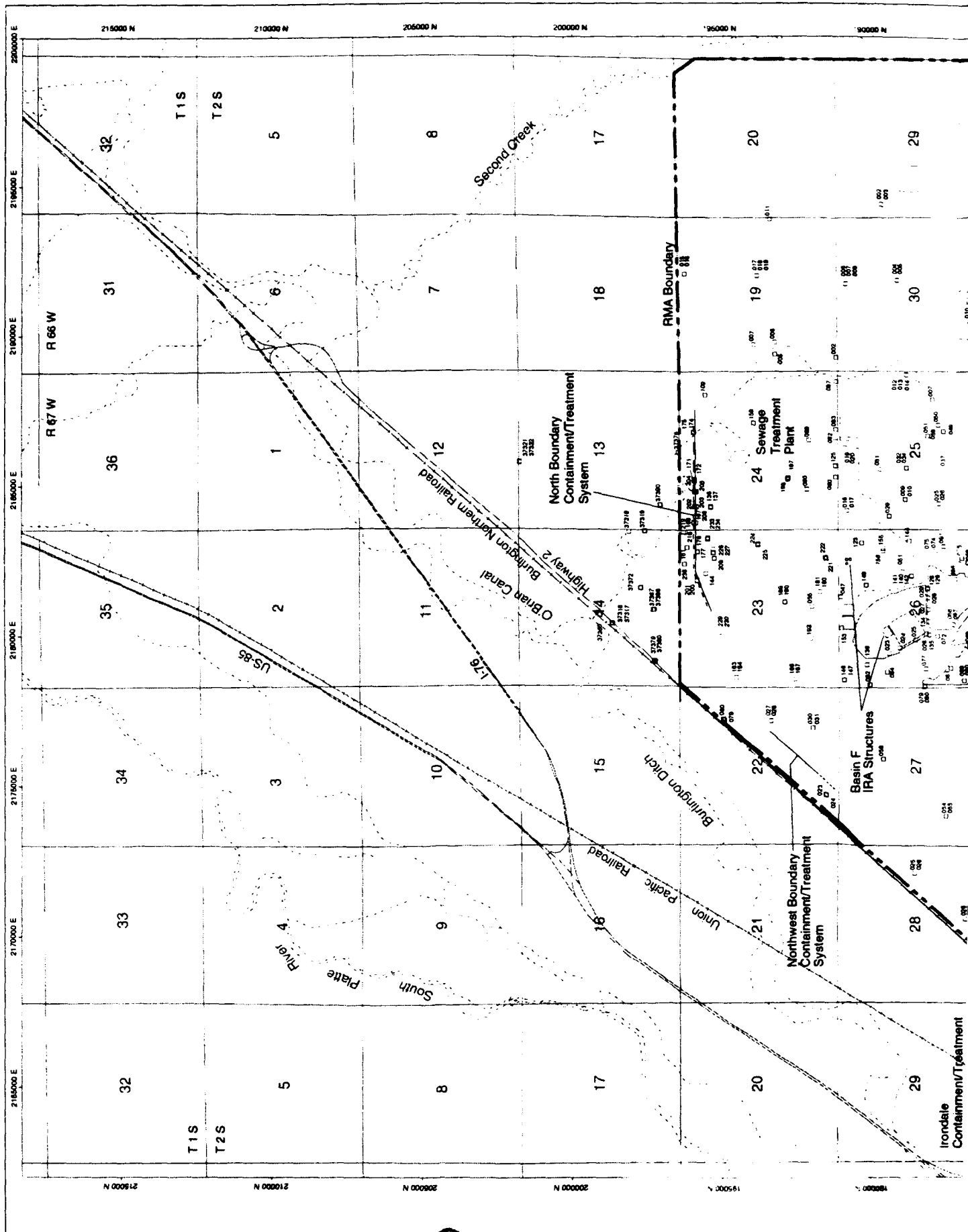


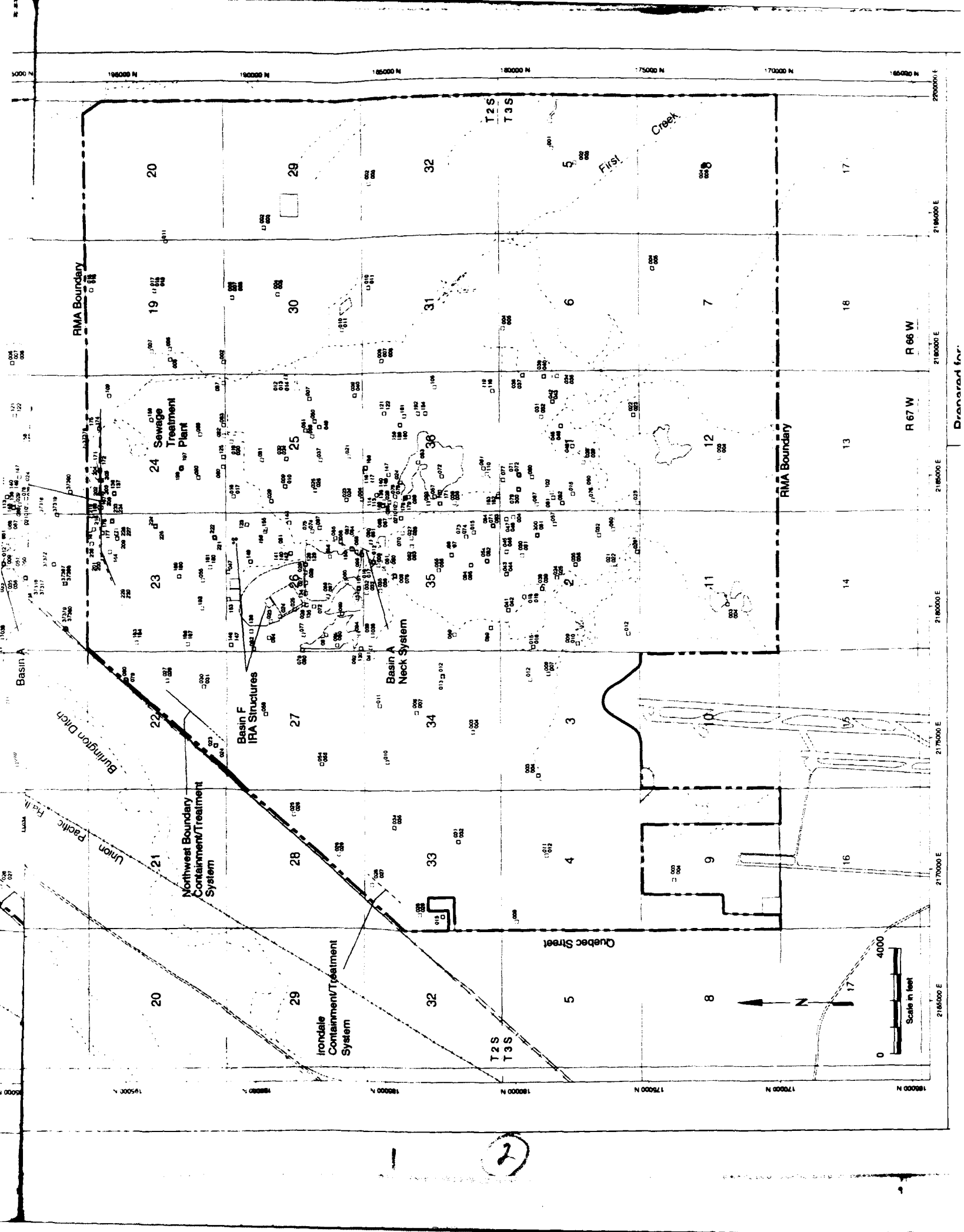


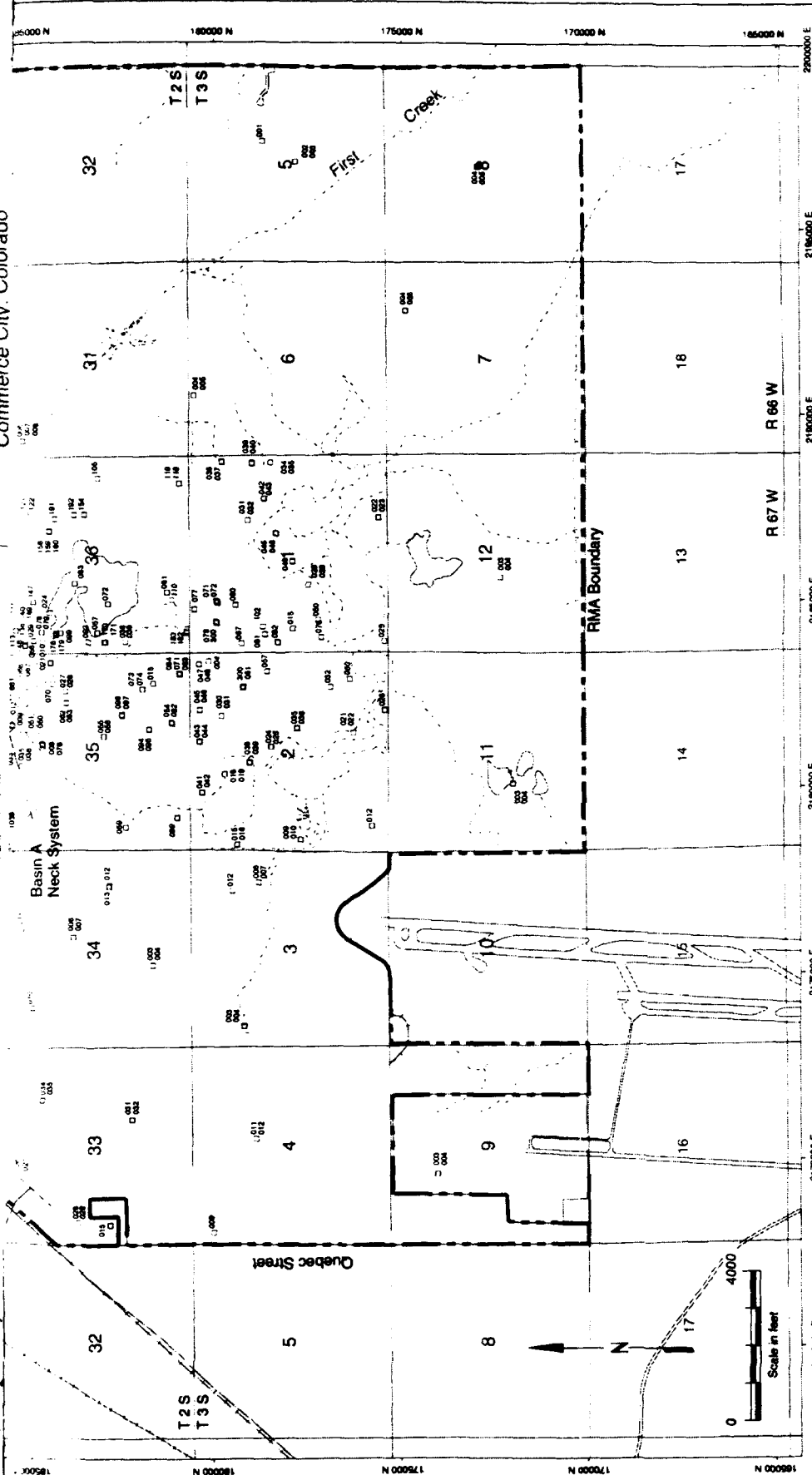
1 2



Prepared for: Program Manager for Rocky Mountain Arsenal Commerce City, Colorado Prepared by: Harding Lawson Associates	Figure 2.4 Rocky Mountain Arsenal Contaminant Migration Pathways GWAR FY91
EXPLANATION Approximate Areas of Unsaturated Alluvium (Based on Winter 1990/1991 Data) Migration Pathway Containment system - Physical barrier - Hydraulic barrier - Recharge trenches - Barrier wall	







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Commerce City, Colorado

Prepared by:

Harding Lawson Associates

Figure 3.1

Winter 1990/1991 Water-level Monitoring Network,
Confined Groundwater Flow System

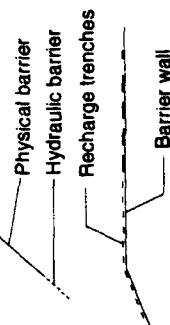
GWAR FY91

EXPLANATION

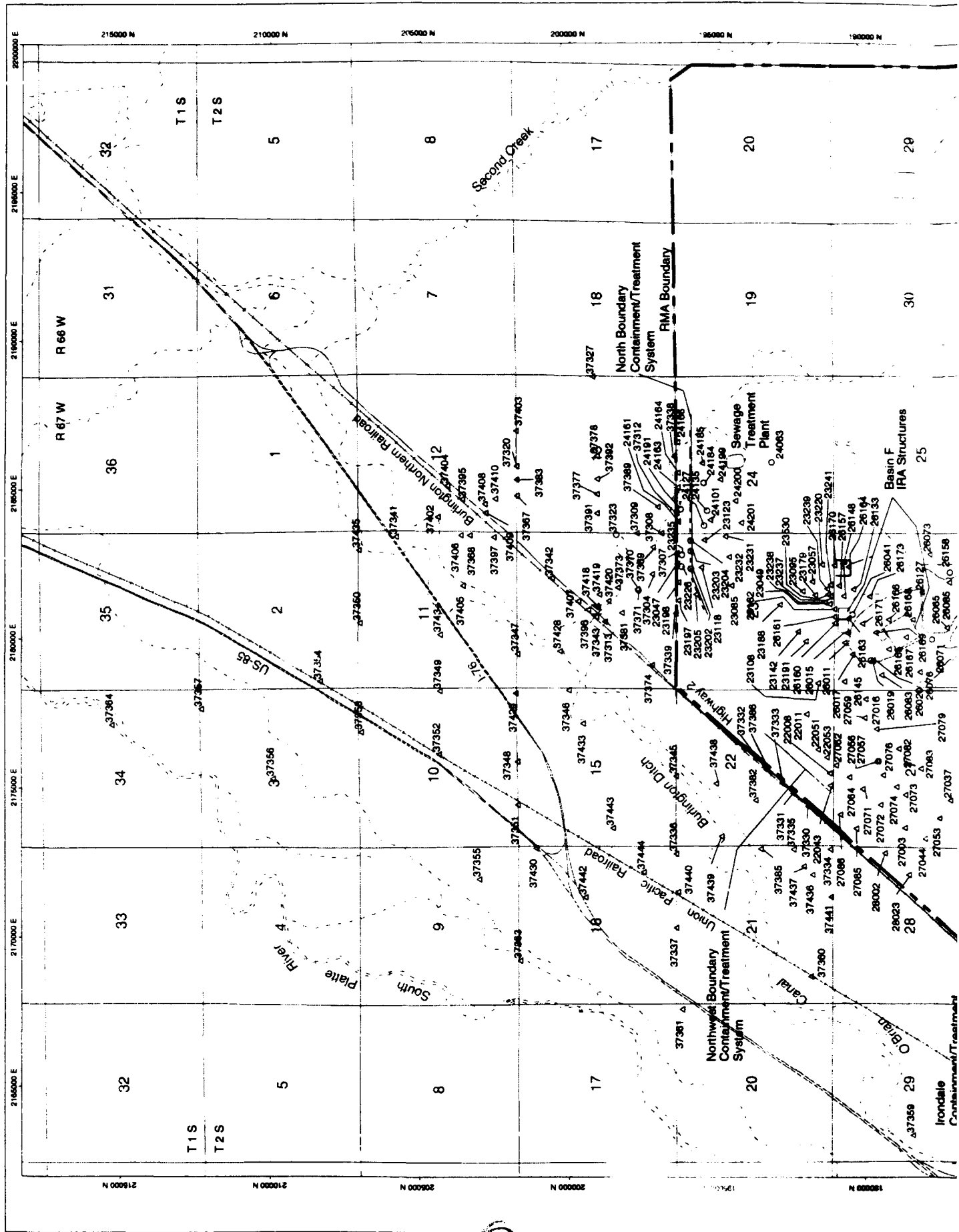
Confined flow system

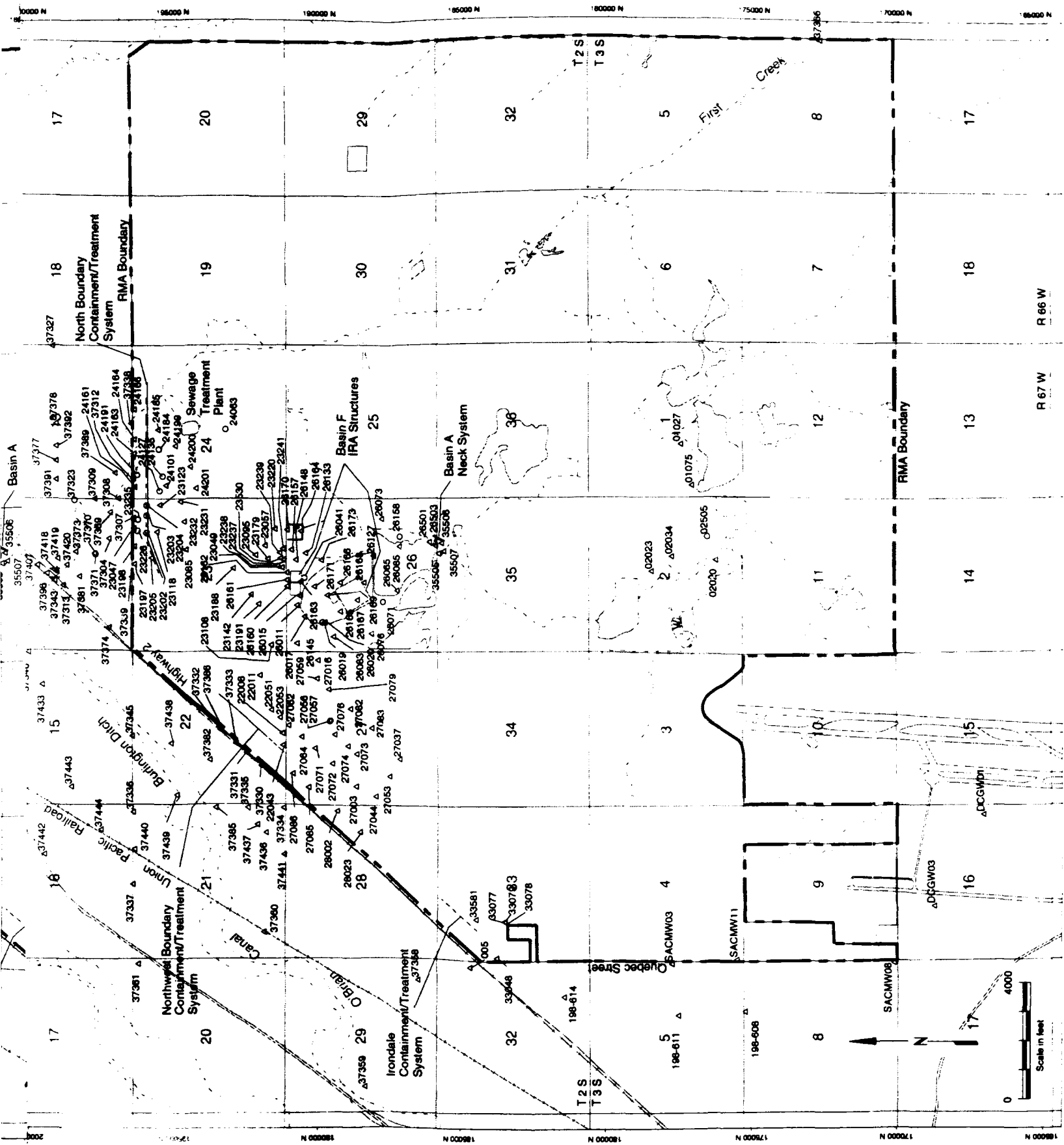
Confined Denver Formation
for onpost wells

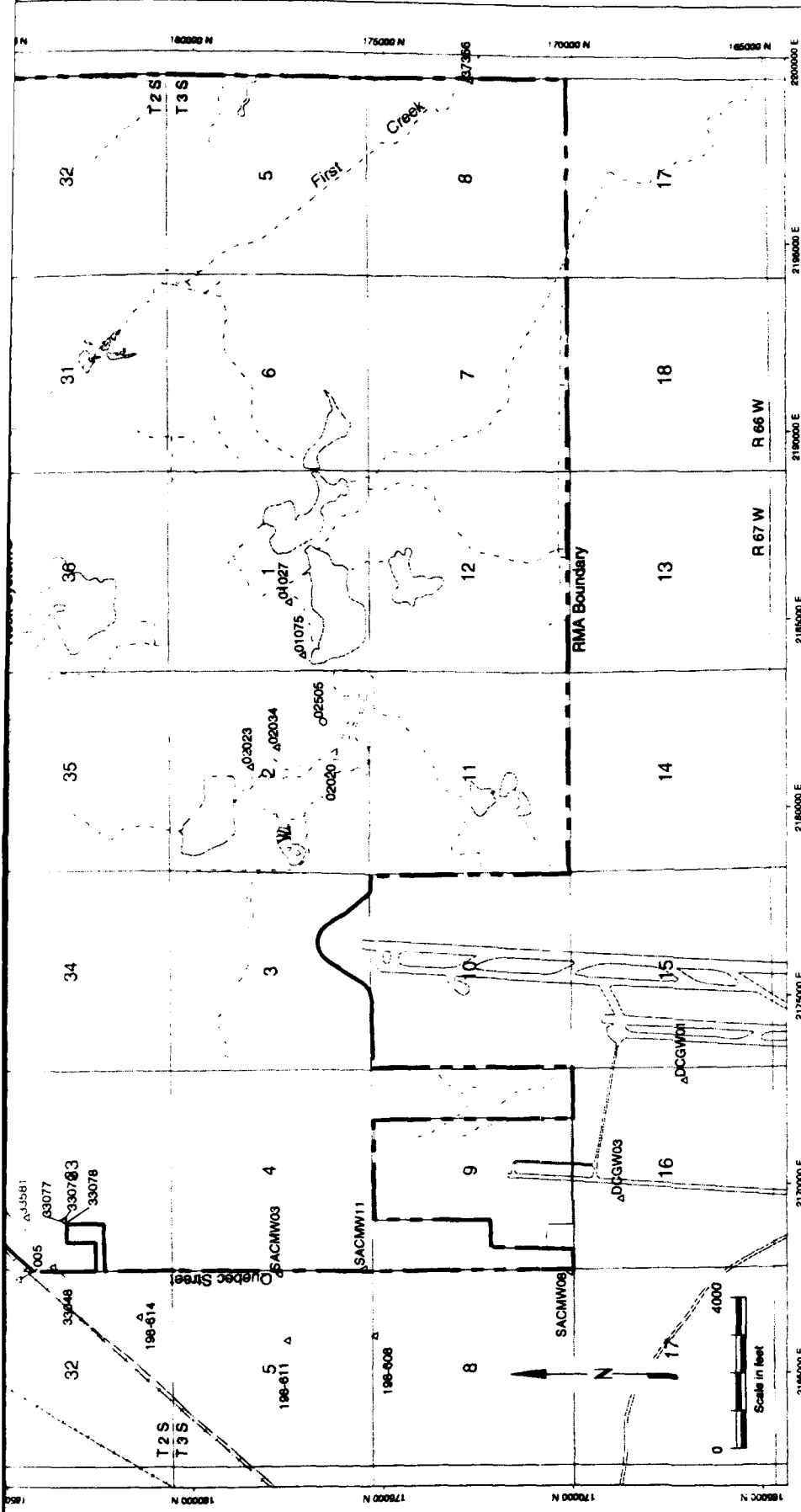
Containment system



Note: For onpost wells, the section number precedes
the three-digit well number shown
(i.e., wells in Section 3 - 03001)
Offpost wells are preceded by 37
(i.e., 37012)







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Figure 3.2
 Winter 1990/1991 Sampling Network,
 Unconfined Groundwater Flow System

GWAR FY91

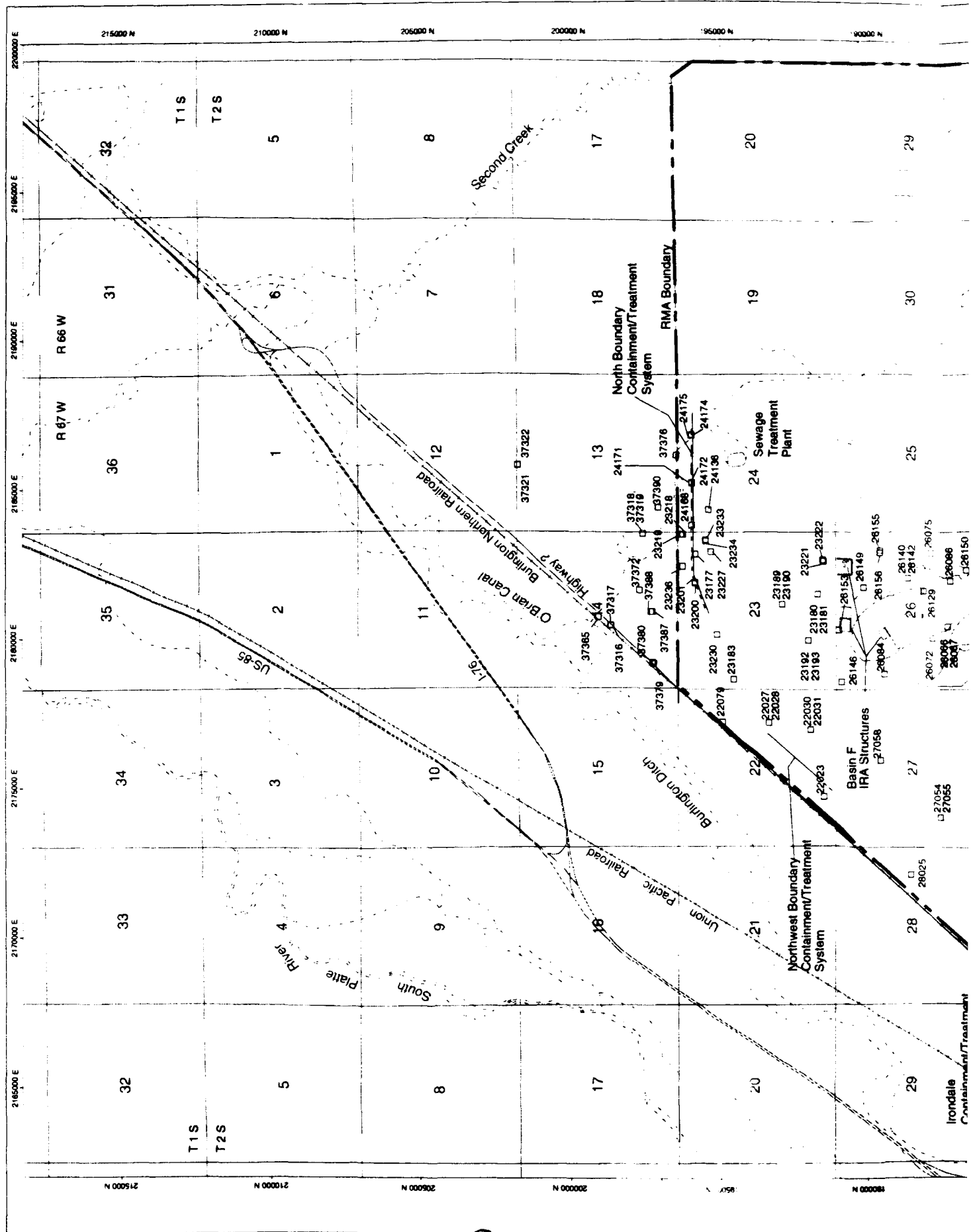
EXPLANATION

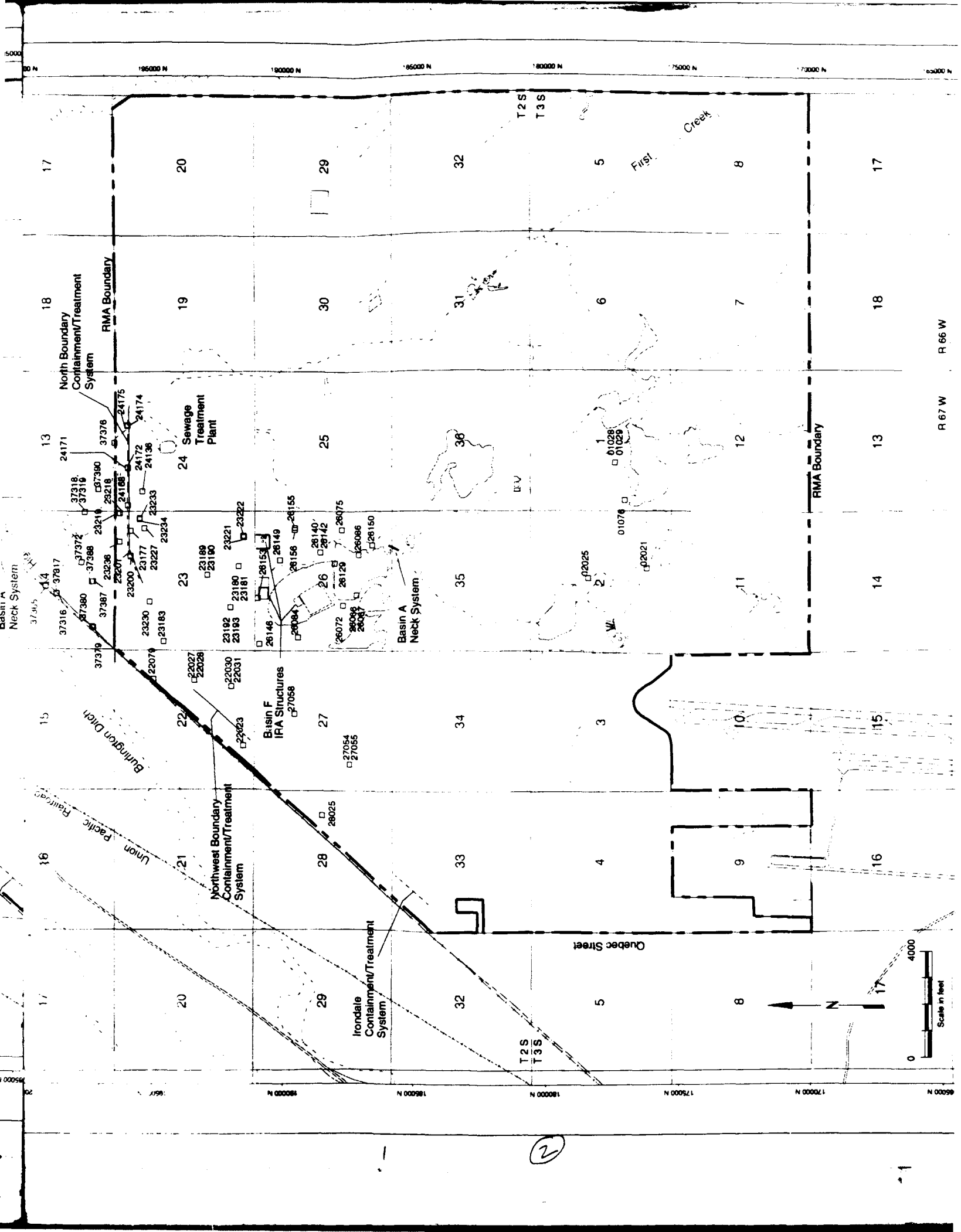
△ SACMW11 Alluvial well location and well identification number
 ○ 26156 Unconfined Denver Formation well location and well identification number

Containment system

Physical barrier
 Hydraulic barrier
 Recharge trenches
 Barrier wall

8/27/92 mme/uncsampr JWJ





Prepared for:



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**Program Manager for
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Commerce City, Colorado
Prepared by:
Harding Lawson Associates**

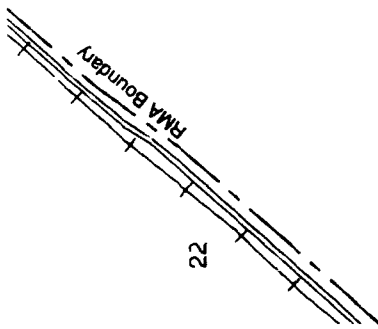
Figure 3.3

Figure 3.3
Winter 1990/1991 Sampling Network,
Denver Formation
Confined Flow System

GWAR FY91

0/27/02 macthampet JVJ

③



22

"C" Street

23

"D" Street

23188 23189
23188 23190

23192 23191
23193

23142 23095

23108

Basin F
Temporary
Storage Ponds

23180 23181 23179
23238 23530 23222
23220 23221
23239 23241

26170
Basin F Liquid
Holding Tanks

26146
26145

26017

26019

Former Basin F

Leachate
Collection
Pond

Basin F
Temporary
Waste Pile

26165
26166

26167

26168

26127

26072
26071

Basin C

26065
26066
26067

Basin E

26085
26158
26096

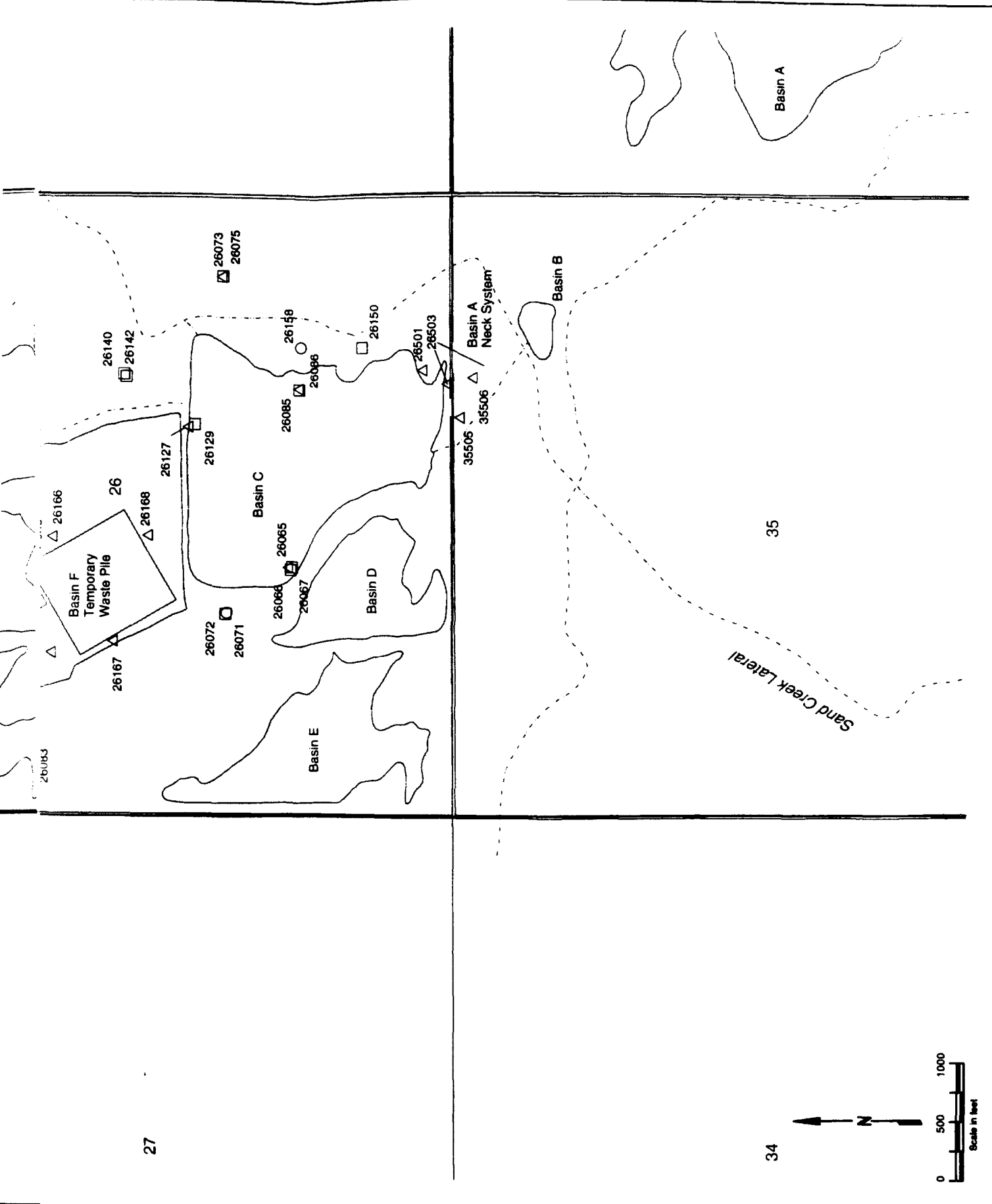
27016

27

26155
26156

26140
26142

26073
26075

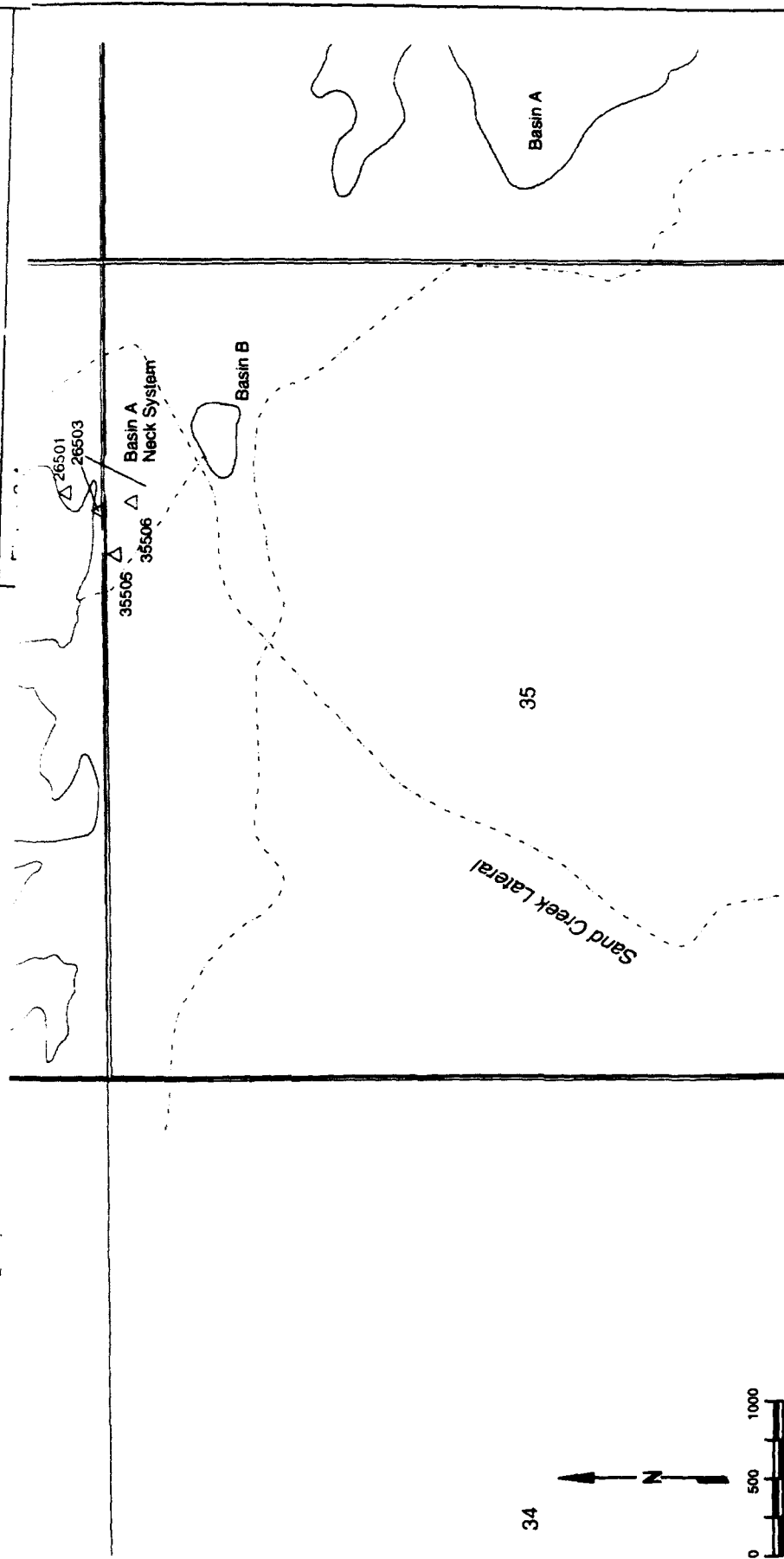


EXPLANATION	Prepared for:
Alluvial well location and well identification number	Program Manager for Rocky Mountain Arsenal Commerce City, Colorado

identification number

location and well

Harding Lawson Associates



EXPLANATION

- △ 26067 Alluvial well location and well identification number
- 26072 Unconfined Denver Formation well location and well identification number
- 35507 Confined flow system well location and well identification number

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Program Manager for
Rocky Mountain Arsenal
Commerce City, Colorado

Prepared by:

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Figure 3.4

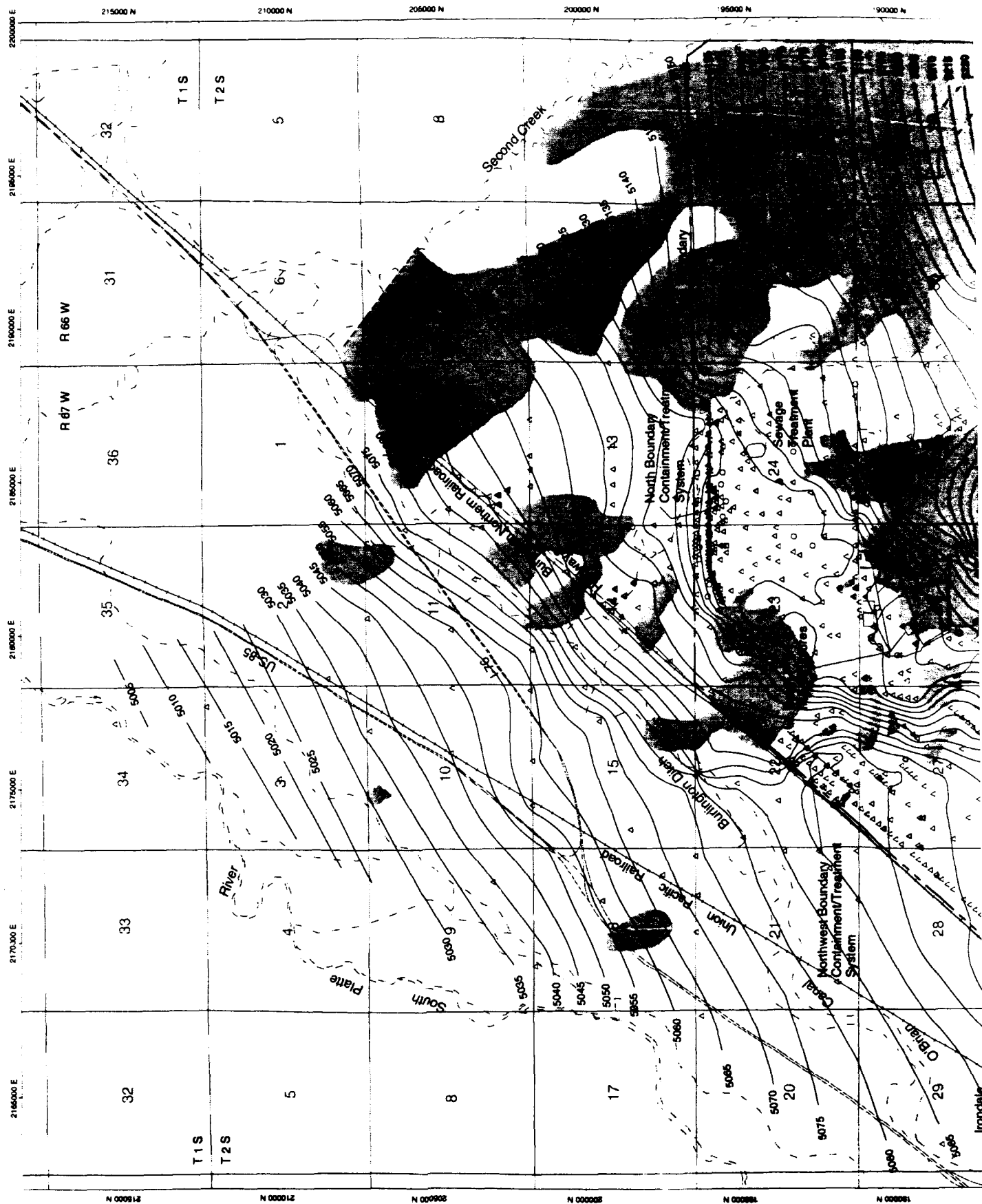
1991 Water Monitoring Year
Basin F Interim Response Action
Sampling Network

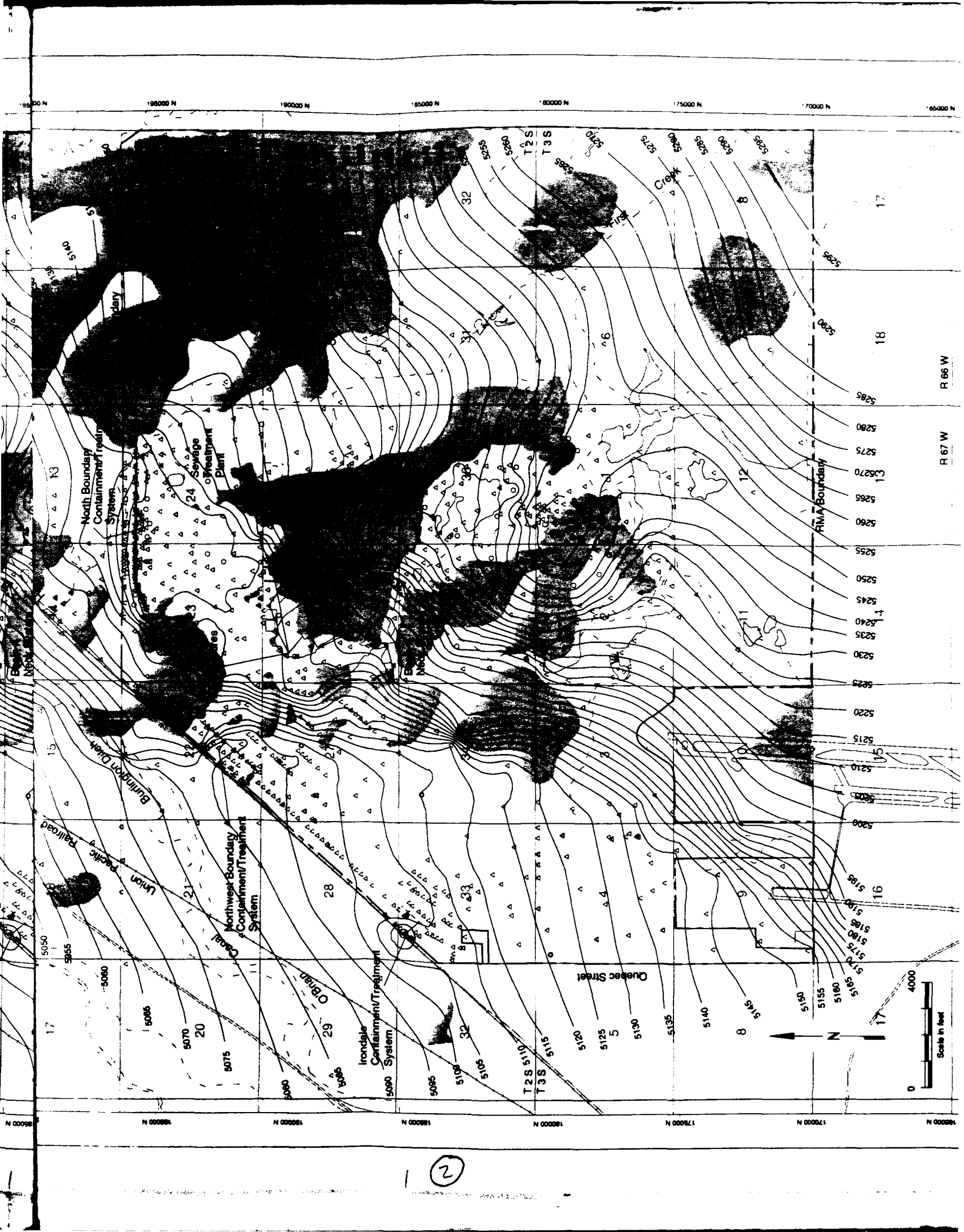
GWAR FY91

2

3

0/27192 (harding.lawson)



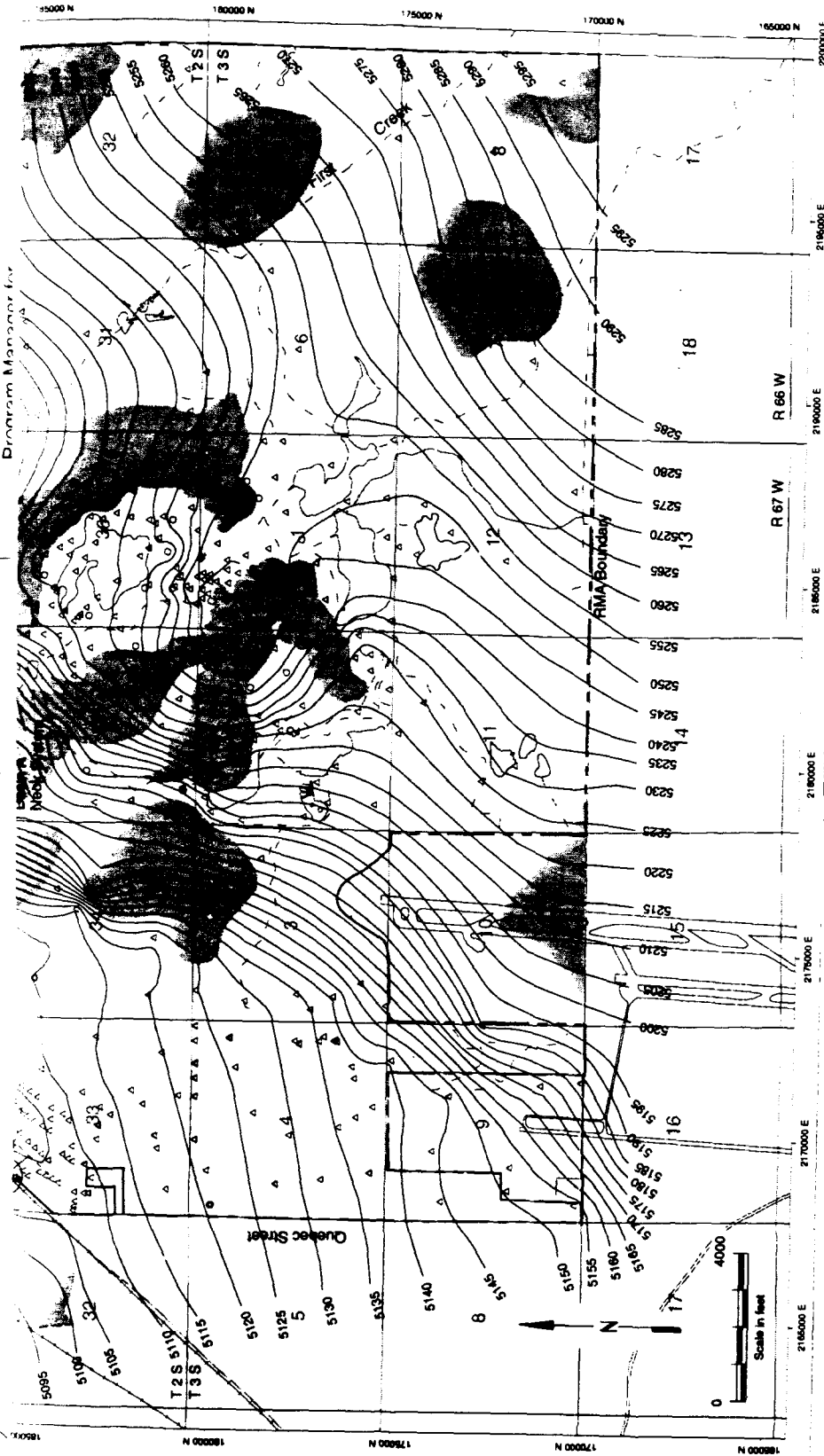


EXPLANATION

Contour interval equals 5 feet
Datum mean sea level

Prepared for:

Program Manager for



EXPLANATION

Water-level elevation contour
(water levels measured from January 23, 1991,
to February 4, 1991)

Approximate areas of unsaturated
alluvium (dashed where inferred)

Well or piezometer location yielding
water-level elevation

△ Alluvial
○ Unconfined Denver Formation

Contour interval equals 5 feet
Datum mean sea level

Containment system

Physical barrier

Hydraulic barrier

Recharge trenches

Barrier wall

Prepared for:

Program Manager for
Rocky Mountain Arsenal
Commerce City, Colorado

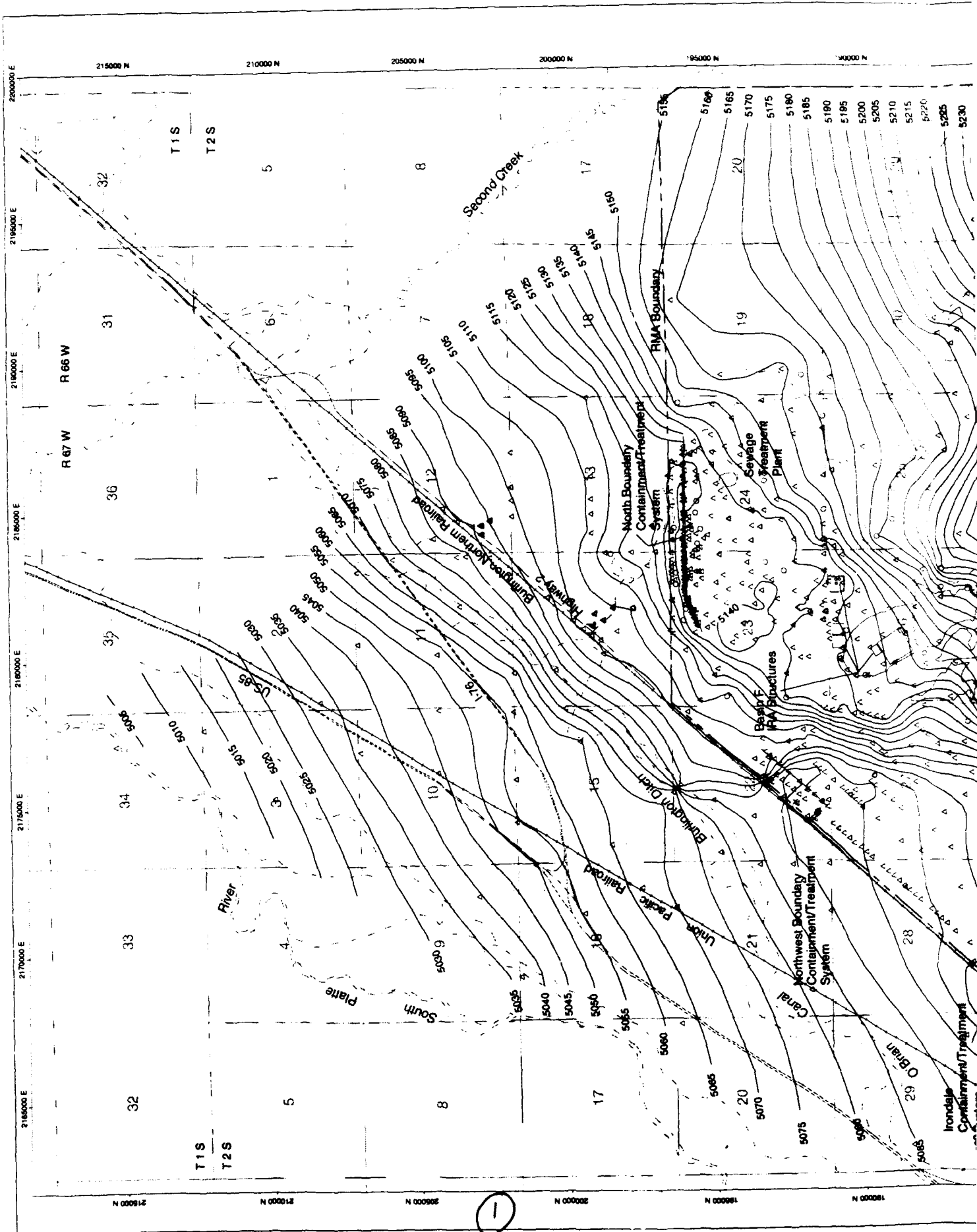
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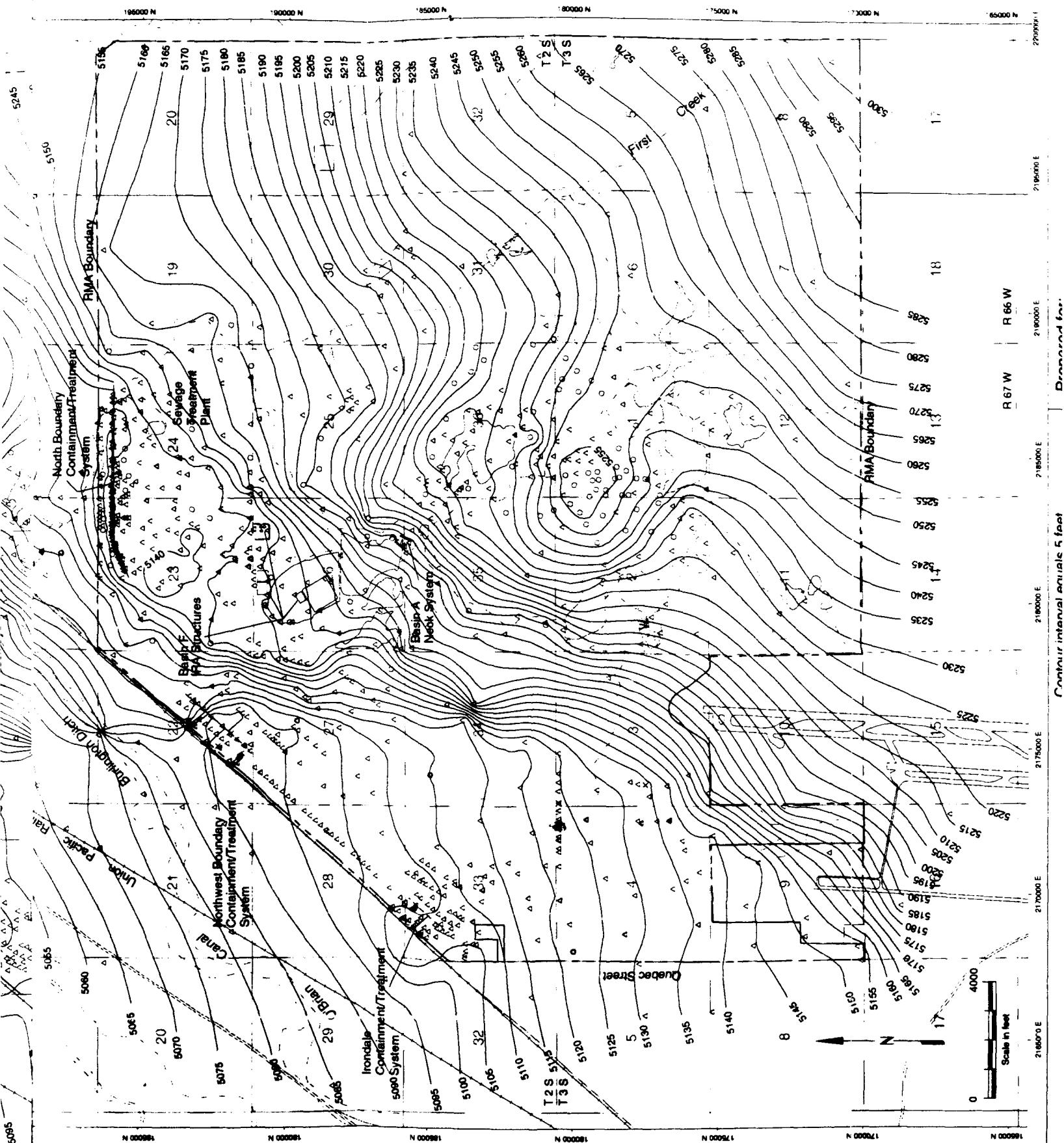
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Figure 4.1

Regional Water-Table Map of the
Unconfined Flow System - Winter 1990/1991

GWAR FY91





Continental interval equals 5 feet

Scale in feet

0 4000

21600'0 E 2170000 E 2180000 E 2190000 E 2200000 E

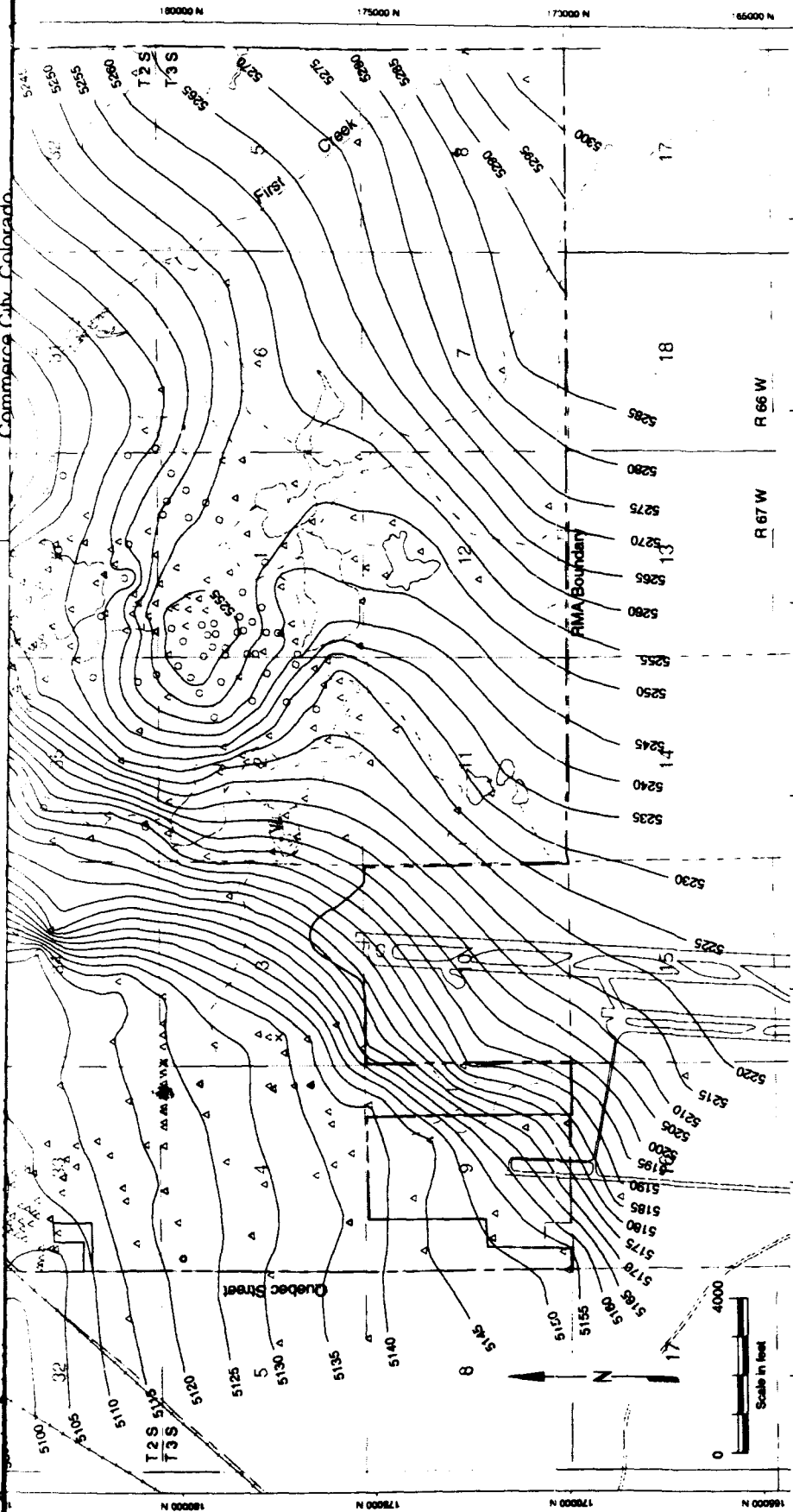
R 66 W R 67 W

2200000 N 2190000 N 2180000 N 2170000 N 2160000 N

2

Water-level elevation contour

Rocky Mountain Arsenal
Commerce City, Colorado



EXPLANATION

Water-level elevation contour
(water levels measured from April 1, 1991,
to April 9, 1991)

Well or piezometer location yielding
water-level elevation

△ Alluvial
○ Unconfined Denver Formation

Contour interval equals 5 feet
Datum mean sea level

Containment system

Physical barrier
Hydraulic barrier
Recharge trenches
Barrier wall

Prepared for:

Program Manager for
Rocky Mountain Arsenal
Commerce City, Colorado

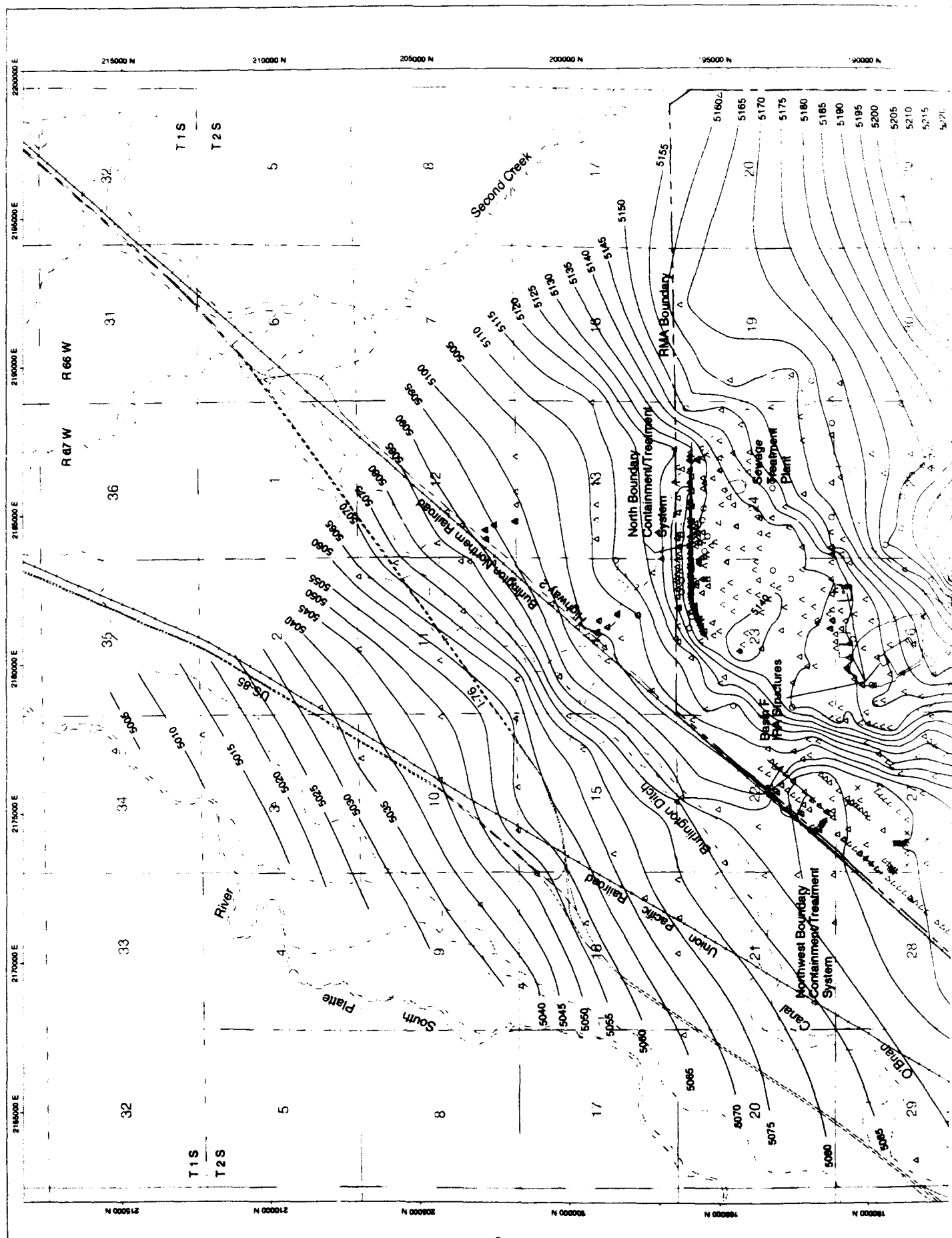
Prepared by:

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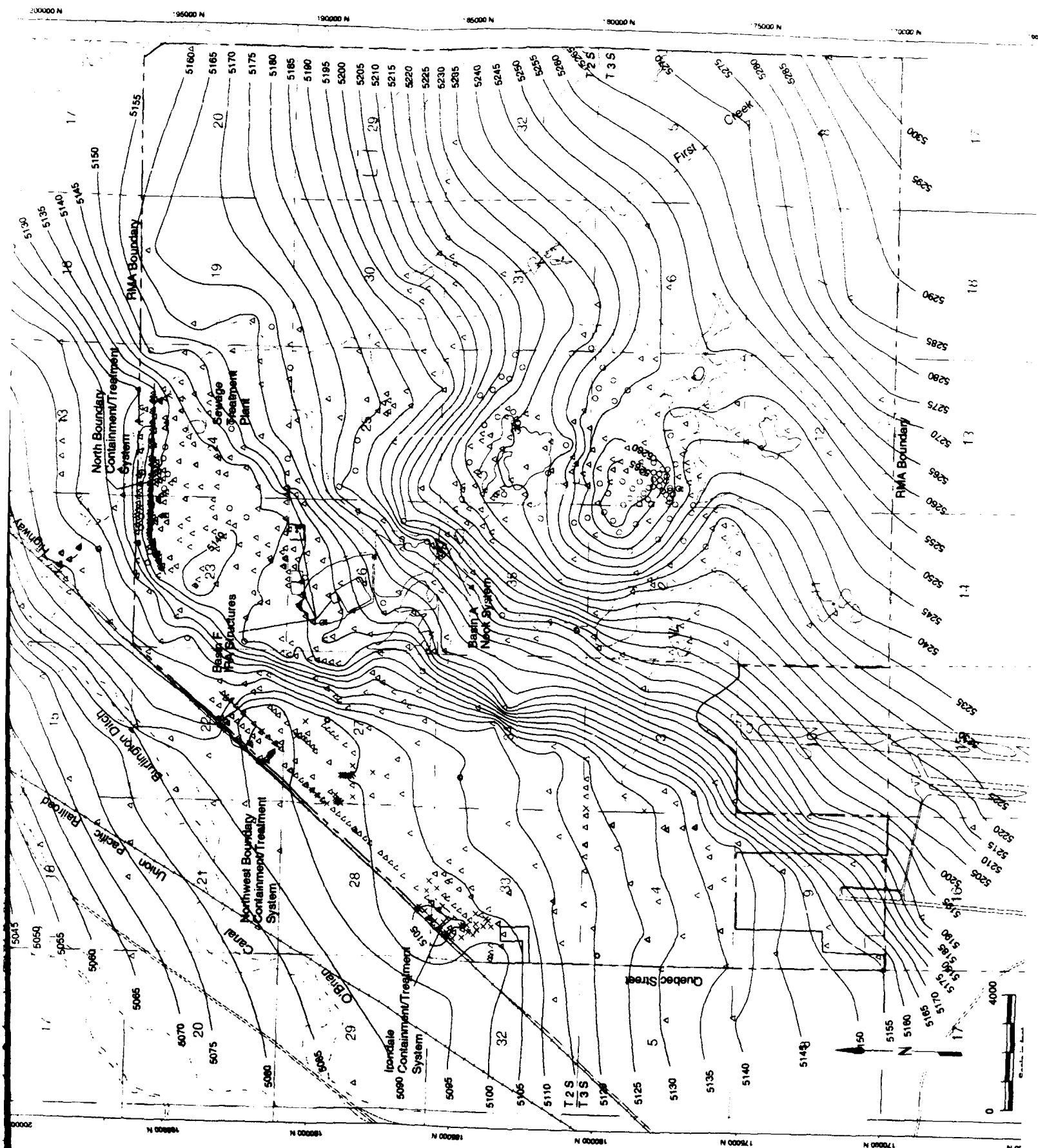
Figure 4.2

Regional Water-Table Map of the
Unconfined Flow System - Spring 1991

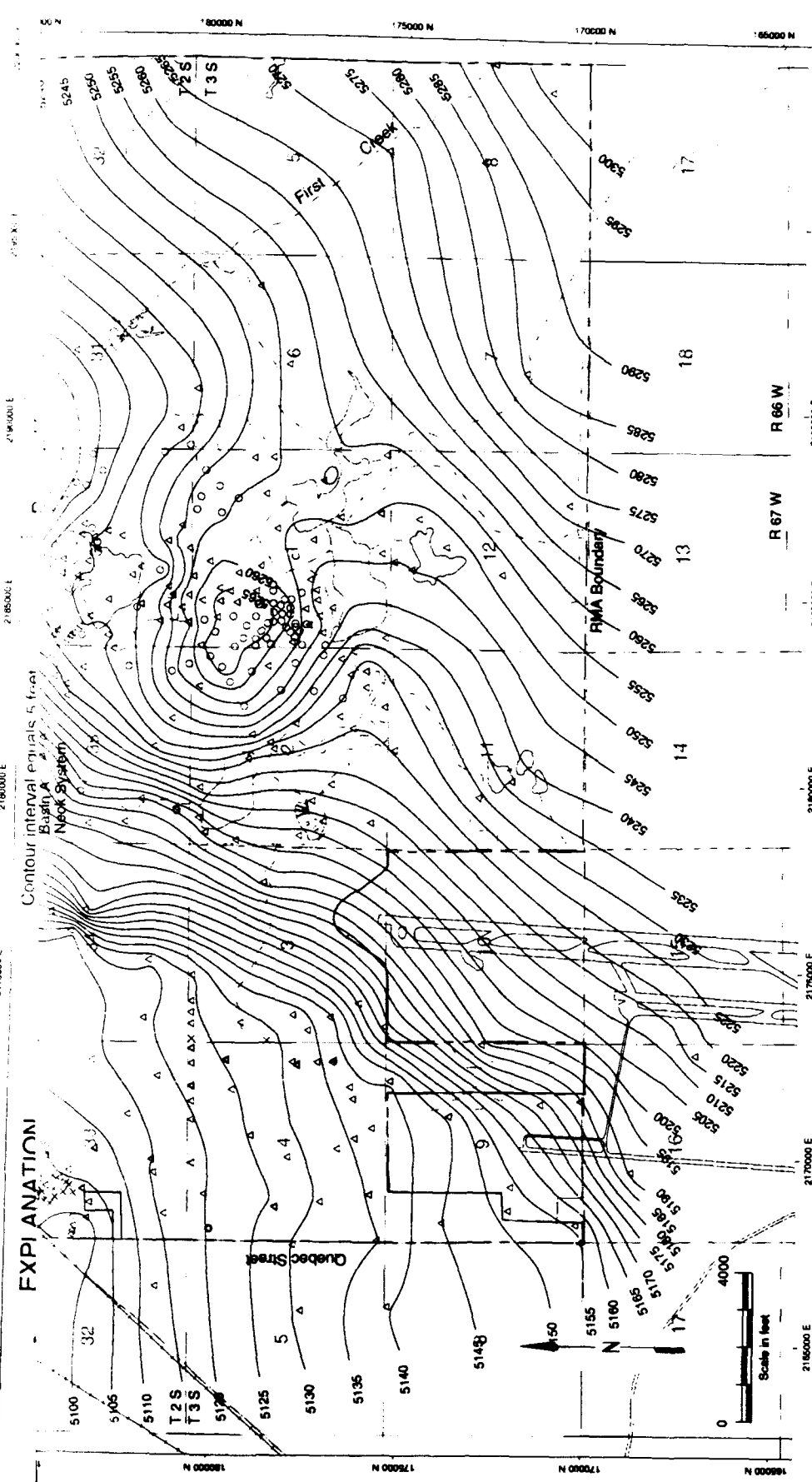
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①



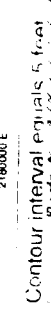
2



EXPLANATION

- Water-level elevation contour (water levels measured from September 16, 1991, to September 27, 1991)
- Well or piezometer location yielding water-level elevation
- Alluvial
- Unconfined Denver Formation

Contour interval equals 5 feet
Datum mean sea level



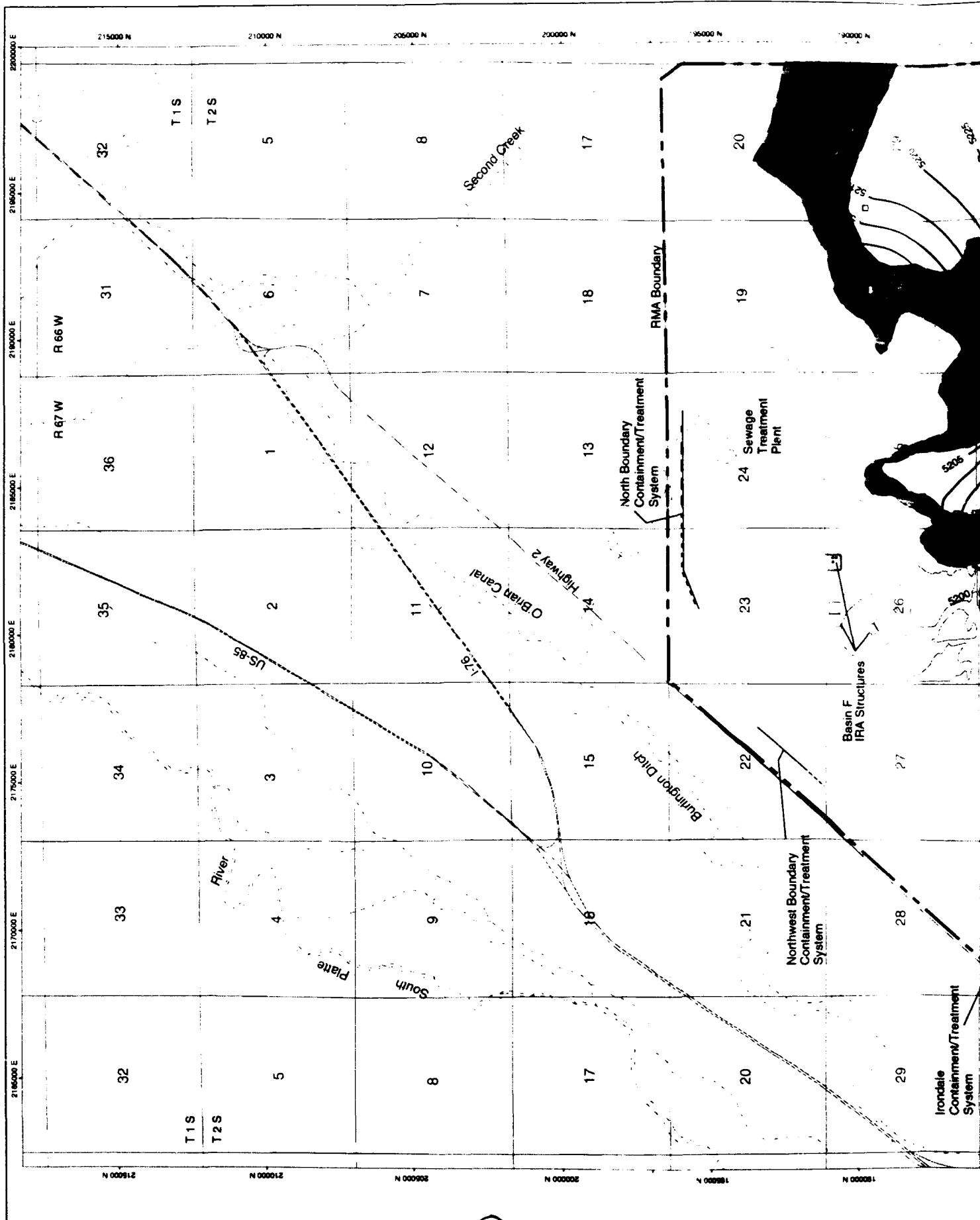
Prepared for:
Program Manager for
Rocky Mountain Arsenal
Commerce City, Colorado

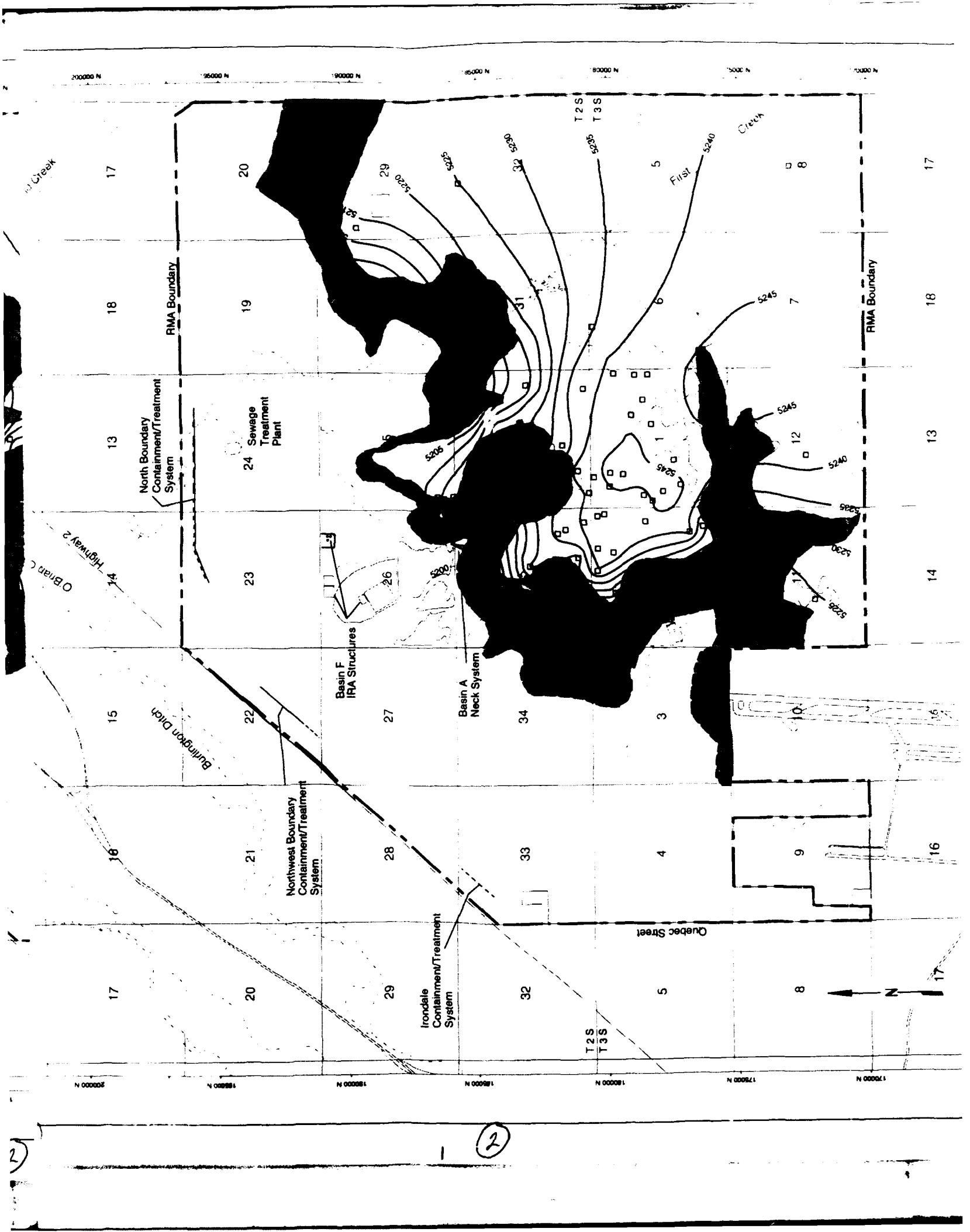
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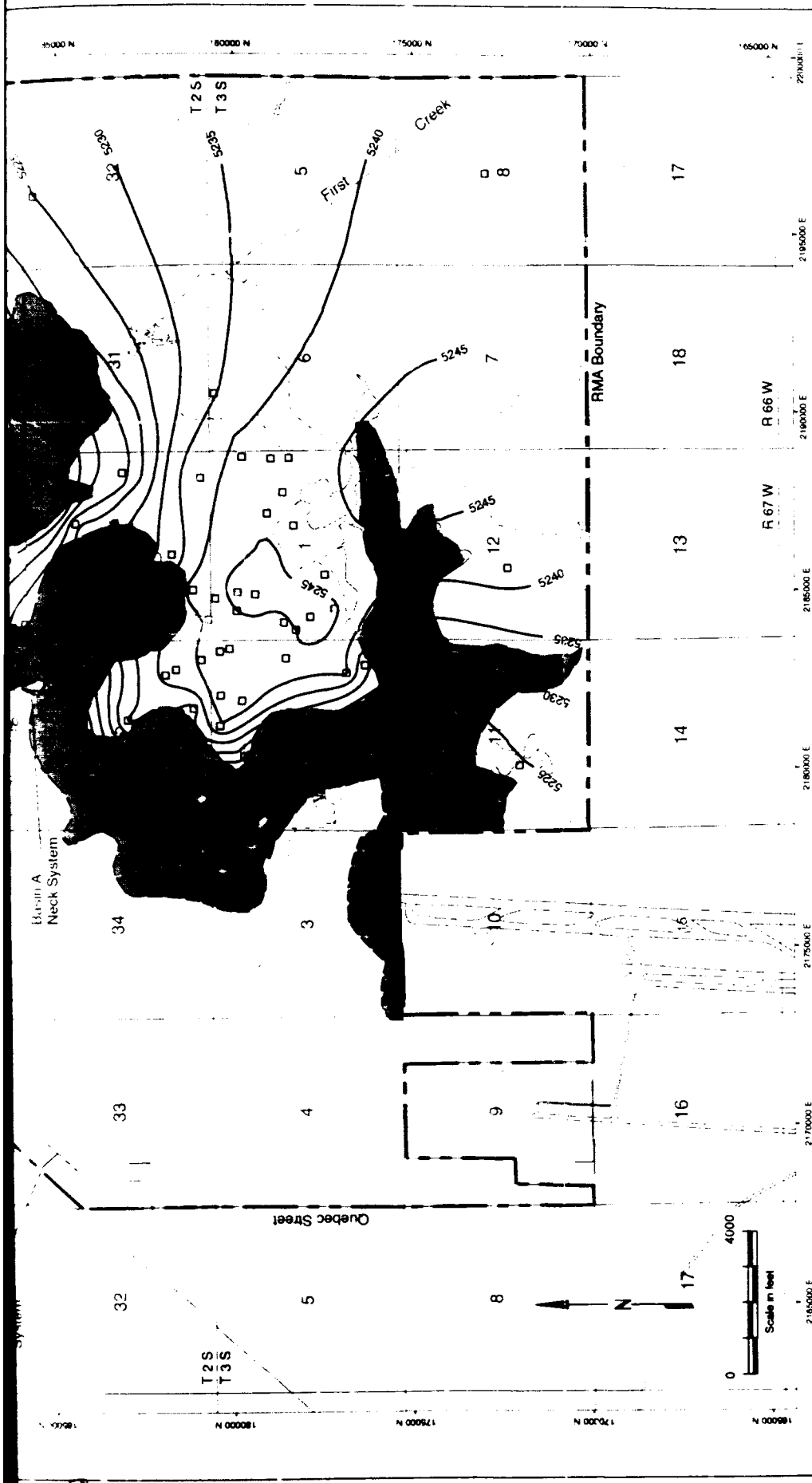
Figure 4.3
Regional Water-Table Map of the
Unconfined Flow System - Fall 1991

GWAR FY91

7/1/92 RMA/20000807 DPG



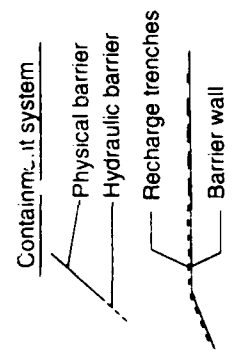




EXPLANATION

- Well location yielding water-level elevation
- 5230 — Elevation of the potentiometric surface (water level measured January 23, 1991, to February 4, 1991)
- Approximate areal extent of subcrop, Denver Zone A (Ebasco, 1989)

Contour interval equals 5 feet
Datum mean sea level

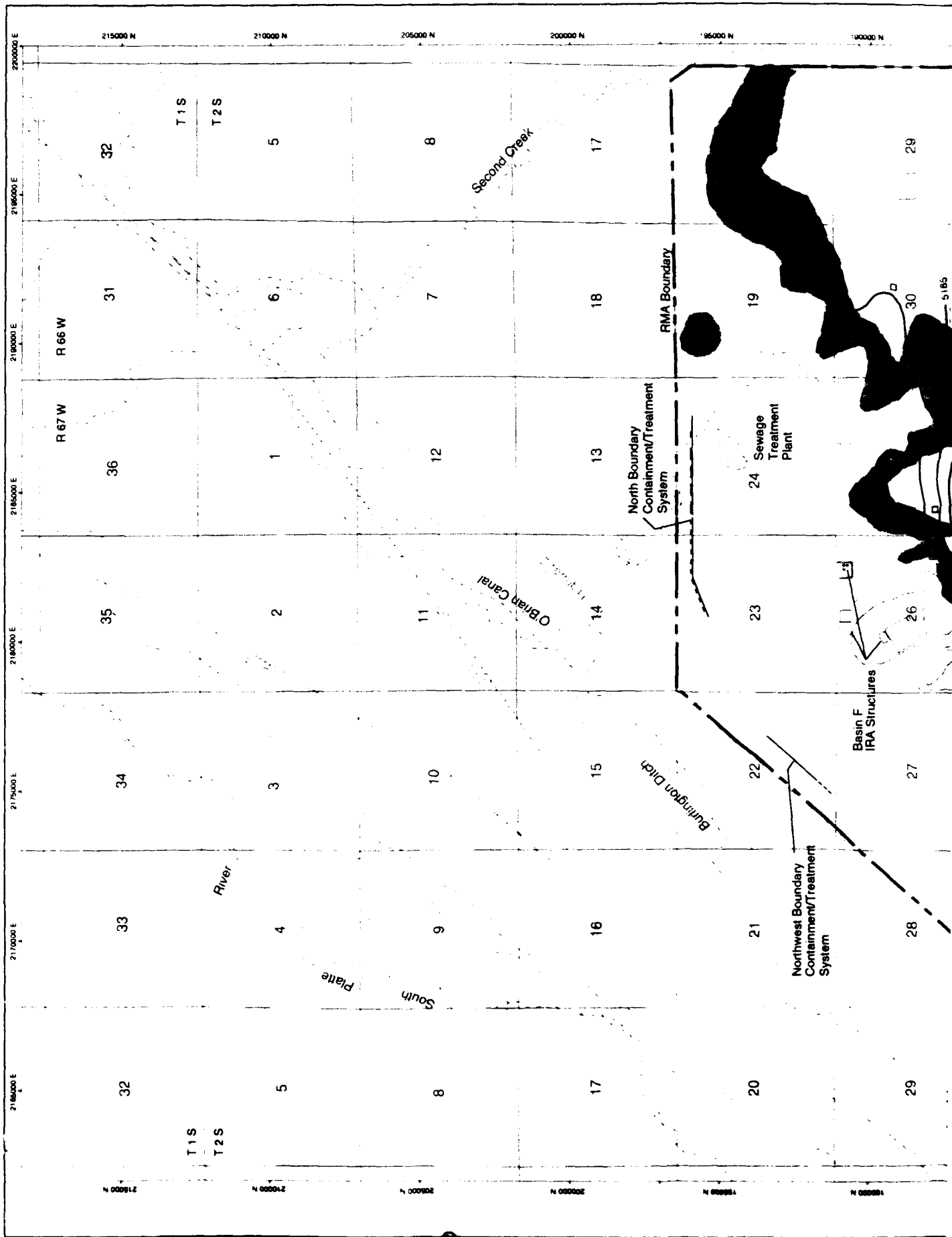


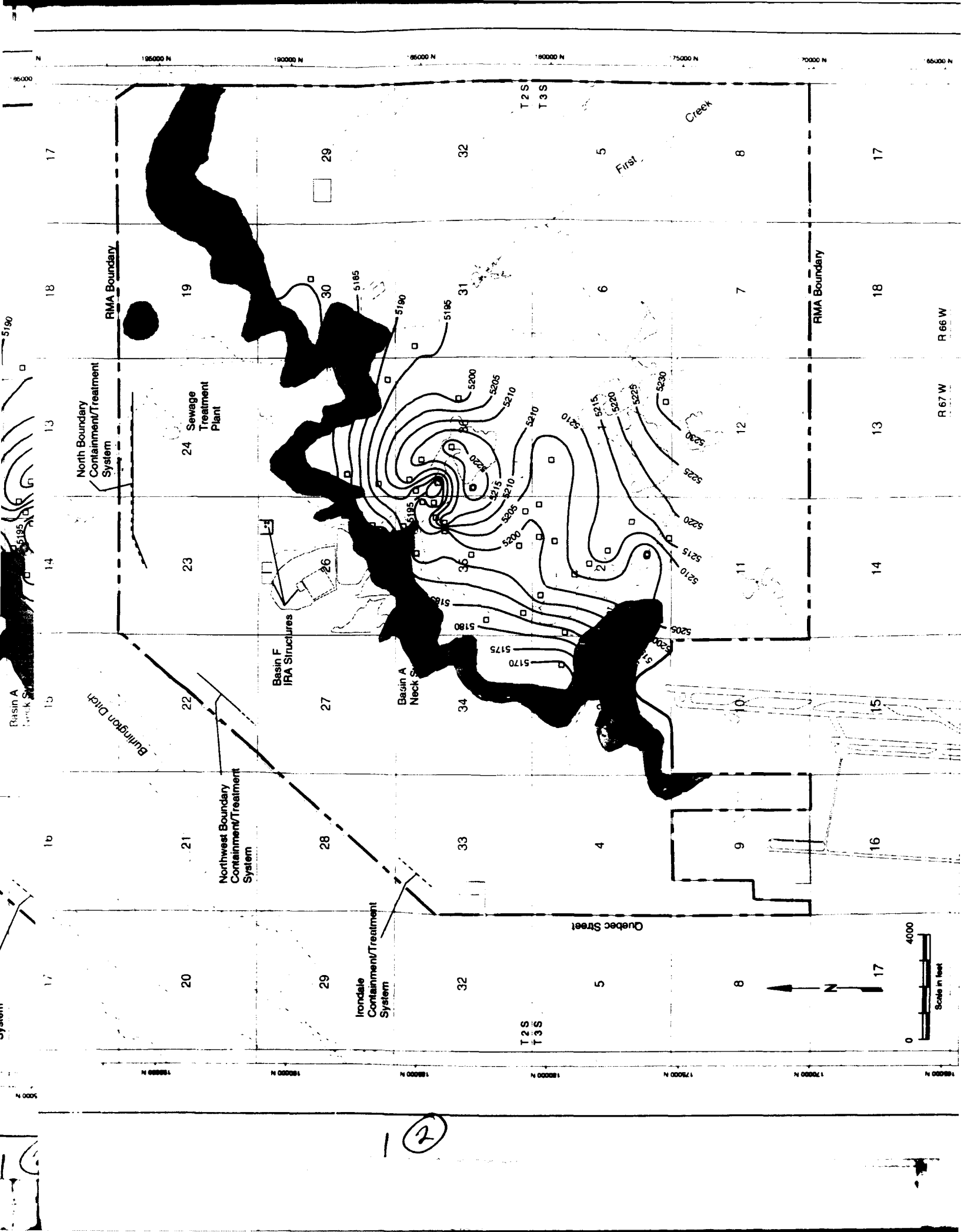
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Program Manager for
Rocky Mountain Arsenal
Commerce City, Colorado

Prepared by:
Harding Lawson Associates

Figure 4.4
Potentiometric Surface of the Denver
Formation, Zone A, Winter 1990/1991

GWAR FY91



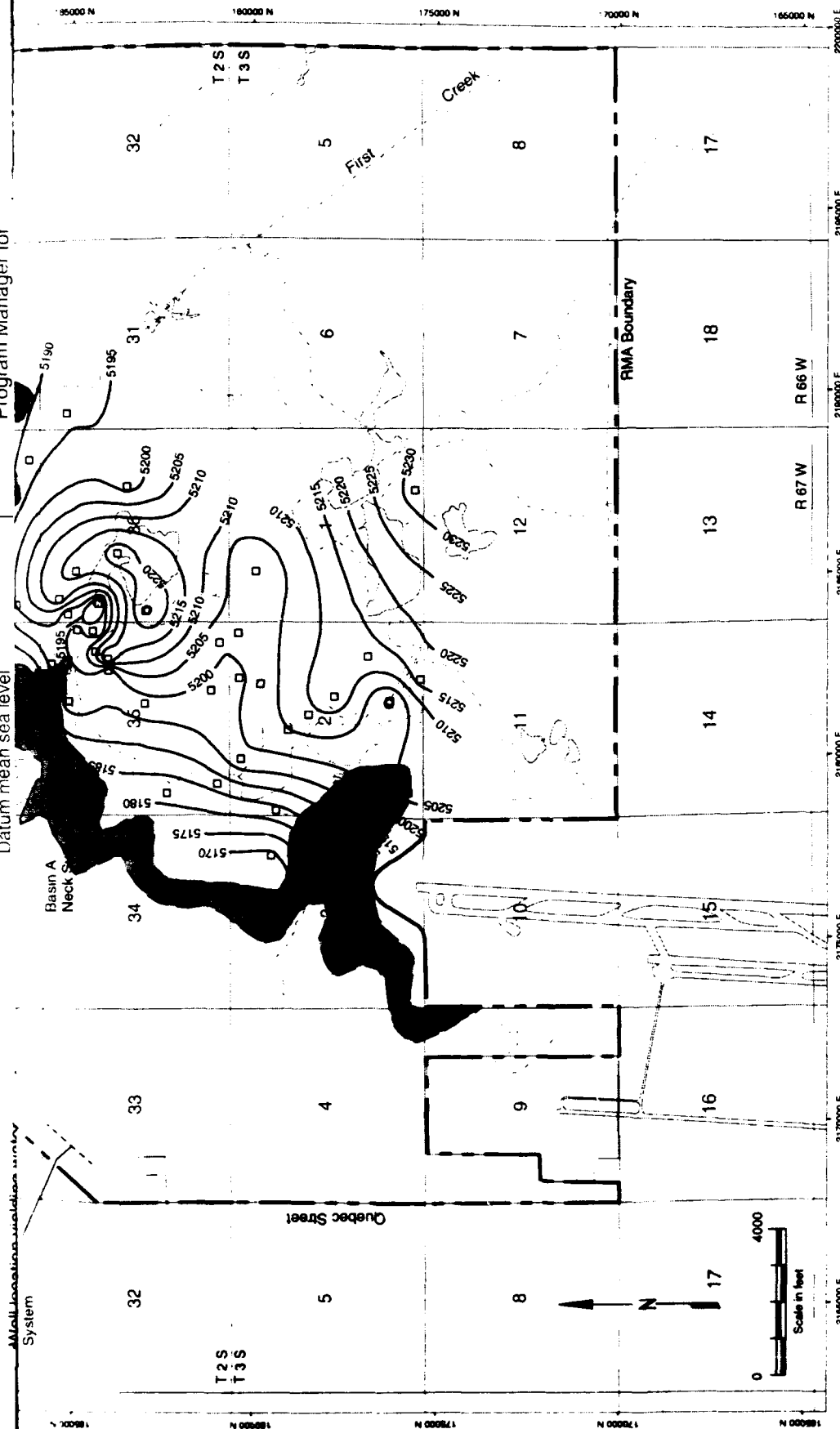


EXPLANATION

Contour interval equals 5 feet
Datum mean sea level

Prepared for:
Program Manager for

Well location yielding water
System



EXPLANATION

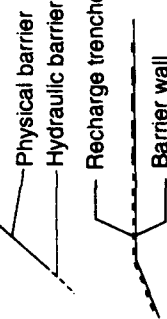
Well location yielding water-
level elevation

Elevation of the potentiometric
surface (water level measured
January 23, 1991, to February 4, 1991)

Approximate areal extent of
subcrop, Denver Zone 1U
(Ebasco, 1989)

Contour interval equals 5 feet
Datum mean sea level

Containment system



Prepared for:

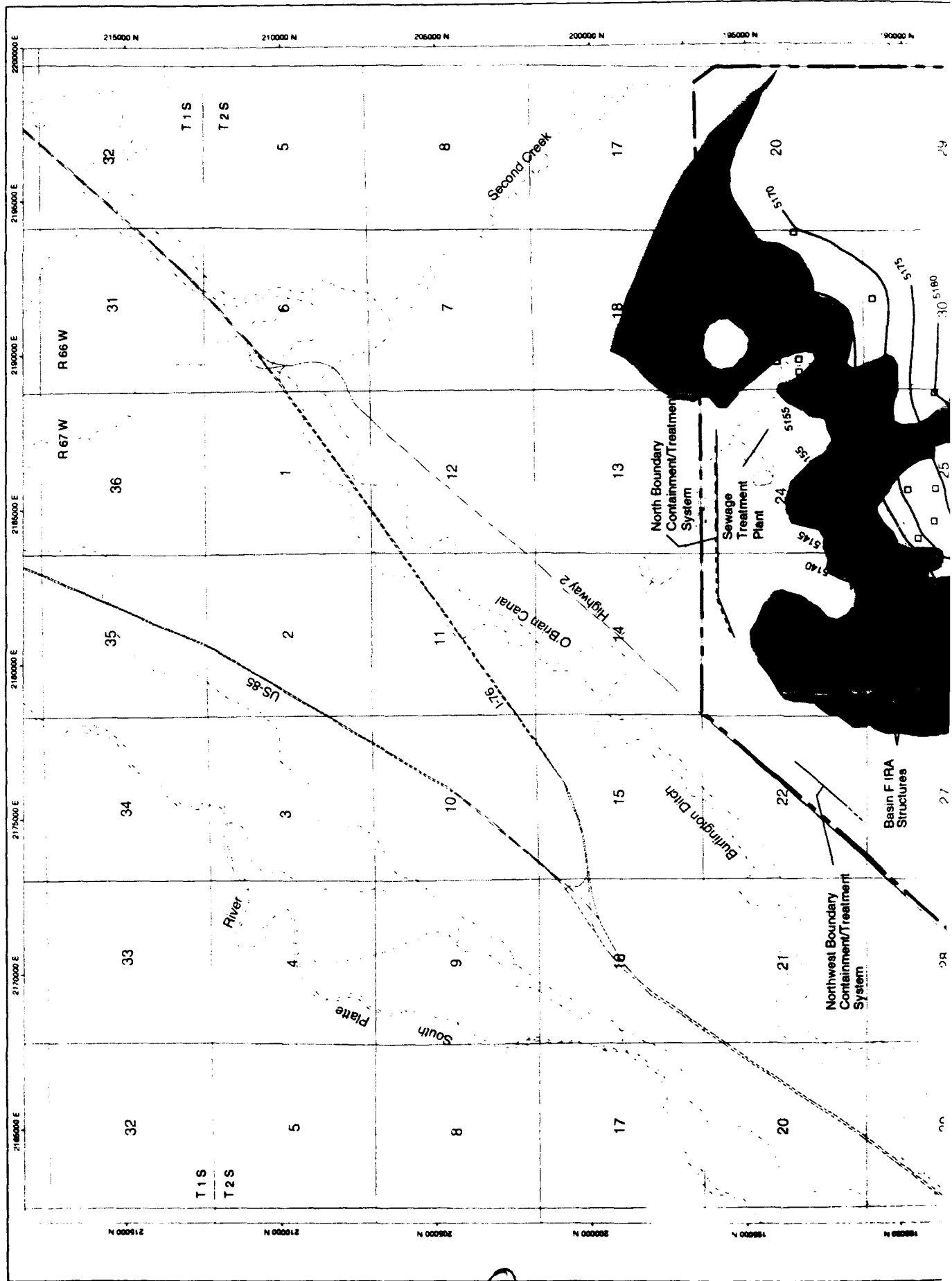
Program Manager for
Rocky Mountain Arsenal
Commerce City, Colorado

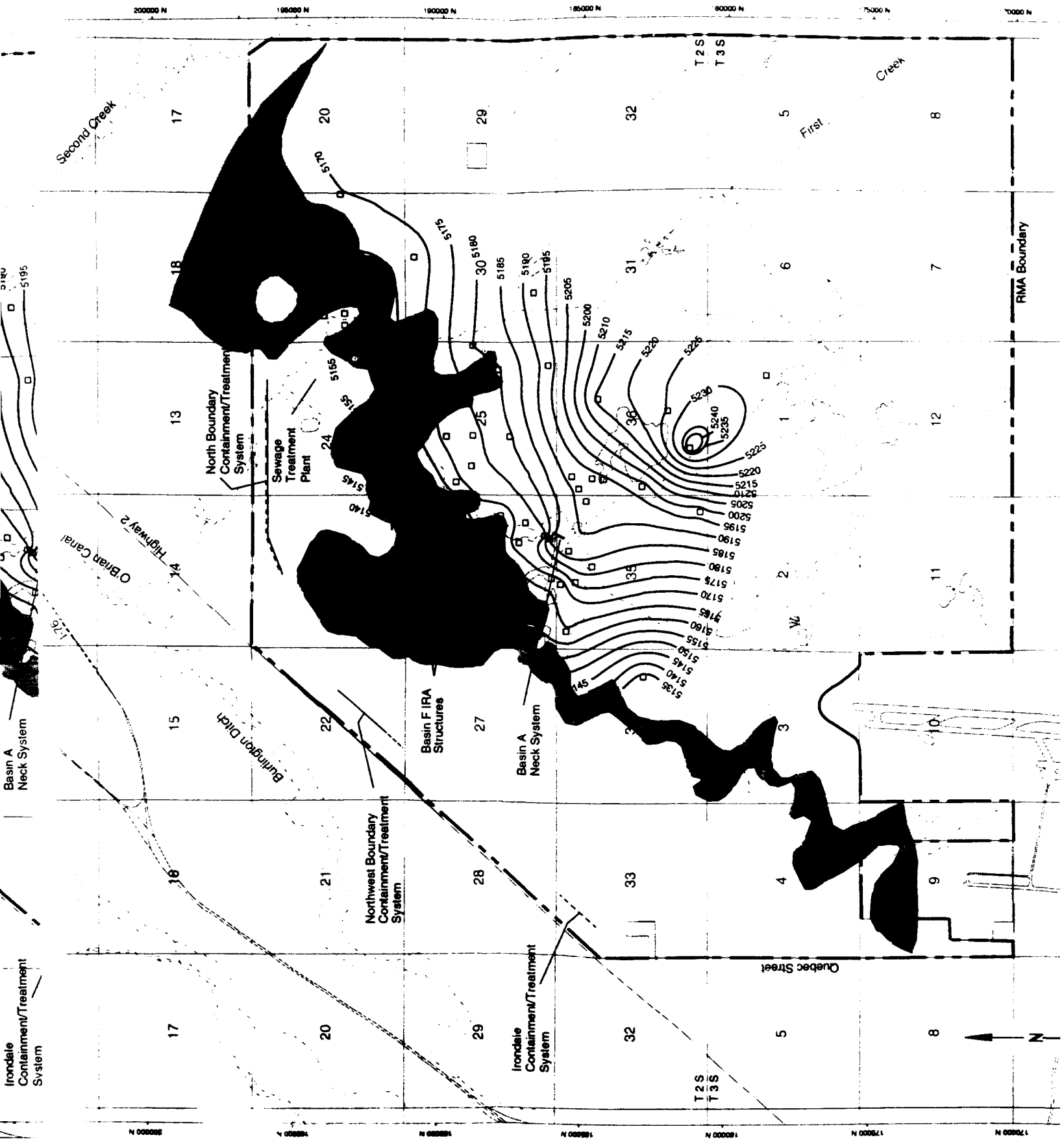
Prepared by:
Harding Lawson Associates

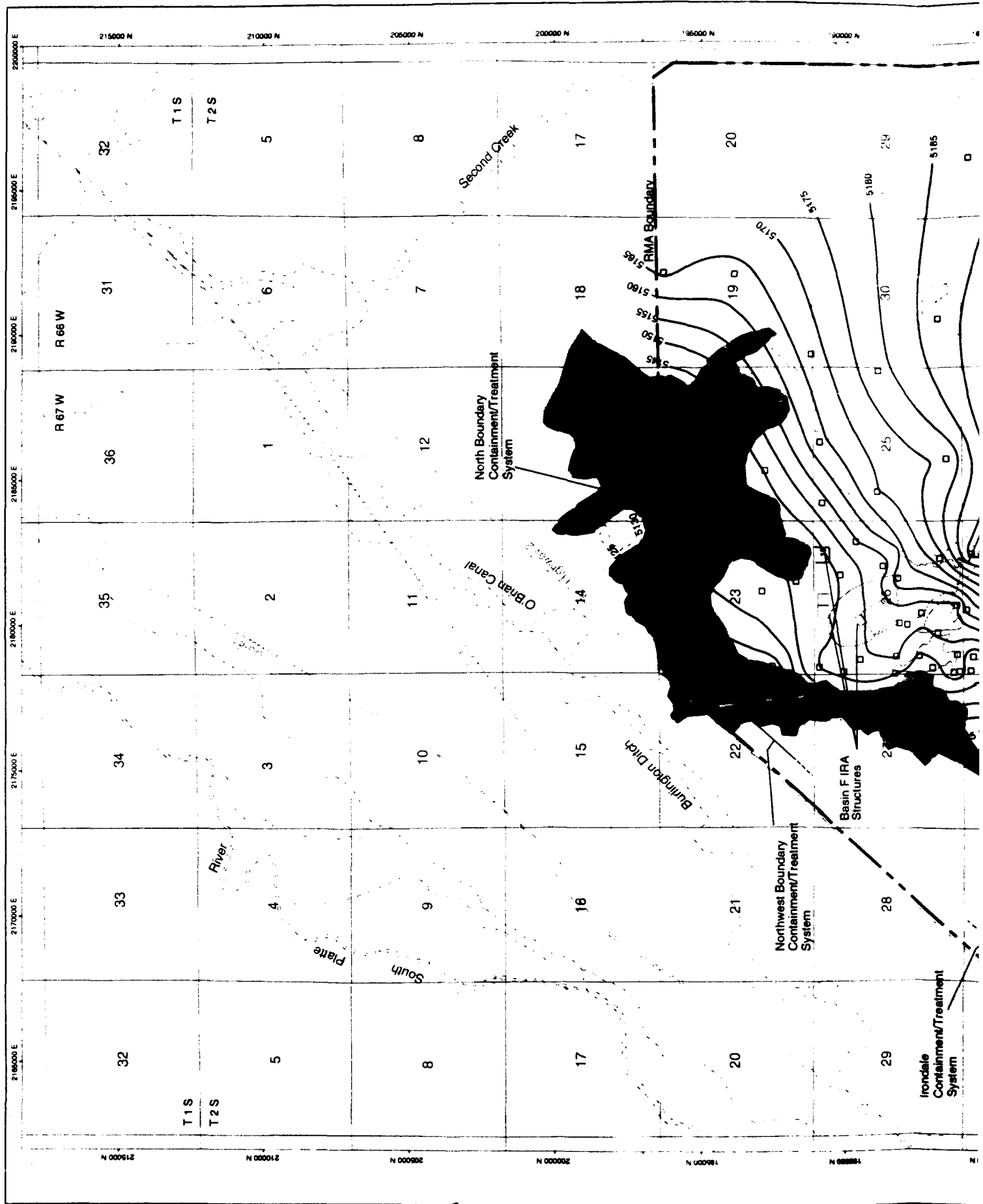
Figure 4.5

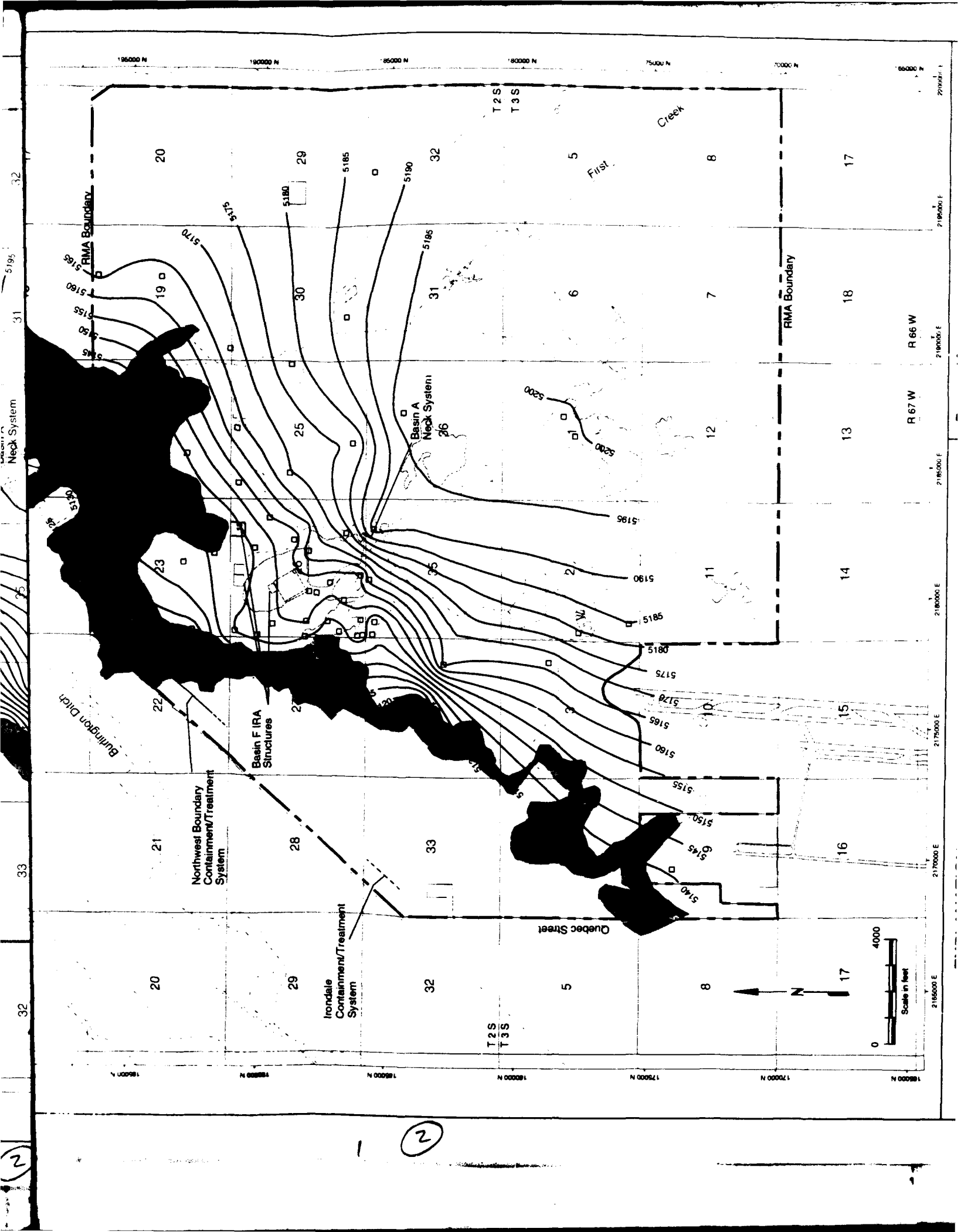
Potentiometric Surface of the Denver
Formation, Zone 1U, Winter 1990/1991

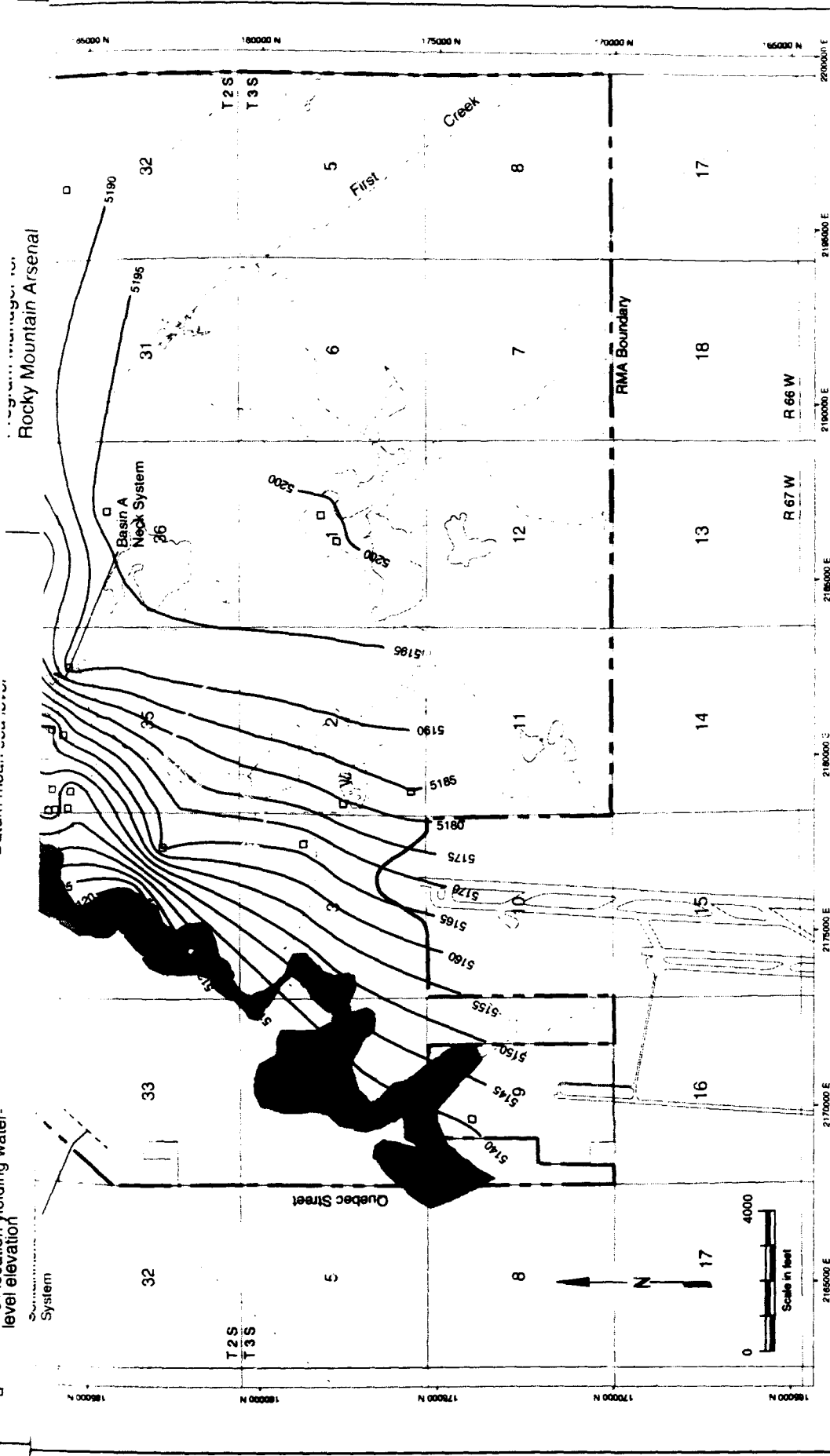
GWAR 1791







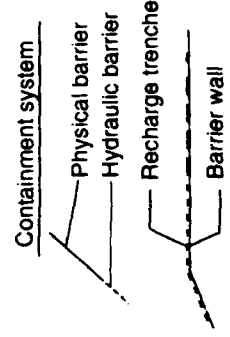




EXPLANATION

- Well location yielding water level elevation
- Elevation of the potentiometric surface (water level measured January 23, 1991, to February 4, 1991)
- Approximate areal extent of subcrop, Denver Zone 2 (Ebasco, 1989)

Contour interval equals 5 feet
Datum mean sea level

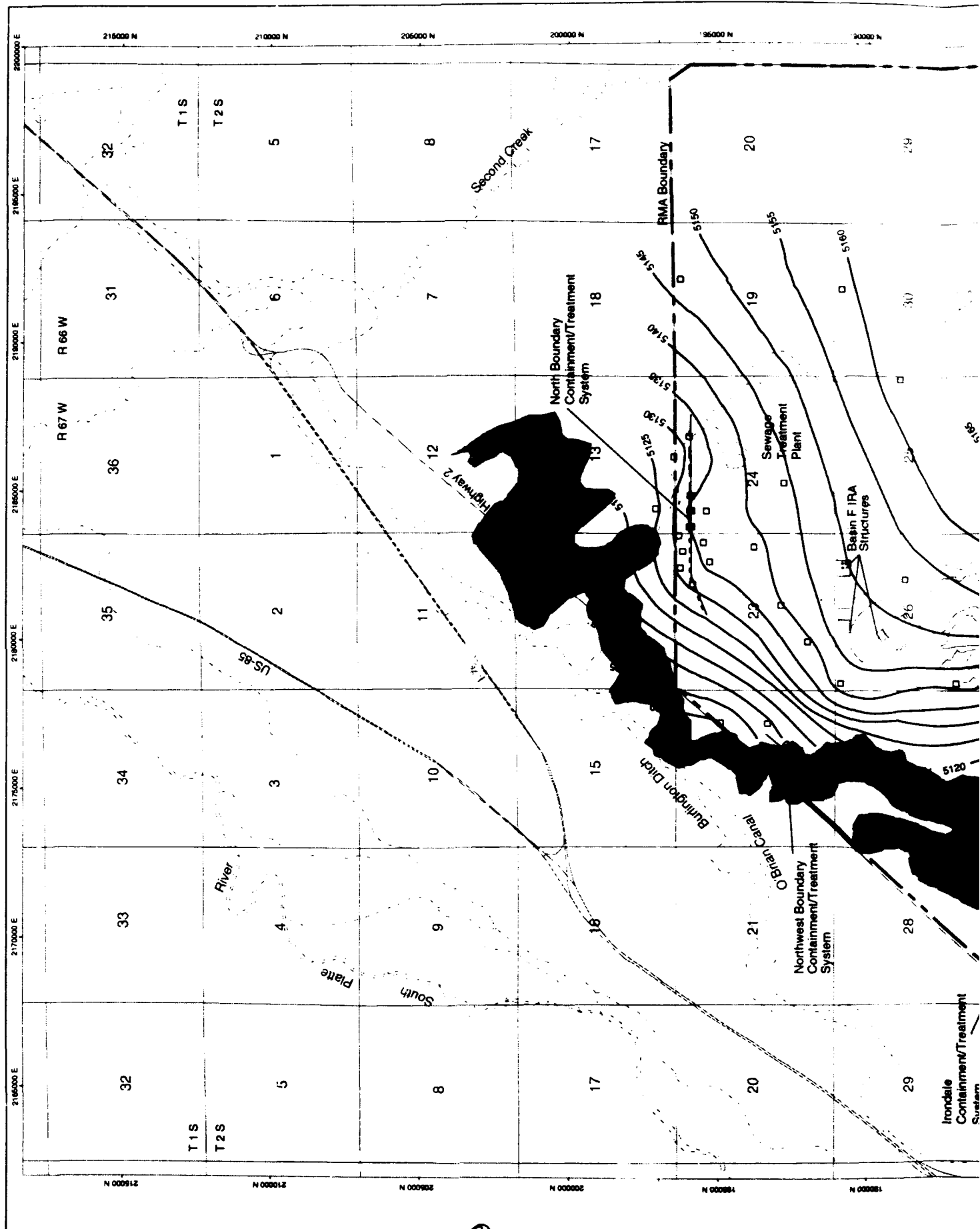


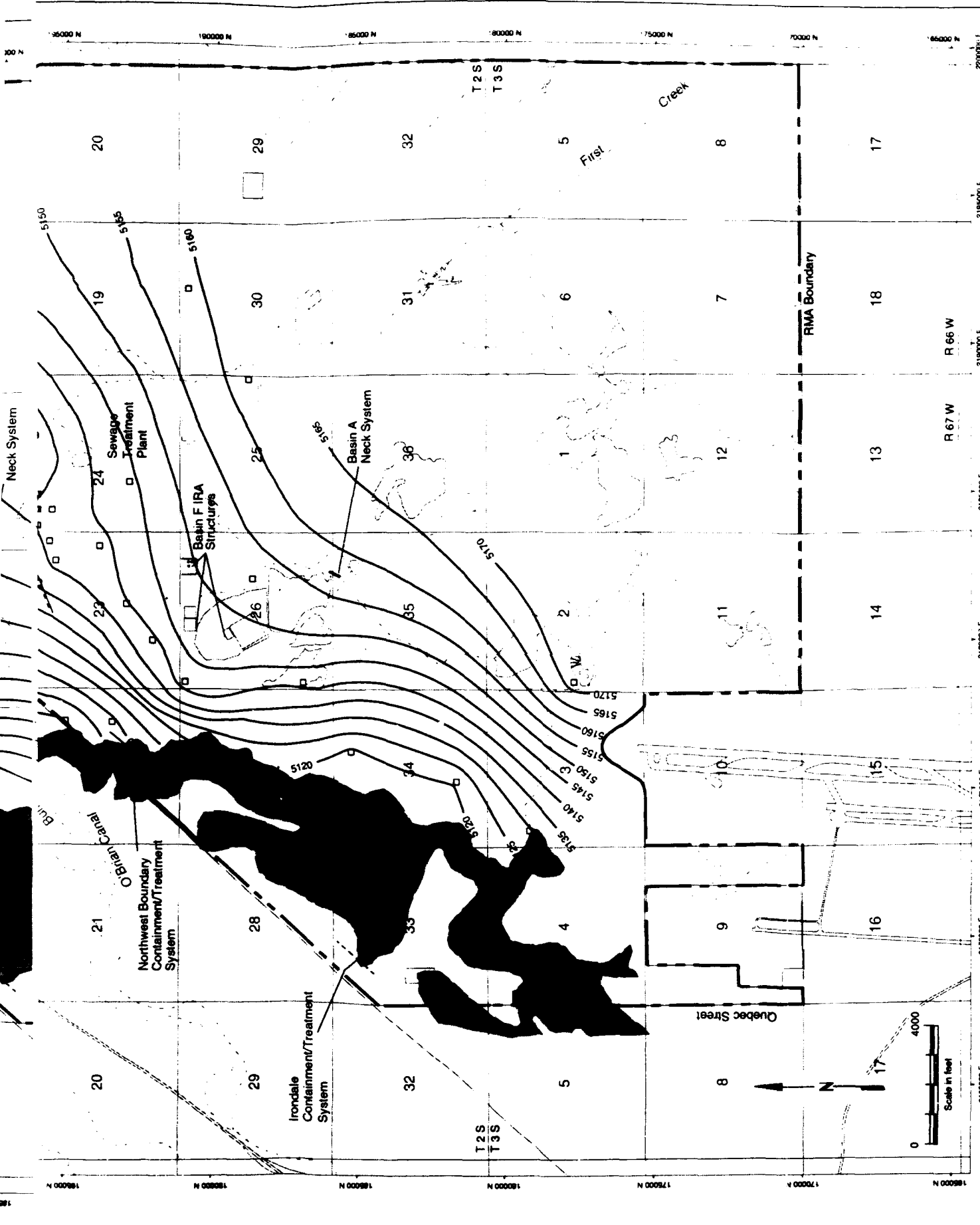
Prepared for:
Program Manager for
Rocky Mountain Arsenal
Commerce City, Colorado

Prepared by:
Harding Lawson Associates

Figure 4.7
Potentiometric Surface of the Denver
Formation, Zone 2, Winter 1990/1991

GWAR FY91





EXPLANATION

Well location yielding water-level elevation

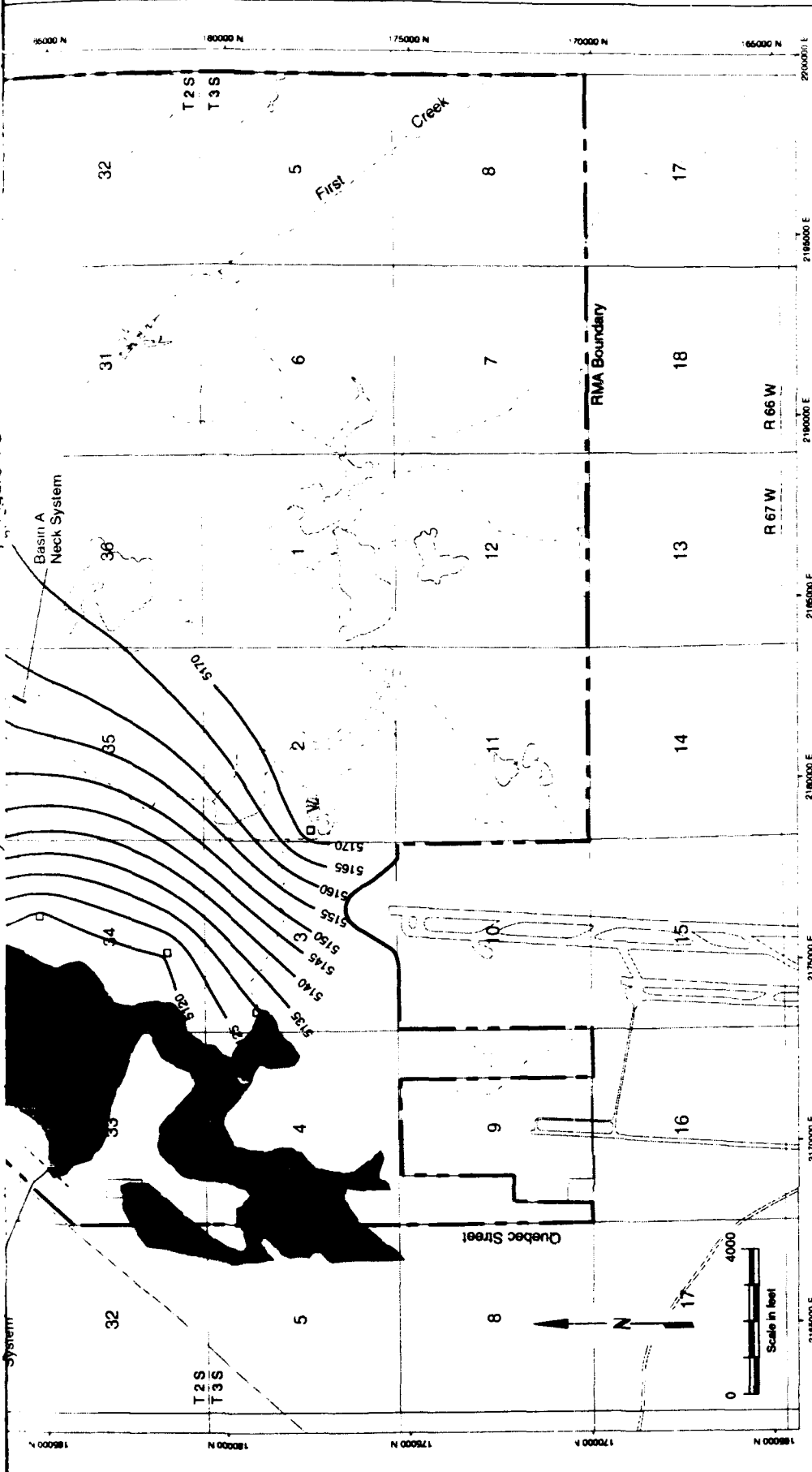
Contour interval equals 5 feet
Datum mean sea level

Prepared for:
Program Manager for
Rocky Mountain Arsenal
Commerce City, Colorado

— 5230 —
 January 23, 1991, to February 4, 1991)

Physical barrier

Figure 4.8



EXPLANATION

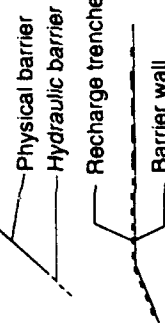
□ Well location yielding water-level elevation

— 5230 —
 Elevation of the potentiometric surface (water level measured January 23, 1991, to February 4, 1991)

Approximate areal extent of subcrop, Denver Zone 3 (Ebasco 1989)

Contour interval equals 5 feet
 Datum mean sea level

Containment system



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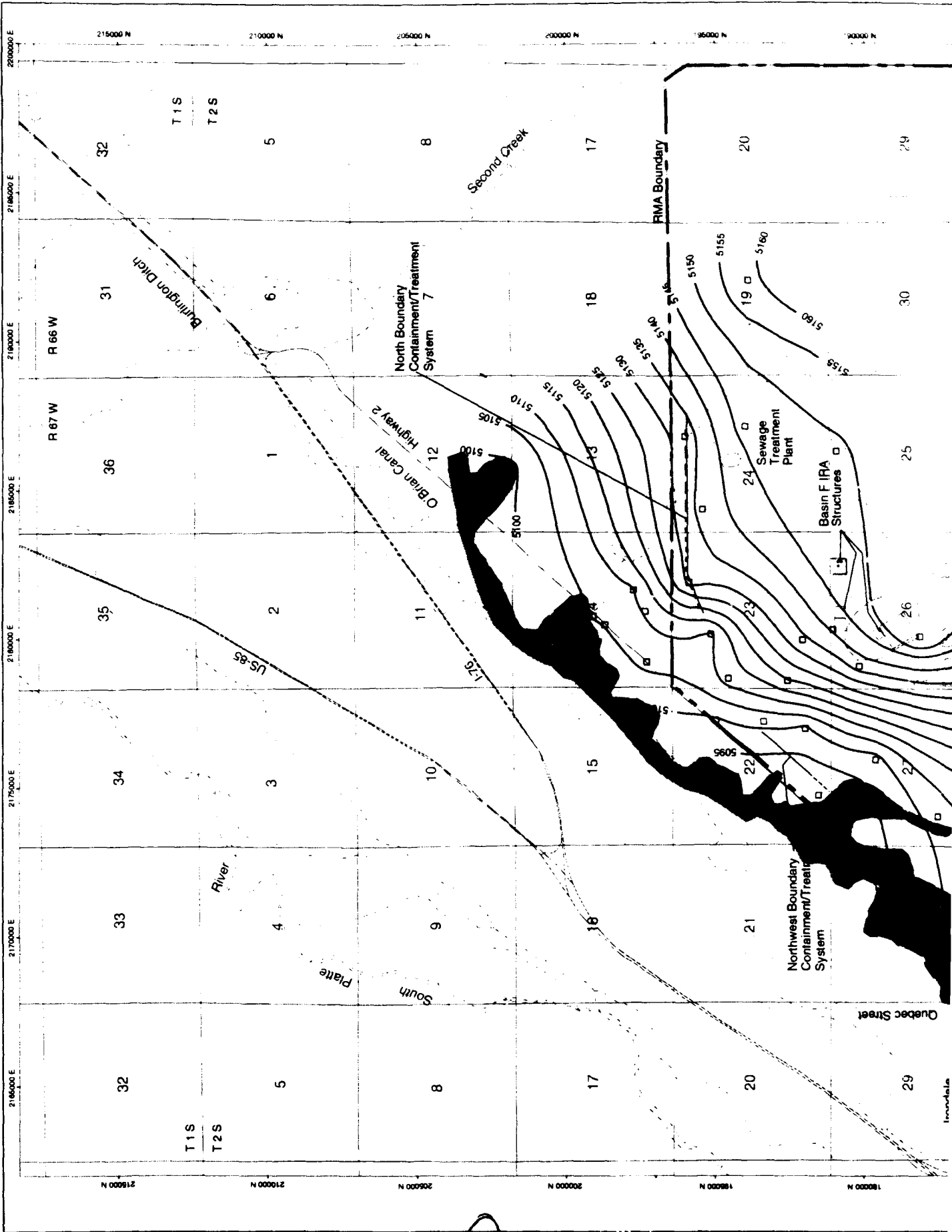
Prepared by:

Harding Lawson Associates

Figure 4.8

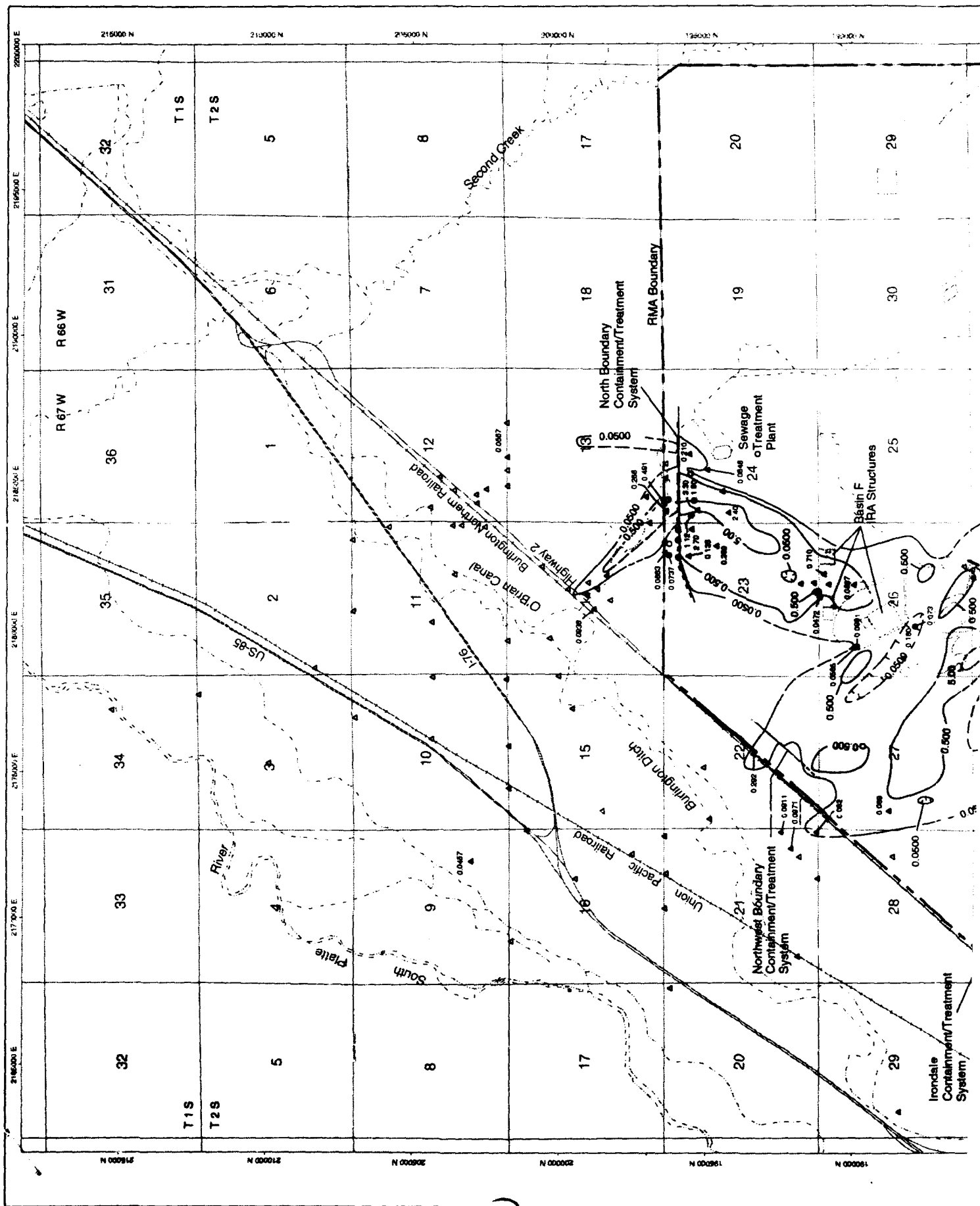
Potentiometric Surface of the Denver Formation, Zone 3, Winter 1990/1991

GWAR FY91

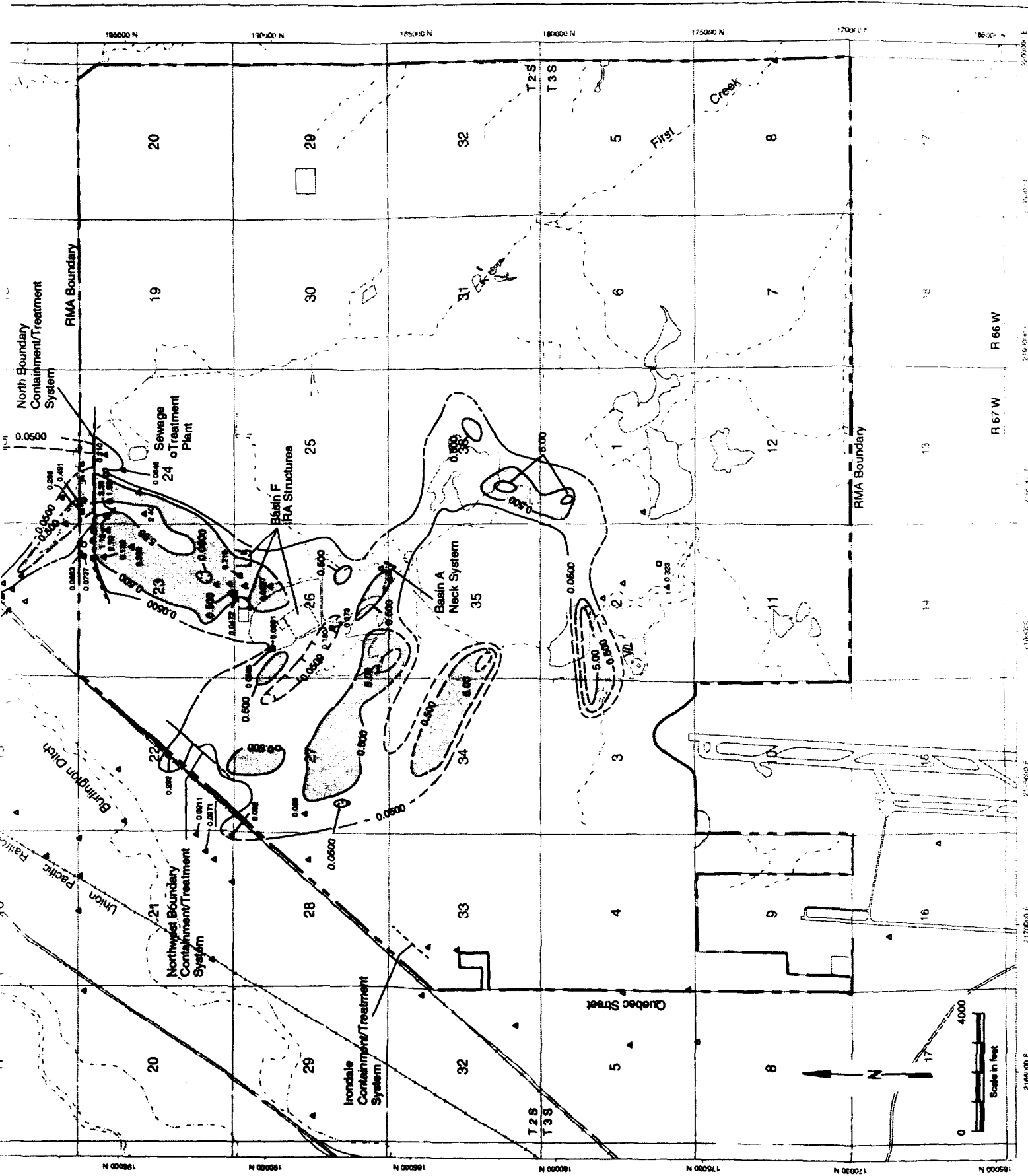


(1)



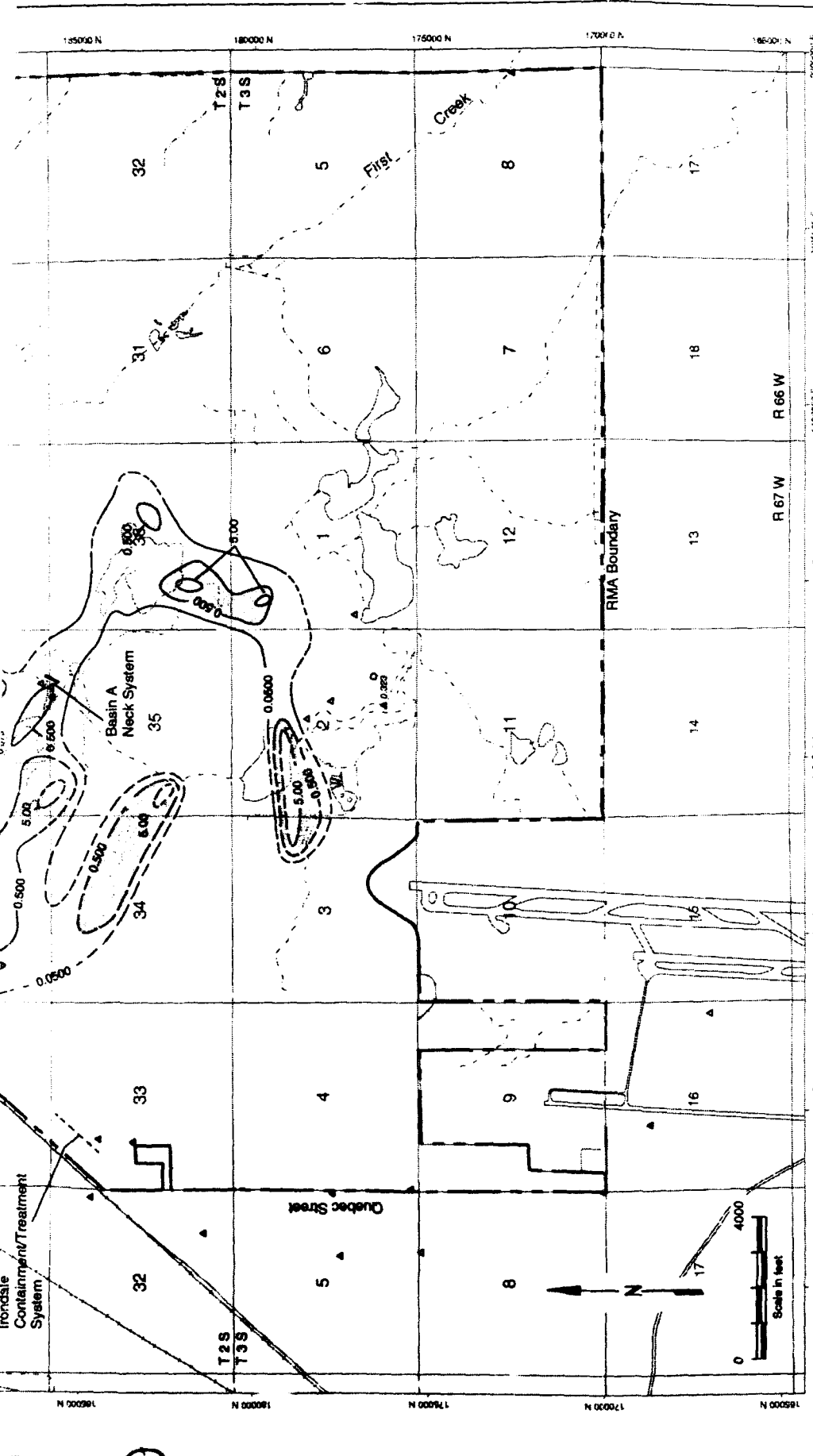


①



EXPLANATION

Prepared for:
 Bureau Manager for



EXPLANATION

Fall 1989 plume
isoconcentration line with
value, dashed where inferred
exists
Hachures where a depression
exists

Concentration ranges (ug/l)
Fall 1989:

- ☐ 0.0500 - 0.499
- ☒ 0.500 - 4.99
- ☐ 5.00 and above

Unconfined flow system

Winter 1990/1991 samples
collected from February 5, 1991, to March 11, 1991

Alluvial] Concentrations
Denver] (ug/l)
0.710
1.80
0.0071

Alluvial (well sampled in
Winter 1990/1991, not
sampled Fall 1989)
Alluvial] Below Certified
Reporting
Limit (CRL)
Denver]
Highest CRL = 0.0539 ug/l
Lowest CRL = 0.050 ug/l

Containment system

- Physical barrier
- Hydraulic barrier
- Recharge trenches
- Barrier wall

Prepared for:

Program Manager for
Rocky Mountain Arsenal
Commerce City, Colorado

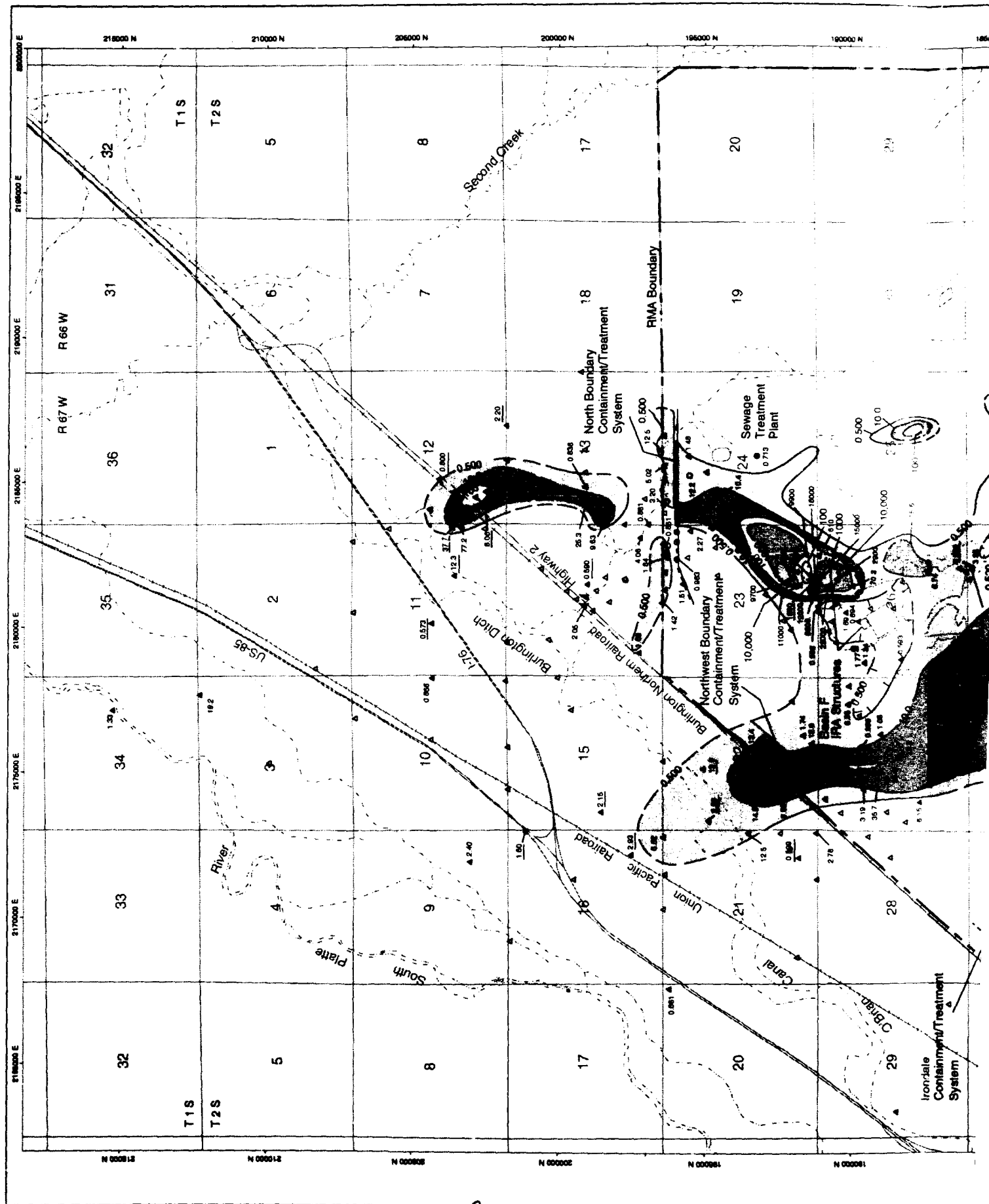
Prepared by:

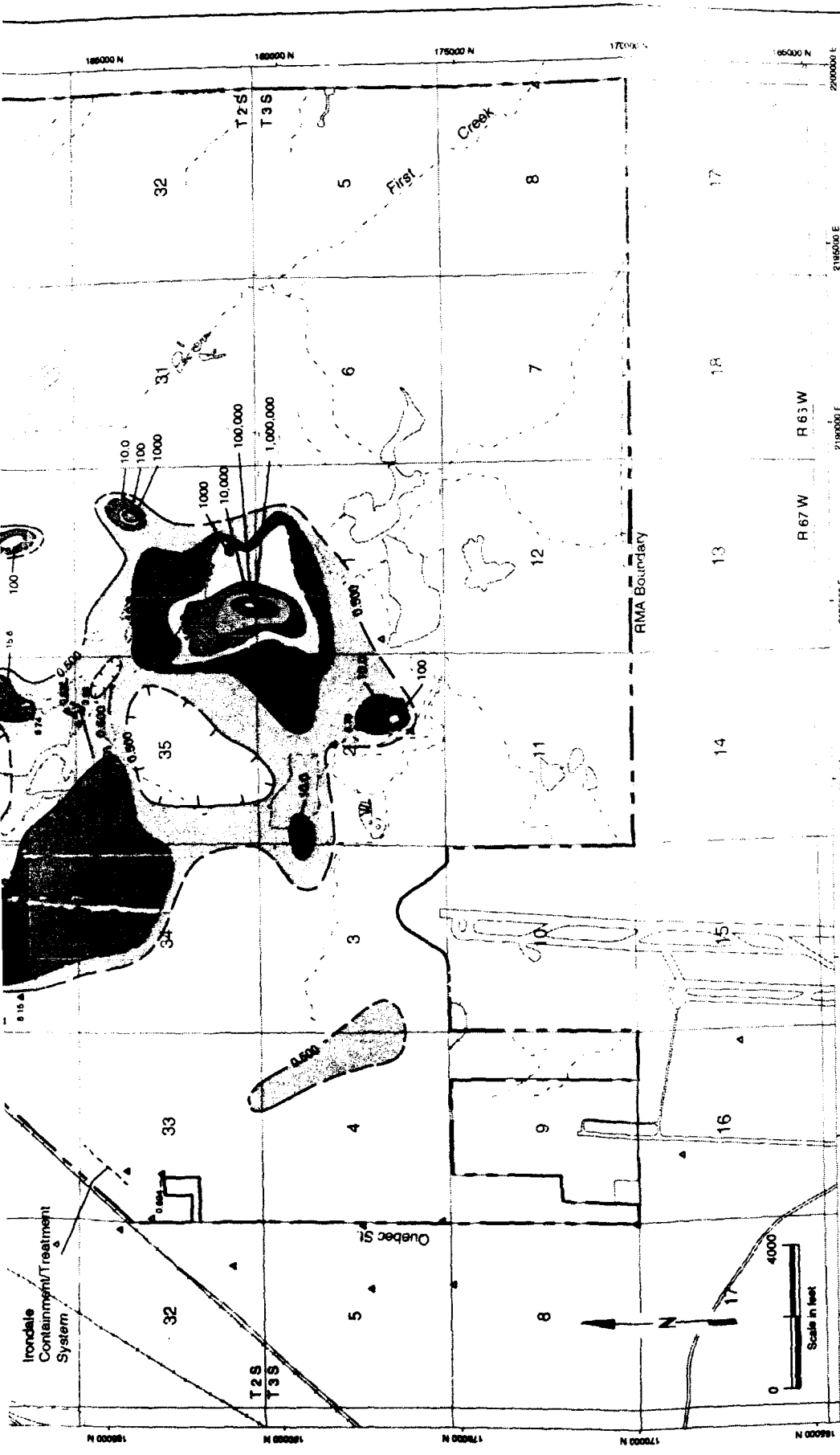
Harding Lawson Associates

Figure 4.10

Unconfined Groundwater Flow System
Fall 1989 Dieldrin Plumes with
Winter 1990/1991 Analytical Results Posted

GWAR FY91





Prepared for:
 U.S. Army Program Manager for
 Rocky Mountain Arsenal
 Commerce City, Colorado

Prepared by:
 Harding Lawson Associates

Figure 4.11
 Unconfined Groundwater Flow System
 Fall 1989 Chloroform Plumes with
 Winter 1990/1991 Analytical Results Posted

GWAR FY91

EXPLANATION

Unconfined flow system
 Winter 1990/1991 samples
 collected from February 5, 1991, to March 11, 1991

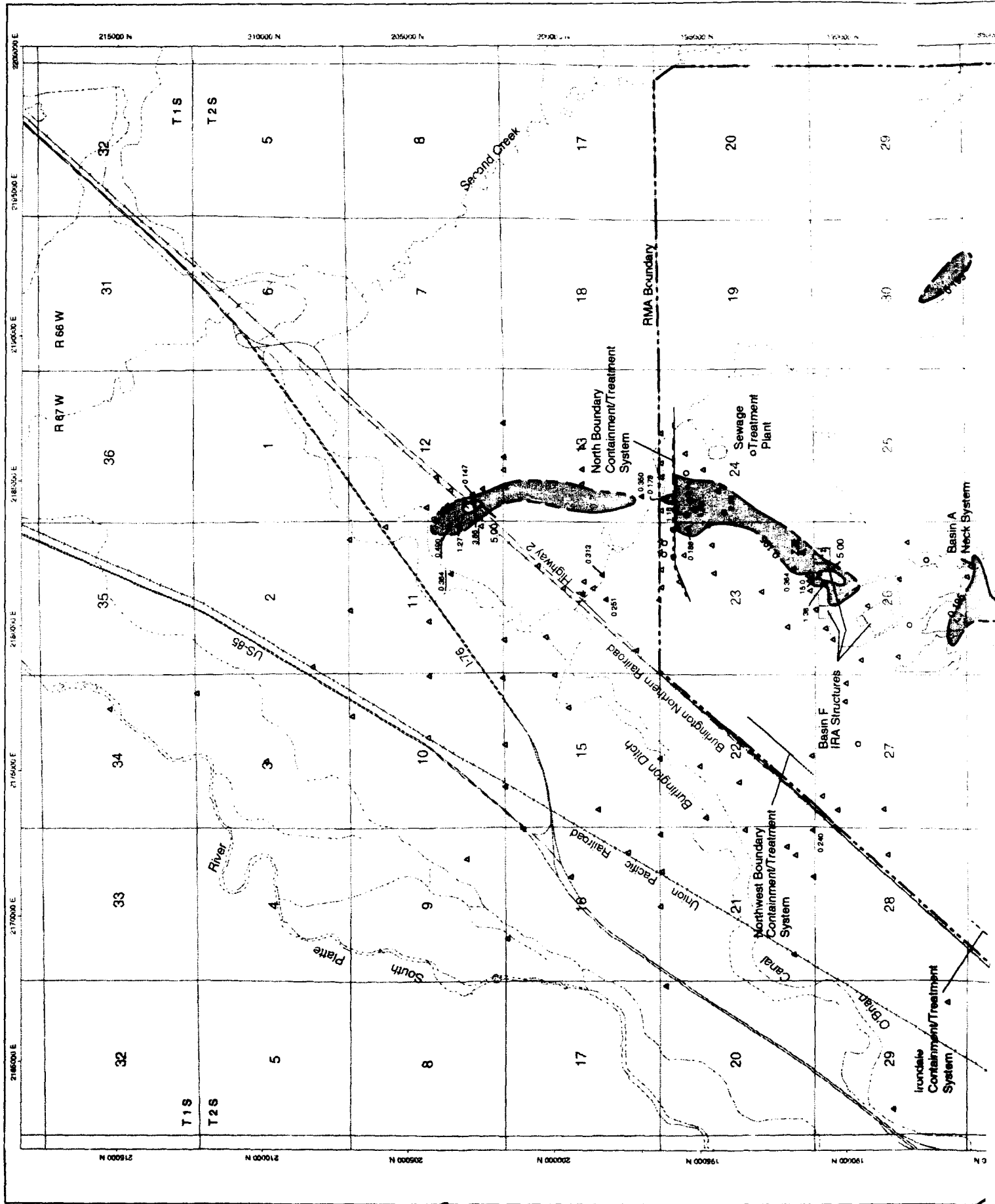
Concentration ranges
 (ug/l) Fall 1989

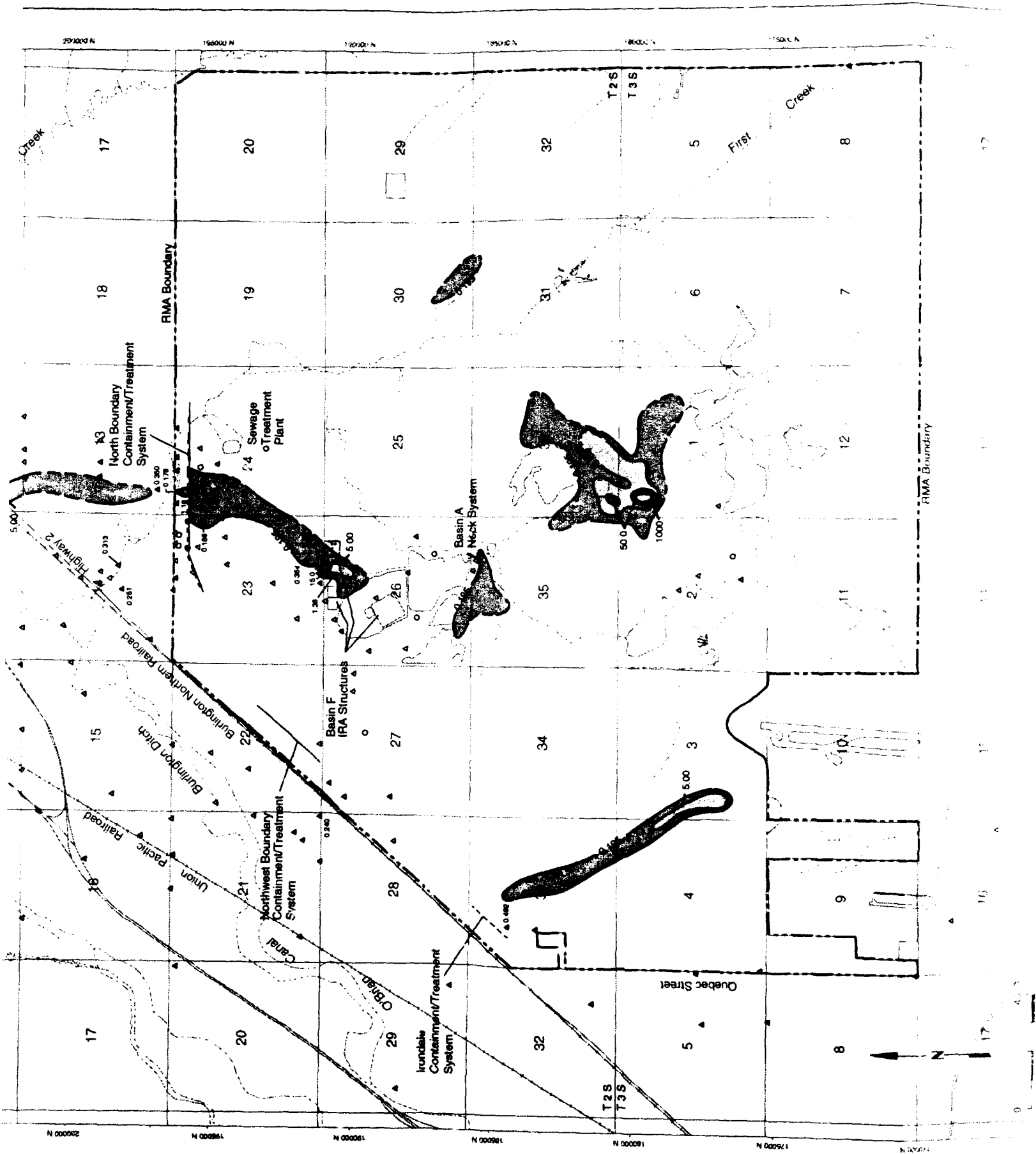
- ☐ 0.500 - 9.99
- ☐ 10.0 - 99.9
- ☐ 100 - 999
- ☐ 1000 - 9,999
- ☐ 10,000 - 99,999
- ☐ 100,000 - 999,999
- ☐ 1,000,000 - and above

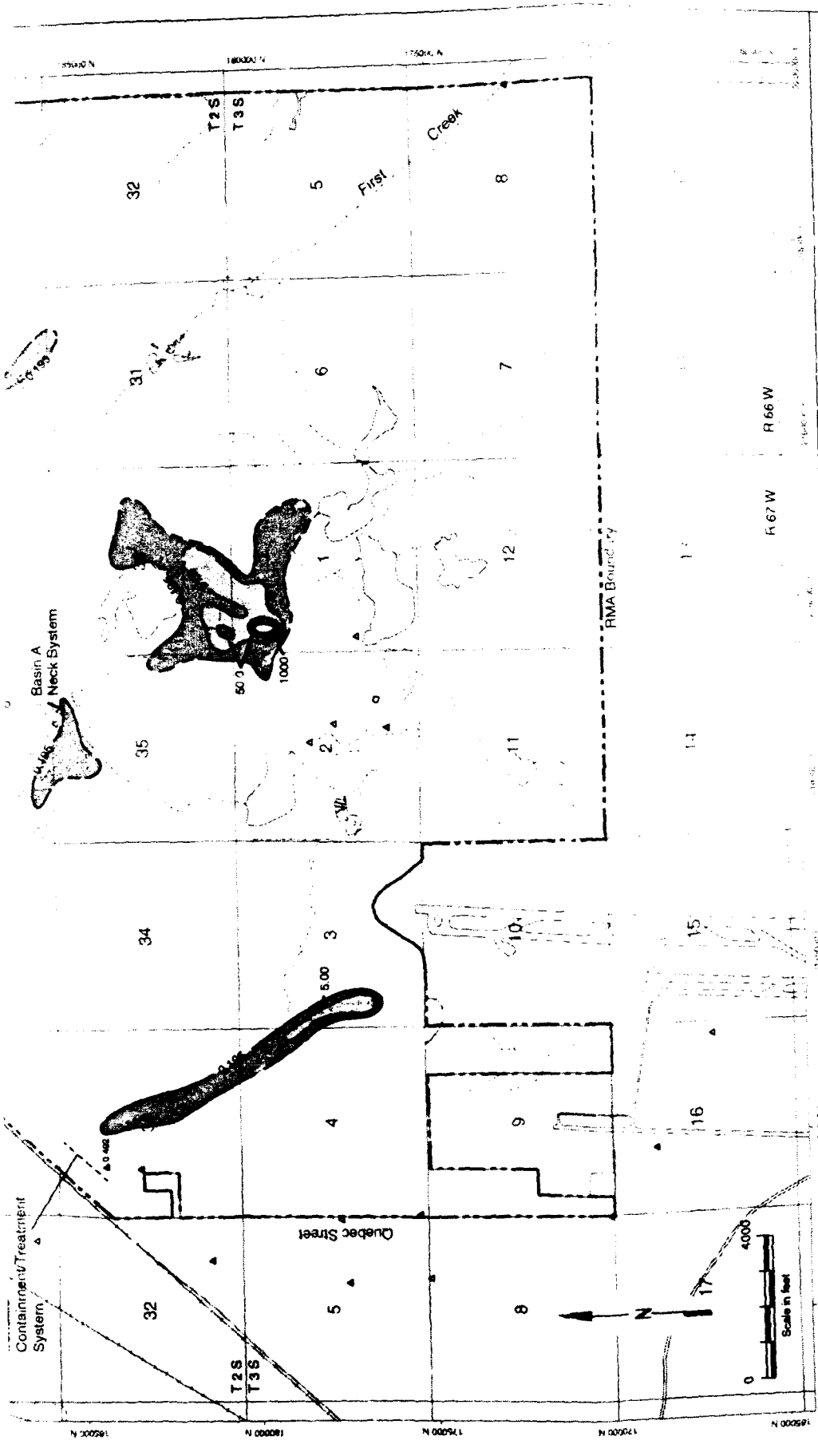
Containment system

- ☐ Physical barrier
- ☐ Hydraulic barrier
- ☐ Recharge trenches
- ☐ Barrier wall

Aluvial } Concentrations
 174 ☐ Denver ☐ (ug/l)
 0.719 ☐ Alluvial (well sampled in
 Winter 1990/1991, not
 sampled Fall 1989)
 0.673 ☐ Alluvial } Below Certified
 Reporting Limit (CRL)
 Denver ☐ Limit (CRL)
 Highest CRL = 0.195 ug/l
 Lowest CRL = 0.130 ug/l







EXPLANATION

Unconfined flow system

Winter 1990/1991 samples collected from February 5, 1991, to March 11, 1991

Fall 1989 plume isocentration line with value, dashed where inferred

Concentration ranges (ug/l)

Fall 1989:

- 0.195 - 4.99
- 5.00 - 49.9
- 50.0 - 999
- 1000 - and above

Concentrations (ug/l)

Aluvial Denver

Aluvial (well sampled in Winter 1990/1991, not sampled Fall 1989)

Aluvial Below Certified Reporting Limit (CRL)

Highest CRL = 0.195 ug/l

Lowest CRL = 0.130 ug/l

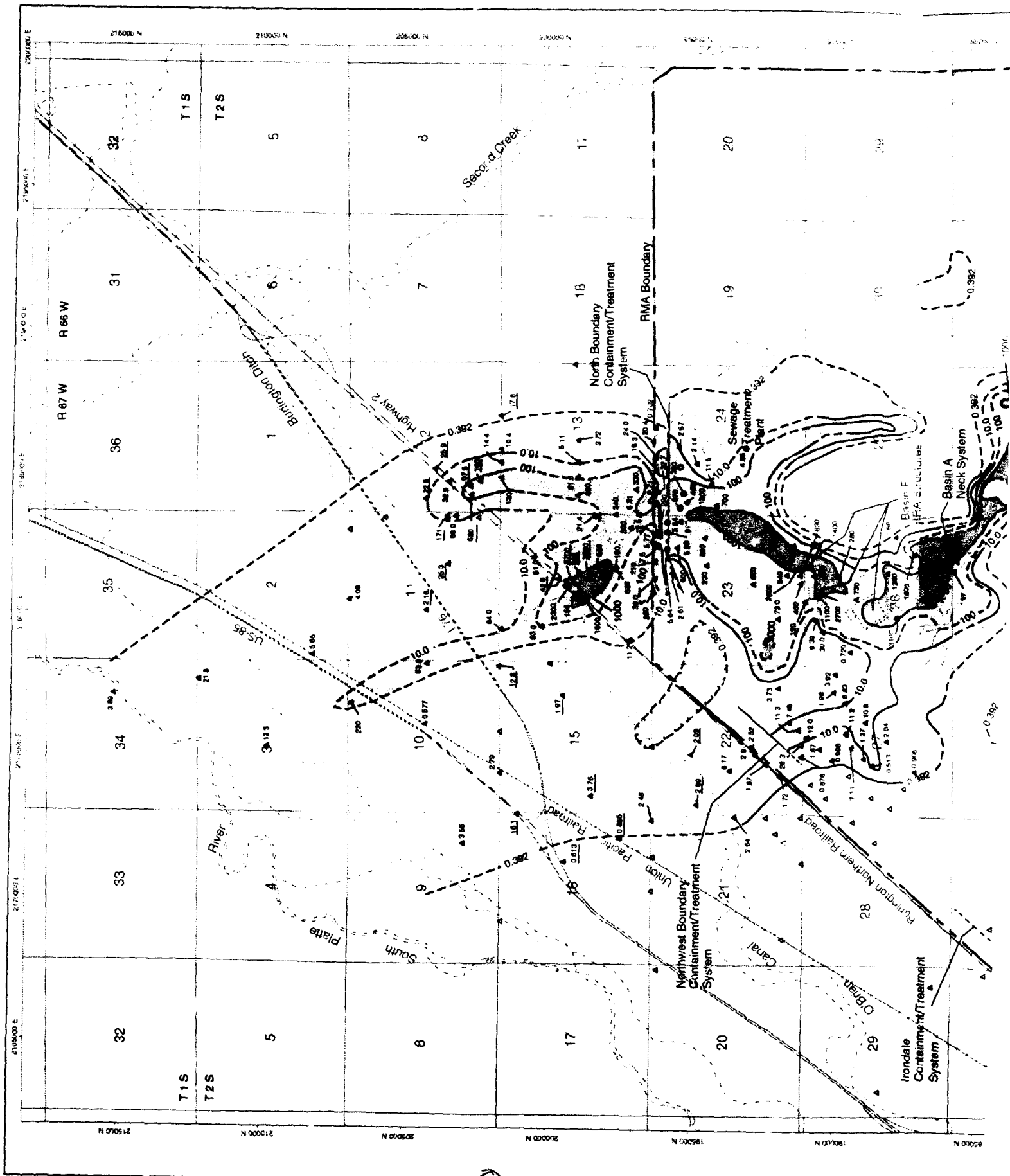
Containment system

- Physical barrier
- Hydraulic barrier
- Recharge trenches
- Barrier wall

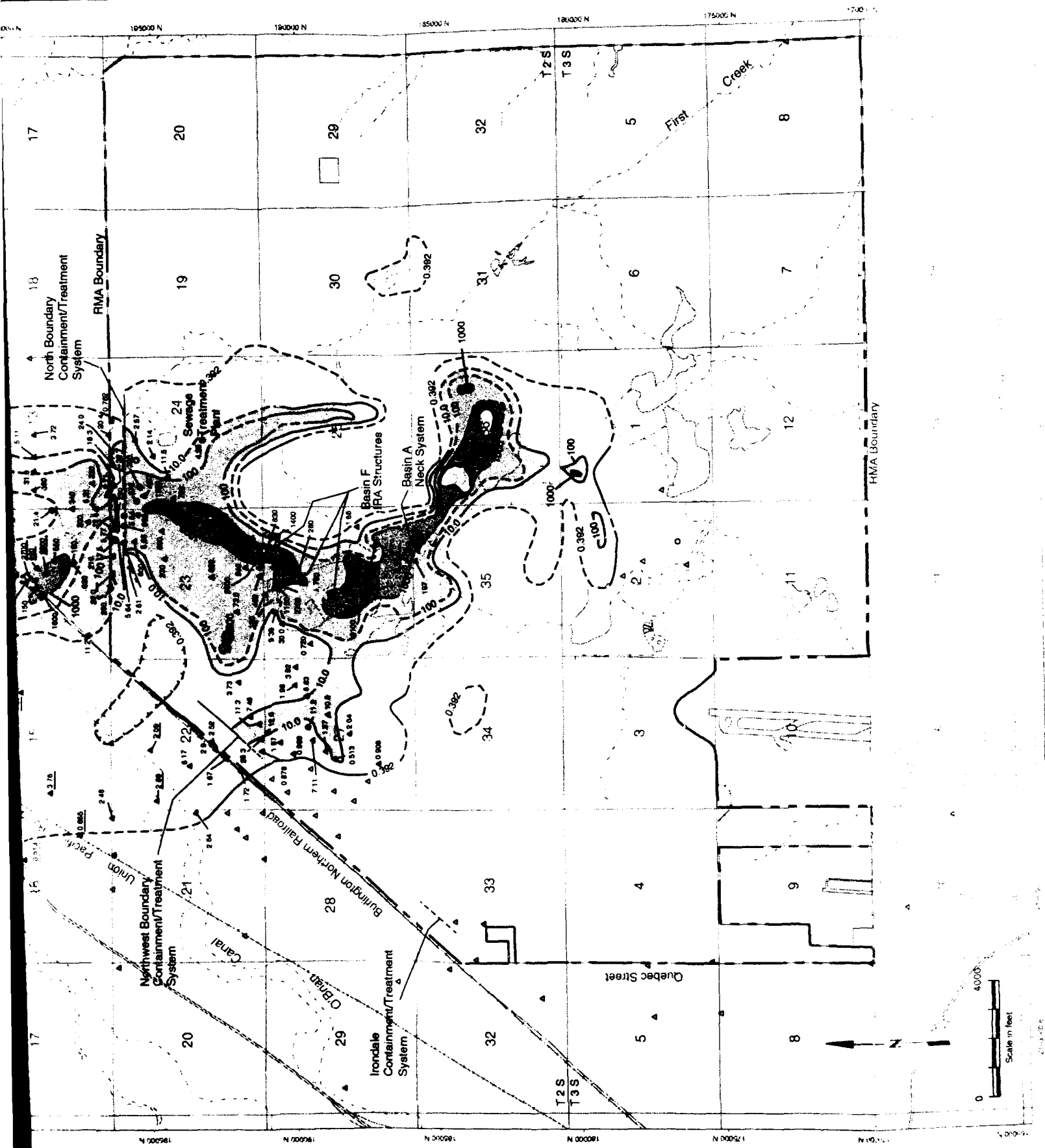
Prepared for:
Program Manager for
Rocky Mountain Arsenal
Commerce City, Colorado

Prepared by:
Harding Lawson Associates

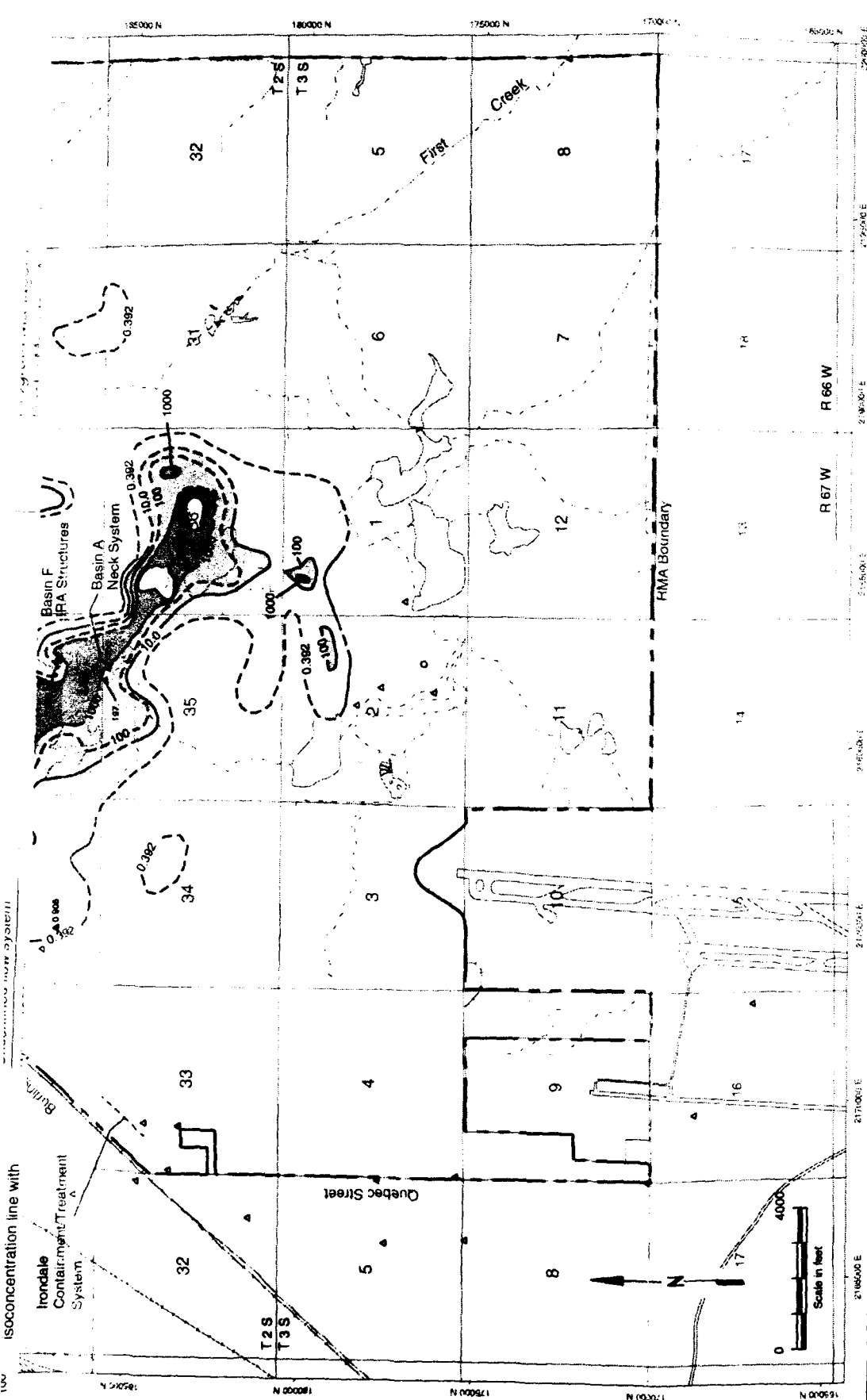
Figure 4.12
Unconfined Groundwater Flow System
Fall 1989 Dibromochloropropane (DBCP)
Plumes with Winter 1990/1991
Analytical Results Posted
GWAR FY91



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2



EXPLANATION

Fall 1989 plume
isoc concentration line with
value, dashed where inferred
Hachures where a depression
exists

Concentration ranges (ug/l)

Fall 1989:
☐ 0.392 - 9.99
☐ 10.0 - 99.9
☐ 100 - 999
☐ 1000 - 9,999
☐ 10,000 and above

Unconfined flow system
 Winter 1990/1991 samples
 collected from February 5, 1991, to March 11, 1991

Location	Concentrations (ug/l)
Alluvial	160
Denver	390
Alluvial (well sampled in Winter 1990/1991, not sampled Fall 1989)	171
Alluvial	Below Certified Reporting Limit (CRL)
Denver	Below Certified Reporting Limit (CRL)

Highest CRL = 10.1 ug/l
 Lowest CRL = 0.392 ug/l

Containment system

Physical barrier
 Hydraulic barrier
 Recharge trenches
 Barrier wall

Prepared for:

Program Manager for
 Rocky Mountain Arsenal
 Commerce City, Colorado

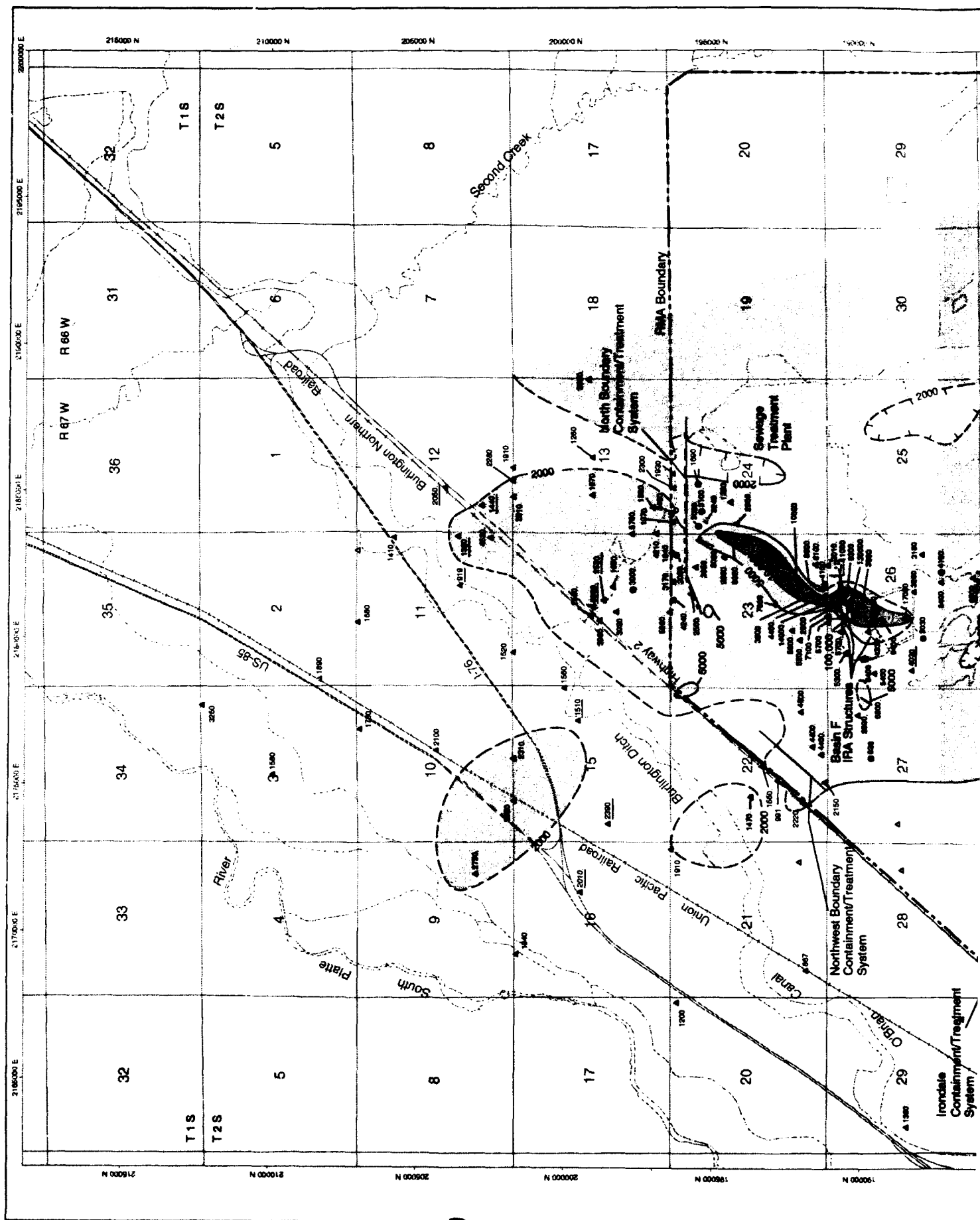
Prepared by:

Harding Lawson Associates

Figure 4.13

Unconfined Groundwater Flow System
 Fall 1989 Disopropylmethylphosphonate (DIMP)
 Plumes with Winter 1990/1991
 Analytical Results Posted

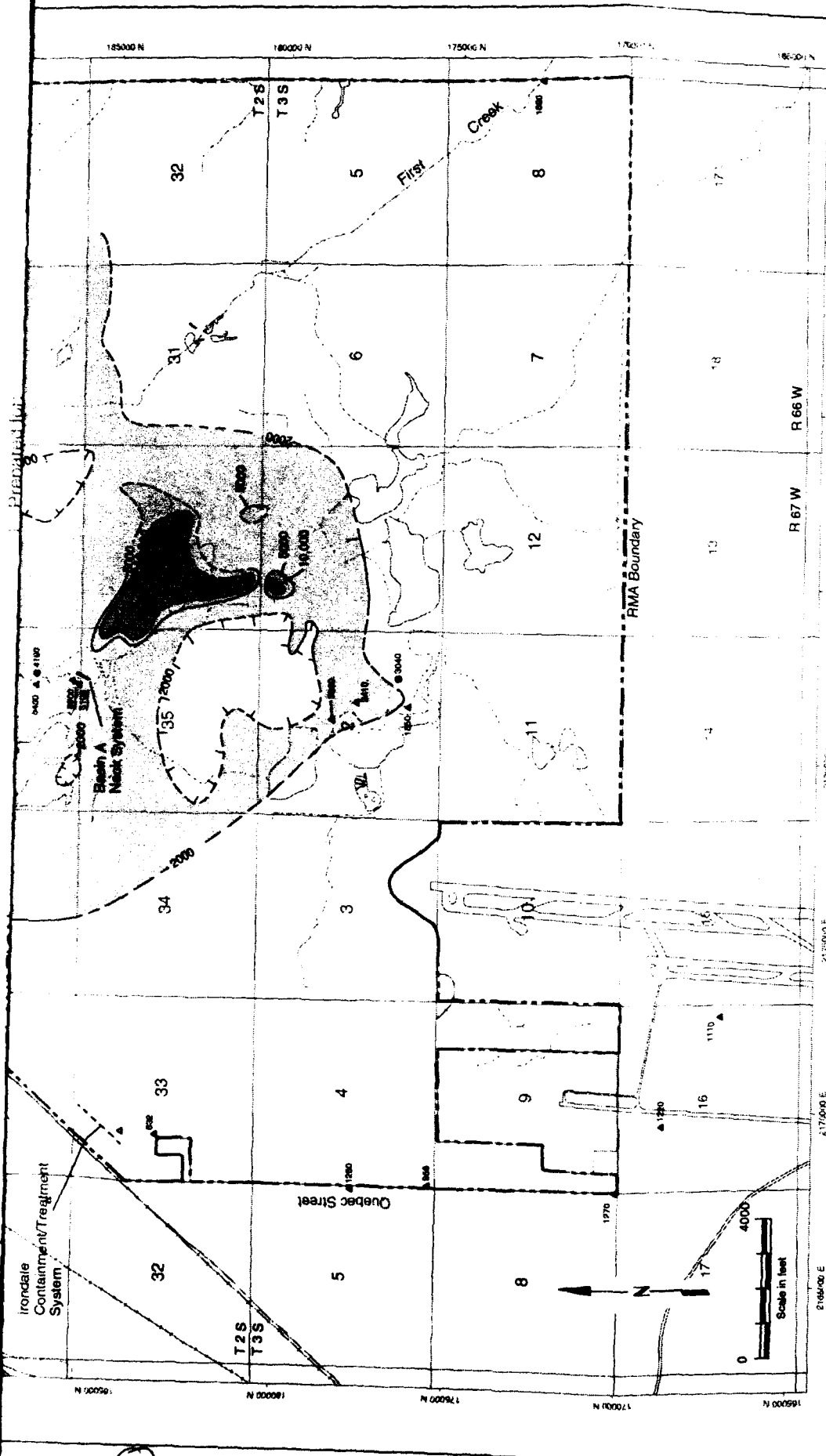
GWAR FY91



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EXPLANATION

Fall 1989 plume
isoconcentration line with
value, dashed where inferred
Hachures where a depression
exists

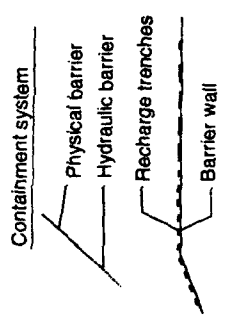
Concentration ranges (ug/l)
Fall 1989:
2000 - 4999
5000 - 9999
10,000 - 99,999
100,000 and above

Unconfined flow system

Winter 1990/1991 samples
collected from February 5, 1991, to March 11, 1991

Alluvial Concentrations (ug/l)
Denver
Alluvial (well sampled in
Winter 1990/1991, not
sampled Fall 1989)
Below Certified
Reporting
Limit (CRL)

Highest CRL = 1000 ug/l
Lowest CRL = 153 ug/l



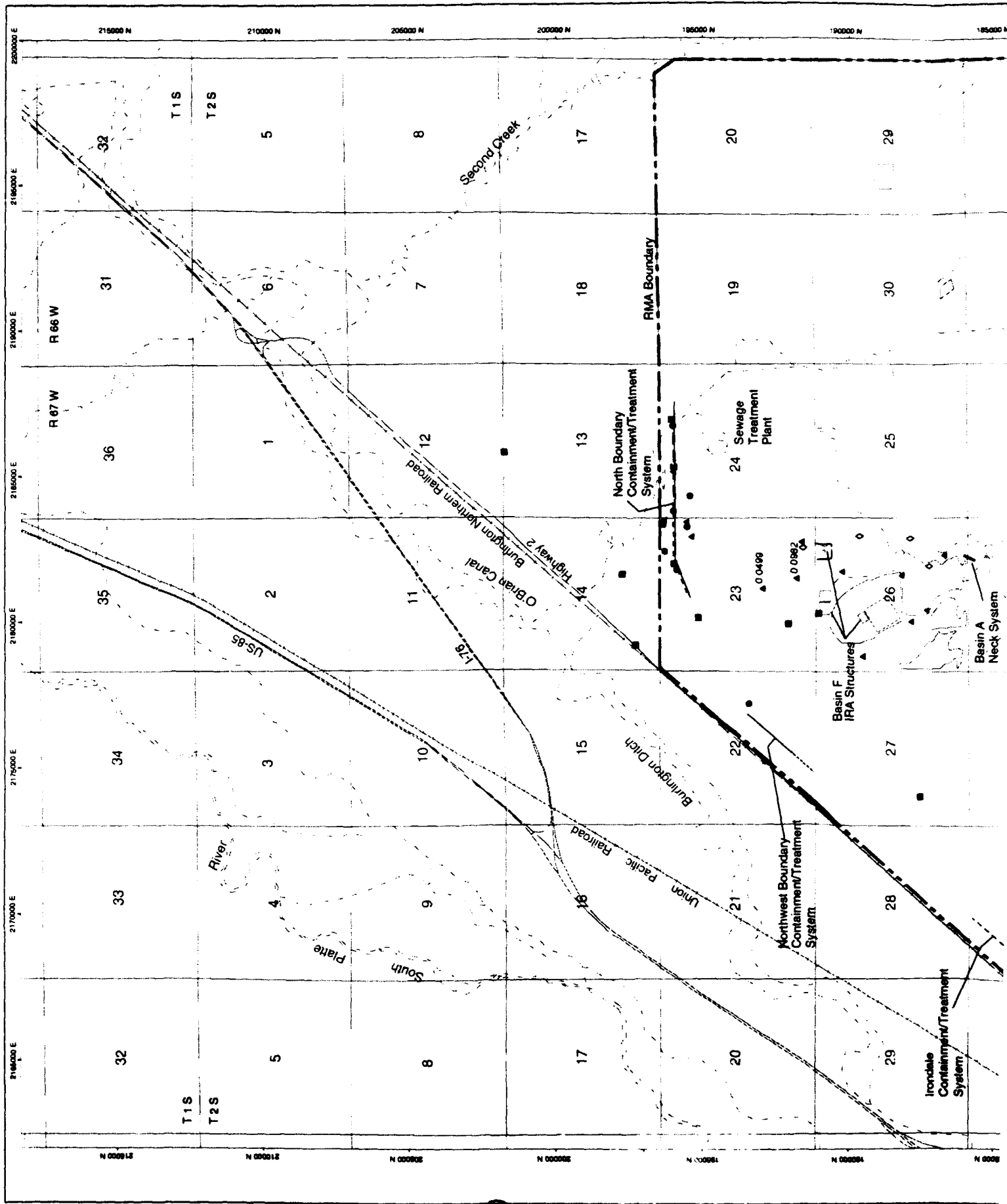
Prepared for:

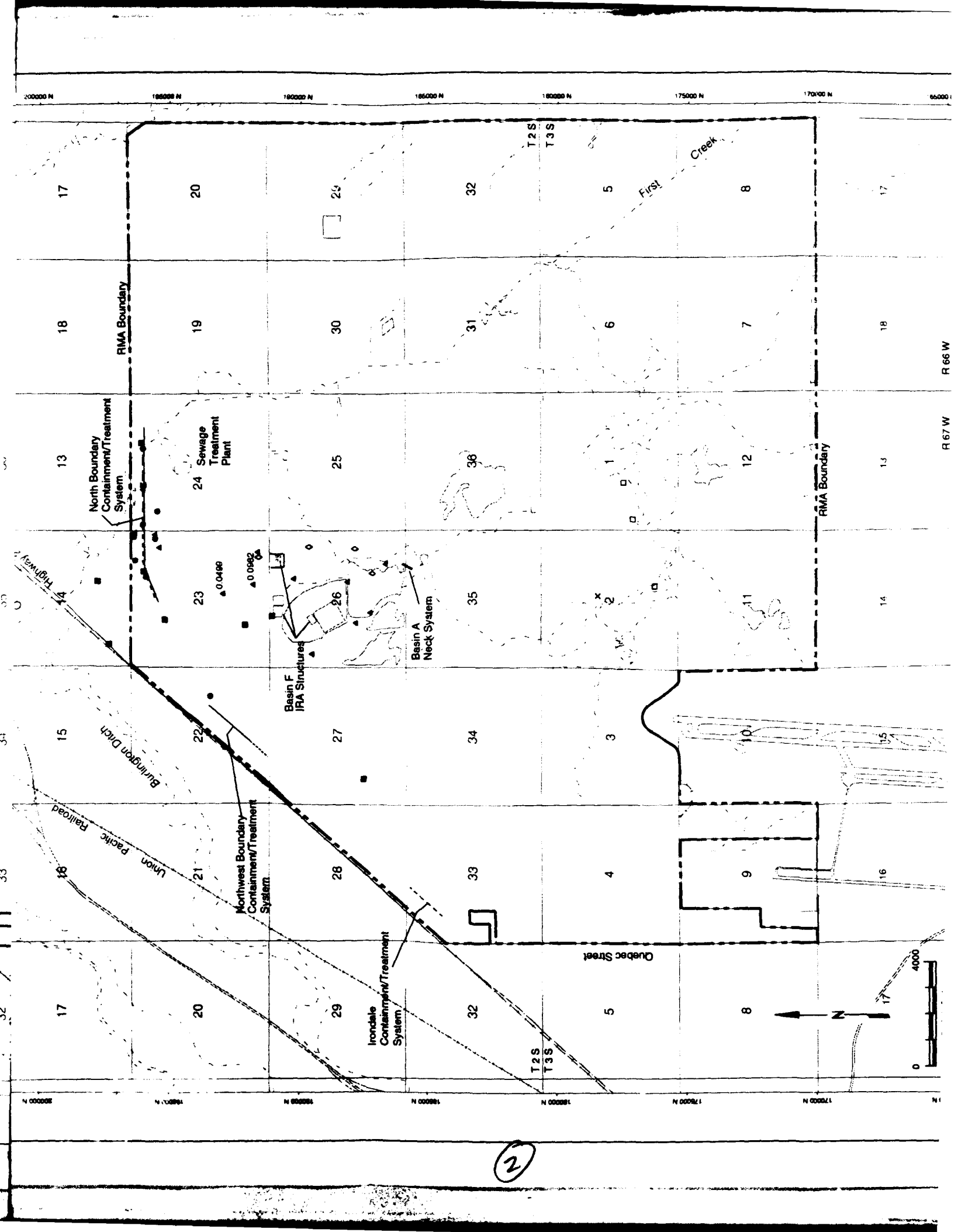
Program Manager for
Rocky Mountain Arsenal
Commerce City, Colorado
Prepared by:
Harding Lawson Associates

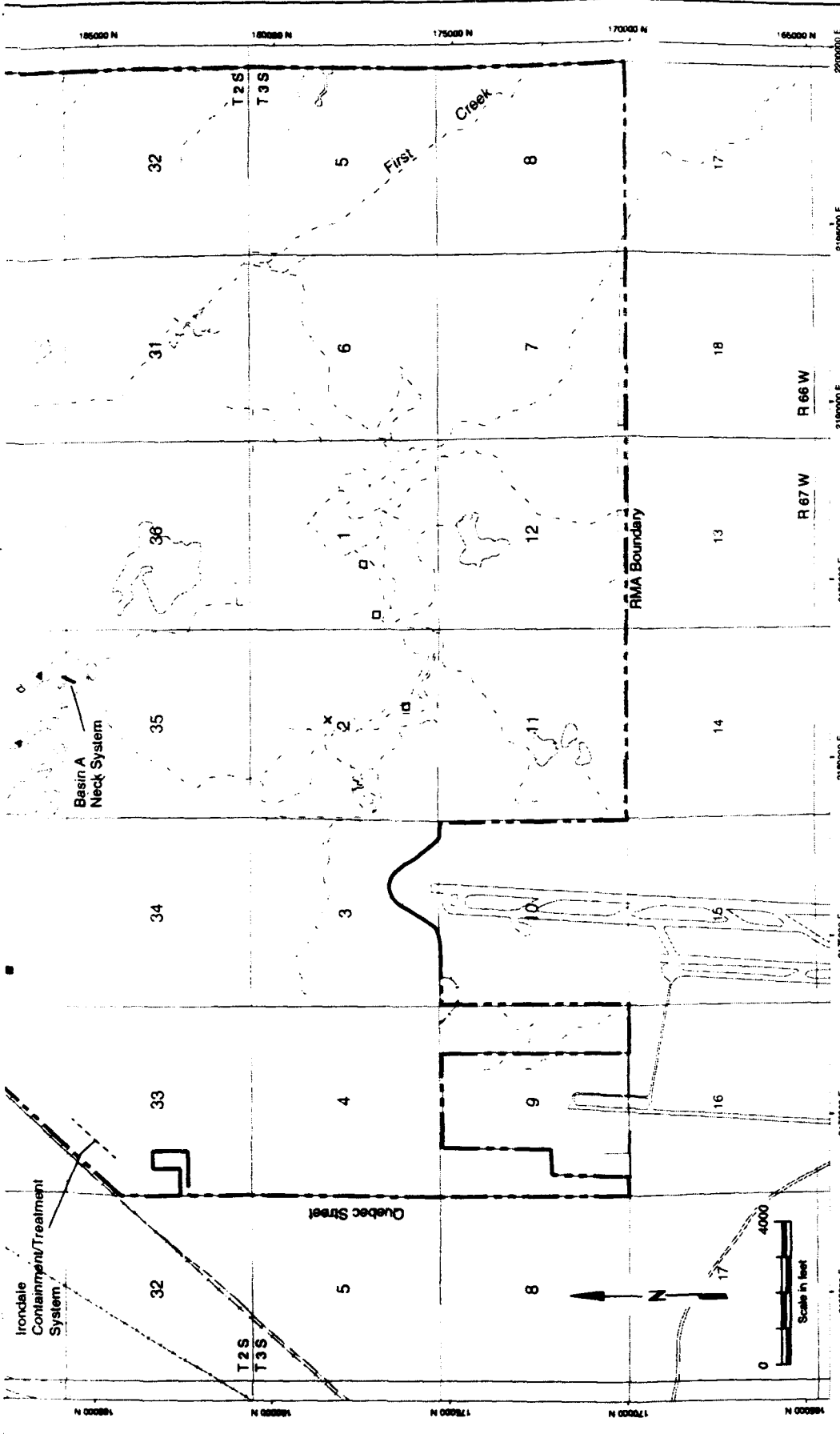
Figure 4.14

Unconfined Groundwater Flow System
Fall 1989 Fluoride Plumes with
Winter 1990/1991 Analytical Results Posted

GWAR FY81



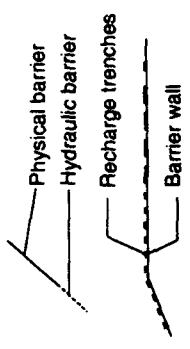




EXPLANATION

- Denver Zone A
- × Denver Zone 1U
- ◇ Denver Zone 1
- ▲ Denver Zone 2
- Denver Zone 3
- Denver Zone 4
- ⌘ Denver Zone 5
- ◆ Denver Zone 6

Containment system



Analyte concentrations in ug/l
 Note: Symbols without values
 indicate nondetections

Prepared for:

Program Manager for
 Rocky Mountain Arsenal
 Commerce City, Colorado
 Prepared by:
 Harding Lawson Associates

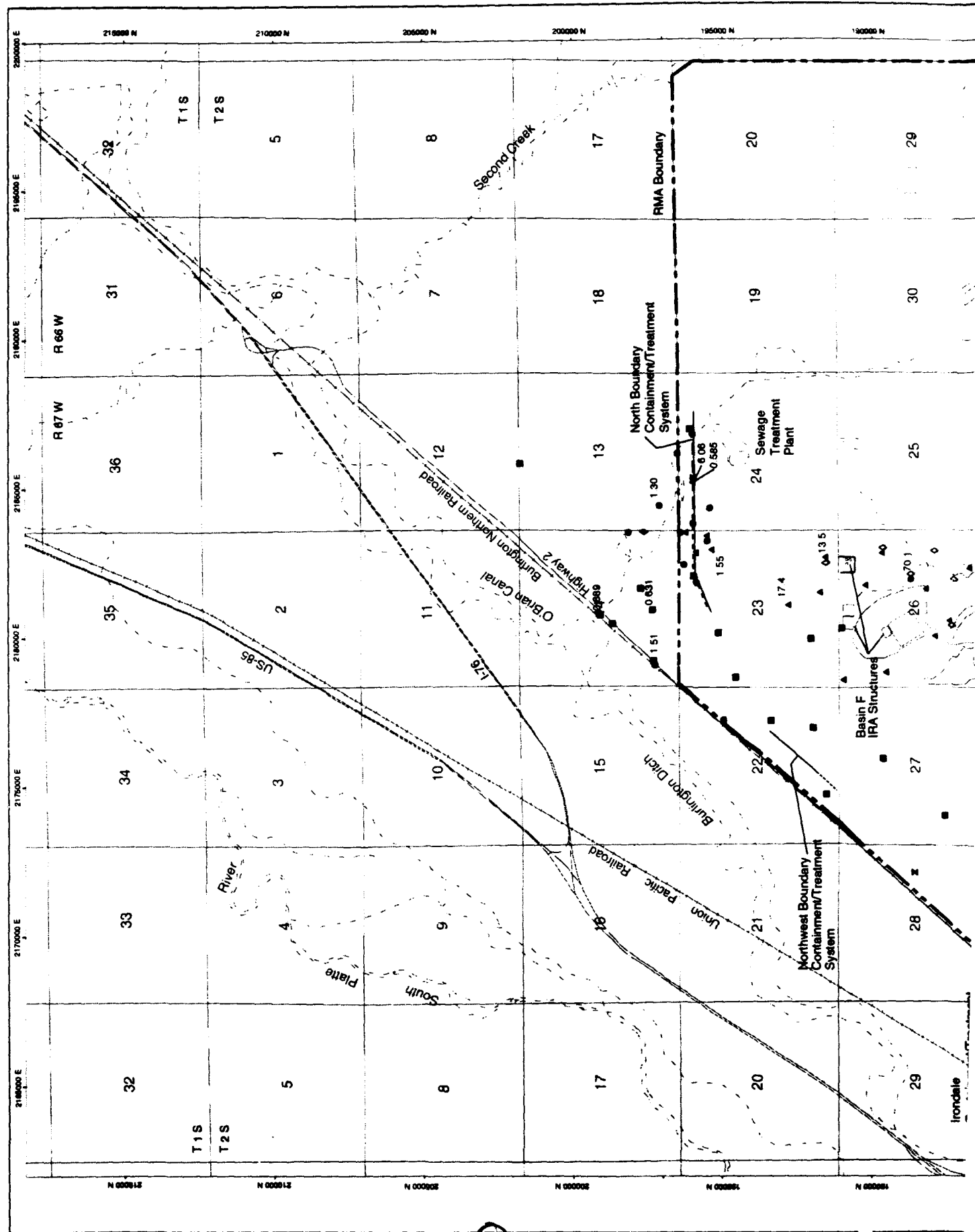
Figure 4.15

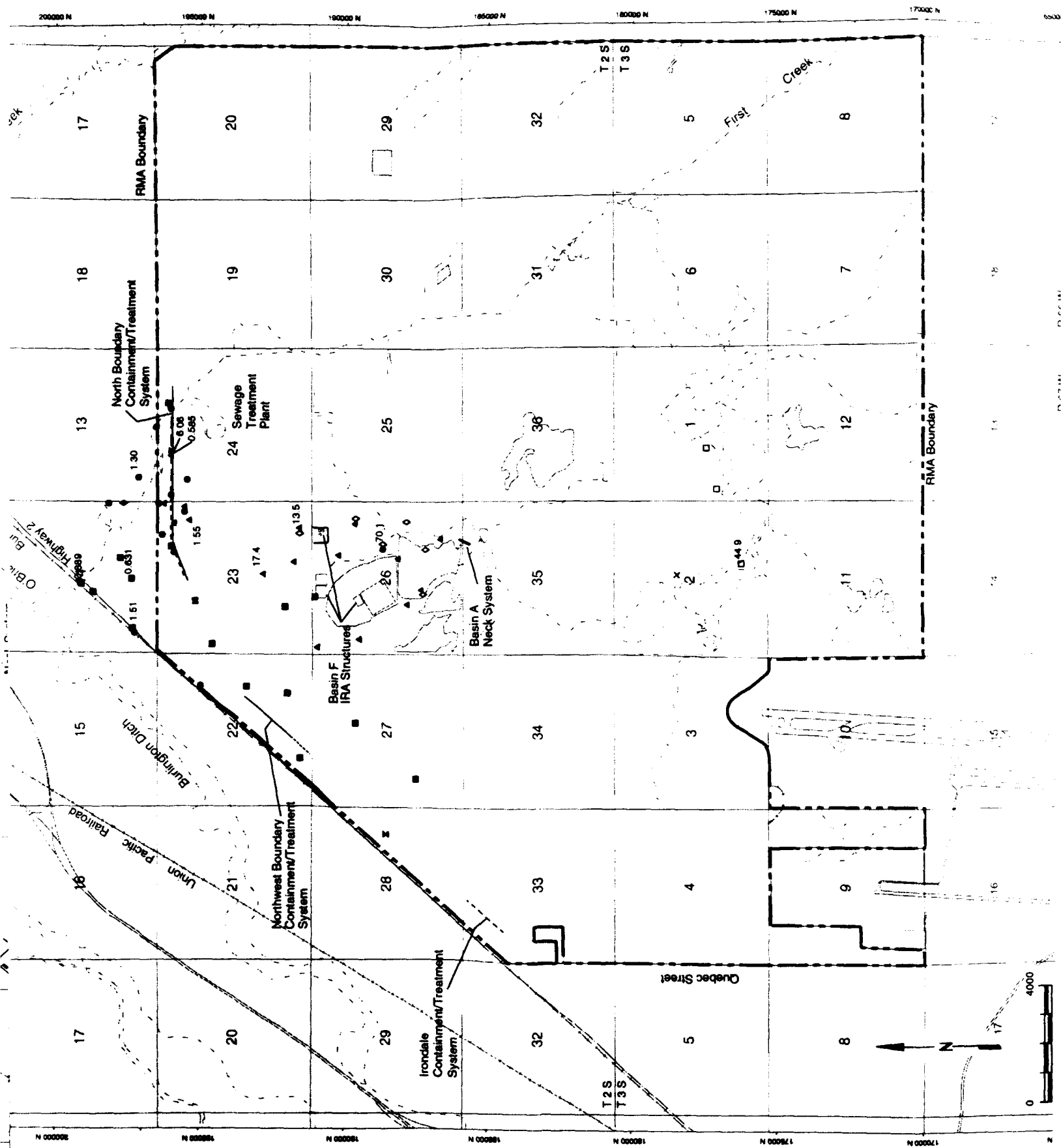
Dieldrin Detections, Confined Groundwater
 Flow System, Winter 1990/1991

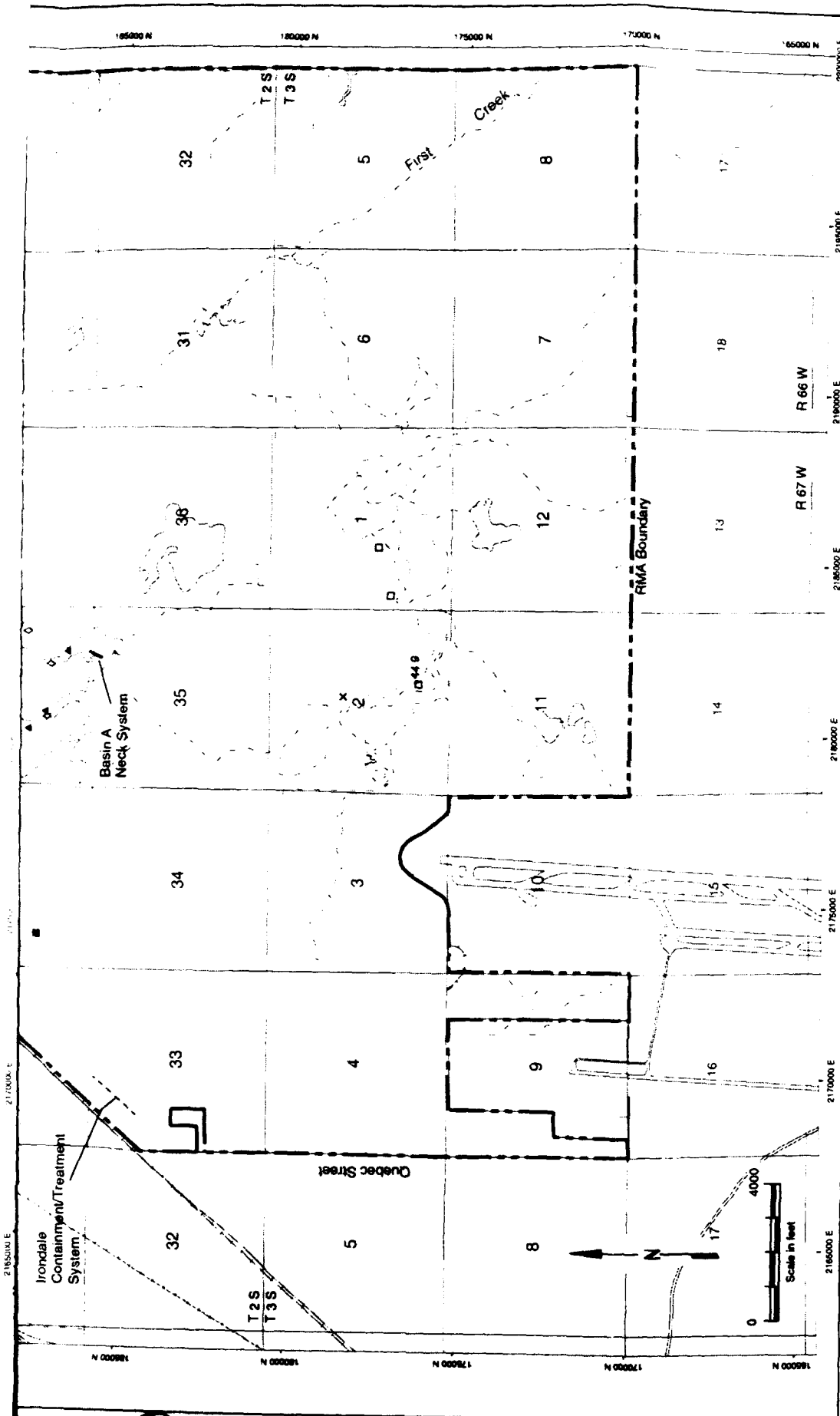
GWAR FY91

2

3







EXPLANATION

- Denver Zone A
- x Denver Zone 1U
- o Denver Zone 1
- + Denver Zone 2
- Denver Zone 3
- Denver Zone 4
- x Denver Zone 5
- ♦ Denver Zone 6

- Containment system
- Physical barrier
 - Hydraulic barrier
 - Recharge trenches
 - Barrier wall

Analyte concentrations in ug/l
 Note: Symbols without values
 indicate nondetections

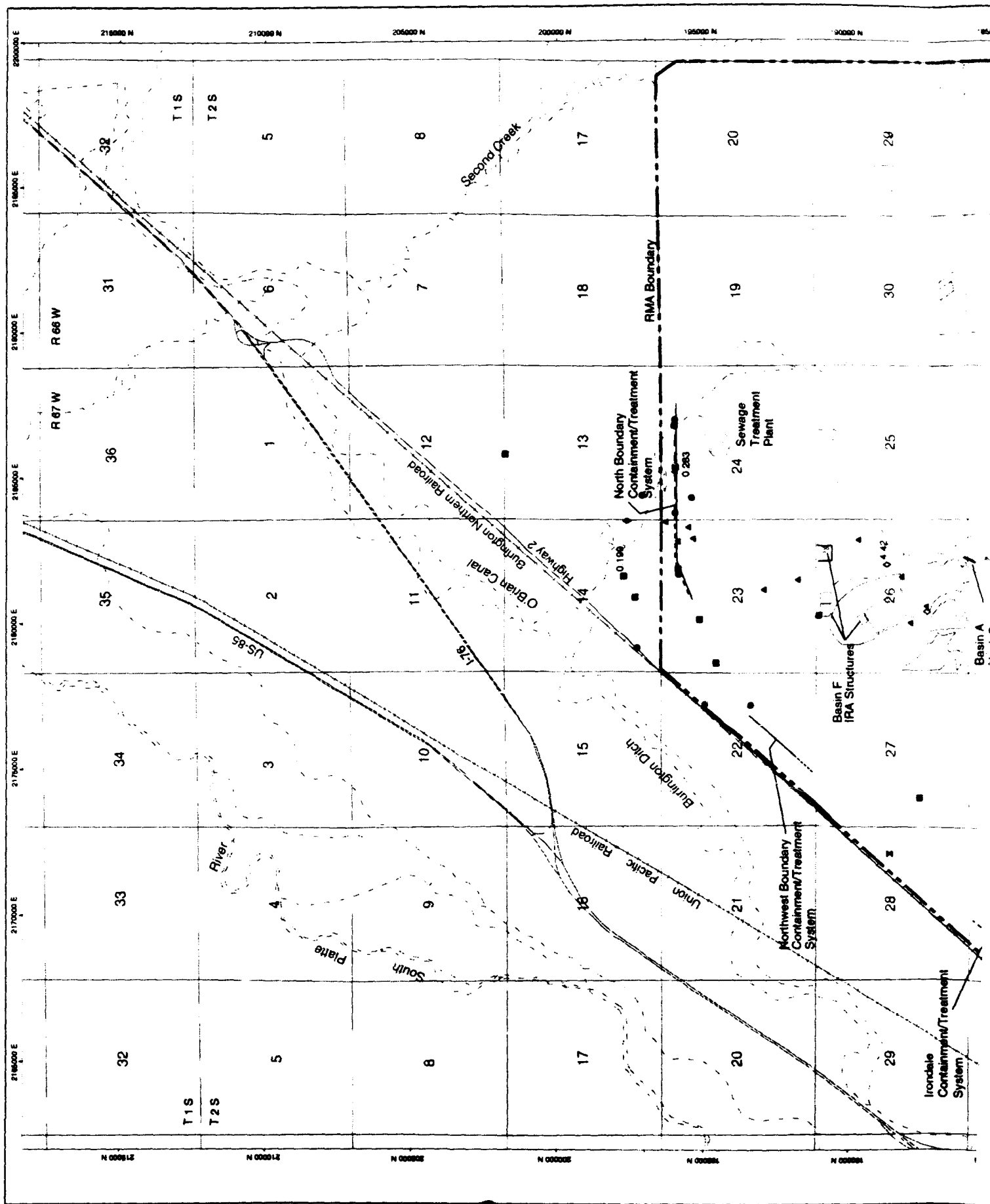
Prepared for:

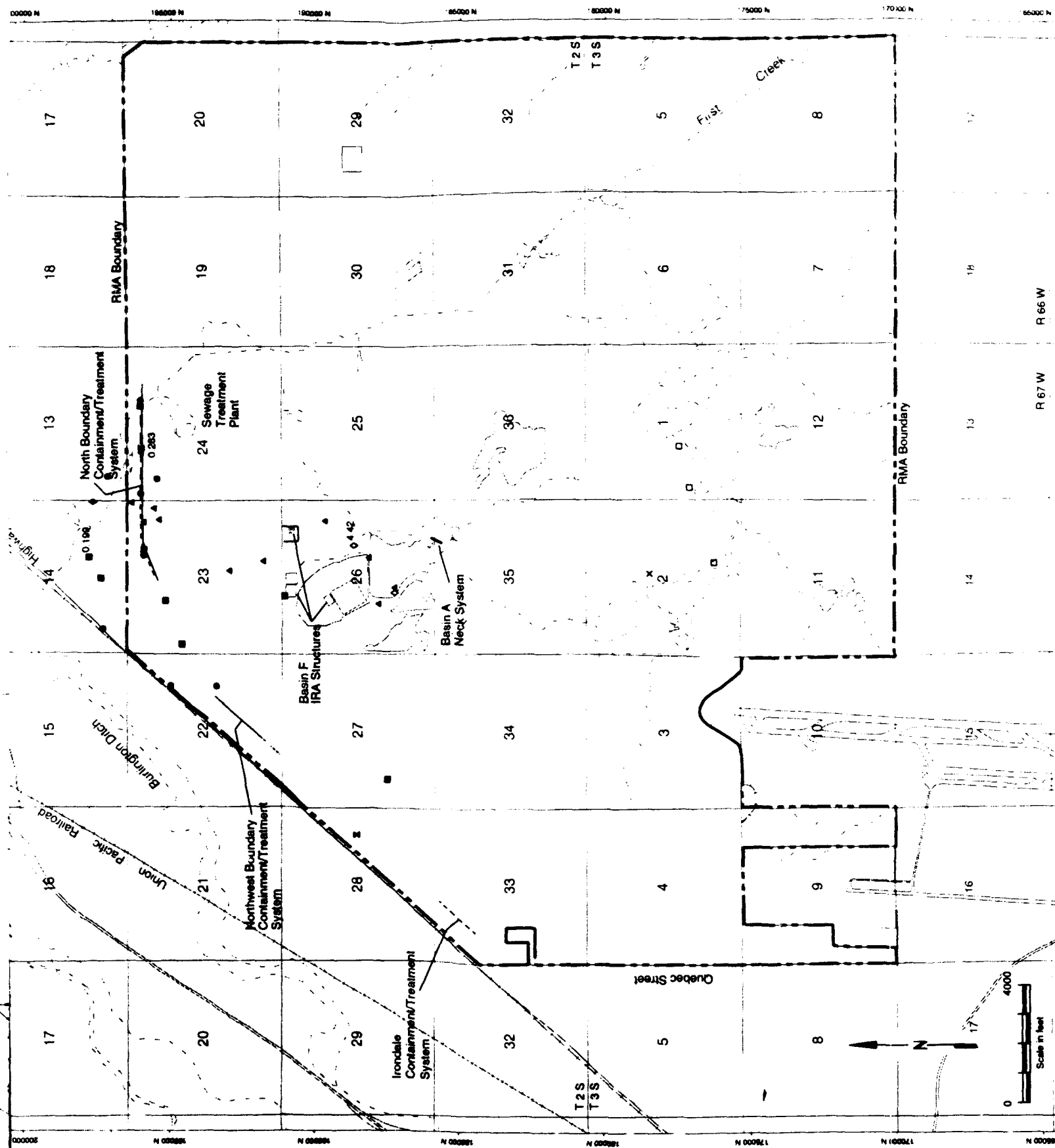
Program Manager for
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 Prepared by:
 Harding Lawson Associates

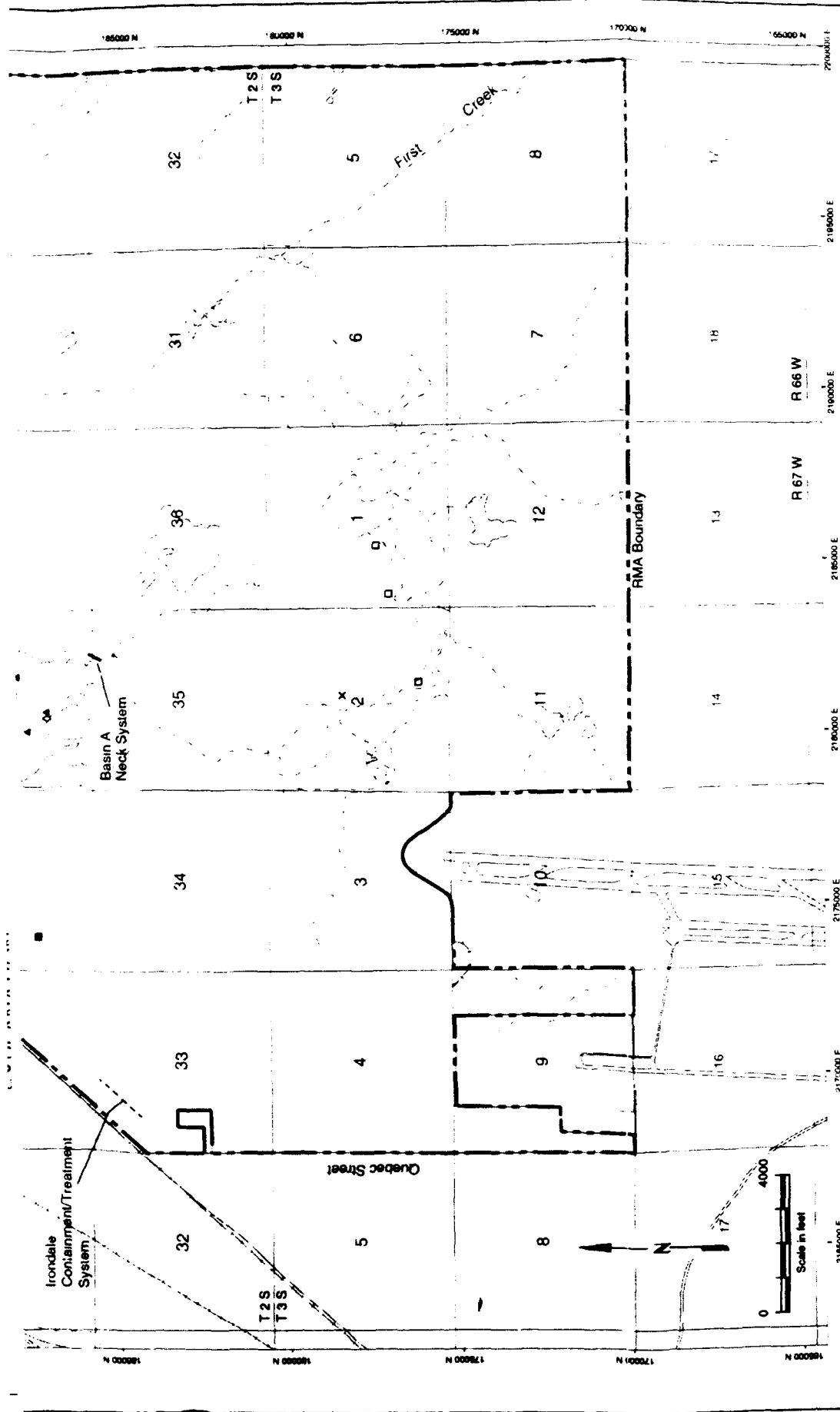
Figure 4.16

Chloroform Detections, Confined Groundwater
 Flow System, Winter 1990/1991

GWAR FY91







EXPLANATION

- Denver Zone A
- × Denver Zone 1U
- ◇ Denver Zone 1
- ▲ Denver Zone 2
- Denver Zone 4
- × Denver Zone 5
- ◆ Denver Zone 6

- Containment system
- Physical barrier
 - Hydraulic barrier
 - Recharge trenches
 - Barrier wall

Analyte concentrations in ug/l
Note: Symbols without values
indicate nondetections

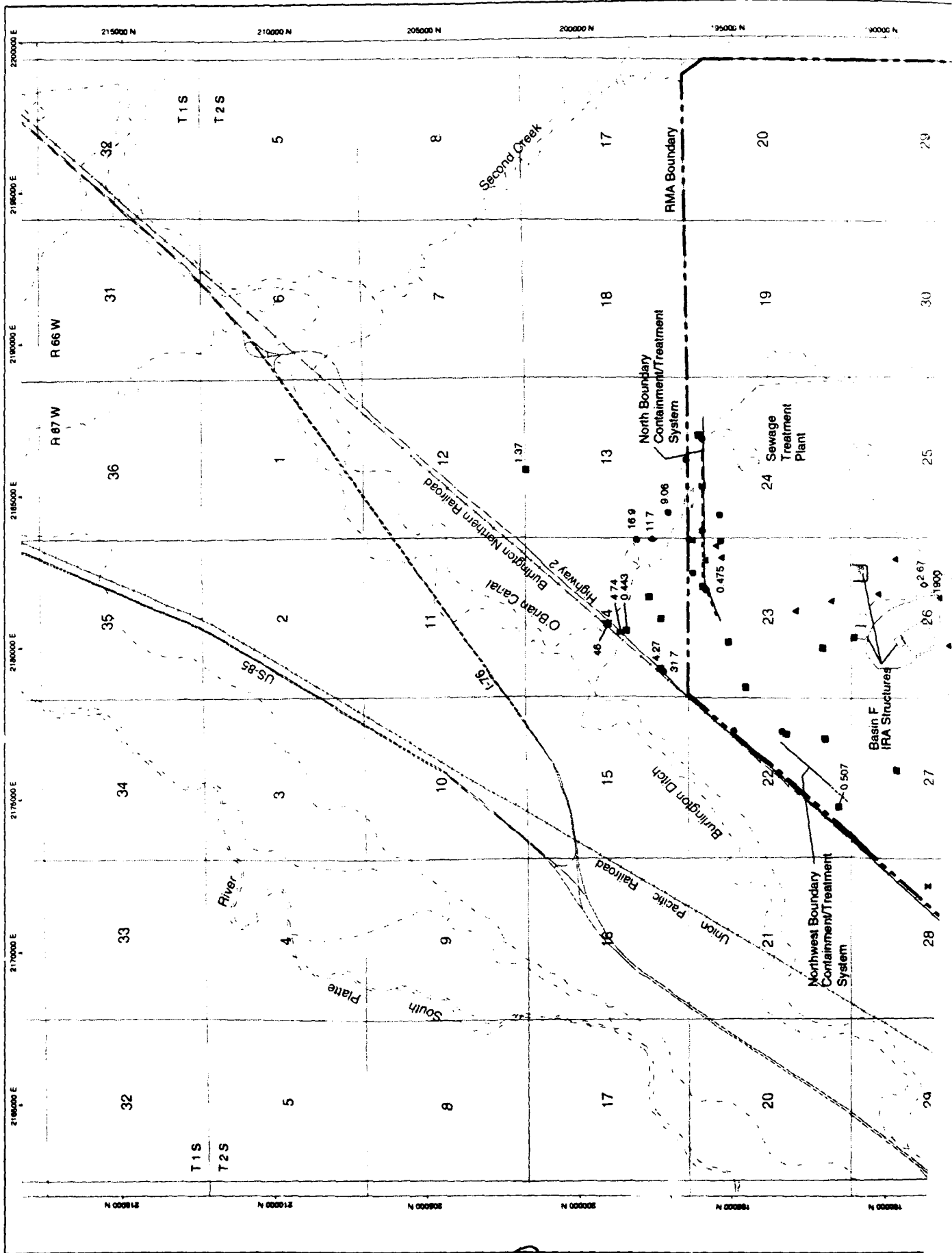
Prepared for:

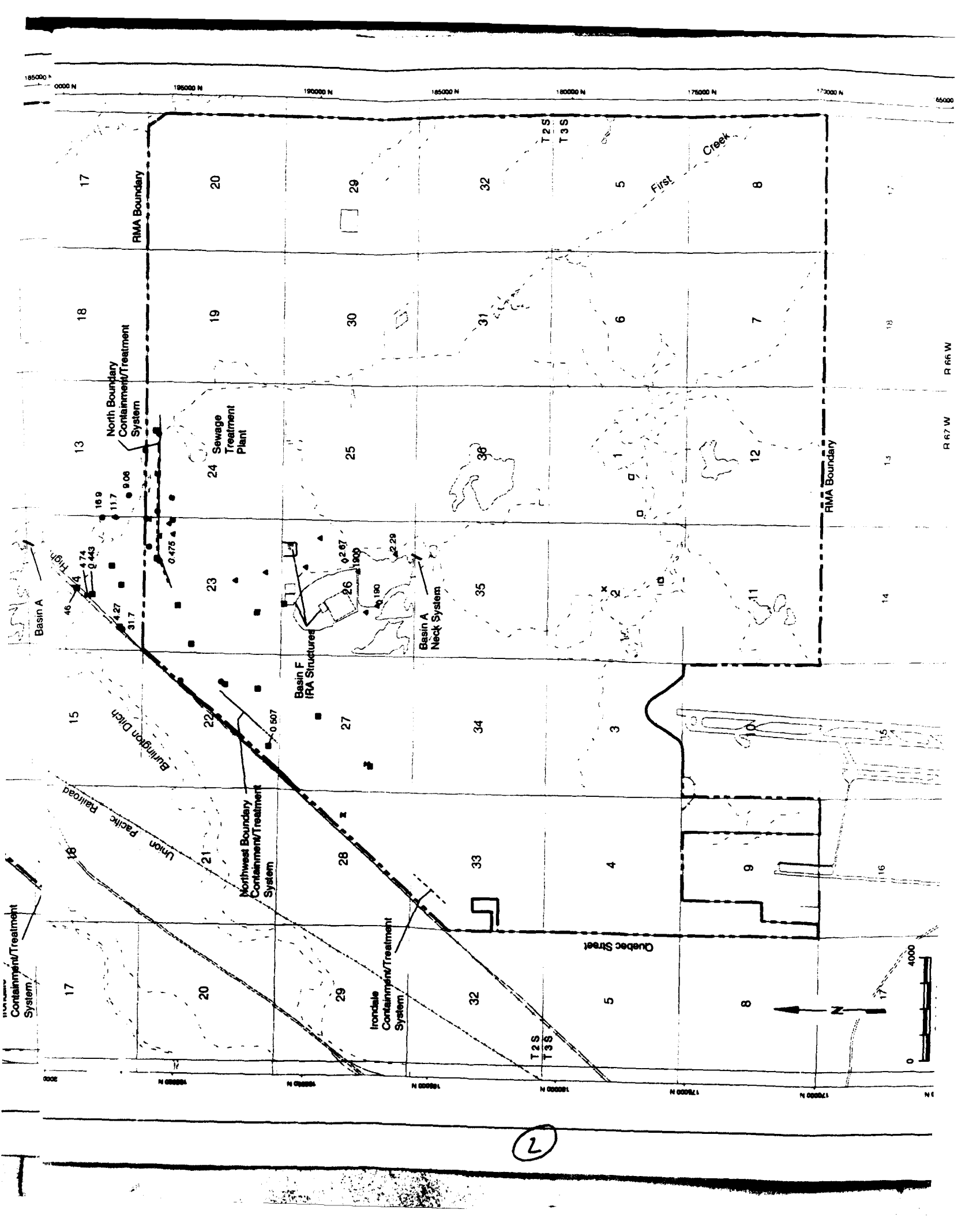
Program Manager for
Rocky Mountain Arsenal
Commerce City, Colorado
Prepared by:
Harding Lawson Associates

Figure 4.17

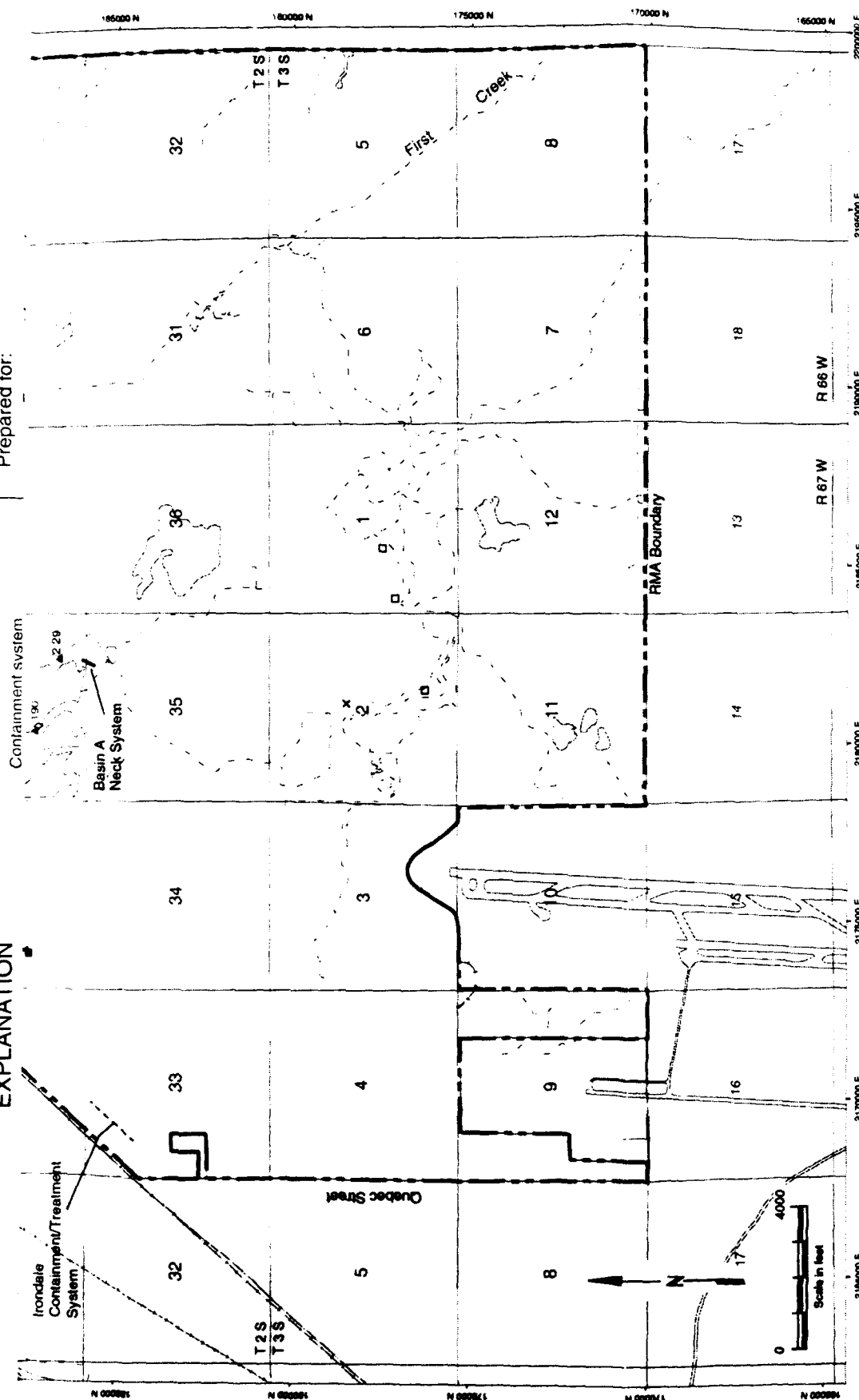
Dibromochloropropane (DBCP) Detections,
Confined Groundwater Flow System,
Winter 1990/1991

GWAR FY81





EXPLANATION



EXPLANATION

**Program Manager for
Rocky Mountain Arsenal
Commerce City, Colorado**

Prepared by:
Harding Lawson Associates

Figure 4.18

**Diisopropylmethylphosphonate (DIMP)
Detections, Confined Groundwater Flow
System, Winter 1990/1991**

GWAR FY91

Containment system

Physical barrier

Hydraulic barrier

— Recharge trenches

Barrier wall

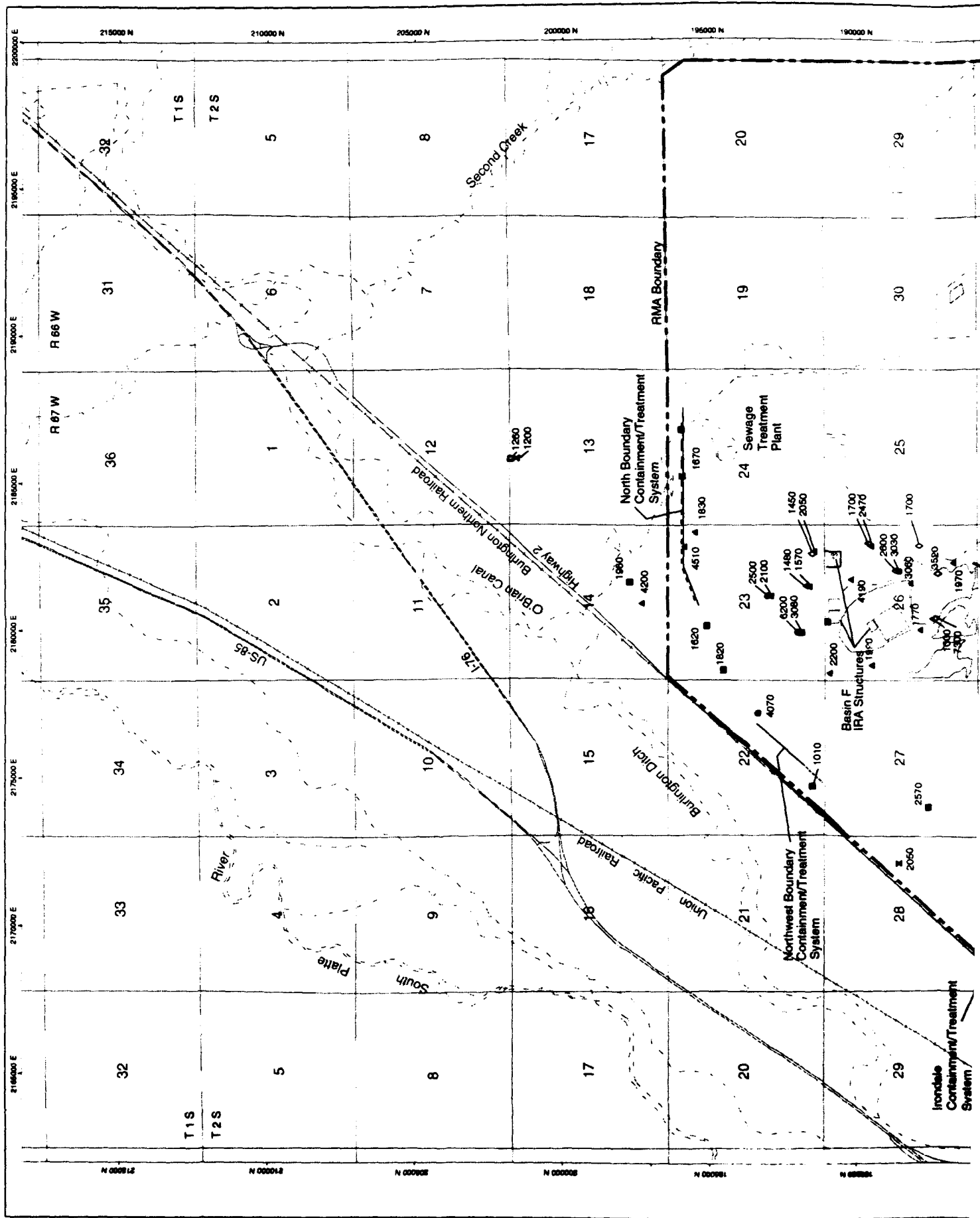
Analyte concentrations in $\mu\text{g/l}$

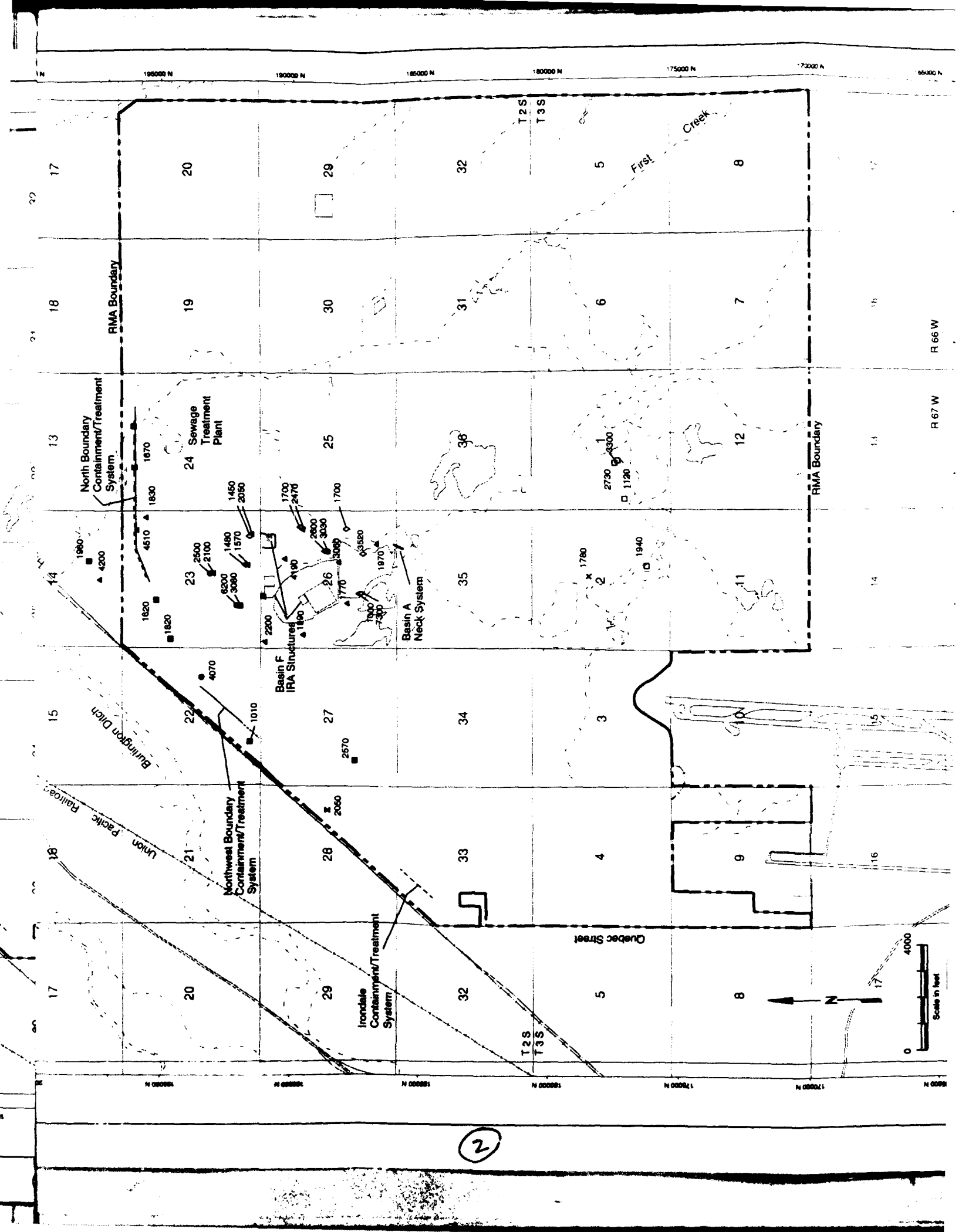
Note: Symbols without values

Indicate nondetections

- ☐ Denver Zone A
 - ✕ Denver Zone 1U
 - ♂ Denver Zone 1
 - ♂ Denver Zone 2
 - Denver Zone 3
 - Denver Zone 4
 - ✕ Denver Zone 5
 - ♂ Denver Zone 6

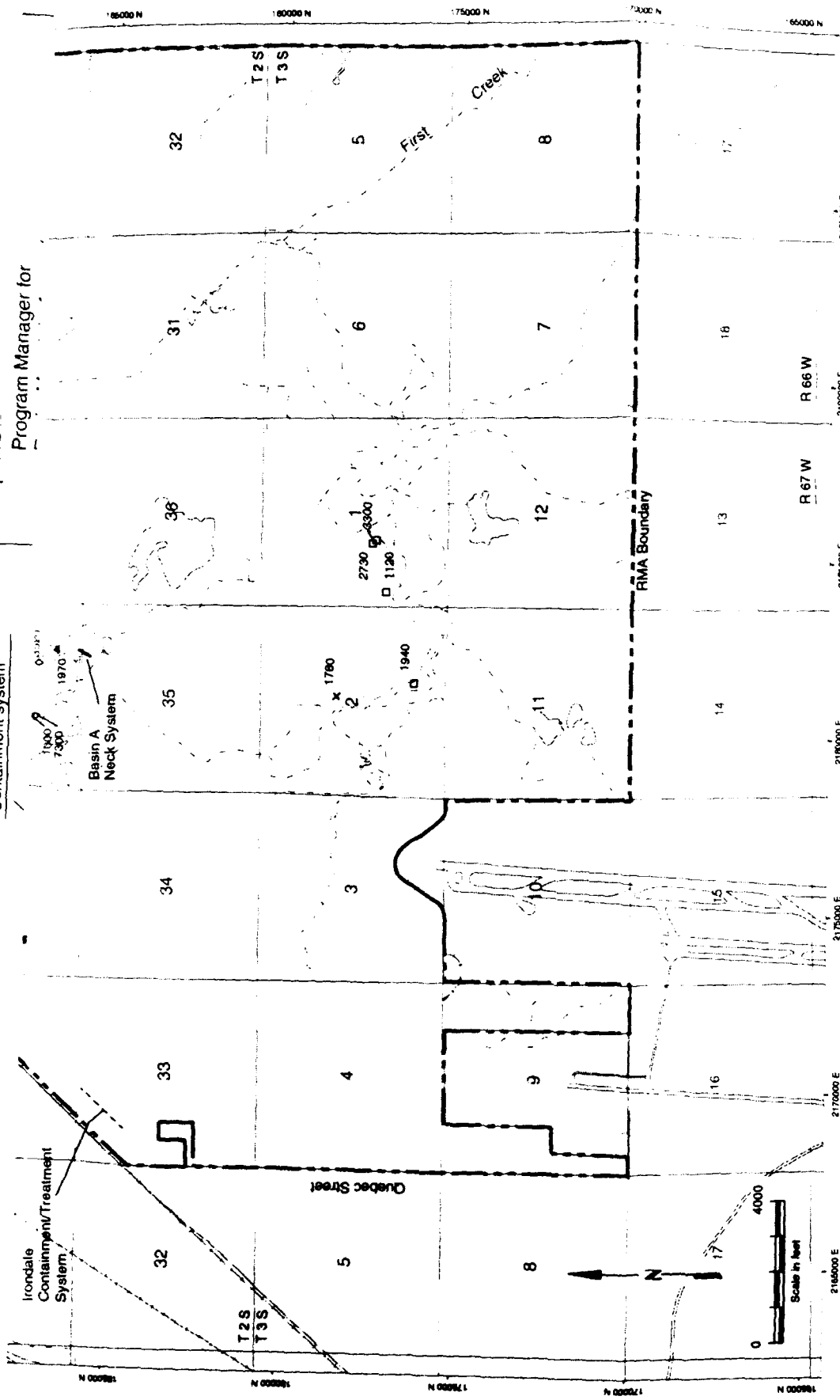
- ☐ Denver Zone A
- ☒ Denver Zone 1U
- ☐ Denver Zone 1
- ☐ Denver Zone 2





2

EXPLANATION



EXPLANATION

- Denver Zone A
- Denver Zone 1U
- Denver Zone 1
- Denver Zone 2
- Denver Zone 3
- Denver Zone 4
- Denver Zone 5
- Denver Zone 6

Containment system

- Physical barrier
- Hydraulic barrier
- Recharge trenches
- Barrier wall

Analyte concentrations in ug/l
Note: Symbols without values indicate nondetections

Prepared for:

Program Manager for
Rocky Mountain Arsenal
Commerce City, Colorado

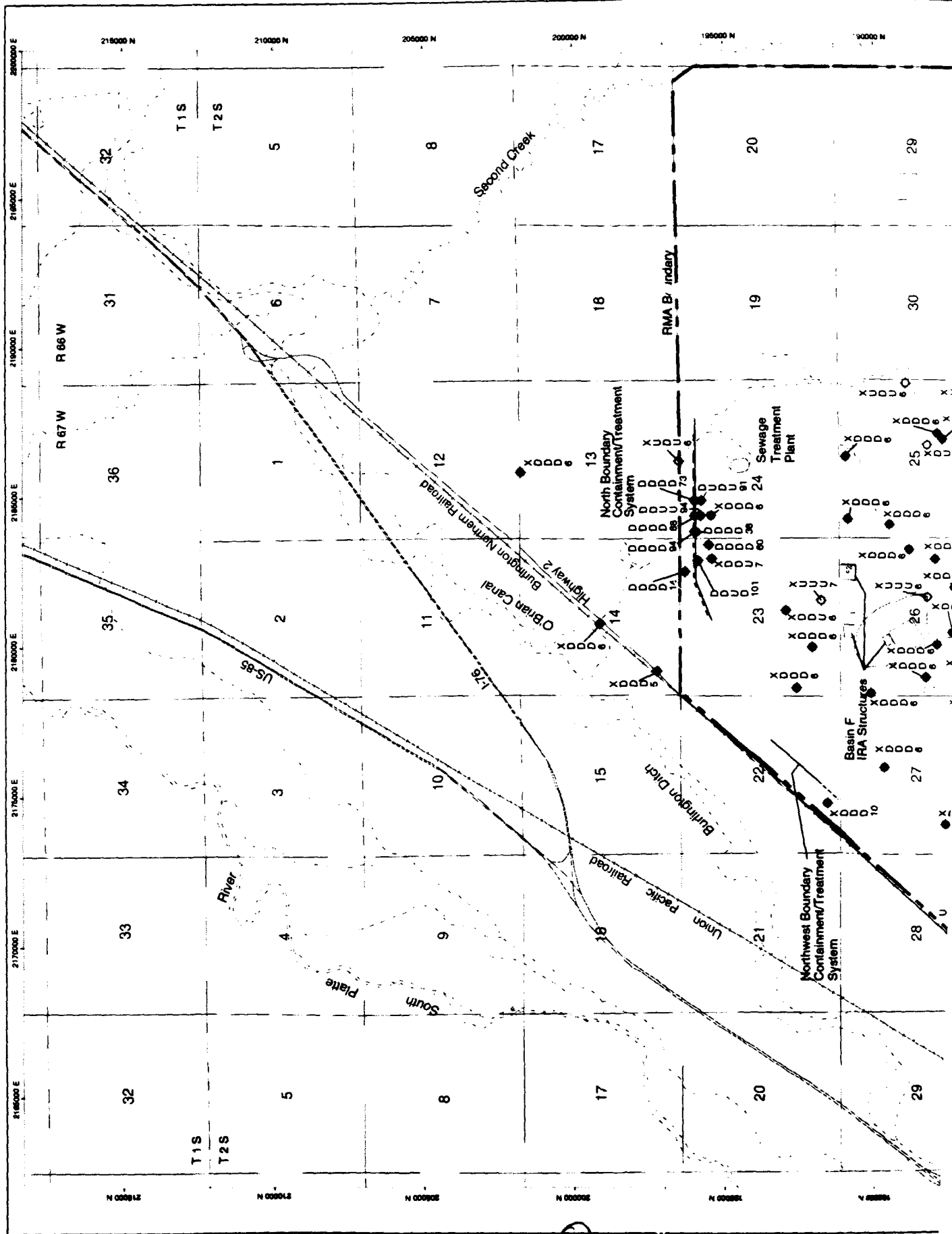
Prepared by:

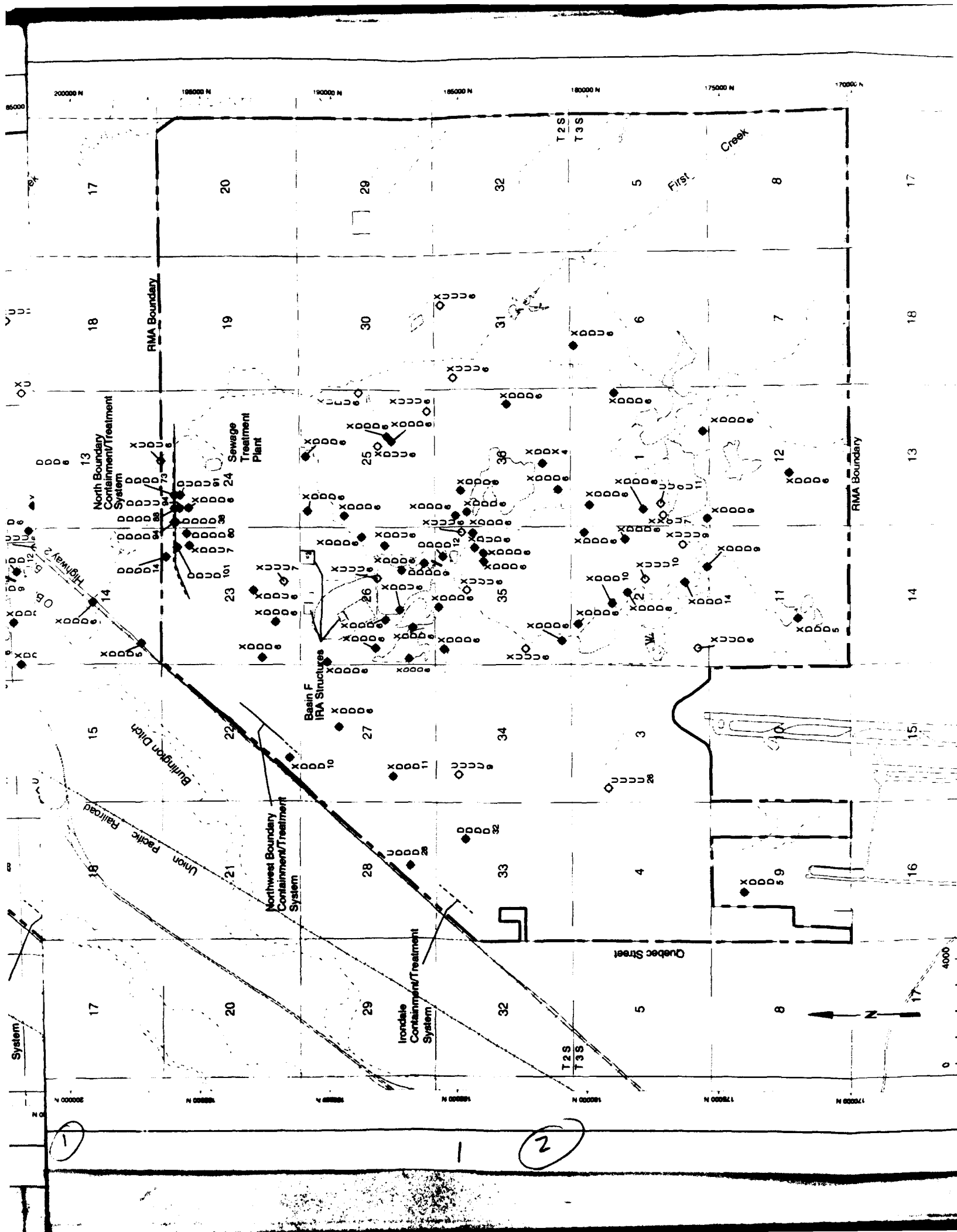
Harding Lawson Associates

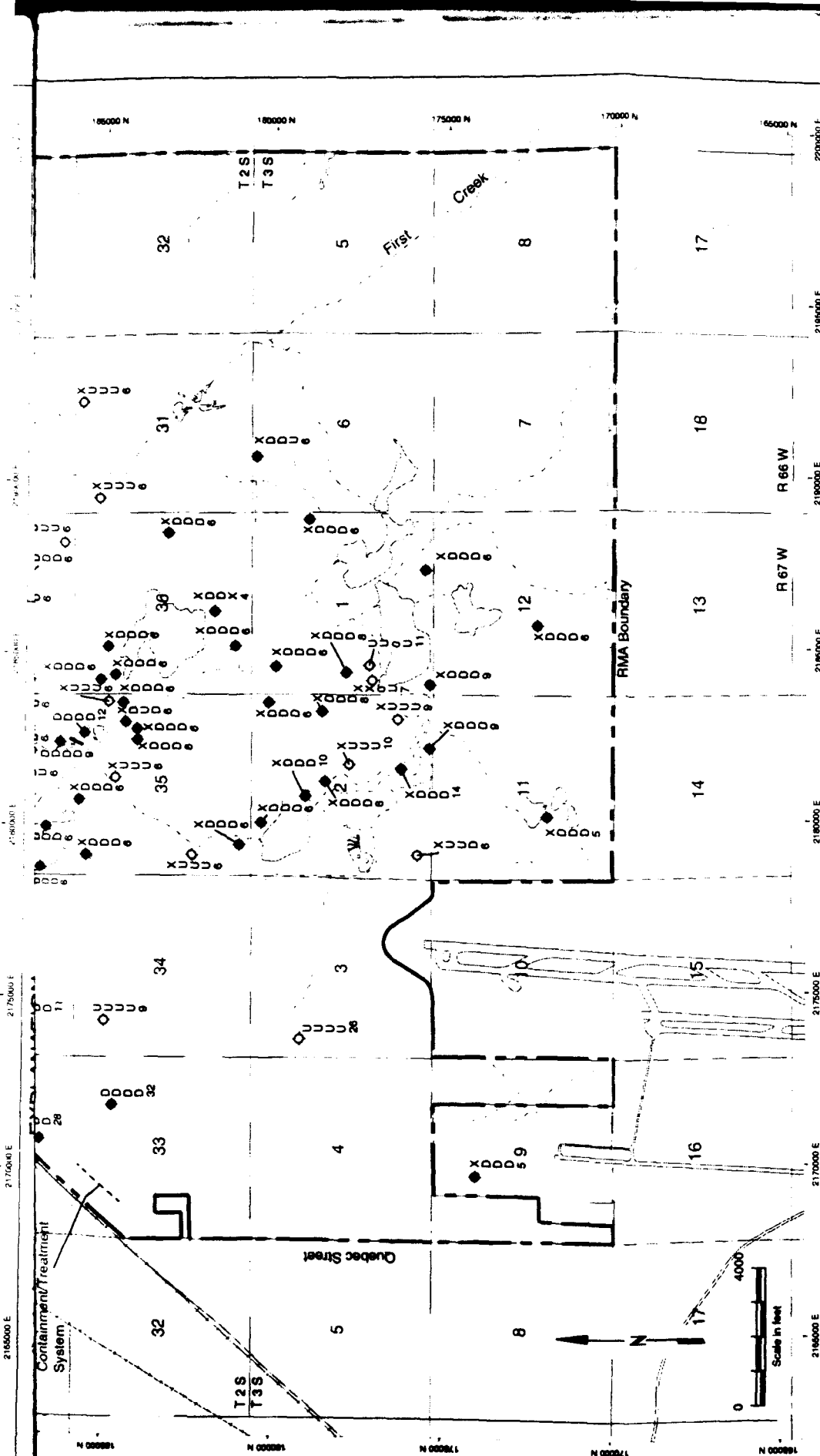
Figure 4.19

Fluoride Detections, Confined Groundwater
Flow System, Winter 1990/1991

GWAR FY91







EXPLANATION

- Upward vertical gradient for water year 1991
- ◆ Downward vertical gradient for water year 1991
- ◆ Indeterminant vertical gradient for water year 1991
- X Well cluster not measured in first quarter
- U Upward vertical gradient in second quarter
- D Downward vertical gradient in third quarter
- o Indeterminant vertical gradient in fourth quarter
- o Total number of water level measurements for well cluster in water year 1991

Containment system

- Physical barrier
- Hydraulic barrier
- Recharge trenches
- Barrier wall

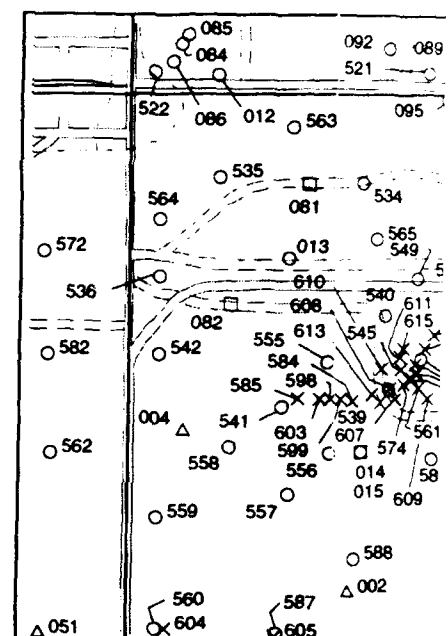
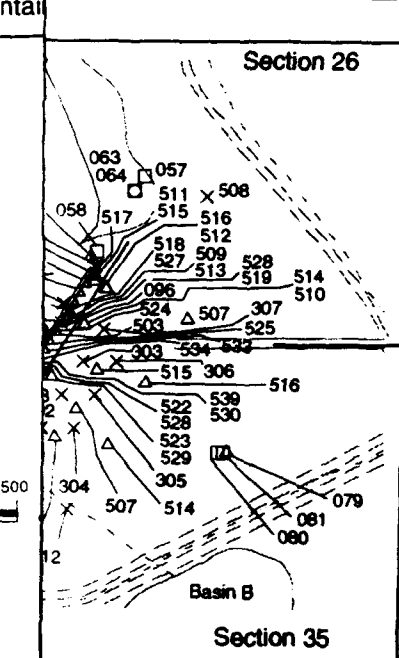
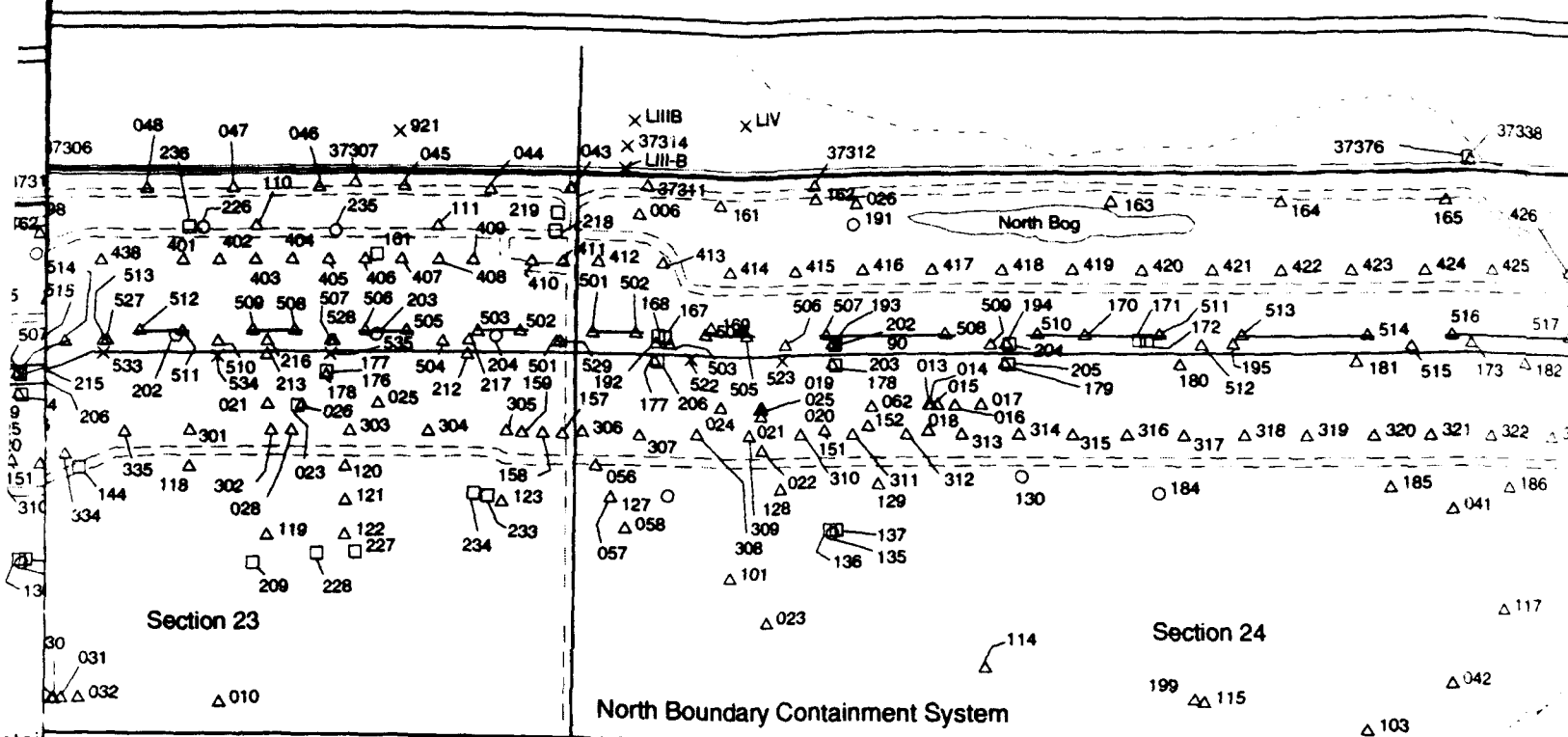
Prepared for:
Program Manager for
Rocky Mountain Arsenal
Commerce City, Colorado

Prepared by:
Harding Lawson Associates

Figure 4.20

Approximate Vertical Gradient Direction between the Unconfined and Confined Flow Systems at Cluster Sites, October 1, 1990, to September 30, 1991

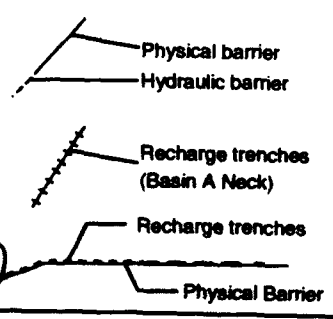
GWAR FY91



EXPLANATION

- △101 Alluvial well
- 102 Unconfined Denver Formation well
- 103 Confined Denver Formation well
- ×104 Not classified (DP Associates, 1991)

Containment System



Prep

Prep

Figure

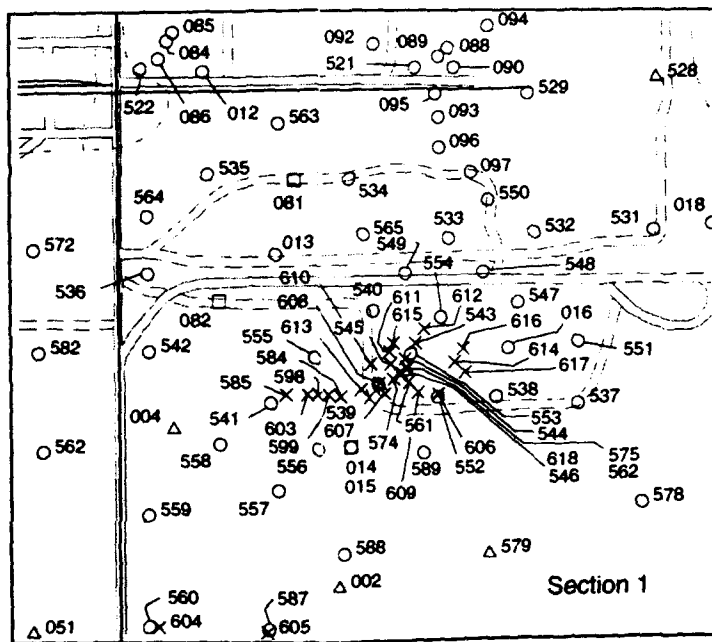
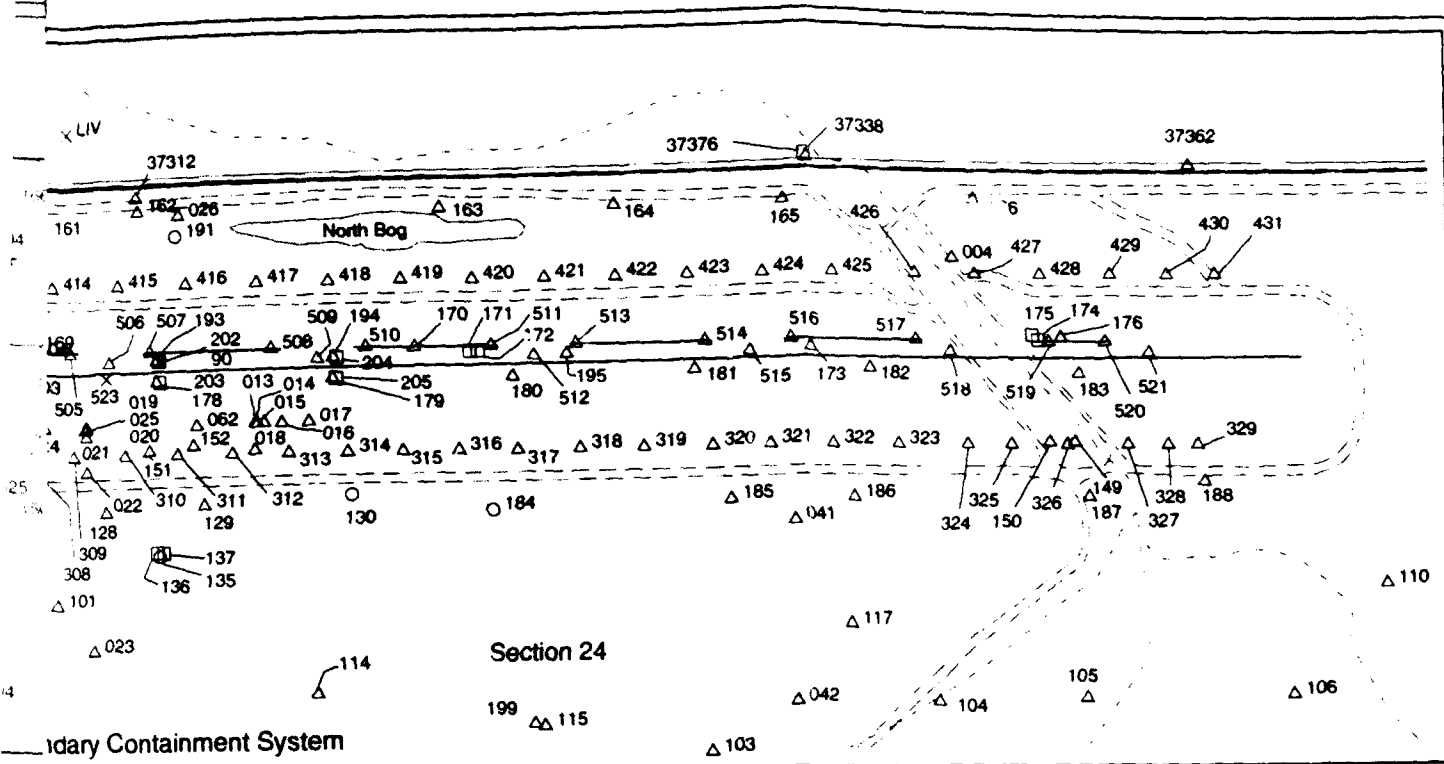
Well

Cont

Cont

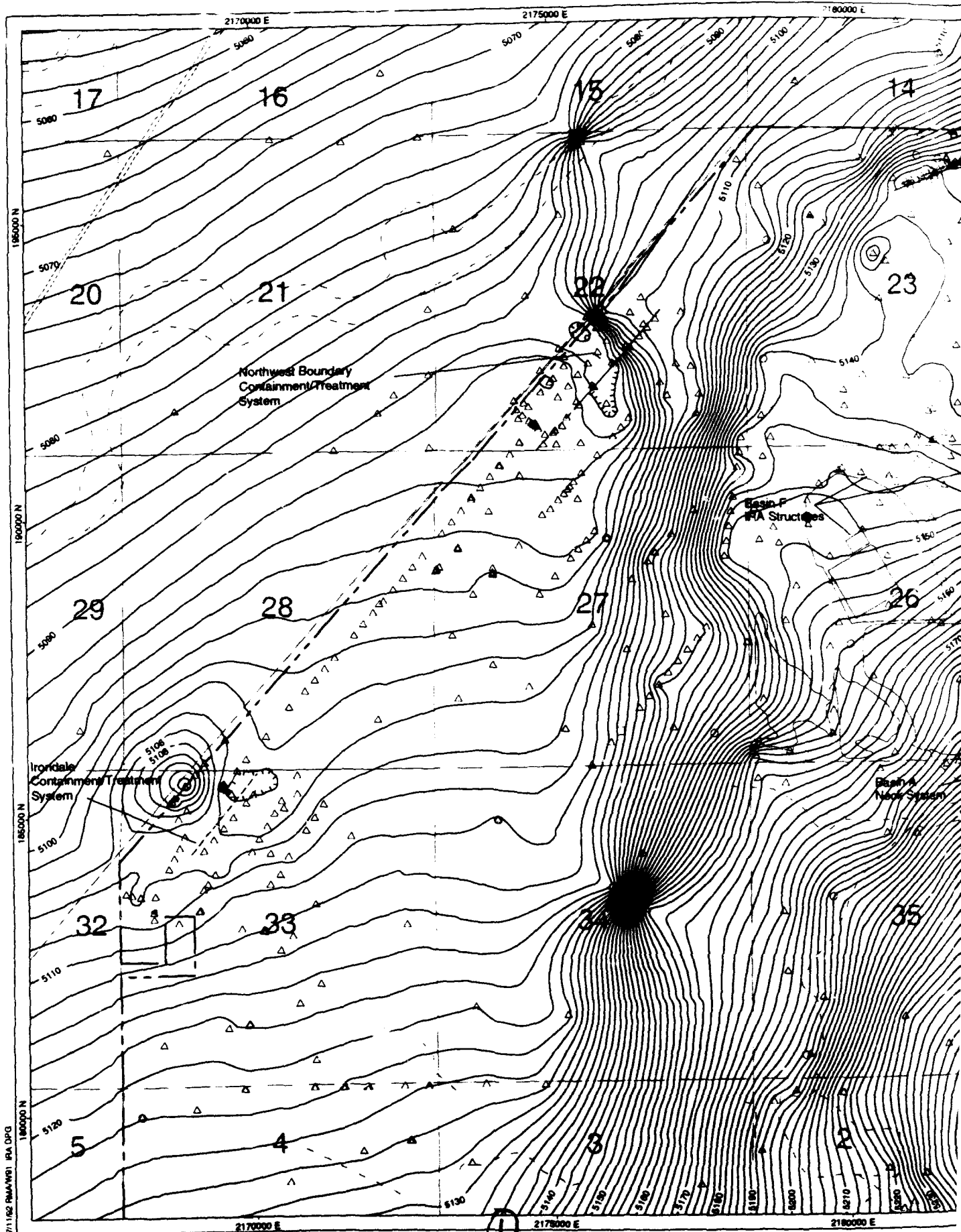
Plan

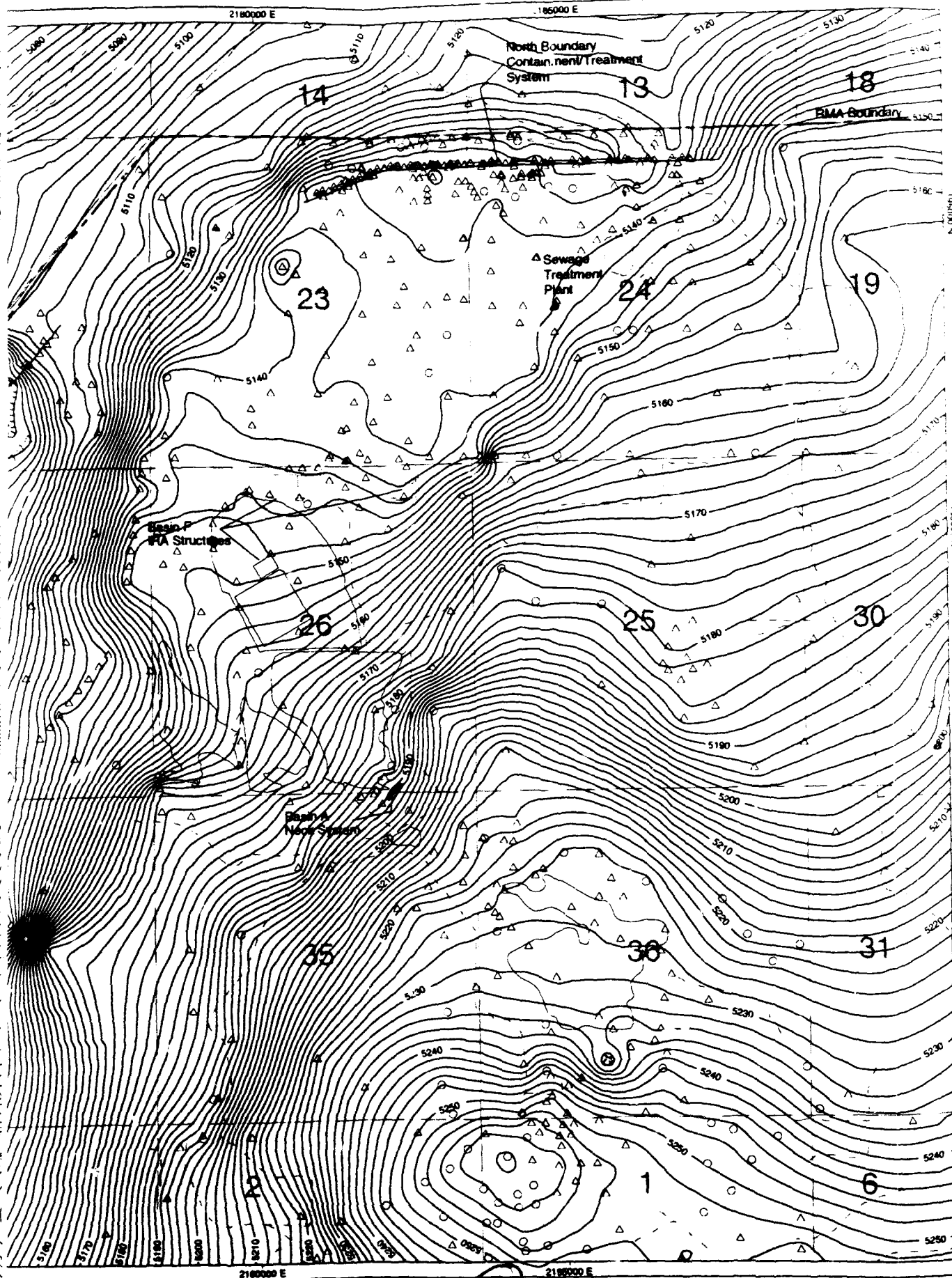
GWA



South Plants South Tank Farm

or: ogra cky imm y: rdin	Containment System Physical barrier Hydraulic barrier Recharge trenches (Basin A Neck) Recharge trenches Physical Barrier 2	Prepared for: Program Manager for Rocky Mountain Arsenal Commerce City, Colorado Prepared by: Harding Lawson Associates	Figure 5.1 Well Location Maps for the North Boundary Containment System, Basin A Neck Containment System, And South Plants South Tank Farm 3 GWAR FY91
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Prepared for:
 Program
 Rocky I
 Comm
 Prepared by:
 Harding

Figure 5.2
 Unconfined Flo
 Elevation Map
 Areas, Winter 1
 GWAR FY91

2

218500 E

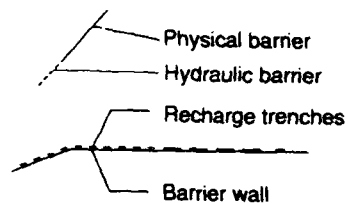
North Boundary
Containment/Treatment
System

BMA Boundary

Sewage
Treatment
Plant

EXPLANATION

Containment system

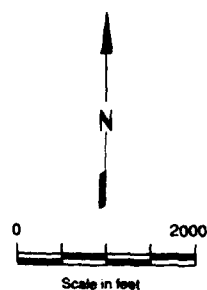


Water-level elevation contour
(water levels measured from January 23, 1991,
to February 4, 1991)

Well or piezometer location yielding
water-level elevation:

- △ Alluvial
- Unconfined Denver Formation

Contour interval equals 2 feet
Datum mean sea level



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Program Manager for
Rocky Mountain Arsenal
Commerce City, Colorado

Prepared by:

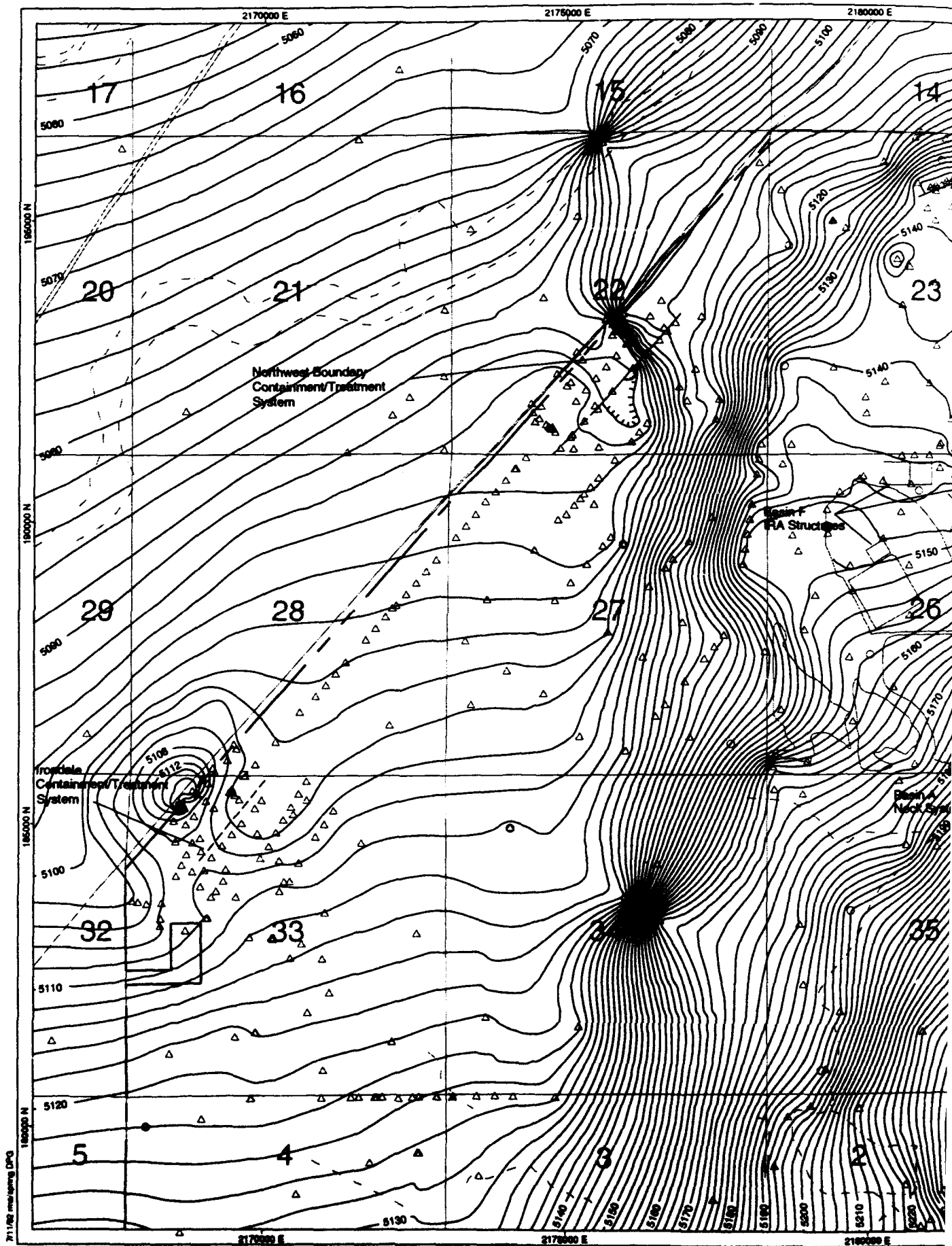
Harding Lawson Associates

Figure 5.2

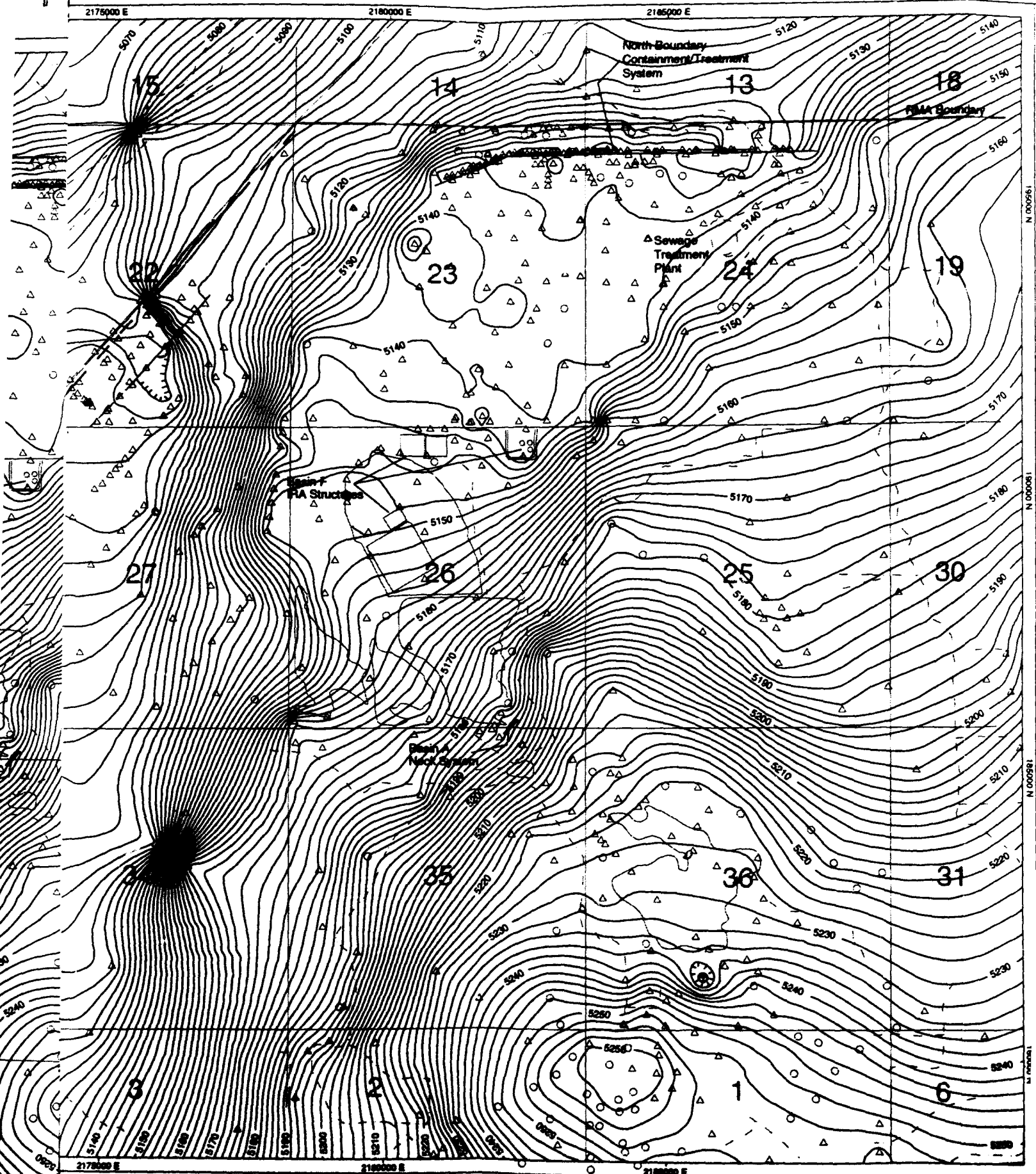
Unconfined Flow System Water-Table
Elevation Map of the Interim Response Action
Areas, Winter 1990/1991

GWAR FY91

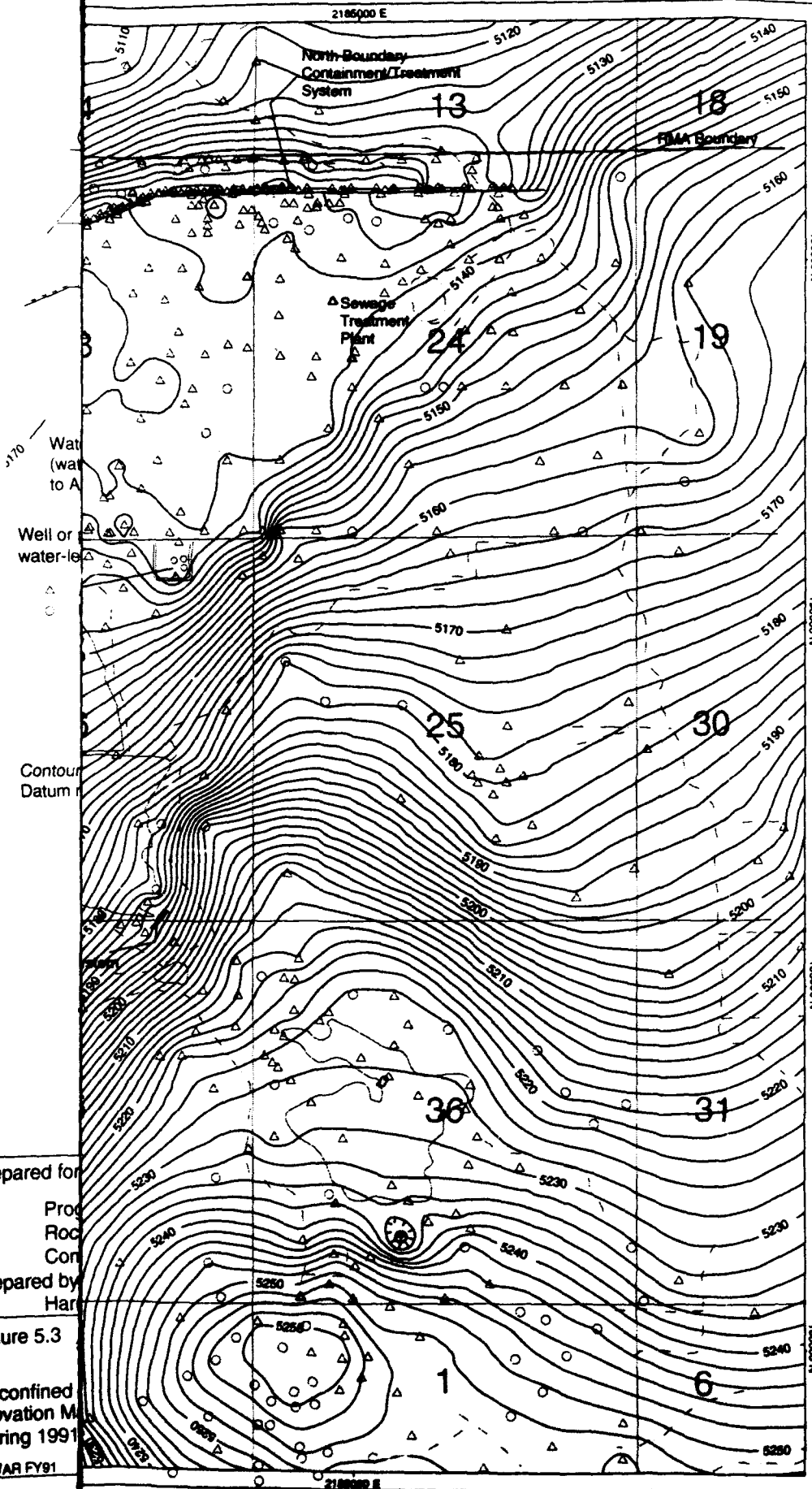
218500 E



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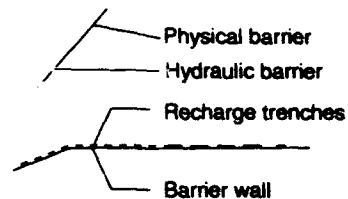


2



EXPLANATION

Containment system

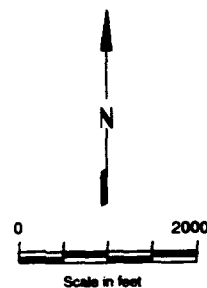


Water-level elevation contour
(water levels measured from April 1, 1991,
to April 9, 1991)

Well or piezometer location yielding
water-level elevation:

- △ Alluvial
- Unconfined Denver Formation

Contour interval equals 2 feet
Datum mean sea level



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Program Manager for
Rocky Mountain Arsenal
Commerce City, Colorado

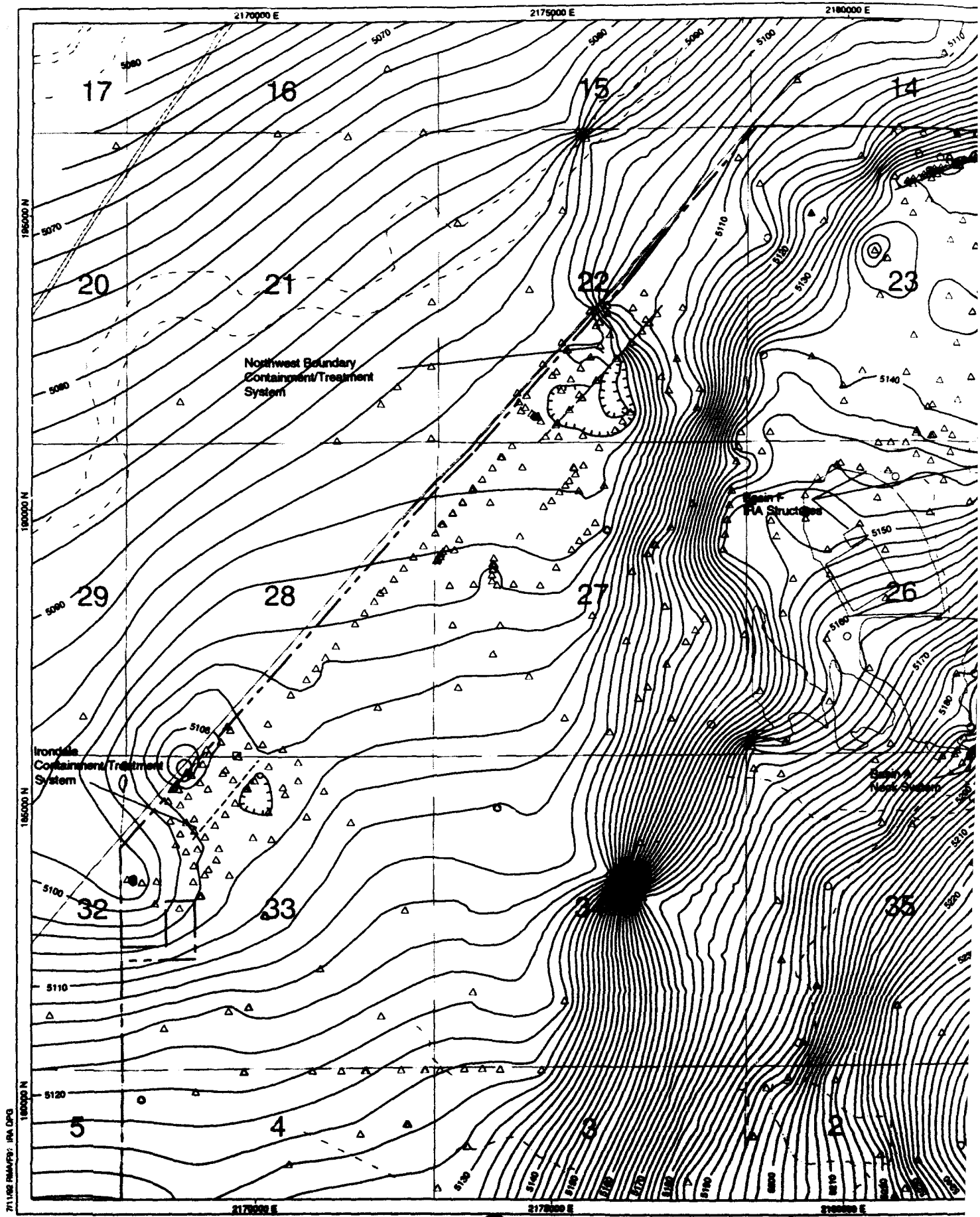
Prepared by:

Harding Lawson Associates

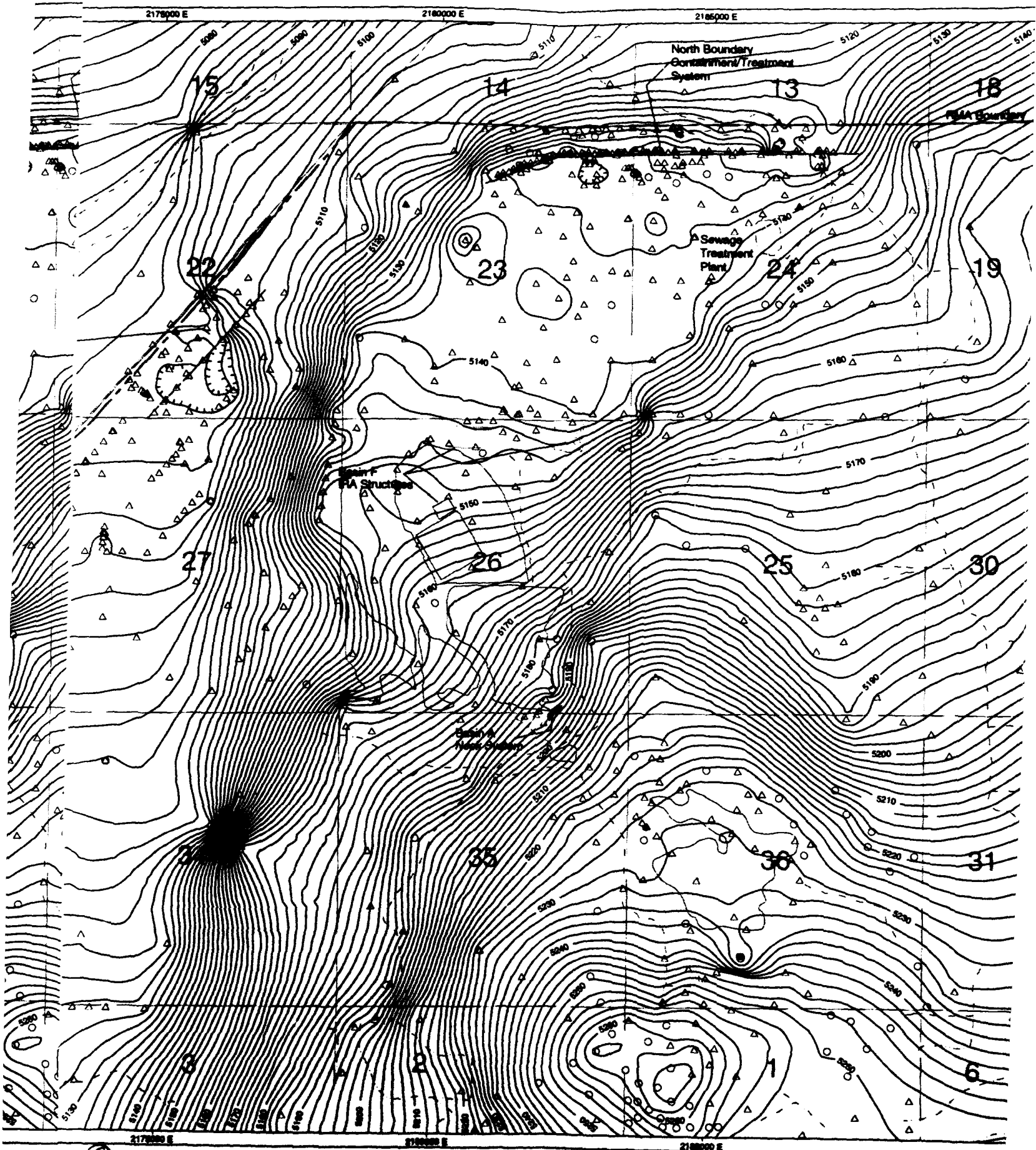
Figure 5.3

Unconfined Flow System Water-Table
Elevation Map of the IRA Areas,
Spring 1991

GWAR FY91



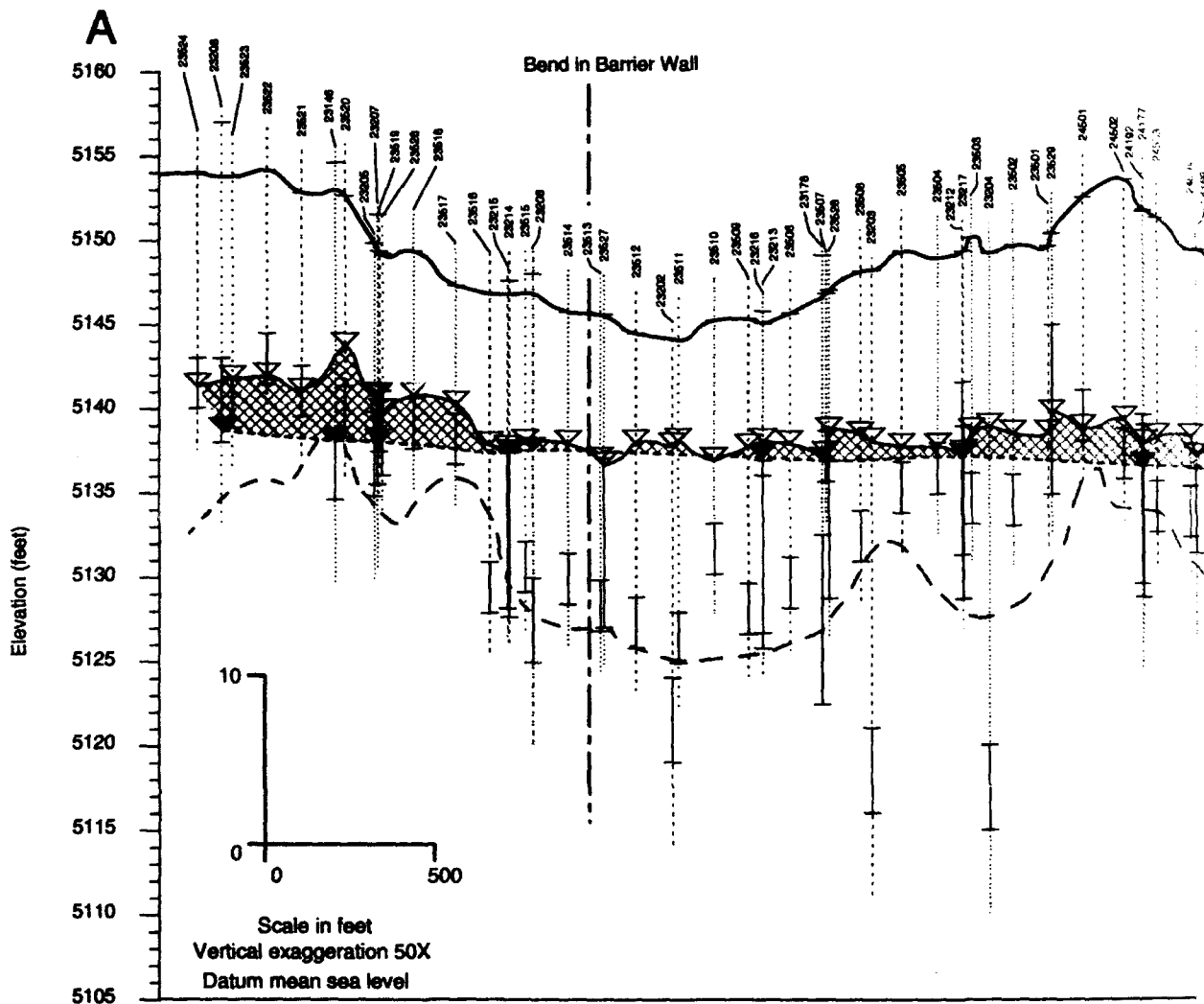
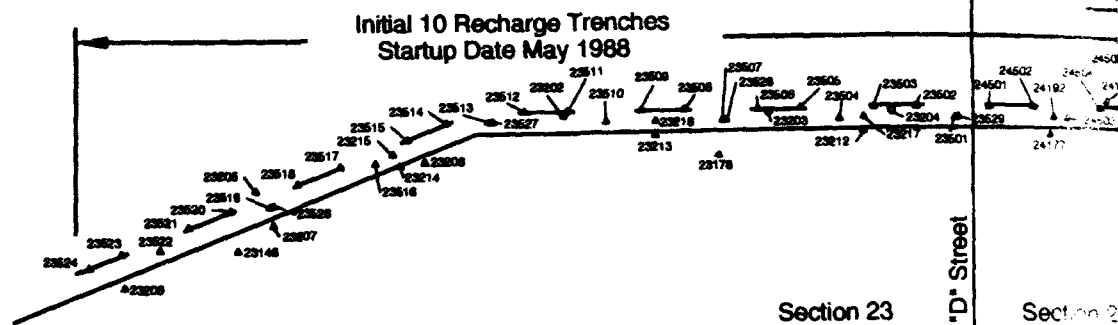
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A



EXPLANATION



Area of reversed hydraulic gradient



Bedrock surface at barrier wall

(Source: Waterways Experiment Station, 1987, plate G-04)



Water-level elevation upgradient (south) of barrier wall



Water-level elevation downgradient (north) of barrier wall



Water-level elevation marker north of barrier wall

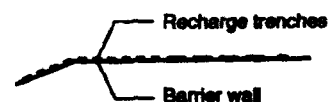


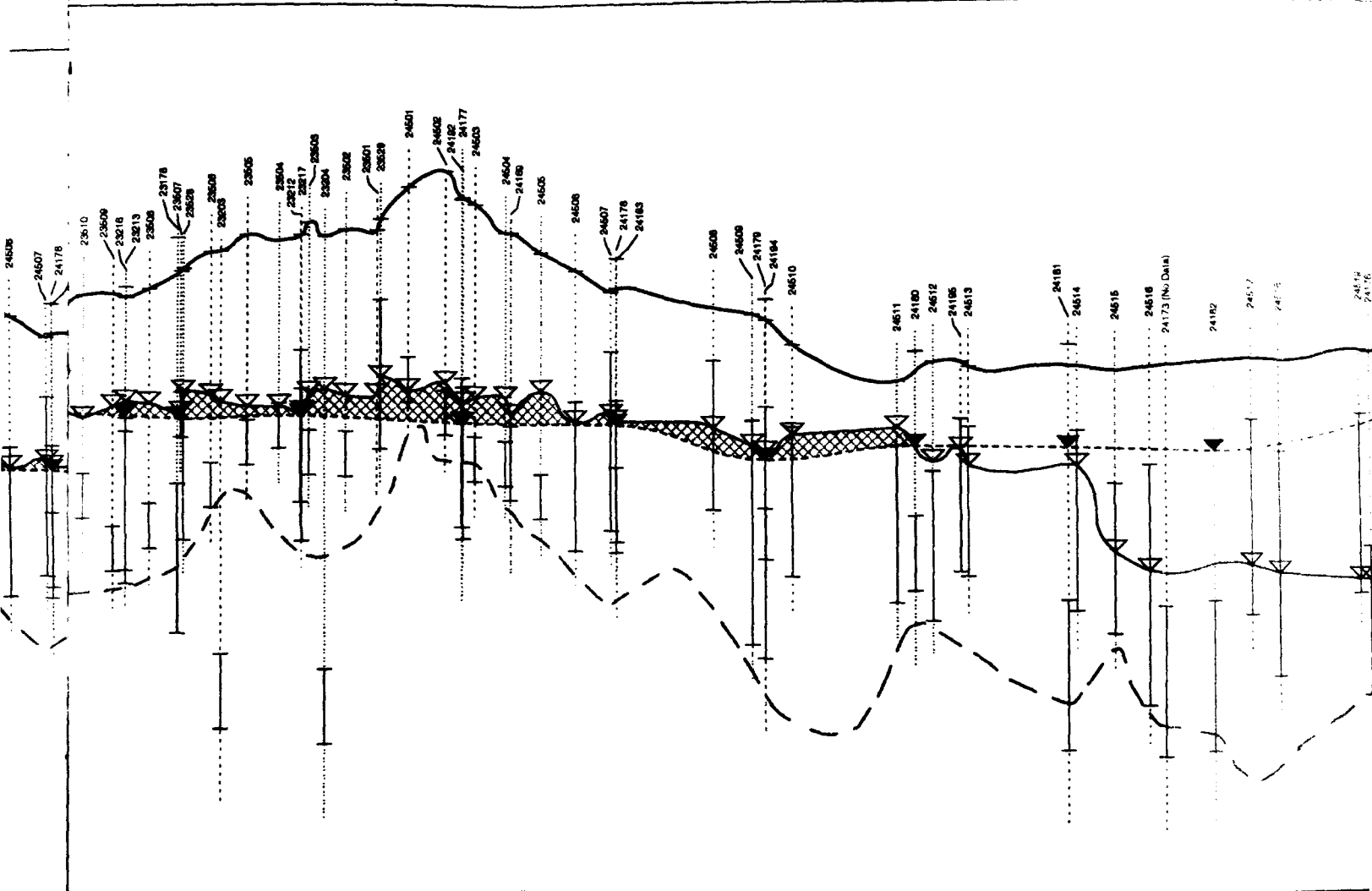
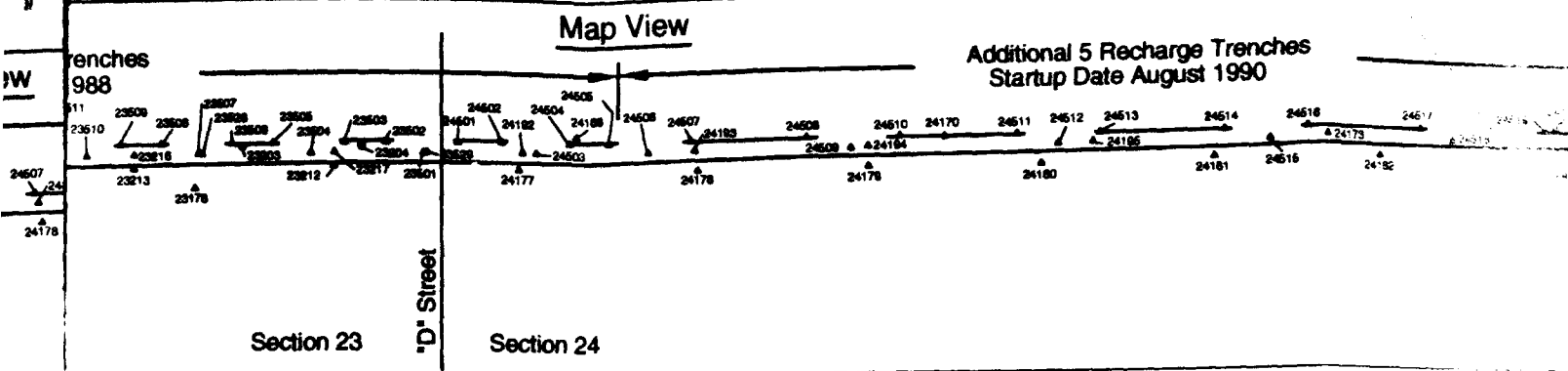
Water-level elevation marker south of barrier wall

23511 Alluvial well

23502 Unconfined Denver Formation

Containment system





EXPLANATION

- 23511 • Alluvial well
 - 23502 • Unconfined Denver Formation well
- Containment system**
- Recharge trenches
 - Barrier wall

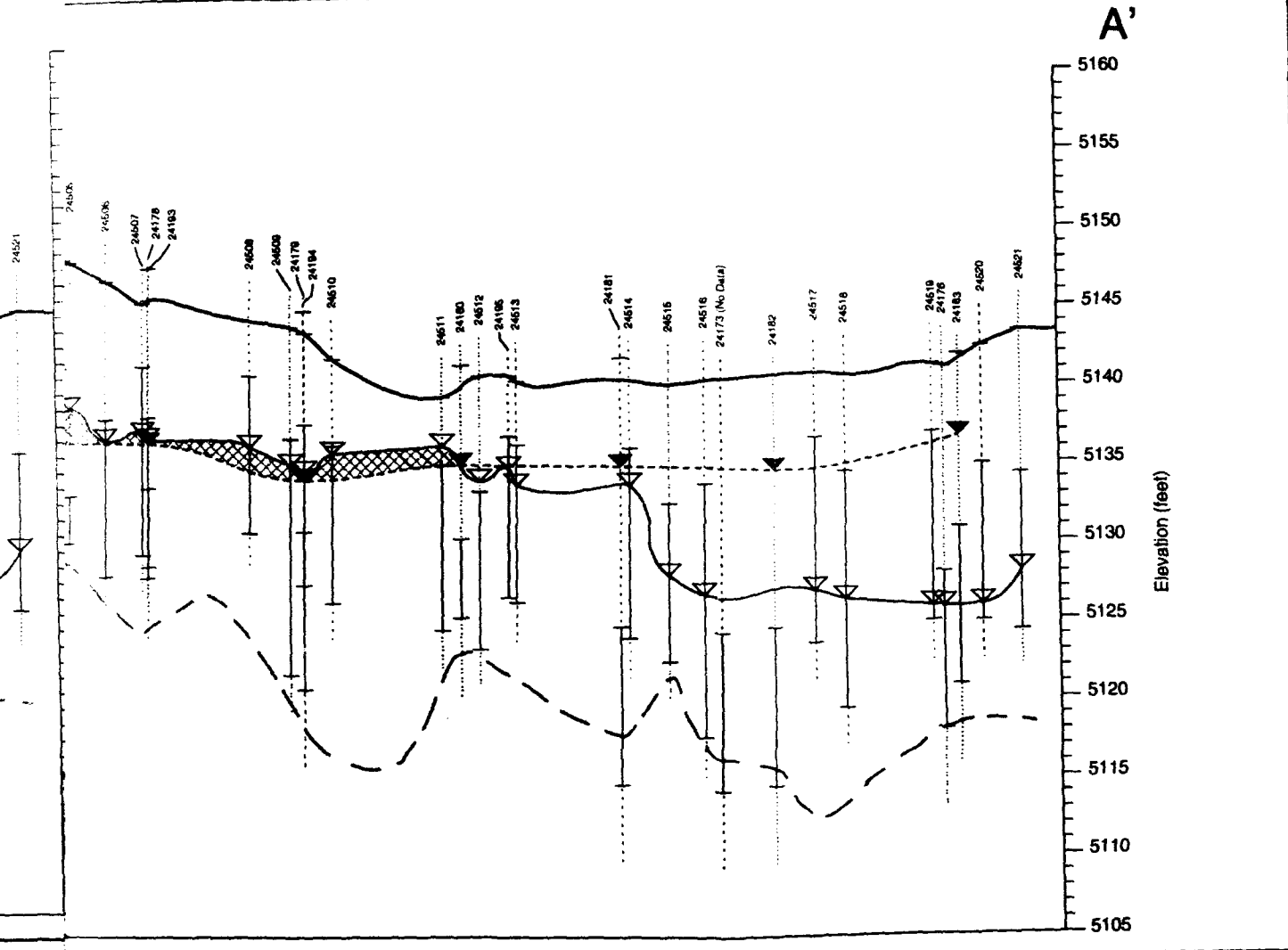
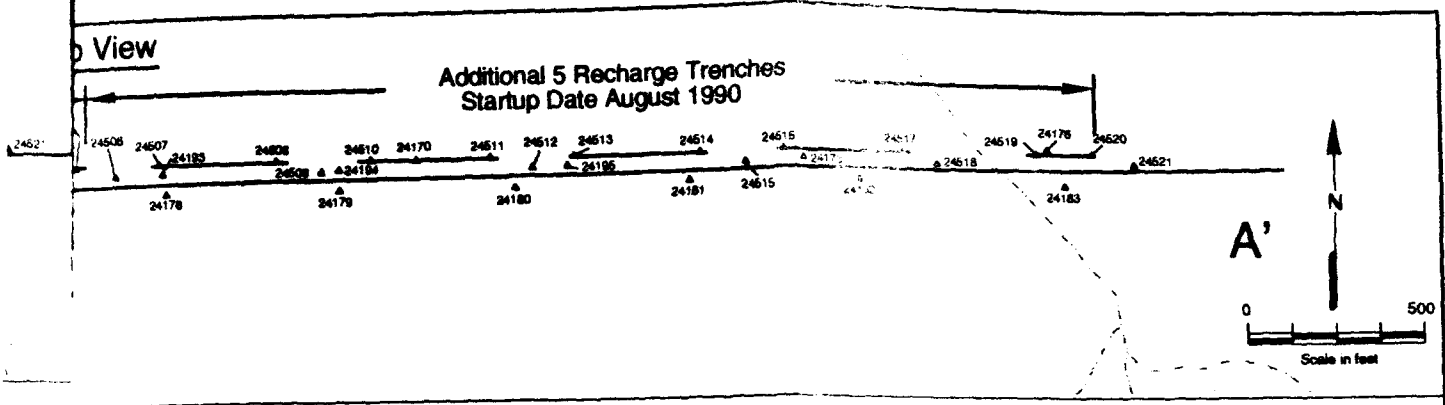
- Well number
- Ground surface (south of the barrier wall)
- Ground surface (north of the barrier wall)
- Cased interval
- Screened interval
- Cased interval

Prepared for:
Program Mar
Rocky Mount
Commerce C

Prepared by:
Harding Law

Figure 5.5
Cross Section of App
Elevations at the No
Treatment System fr
December 31, 1990

CMP GWAR FY91

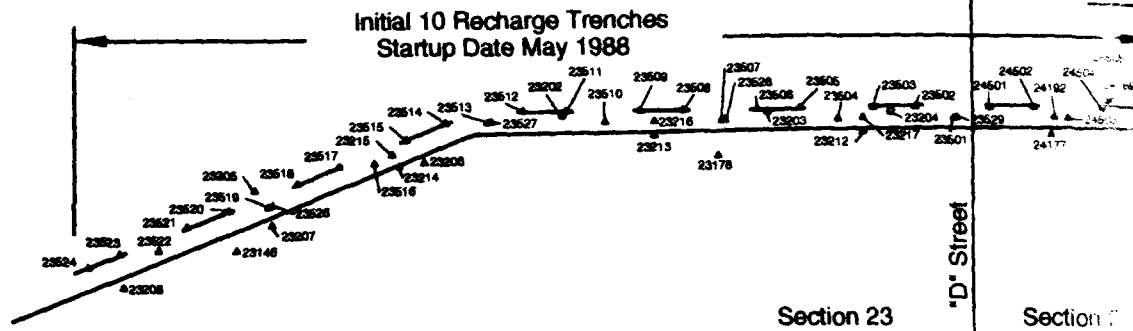


Well number Ground surface (south of the barrier wall) Ground surface (north of the barrier wall) Cased interval Screened interval Cased interval	Prepared for: Program Manager for Rocky Mountain Arsenal Commerce City, Colorado Prepared by: Harding Lawson Associates
	Figure 5.5 Cross Section of Approximate Water-Table Elevations at the North Boundary Containment/ Treatment System from October 1 to December 31, 1990 CMP GVAR FY91

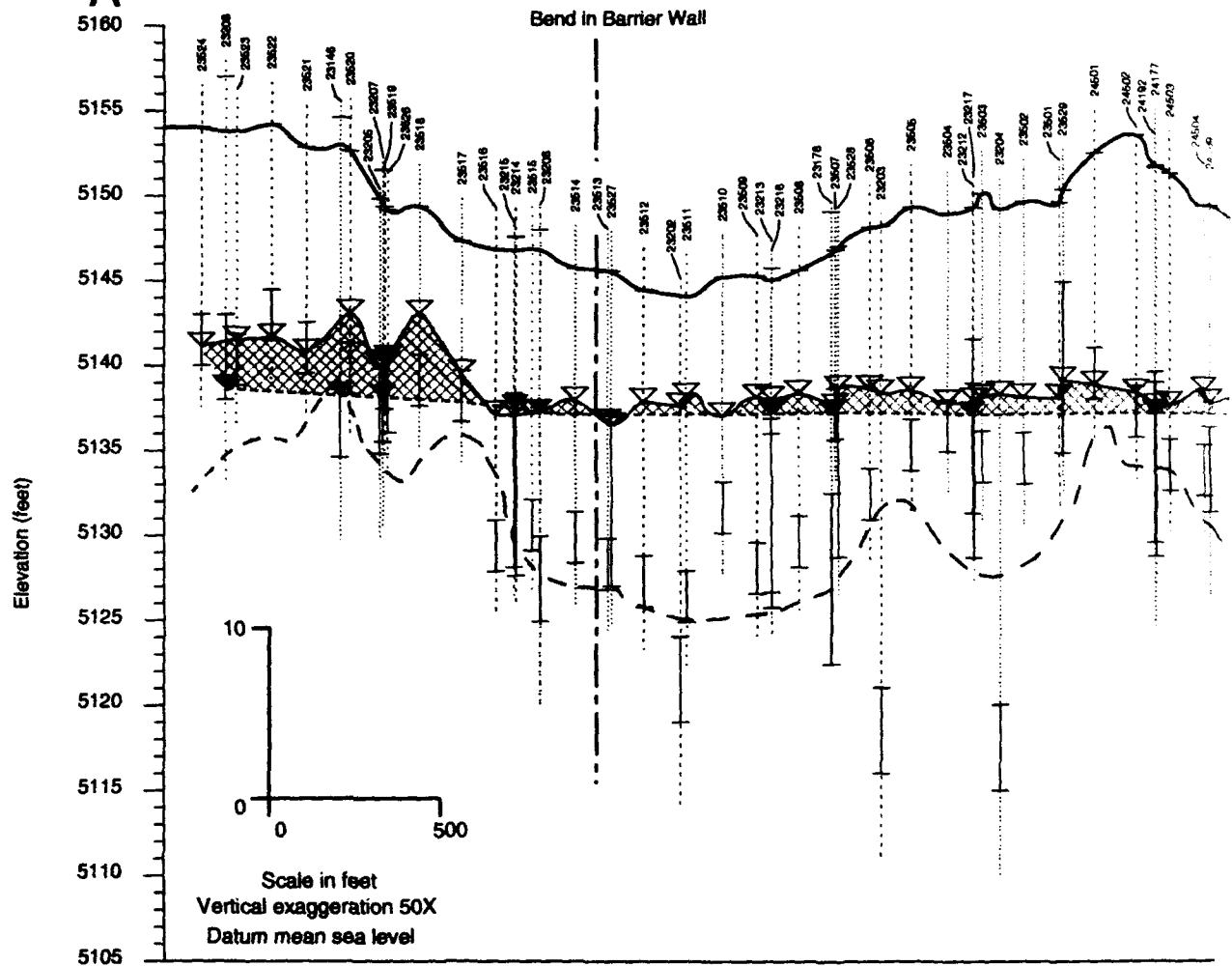
2

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A



A



EXPLANATION



Area of reversed hydraulic gradient



Bedrock surface at barrier wall

(Source: Waterways Experiment Station, 1987, plate G-04)



Water-level elevation upgradient (south) of barrier wall



Water-level elevation downgradient (north) of barrier wall



Water-level elevation marker north of barrier wall

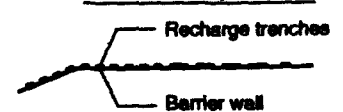


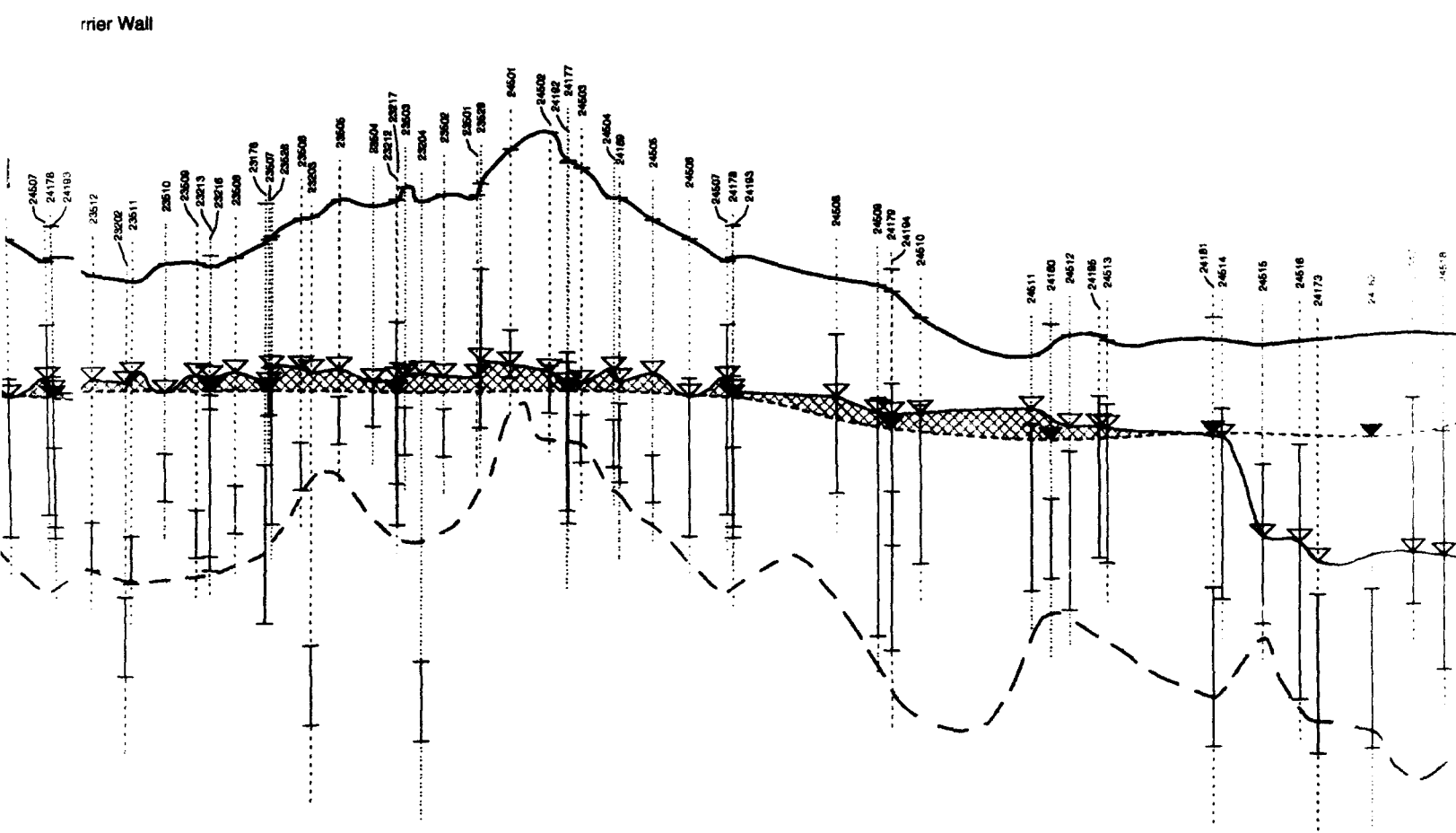
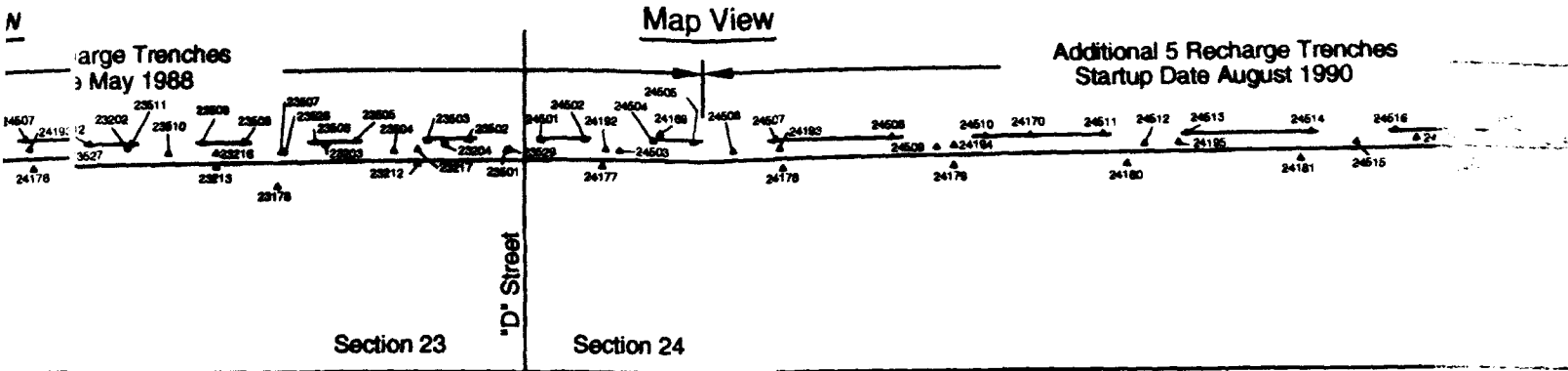
Water-level elevation marker south of barrier wall

23511 ▲ Alluvial well

23802 ○ Unconfined Denver Formatic

Containment system





EXPLANATION

- 23511 ▲ Alluvial well
- 23502 ● Unconfined Denver Formation well
- Containment system
- Recharge trenches
- Barrier wall

- Well number
- Ground surface (south of the barrier wall)
- Ground surface (north of the barrier wall)
- Cased interval
- Screened interval
- Cased interval

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Prog
Rock
Comm
Prepared by
Hart

Figure 5.6
Cross Section
Elevations and
Treatment

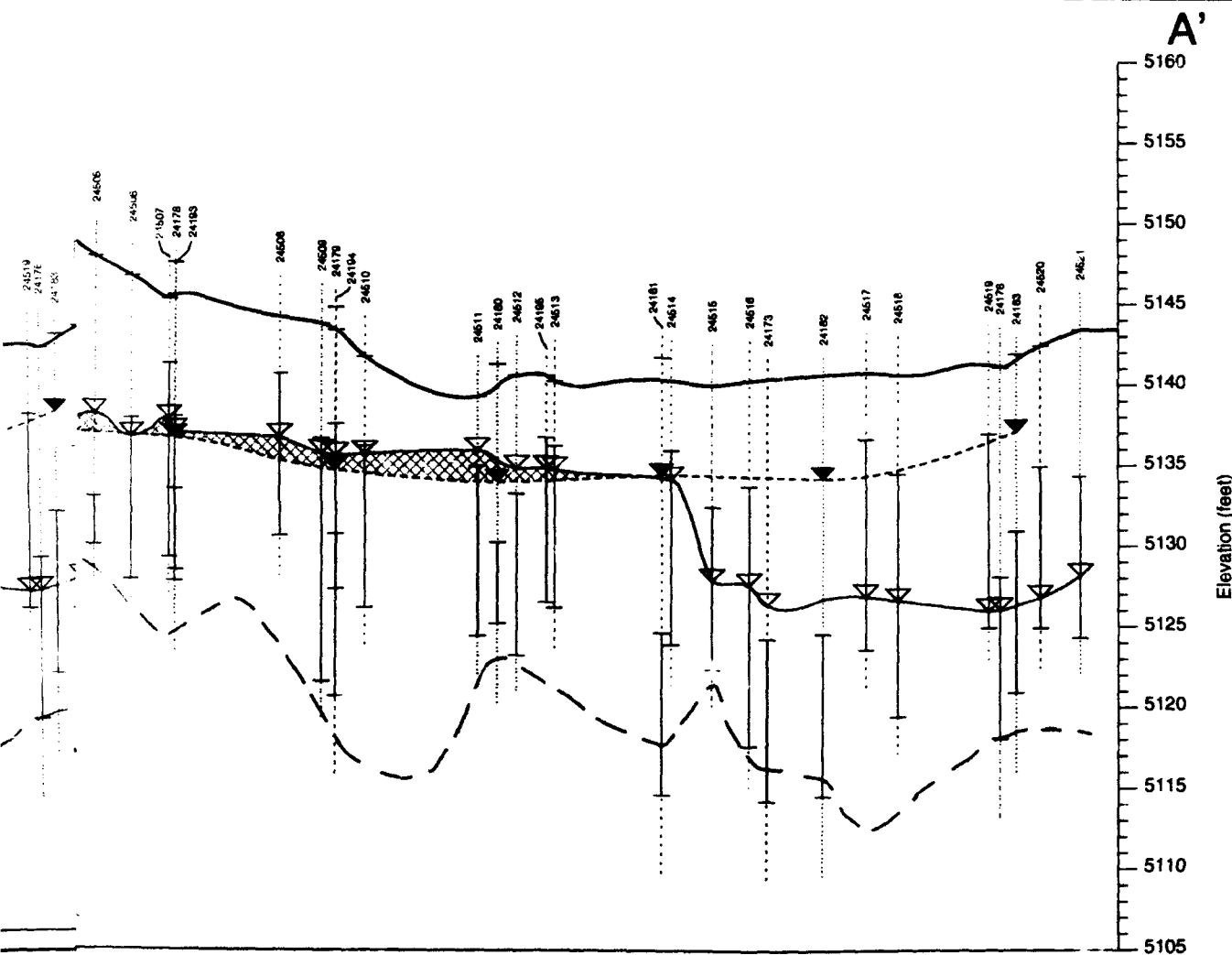
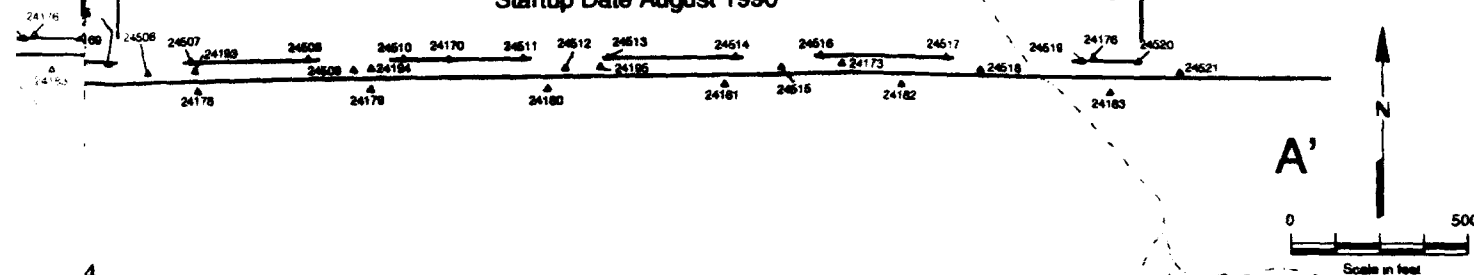
GWAR FY91

1

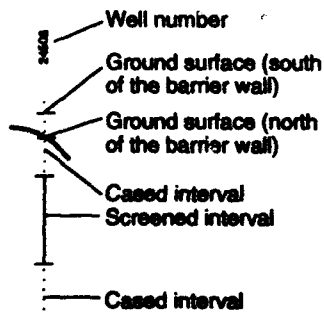
2

ap View

Additional 5 Recharge Trenches
Startup Date August 1990



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Prepared for:

Program Manager for
Rocky Mountain Arsenal
Commerce City, Colorado

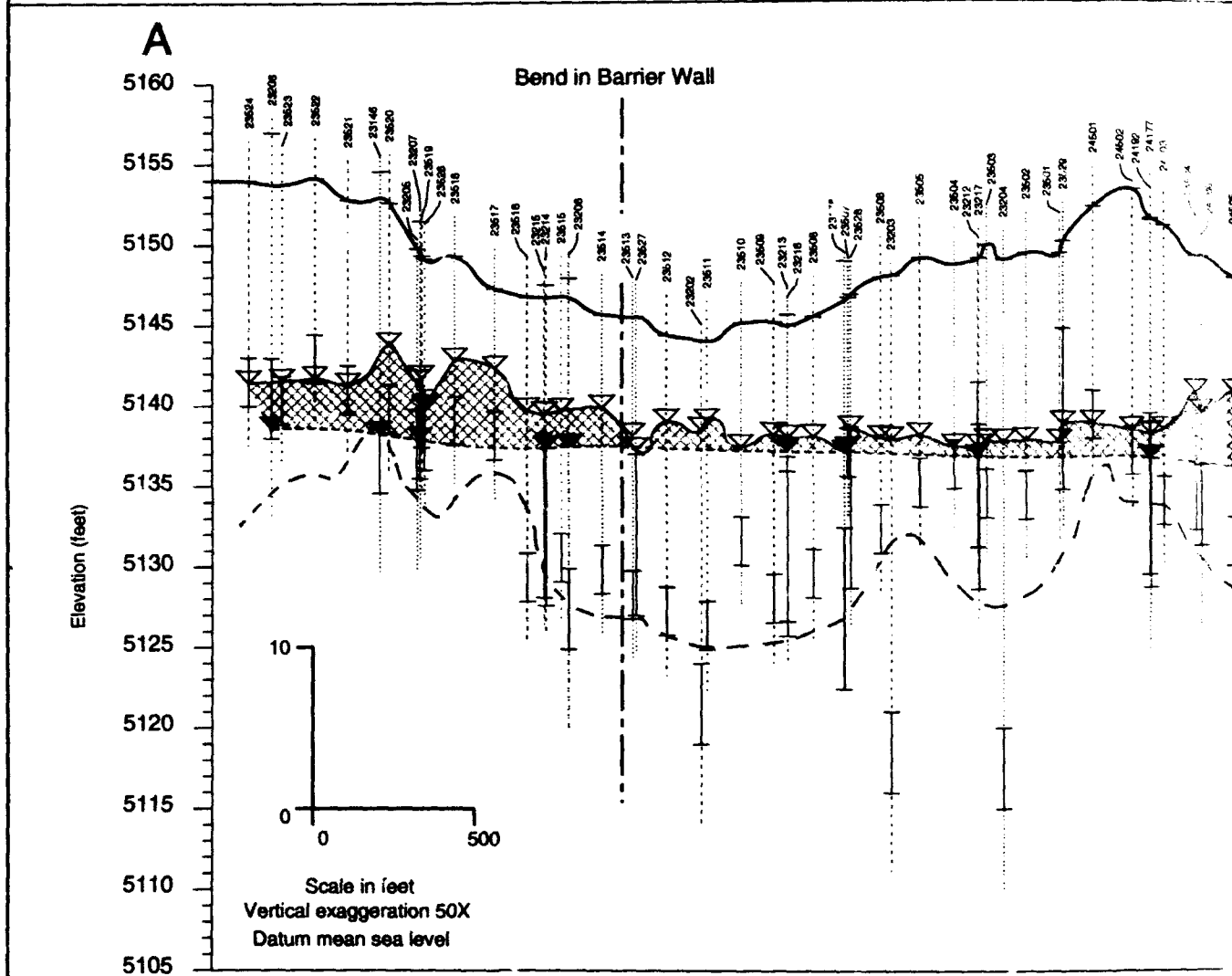
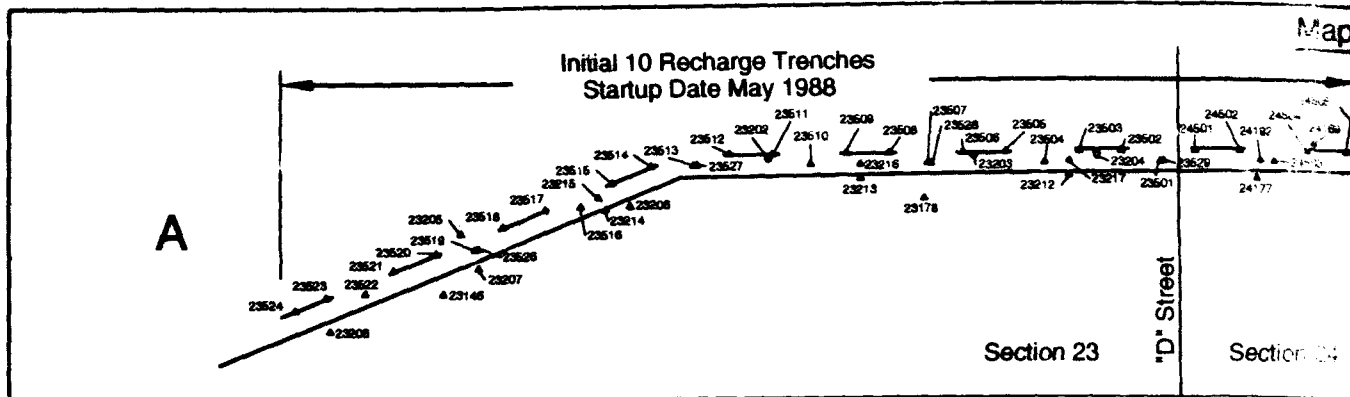
Prepared by:

Harding Lawson Associates

Figure 5.6

Cross Section of Approximate Water-Table
Elevations at the North Boundary Containment/
Treatment System from January 1 to March 31, 1991

GWAR FY91



EXPLANATION



Area of reversed hydraulic gradient



Bedrock surface at barrier wall

(Source: Waterways Experiment Station, 1987, plate G-04)



Water-level elevation upgradient (south) of barrier wall



Water-level elevation downgradient (north) of barrier wall



Water-level elevation marker north of barrier wall

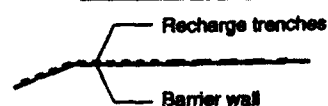


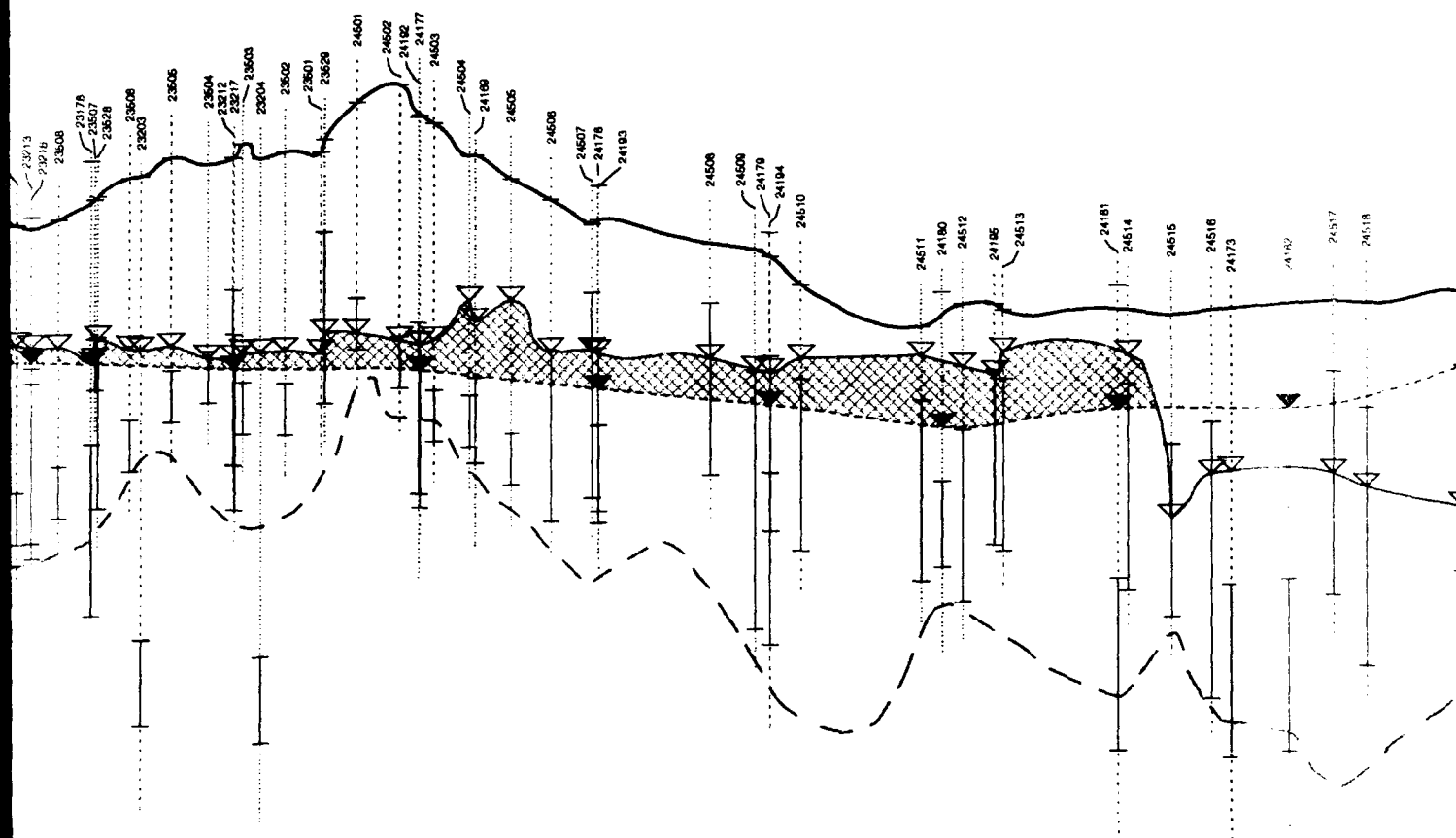
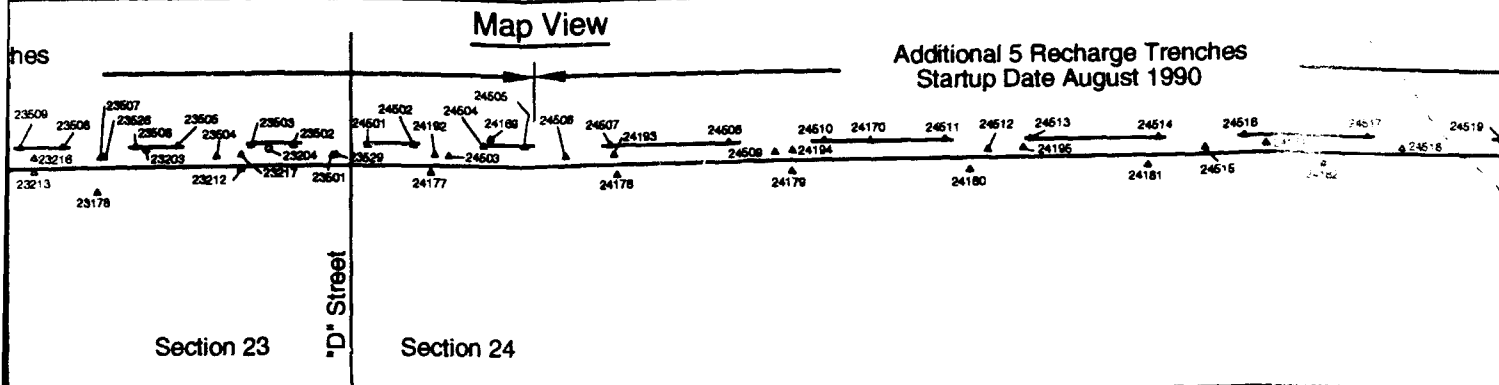
Water-level elevation marker south of barrier wall

23511 Alluvial well

23502 Unconfined Denver Forma

Containment system



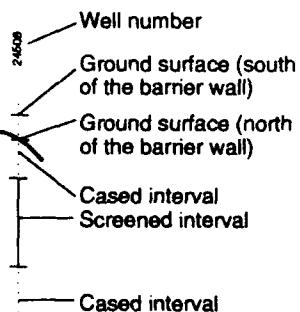
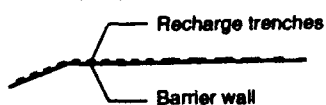


EXPLANATION

23511 ▲ Alluvial well

23202 ○ Unconfined Denver Formation well

Containment system

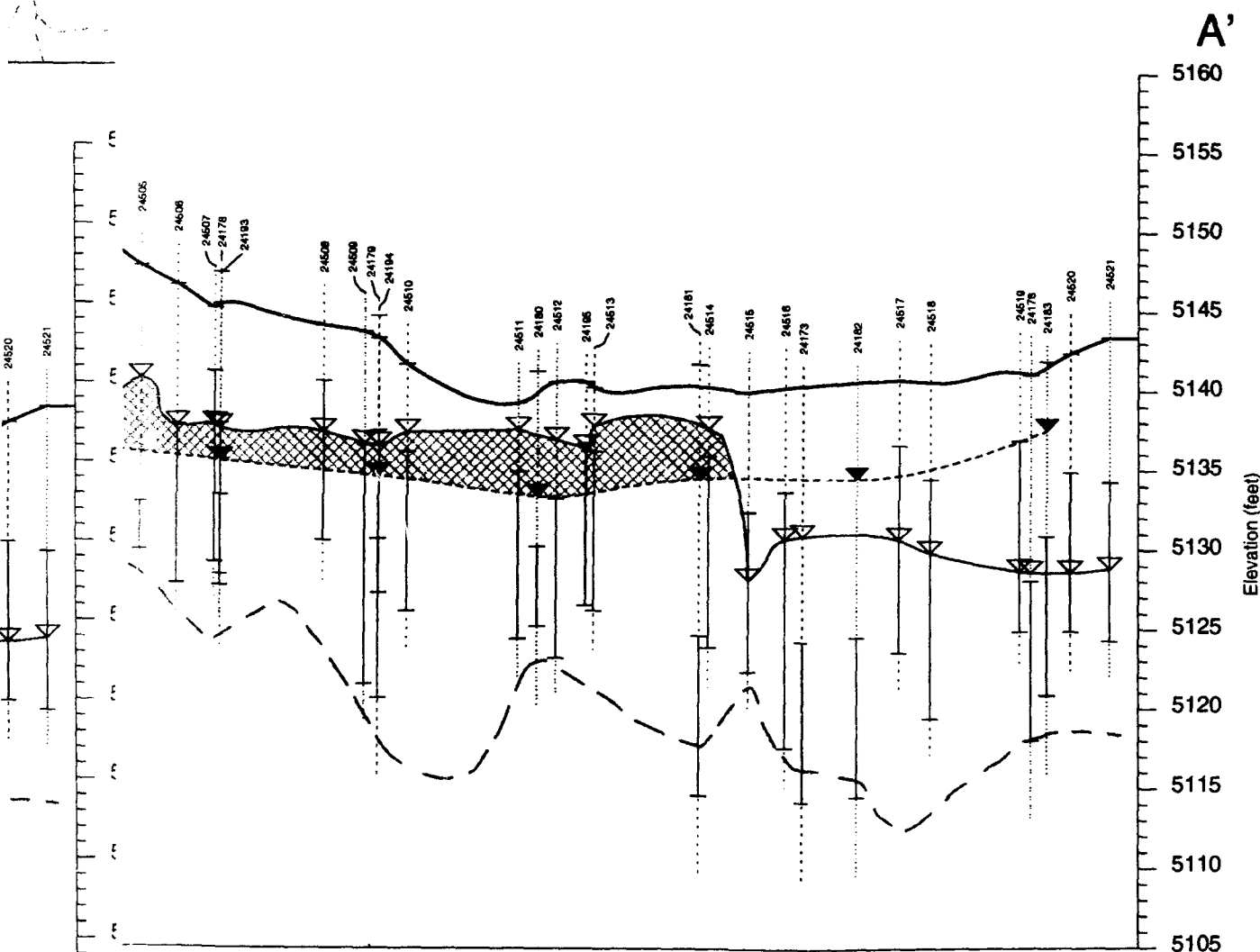
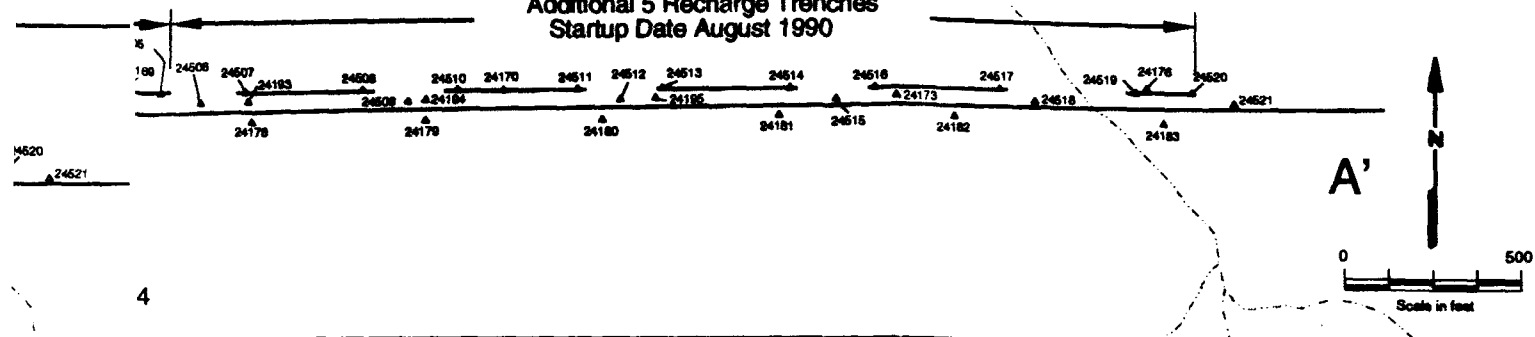


Prepared for:
Program Manager
Rocky Mountain
Commerce City
Prepared by:
Harding Lawso

Figure 5.7
Cross Section of A
Elevations at the N
Treatment System

ap View

Additional 5 Recharge Trenches
Startup Date August 1990



- Well number
- Ground surface (south of the barrier wall)
- Ground surface (north of the barrier wall)
- Cased interval
- Screened interval
- Cased interval

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Program Manager for
Rocky Mountain Arsenal
Commerce City, Colorado
Prepared by:
Harding Lawson Associates

Figure 5.7
Cross Section of Approximate Water-Table
Elevations at the North Boundary Containment/
Treatment System from April 1 to June 30, 1991

GWAR FY91

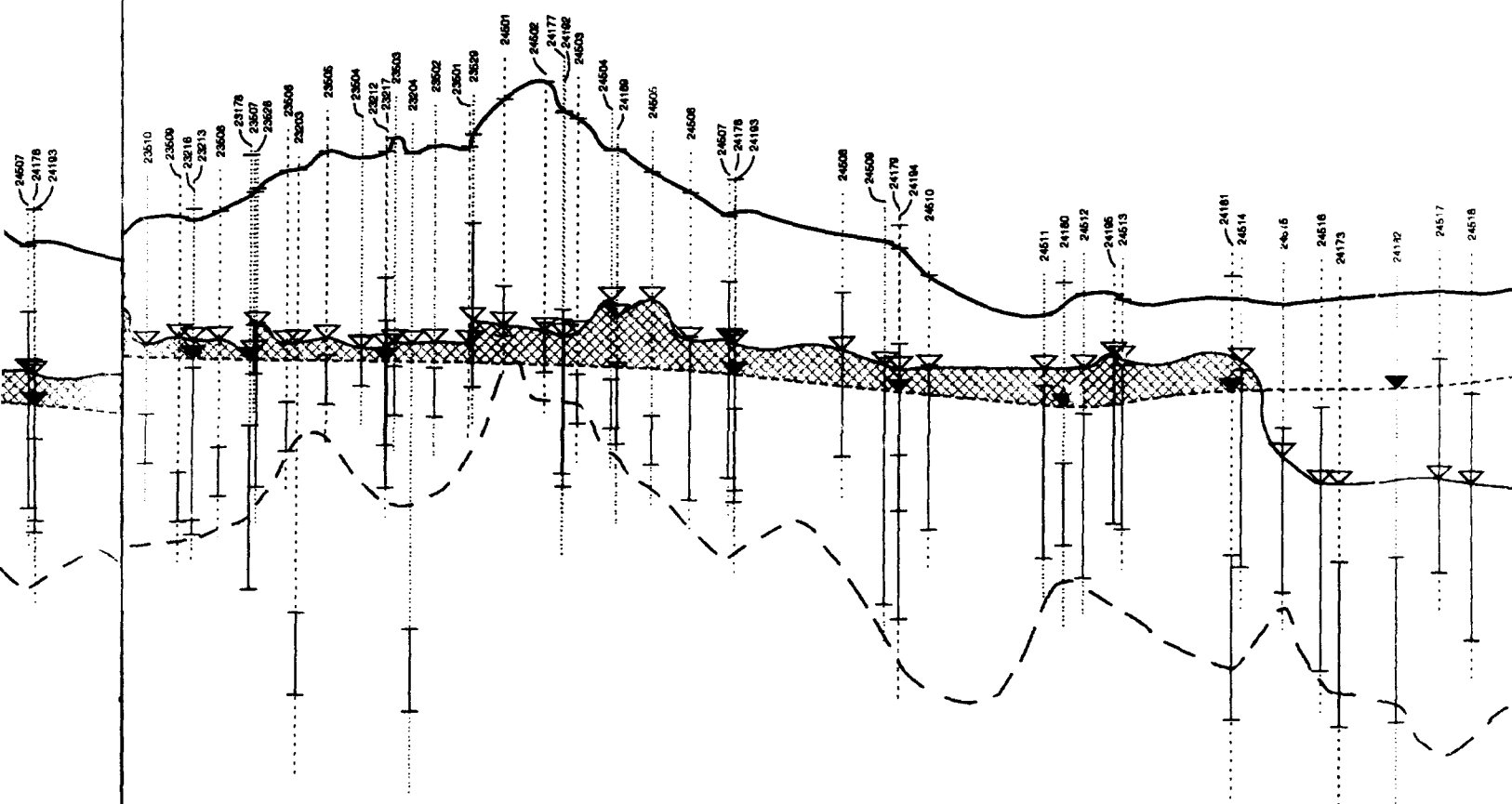
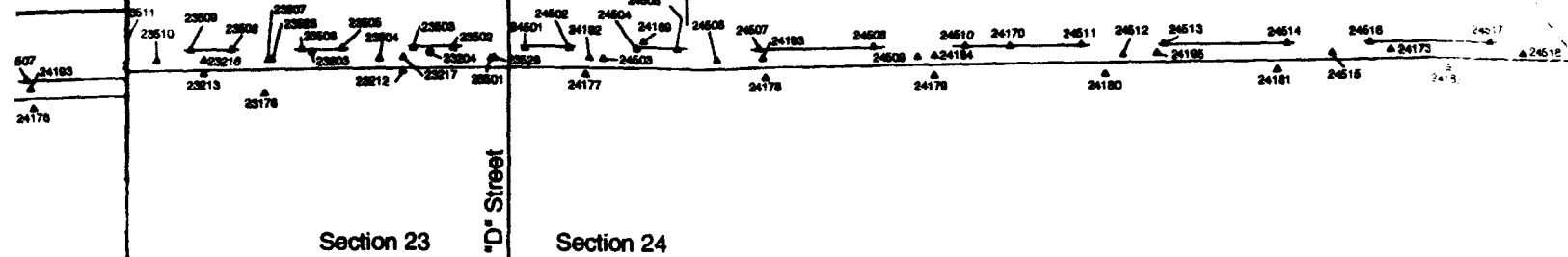
2

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Map View

Trenches
1988

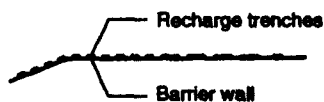
Additional 5 Recharge Trenches
Startup Date August 1990



EXPLANATION

- 23511 ▲ Alluvial well
- 23502 ○ Unconfined Denver Formation well

Containment system



- Well number
- Ground surface (south of the barrier wall)
- Ground surface (north of the barrier wall)
- Cased interval
- Screened interval
- Cased interval

2

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Program M
Rocky Mountain
Commerce
Prepared by:
Harding La

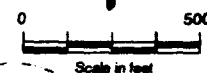
Figure 5.8
Cross Section
Elevations at the
Treatment System

GWAR FY91

iew

Additional 5 Recharge Trenches Startup Date August 1990

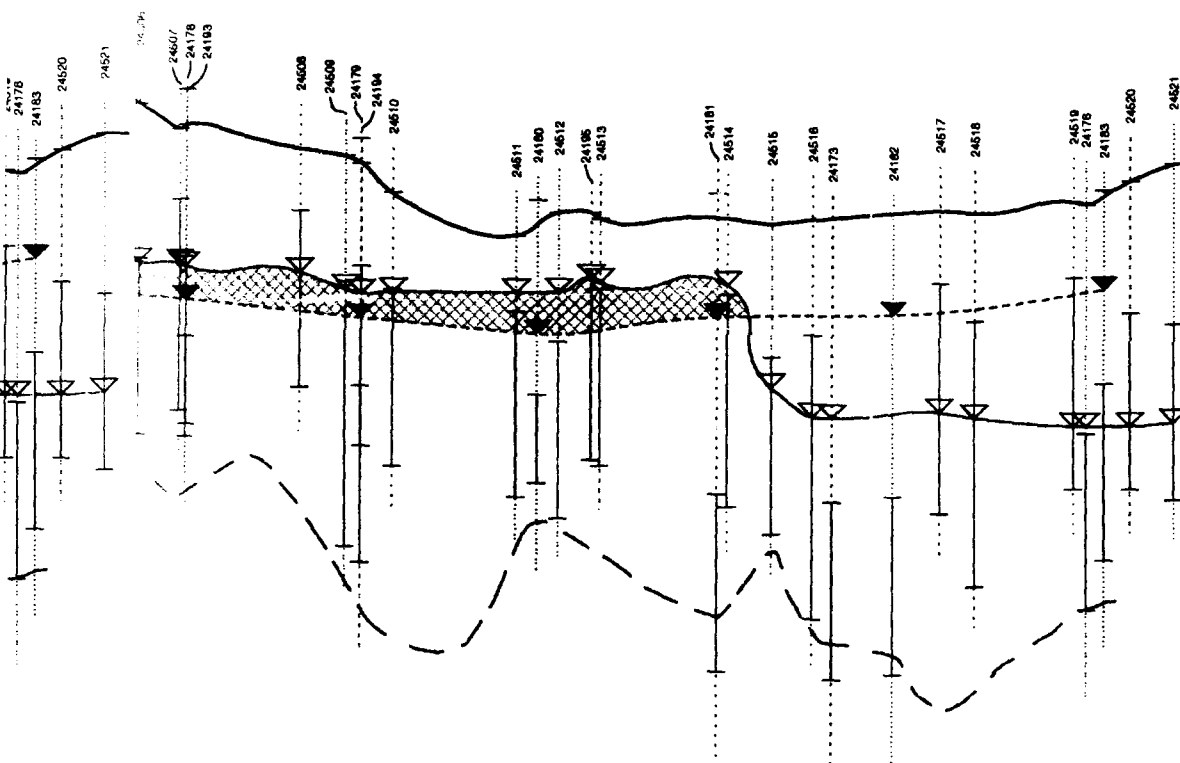
A'



A'

5160
5155
5150
5145
5140
5135
5130
5125
5120
5115
5110
5105

Elevation (feet)



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Arsenal
Colorado

Associates

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om July 1 to

- Well number
- Ground surface (south of the barrier wall)
- Ground surface (north of the barrier wall)
- Cased interval
- Screened interval
- Cased interval

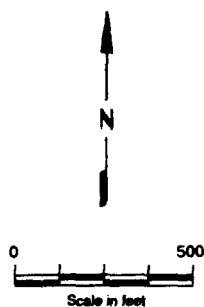
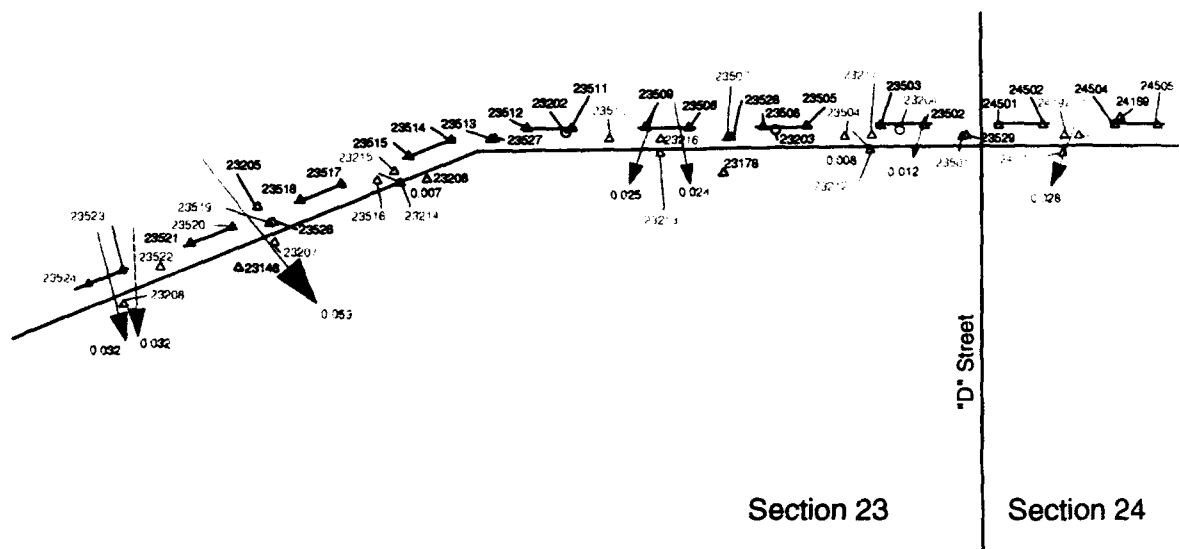
2

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Program Manager for
Rocky Mountain Arsenal
Commerce City, Colorado
Prepared by:
Harding Lawson Associates

Figure 5.8
Cross Section of Approximate Water-Table
Elevations at the North Boundary Containment/
Treatment System from July 1 to September 30, 1991

GWAR FY91

3



EXPLANATION

▲23101 Alluvial well

○23102 Unconfined Denver Formation well

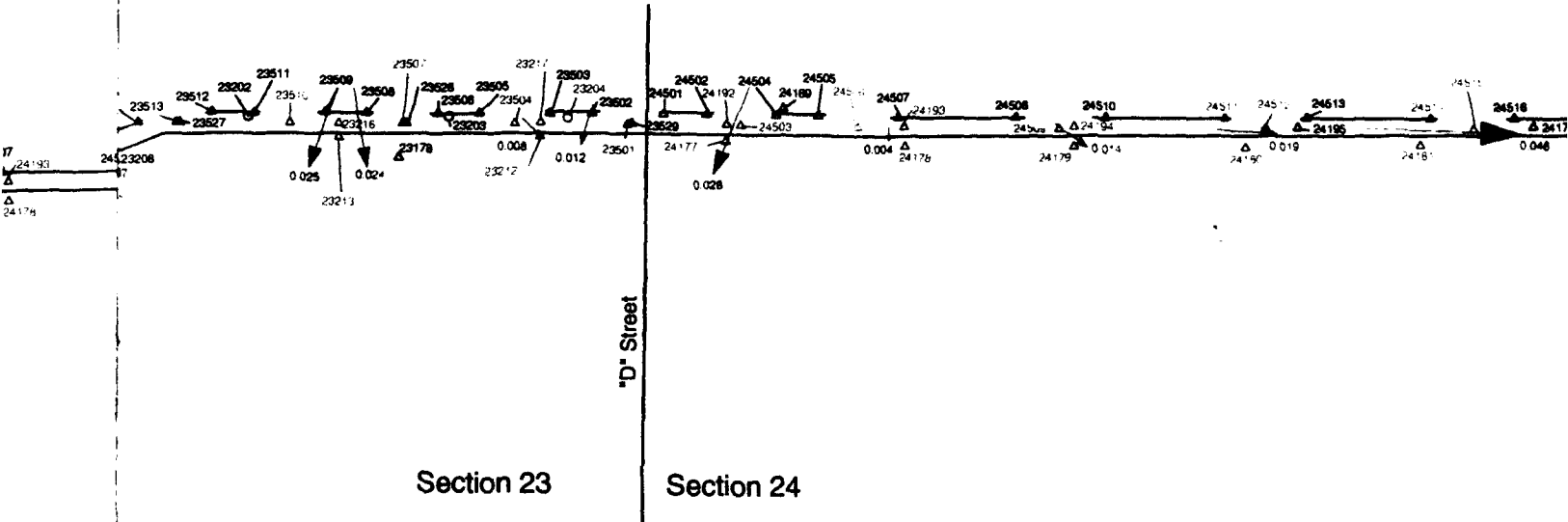
→ Direction and magnitude of water-table gradient in feet/feet

Note: Wells in red were utilized in three-point solutions of water-table direction and magnitude.

--- Drainage

Contain





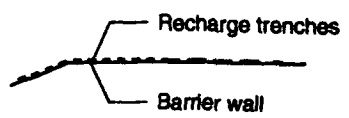
Section 23

Section 24

EXPLANATION

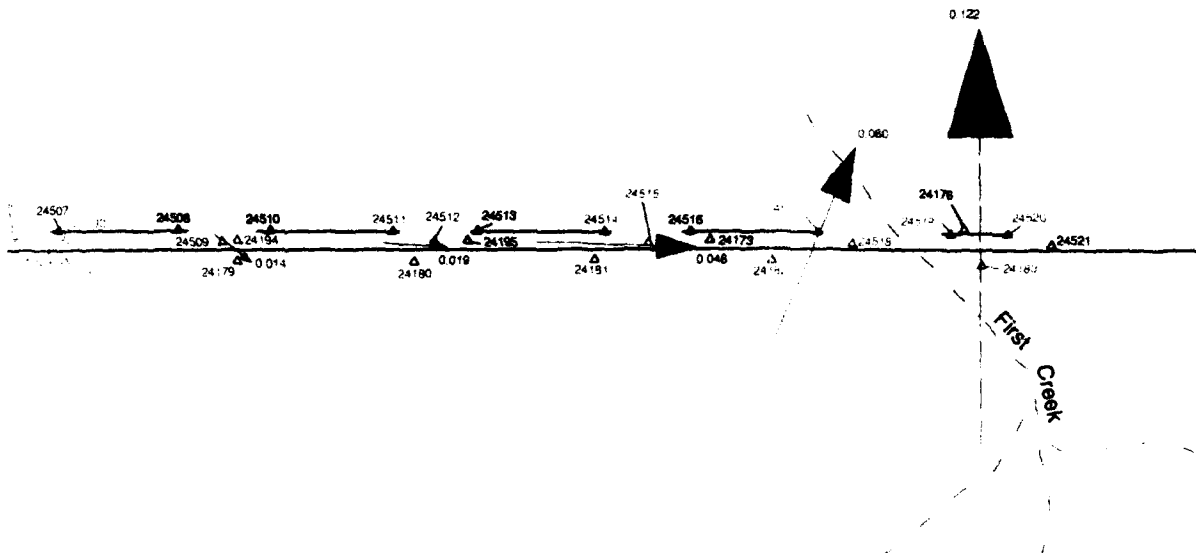
well
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 wells in red were utilized in three-point
 solutions of water-table direction and
 magnitude.
 rrier wall

Containment system



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Prepared
Treatment system

Figure 5.9

Direction of Recharge trenches
in the Vicinity of the

Treatment System Barrier wall
October 1 to December 31, 1990

GWAR FY91

Prepared for:

Program Manager for
Rocky Mountain Arsenal
Commerce City, Colorado

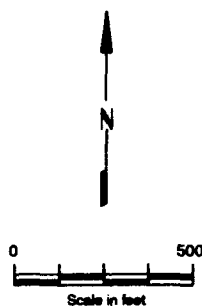
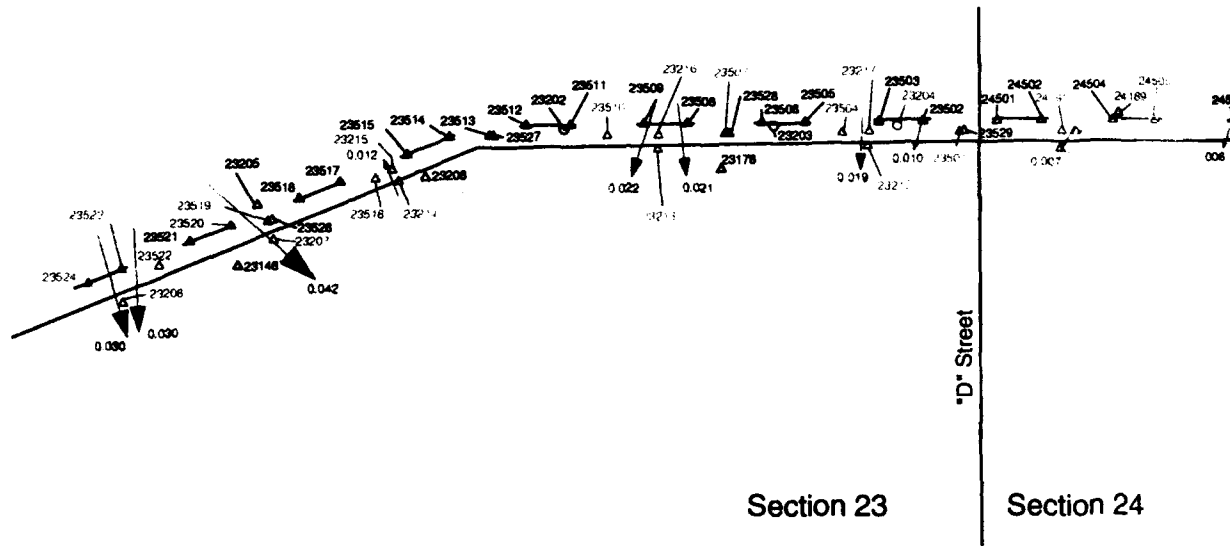
Prepared by:

Harding Lawson Associates

Figure 5.9

Direction and Magnitude of Water-Table Gradients
in the Vicinity of the North Boundary Containment/
Treatment System Barrier Wall from
October 1 to December 31, 1990

GWAR FY91



EXPLANATION

- ▲23101 Alluvial well
- 23102 Unconfined Denver Formation well

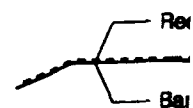


Direction and magnitude of water-table gradient in feet/feet

Note: Wells in red were utilized in three-point solutions of water-table direction and magnitude.

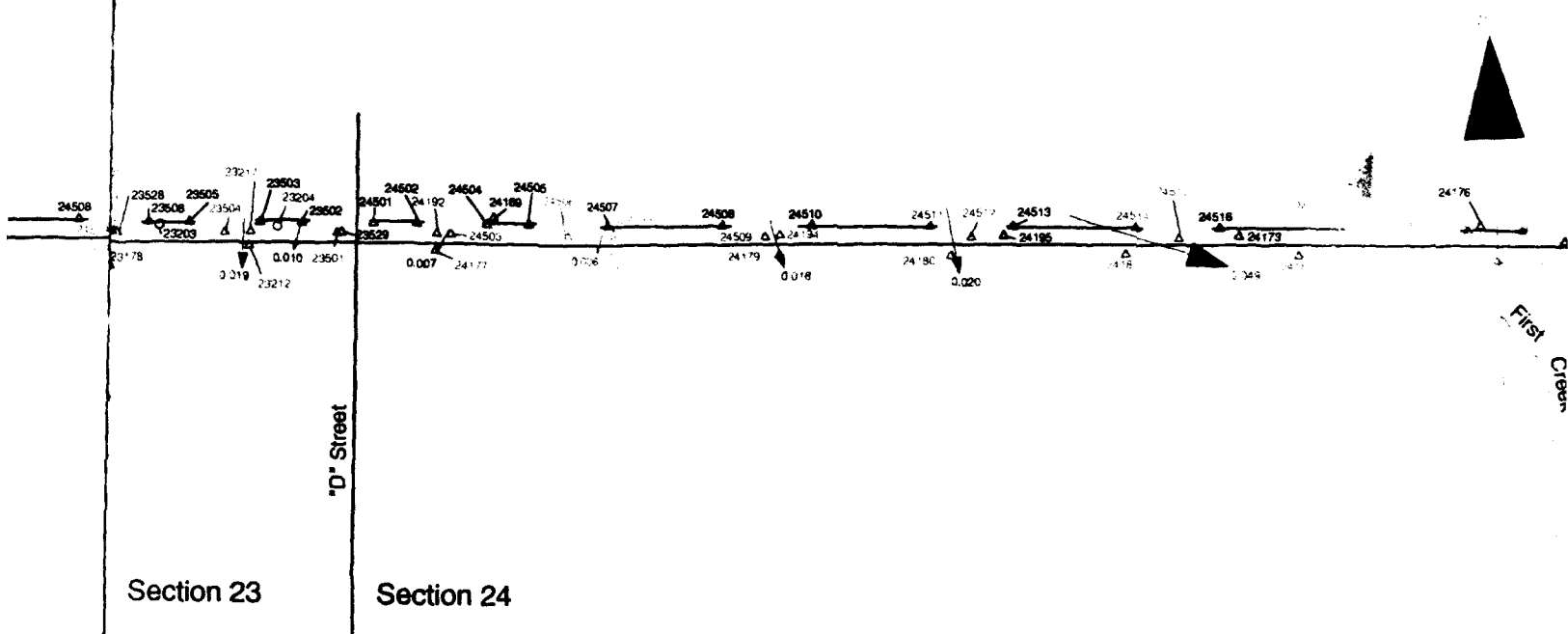
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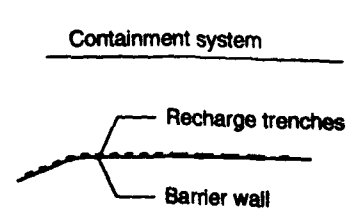


9/27/82 RMA/SP/TORT2R JWW

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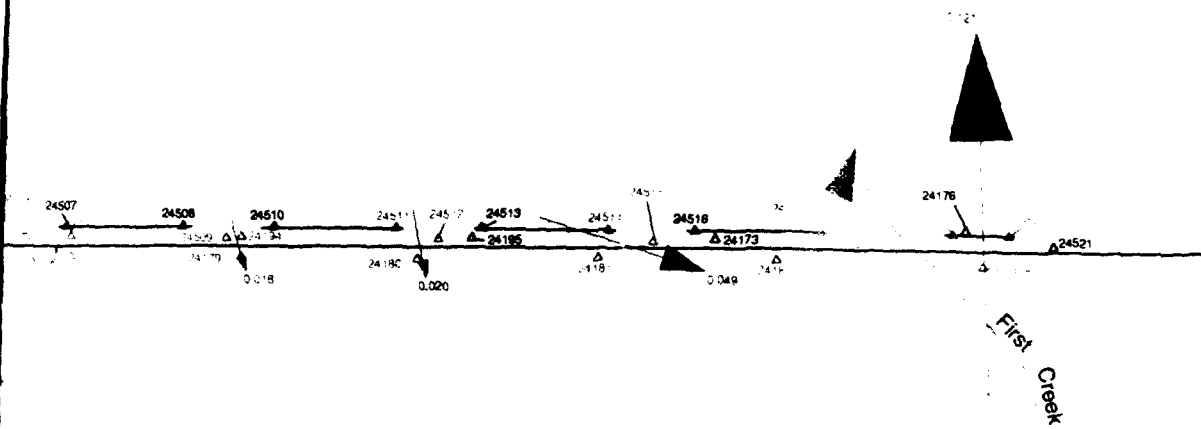


EXPLANATION



Prepared for:
Program Manager
Rocky Mountain
Commerce Center
Prepared by:
Harding Law

Figure 5.10
Direction and Magnitude
in the Vicinity of the
Treatment System B
January 1 to March 1
GWAR FY91



ment system

Recharge trenches

Barrier wall

Prepared for:

Program Manager for
Rocky Mountain Arsenal
Commerce City, Colorado

Prepared by:

Harding Lawson Associates

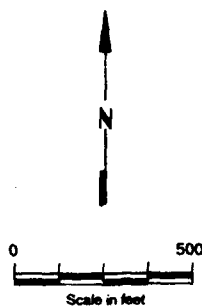
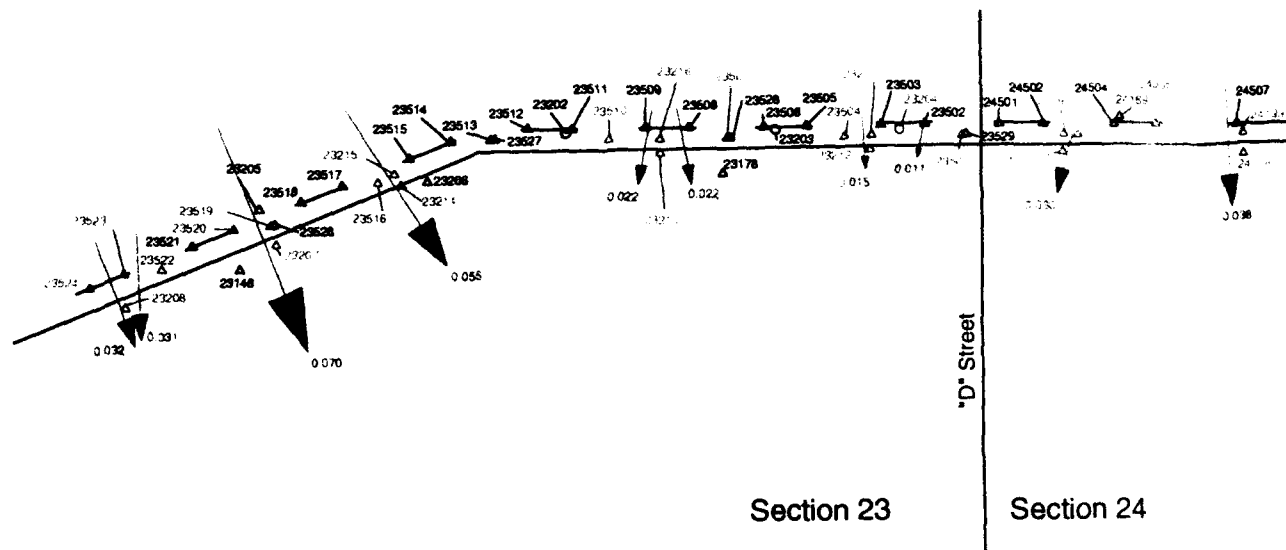
Figure 5.10

Direction and Magnitude of Water-Table Gradients
in the Vicinity of the North Boundary Containment/
Treatment System Barrier Wall from
January 1 to March 31, 1991

GWAR FY91

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EXPLANATION

- ▲23101 Alluvial well
- 23102 Unconfined Denver Formation well

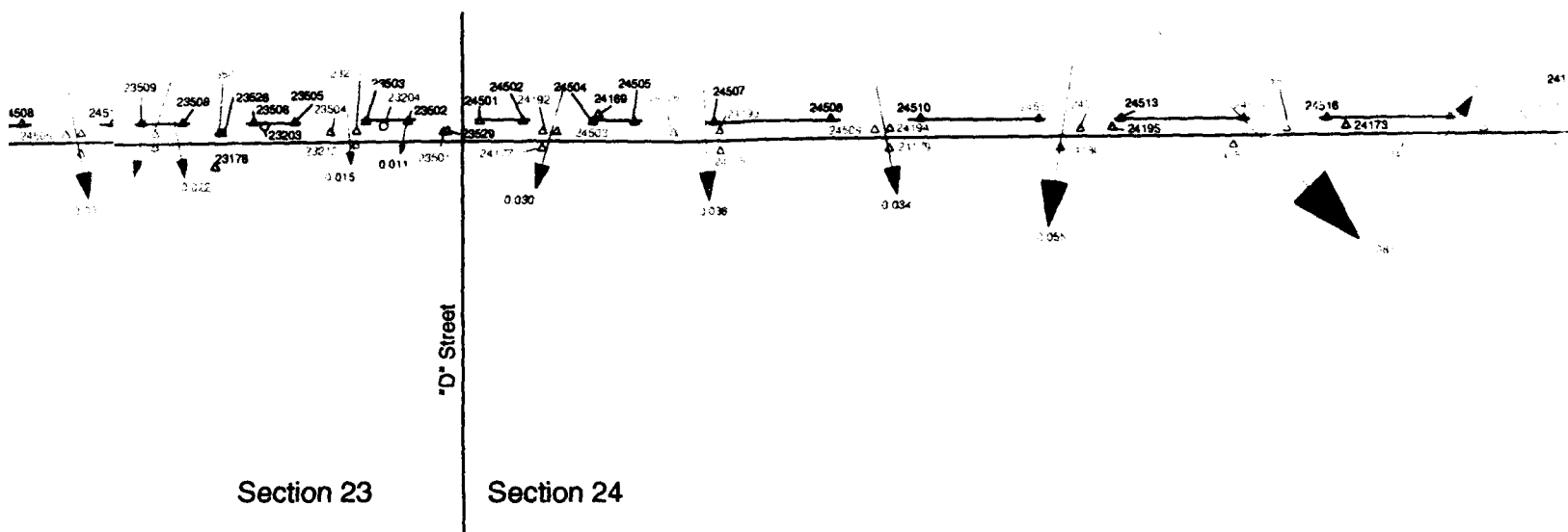
Direction and magnitude of water-table gradient in feet/feet

Note: Wells in red were utilized in three-point solutions of water-table direction and magnitude.

Drainage

Containment system

Recharge
Barrier



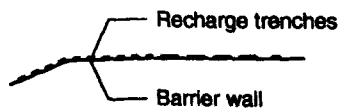
EXPLANATION

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Figure 5.

Direction

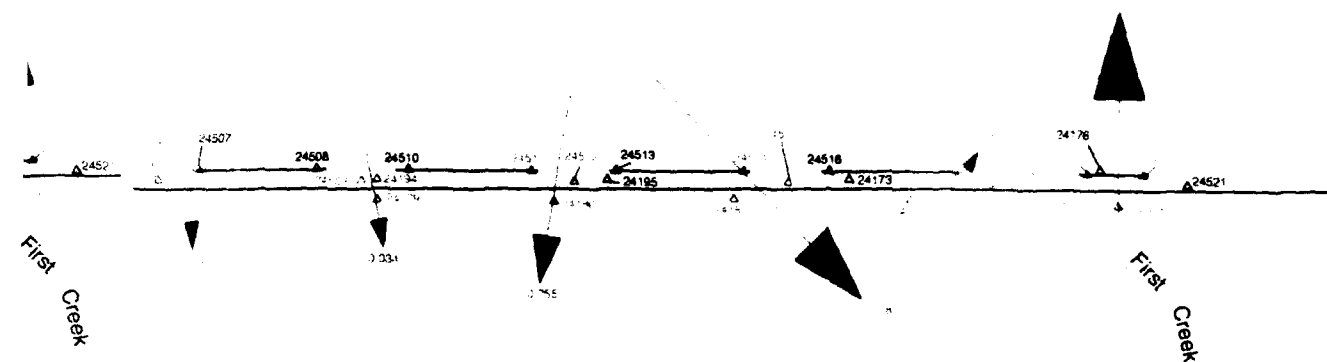
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April 1 to

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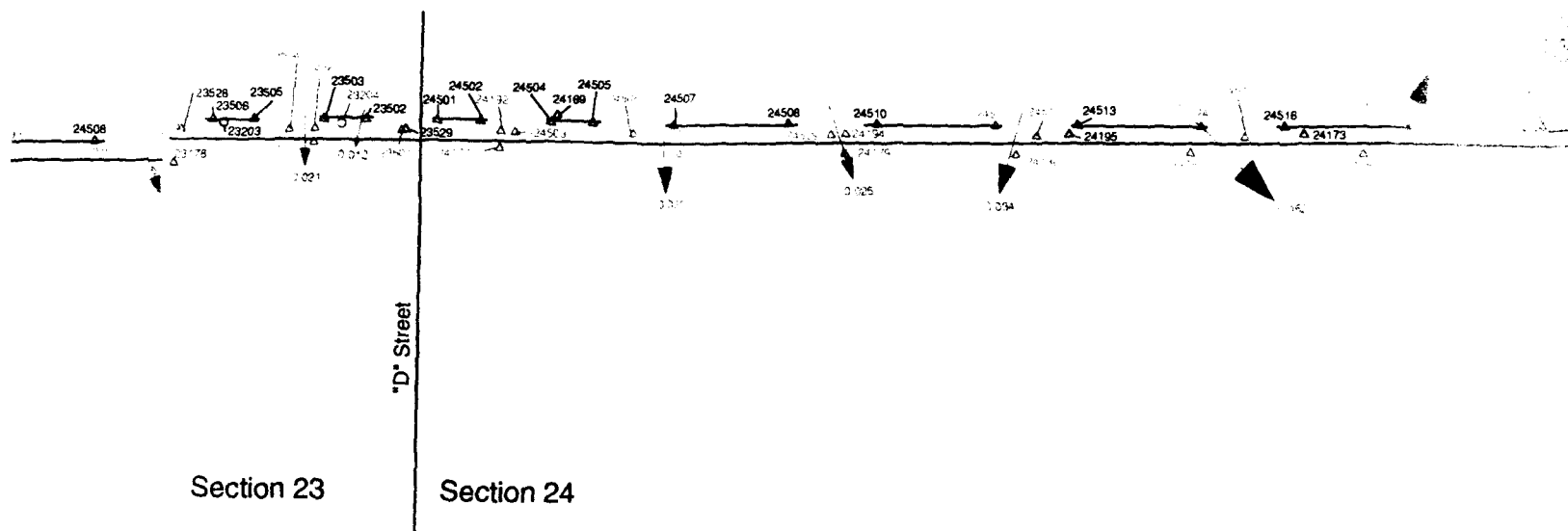
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Recharge trenches
agnitude
f the Nor Barrier wall
em Barri
30, 1991

Prepared for:
Program Manager for
Rocky Mountain Arsenal
Commerce City, Colorado
Prepared by:
Harding Lawson Associates

Figure 5.11
Direction and Magnitude of Water-Table Gradients
in the Vicinity of the North Boundary Containment/
Treatment System Barrier Wall from
April 1 to June 30, 1991
GWAR FY91

(2)

(3)



EXPLANATION

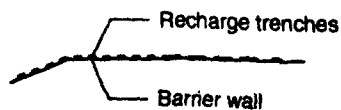
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Containment system



Prepared for:

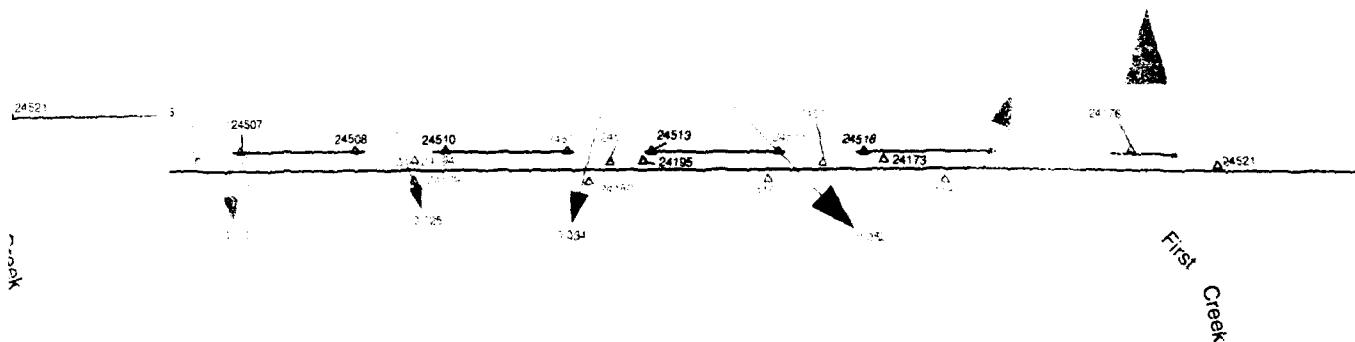
Progra
Rocky
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Prepared by:
Hardin

Figure 5.12

Direction and I
in the Vicinity
Treatment Sy:
July 1 to Sept
GWAR FY91

2



Manager for
Rocky Mountain Arsenal
Commerce City, Colorado

Lawson Associates

Recharge trenches
North Boundary
Barrier Wall from
July 1 to September 30, 1991

Prepared for:

Program Manager for
Rocky Mountain Arsenal
Commerce City, Colorado

Prepared by:

Harding Lawson Associates

Figure 5.12

Direction and Magnitude of Water-Table Gradients
in the Vicinity of the North Boundary Containment/
Treatment System Barrier Wall from
July 1 to September 30, 1991

GWAR FY91

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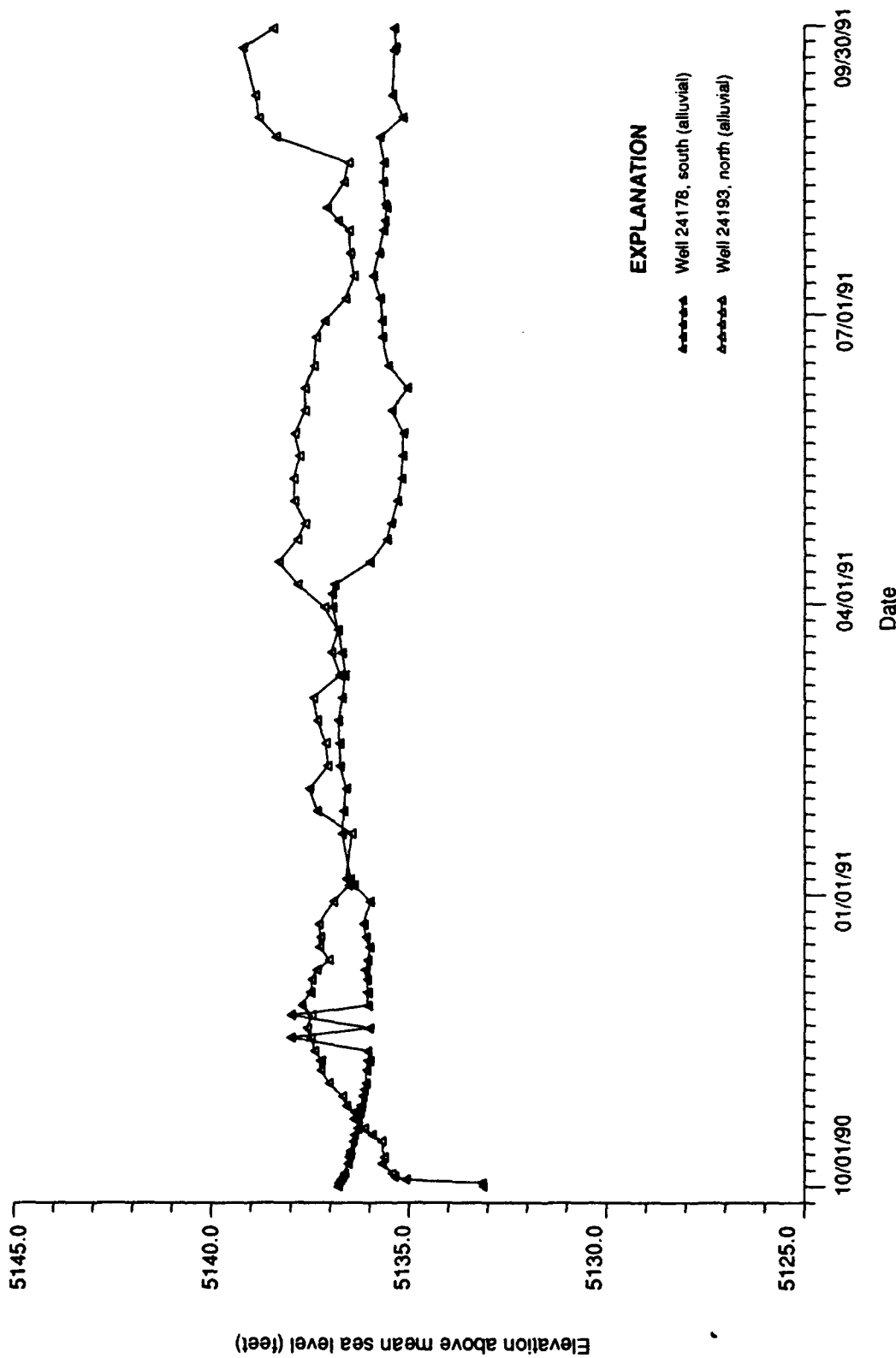


Figure 5.13

Hydrograph of Unconfined Flow System Wells Across the North Boundary Containment/Treatment System Barrier Wall (wells 24178 and 24193)

Prepared for:
Program Manager for
Rocky Mountain Arsenal
Commerce City, Colorado

Prepared by:
GWAR FY91

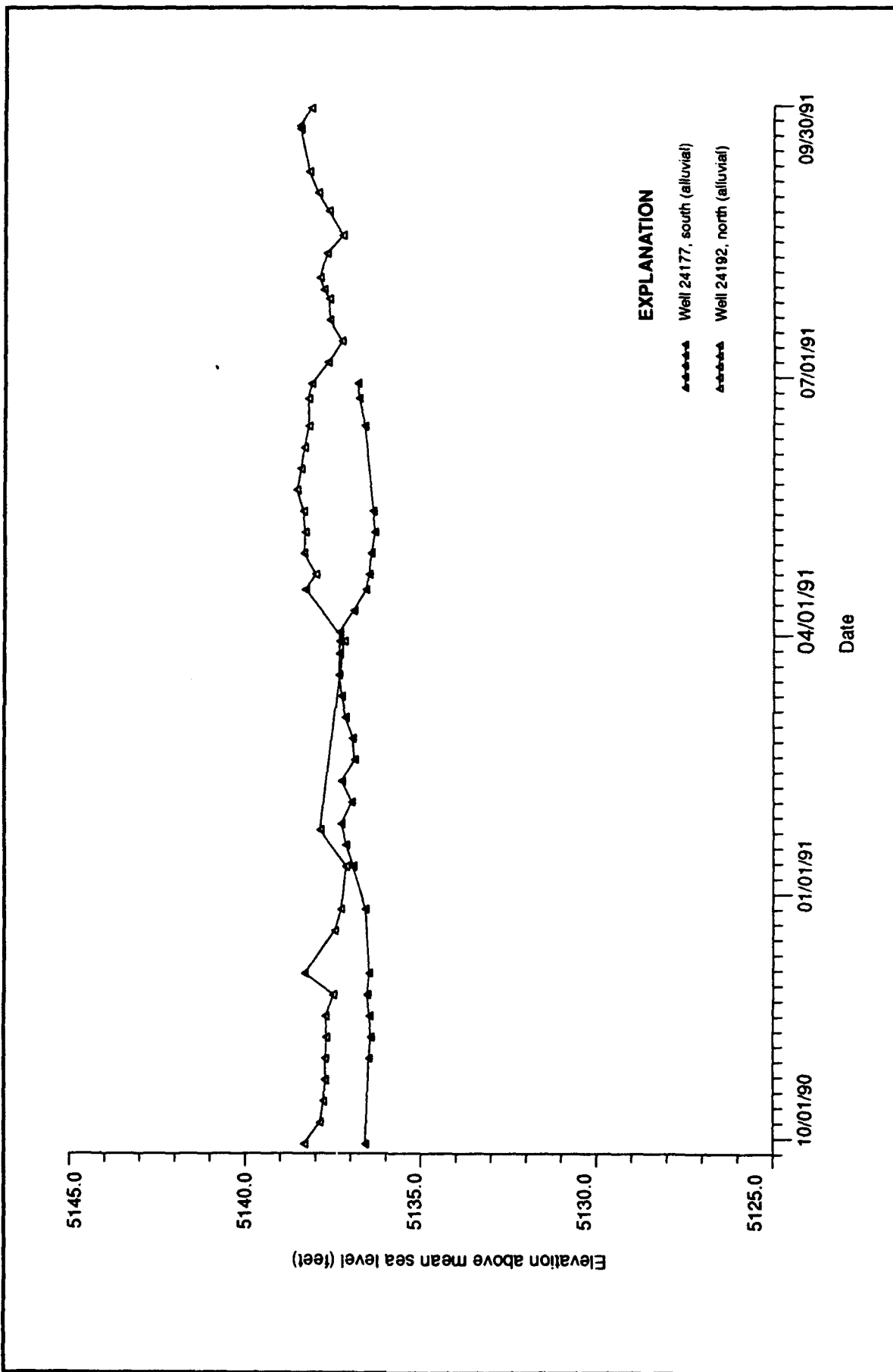


Figure 5.14

Hydrograph of Unconfined Flow System Wells Across the North Boundary Containment/Treatment System Barrier Wall (wells 24177 and 24192)

Prepared for:
Program Manager for
Rocky Mountain Arsenal
Commerce City, Colorado

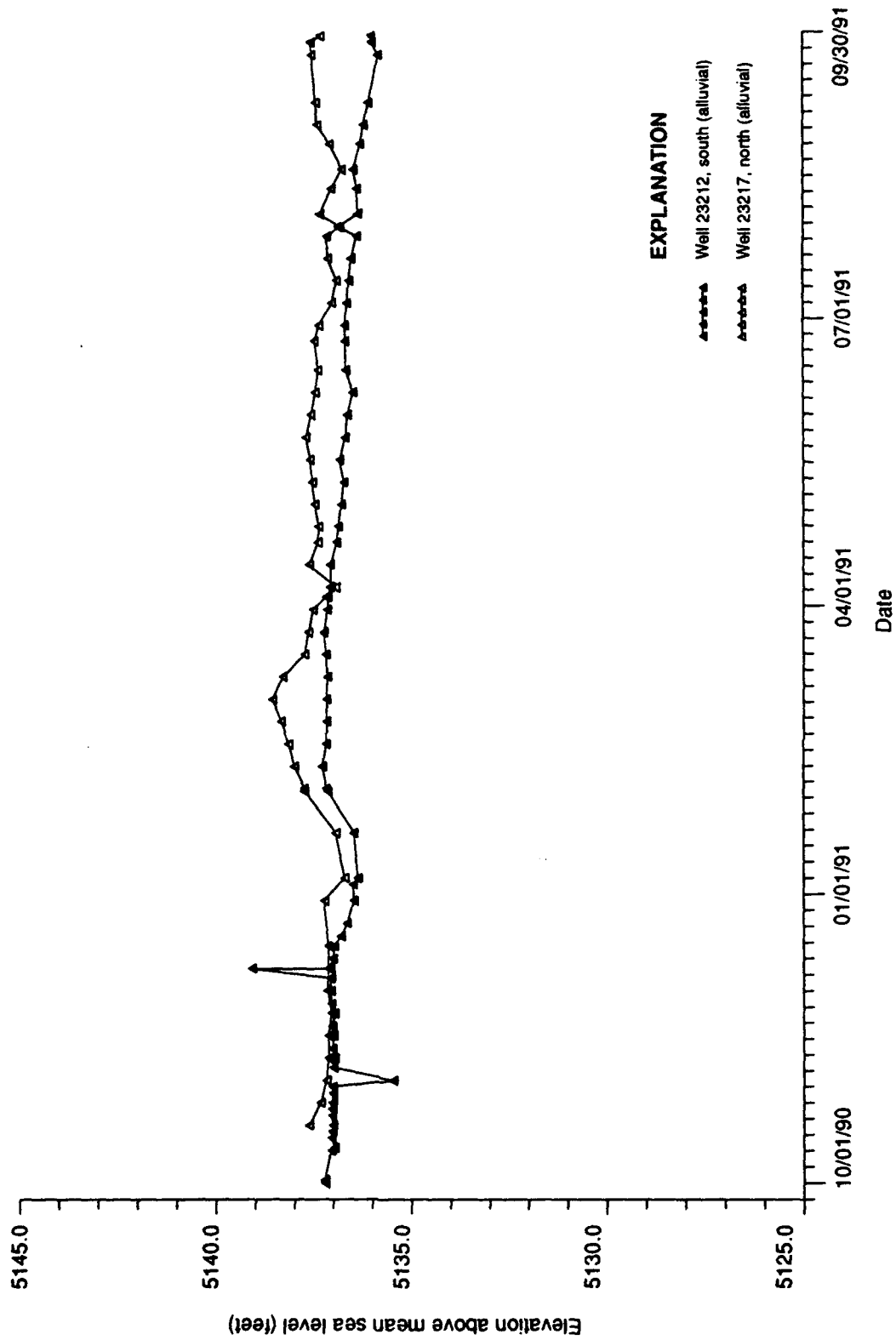


Figure 5.15

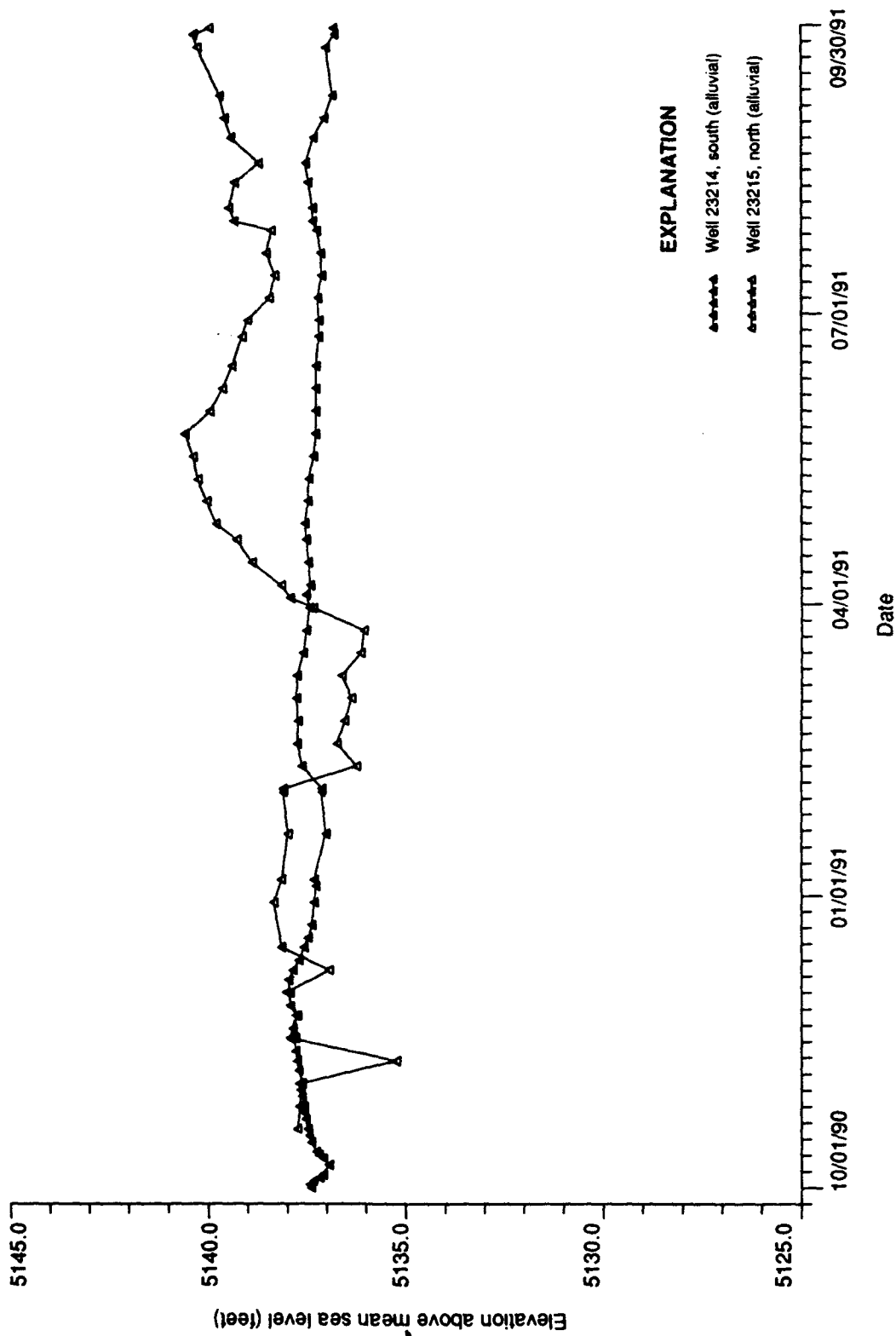
Hydrograph of Unconfined Flow System Wells Across the North Boundary Containment/Treatment System Barrier Wall (wells 23212 and 23217)

Prepared for:
Program Manager for
Rocky Mountain Arsenal
Commerce City, Colorado

Drawn by:

GWAR FY91

RMA 1076.7



EXPLANATION

- ▲ Well 23214, south (alluvial)
- Well 23215, north (alluvial)

Prepared for:

Program Manager for
Rocky Mountain Arsenal
Commerce City, Colorado

Prepared by:

Figure 5.16

Hydrograph of Unconfined Flow System Wells Across the North Boundary
Containment/Treatment System Barrier Wall (wells 23214 and 23215)

GWAR FY91

RMA 1076.1

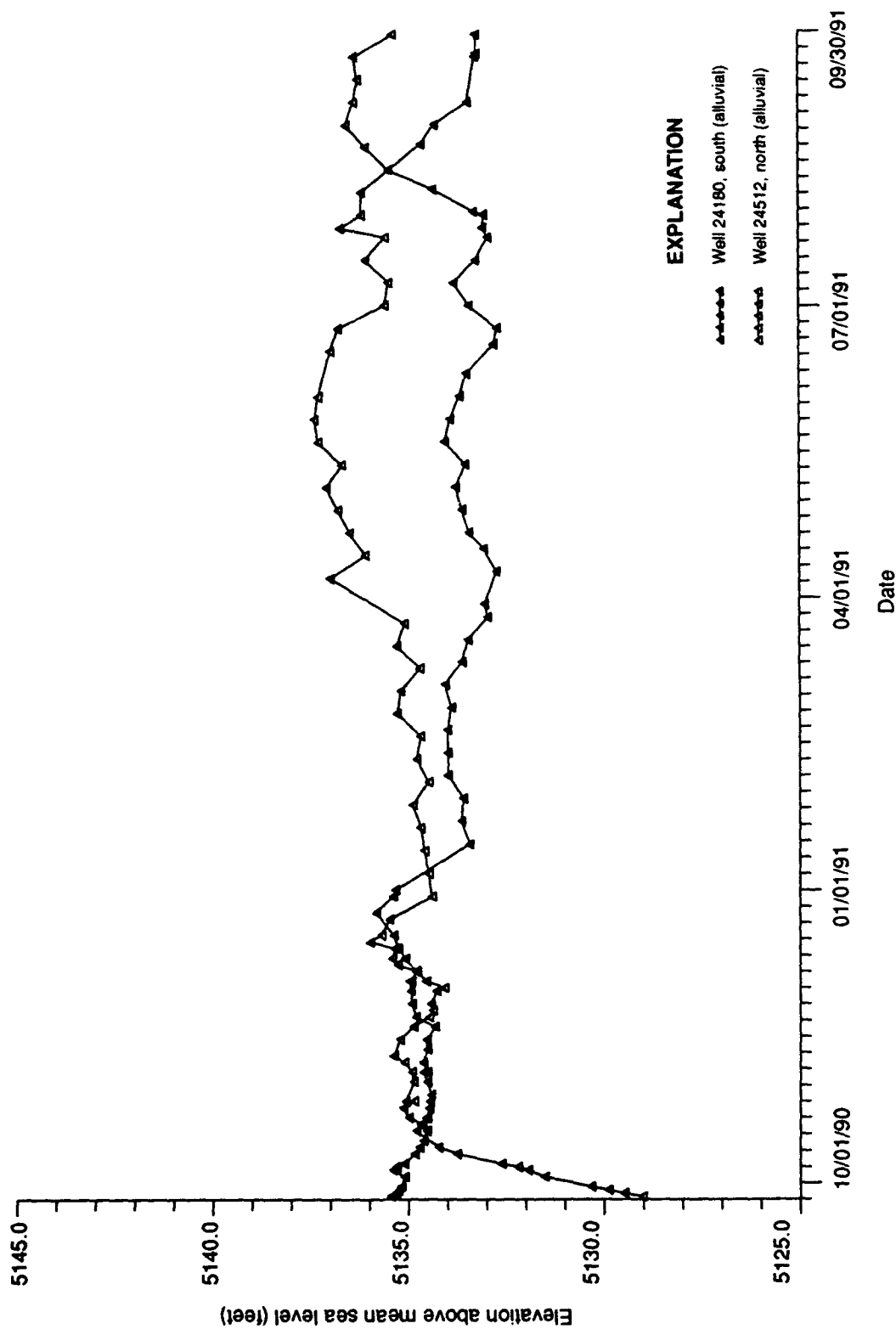
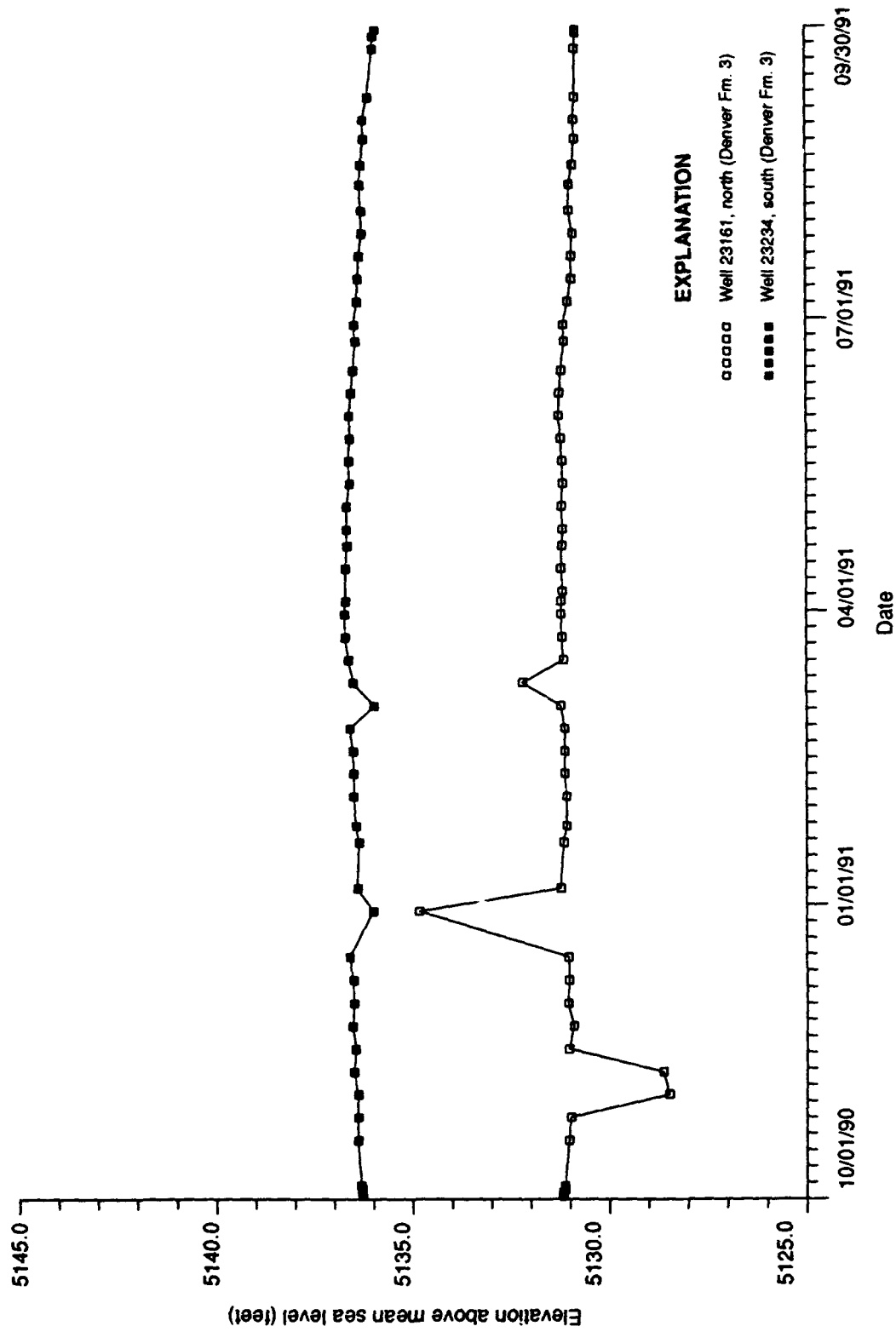


Figure 5.17

Hydrograph of Unconfined Flow System Wells Across the North Boundary Containment/Treatment System Barrier Wall (wells 24180 and 24512)

Prepared for:
Program Manager for
Rocky Mountain Arsenal
Commerce City, Colorado

RMMA 1078.12



Prepared for:
Program Manager for
Rocky Mountain Arsenal
Commerce City, Colorado

Prepared by:
Harding Lawson Associates

Figure 5.18
Hydrograph of Confined Flow System Wells Across the North Boundary
Containment/Treatment System Barrier Wall (wells 23161 and 23234)
GWAR FY91

RMA 1076.9

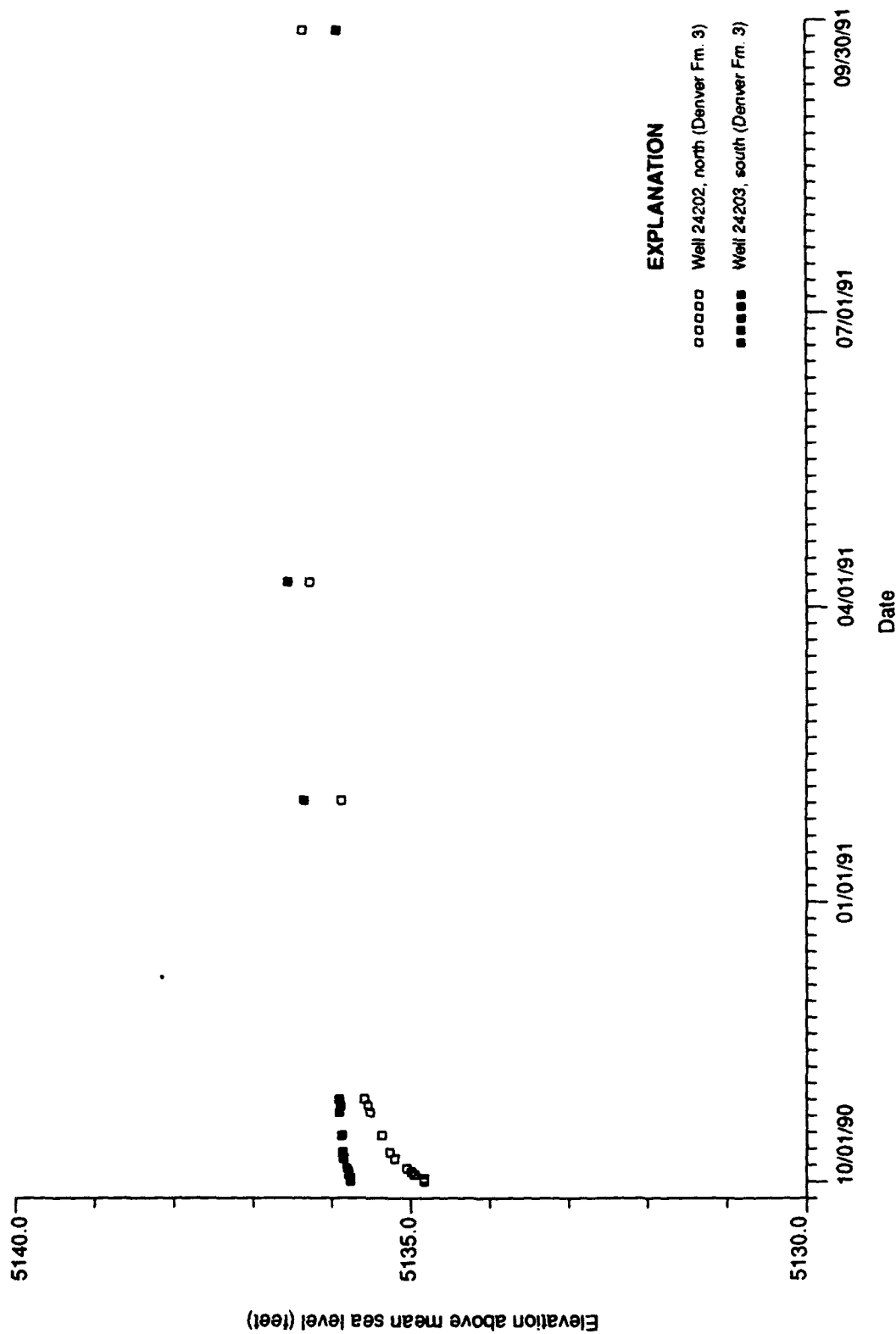


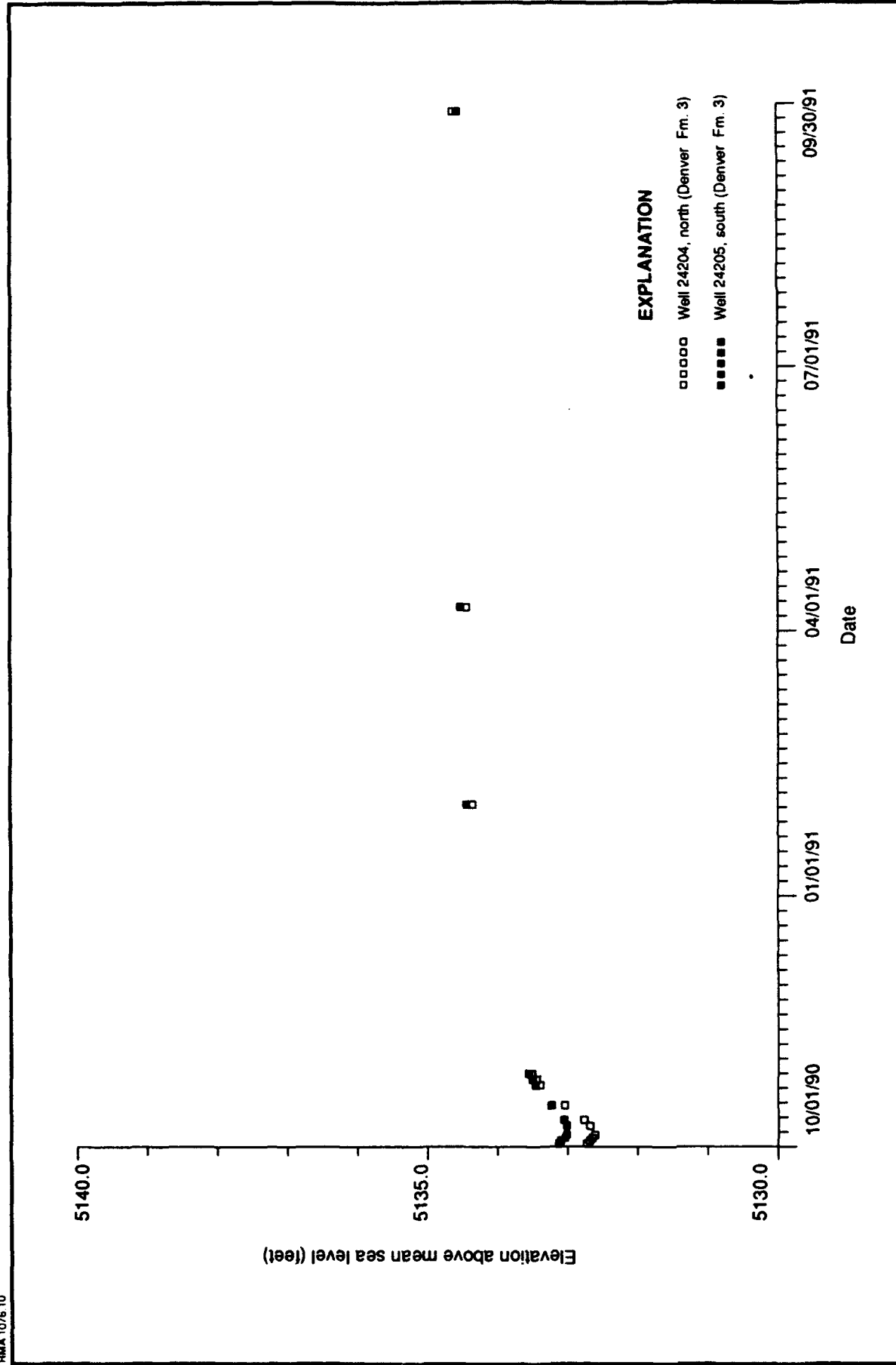
Figure 5.19
Hydrograph of Confined Flow System Wells Across the North Boundary
Containment/Treatment System Barrier Wall (wells 24202 and 24203)

Prepared for:
Program Manager for
Rocky Mountain Arsenal
Commerce City, Colorado

Revised by:

01/01/91

RMA 1076 10



Prepared for: Program Manager for Rocky Mountain Arsenal Commerce City, Colorado

Prepared by:

Figure 5.20
Hydrograph of Confined Flow System Wells Across the North Boundary Containment/Treatment System Barrier Wall (wells 24204 and 24205)

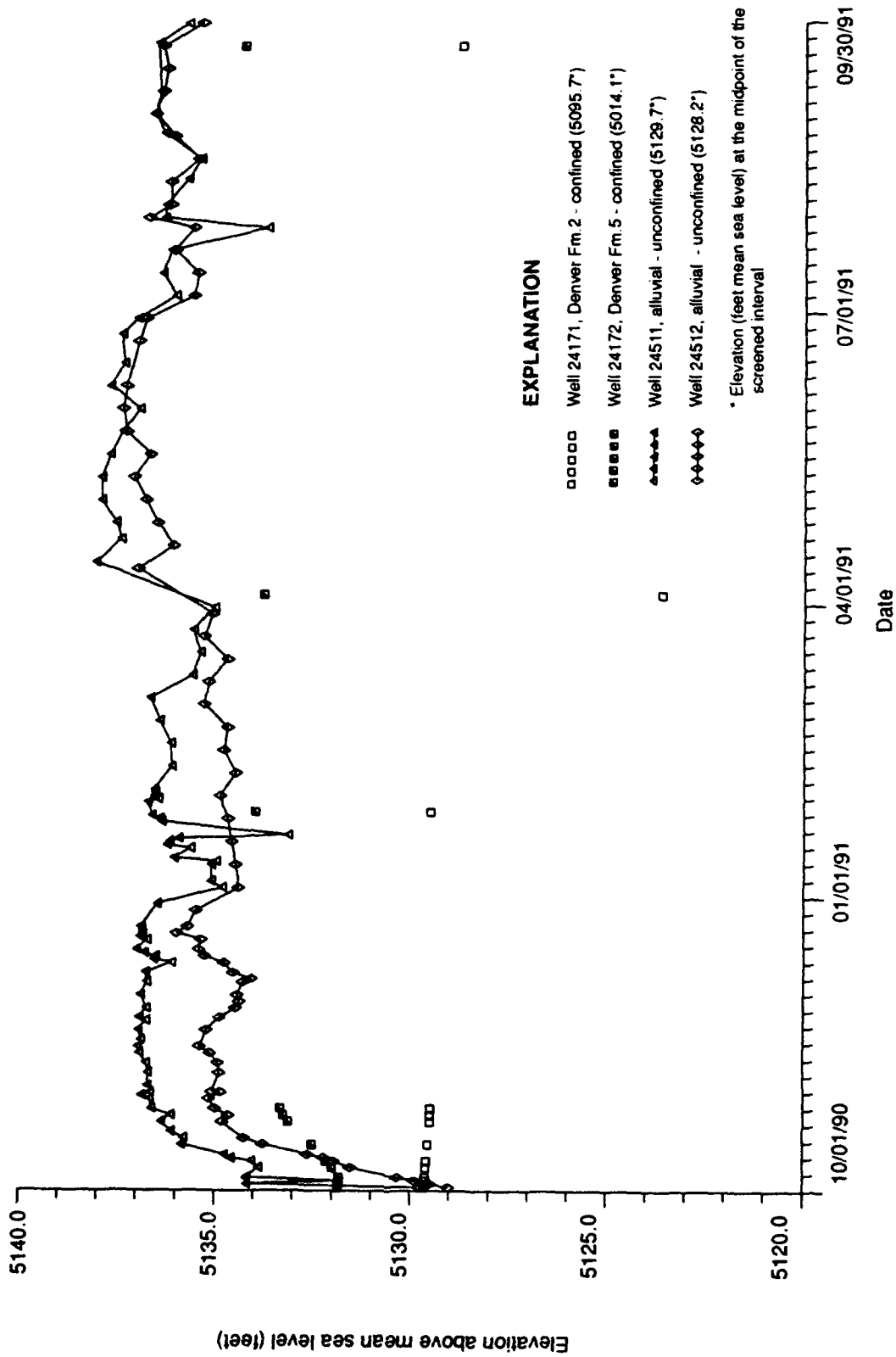


Figure 5.21
Hydrograph of Well Cluster North of the North Boundary Containment/Treatment System Barrier Wall (wells 24171, 24172, 24511, and 24512)

Prepared for:
Program Manager for
Rocky Mountain Arsenal
Commerce City, Colorado

Prepared by:

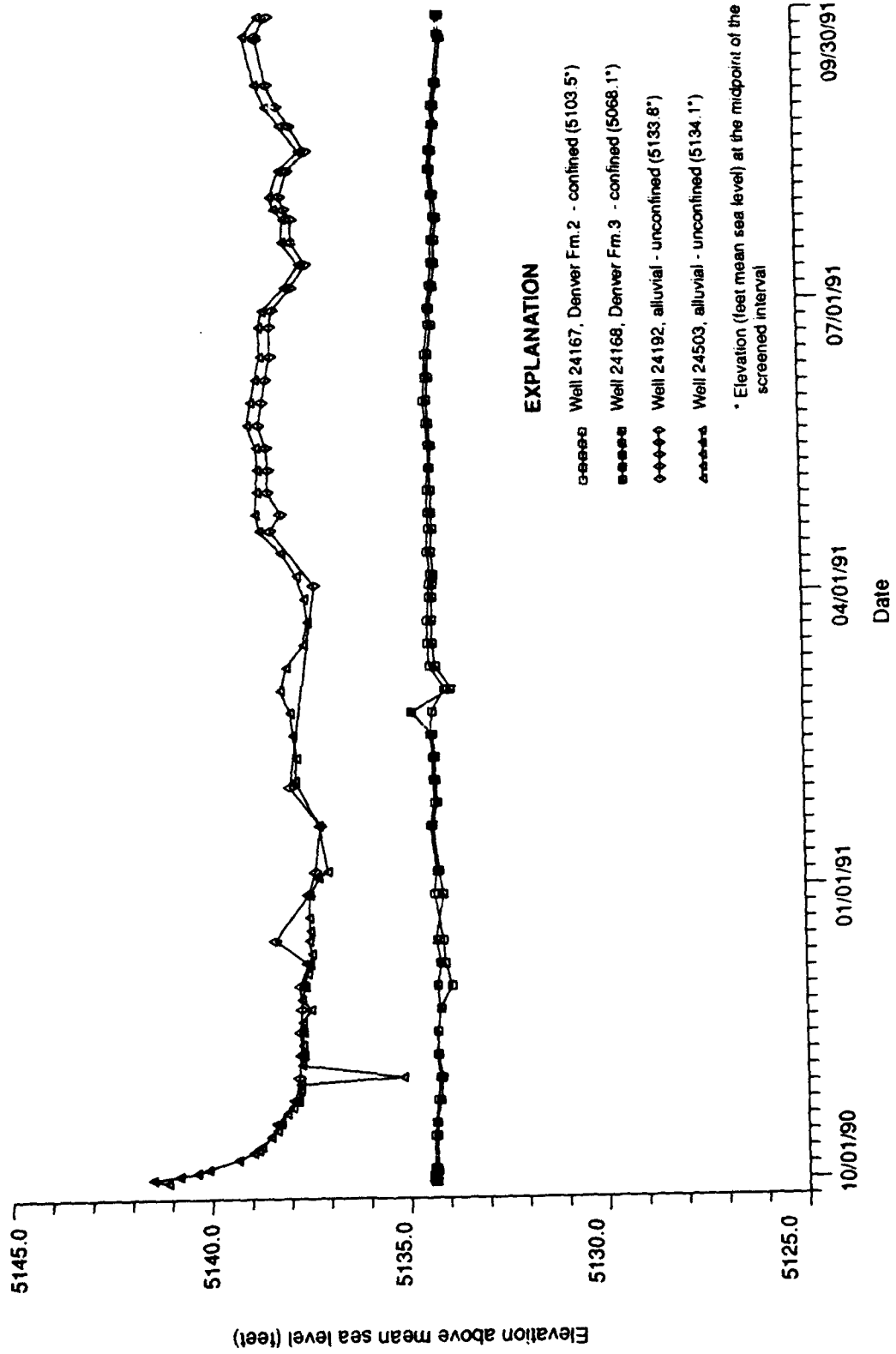


Figure 5.22
Hydrograph of Well Cluster North of the North Boundary Containment/Treatment System Barrier Wall (wells 24167, 24168, 24192, and 24503)

Prepared for:
Program Manager for
Rocky Mountain Arsenal
Commerce City, Colorado

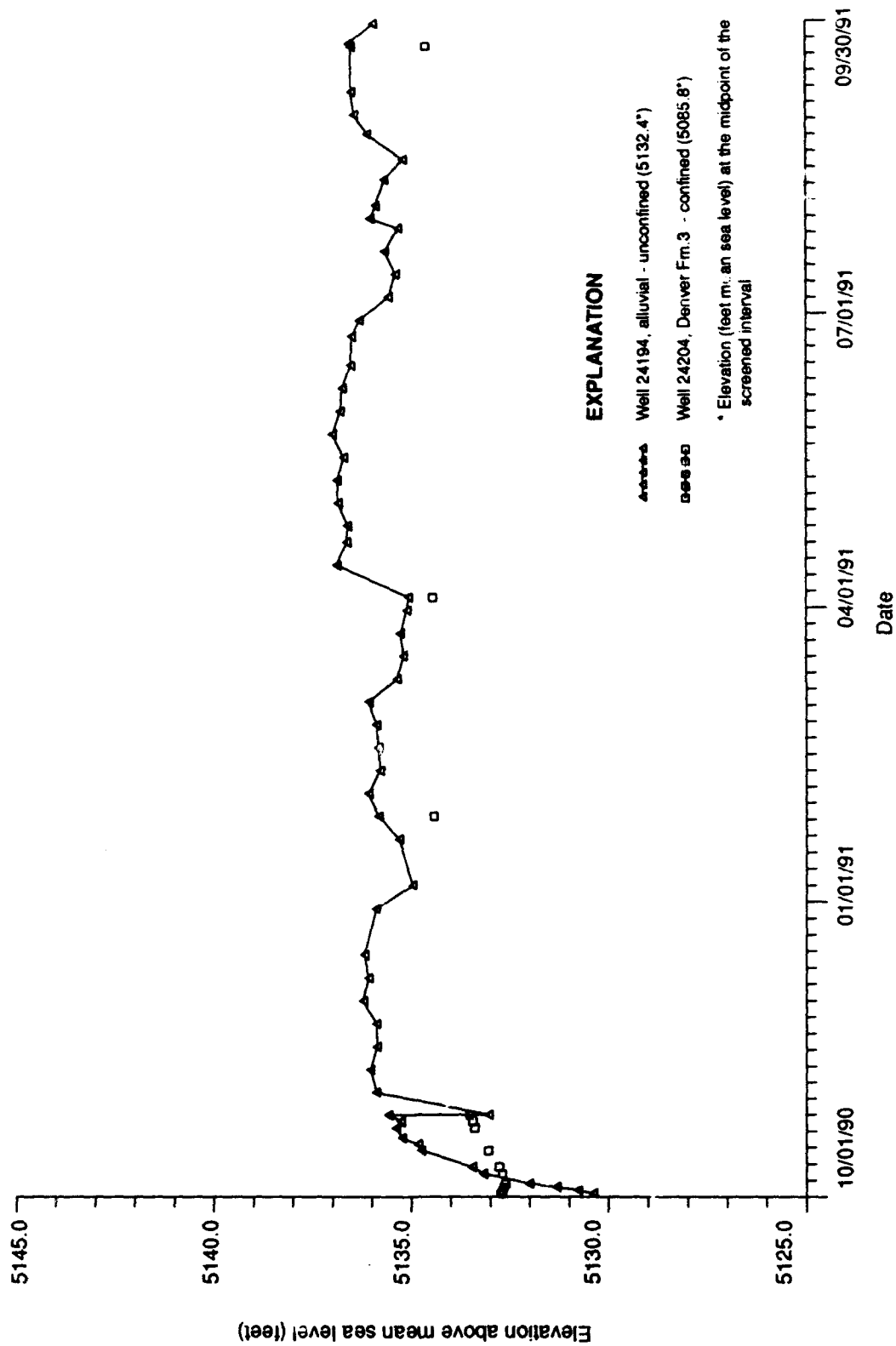


Figure 5.23
Hydrograph of Well Cluster North of the North Boundary Containment/Treatment System Barrier Wall (wells 24194 and 24204)

Prepared for:
Program Manager for
Rocky Mountain Arsenal
Commerce City, Colorado

Prepared by:
Lundberg & Associates

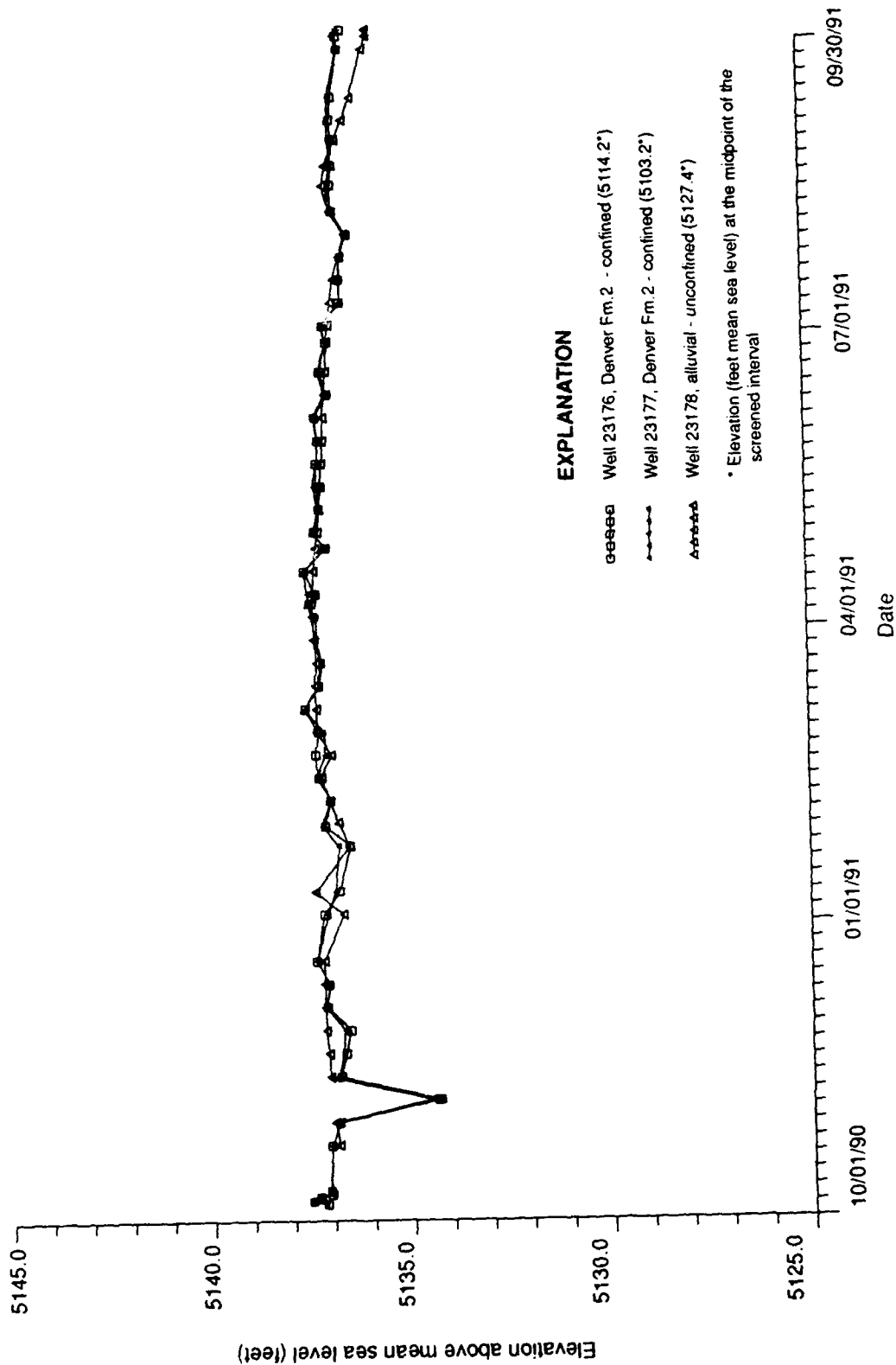
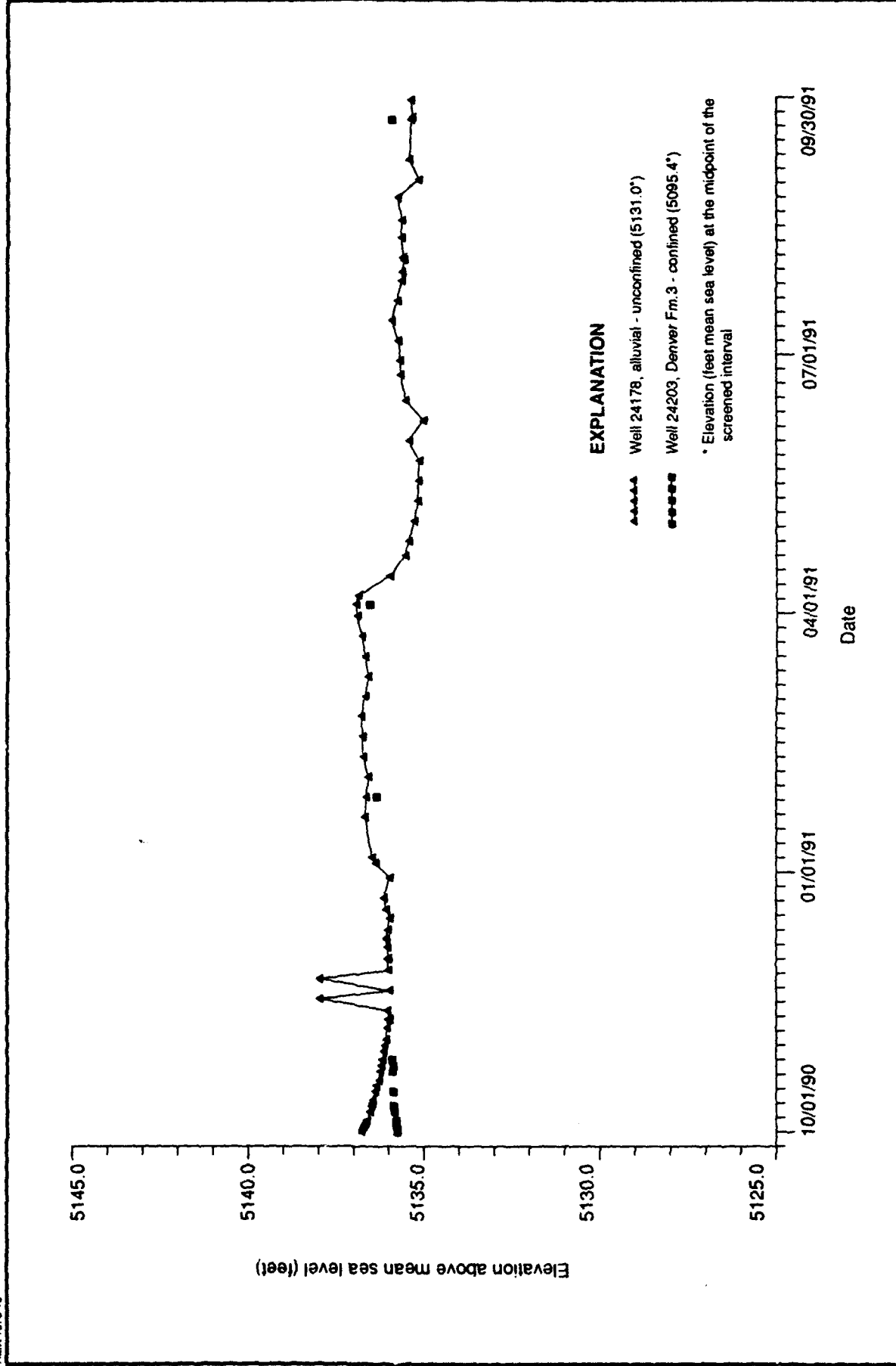


Figure 5.24
Hydrograph of Well Cluster South of the North Boundary Containment/Treatment

Prepared for:
Program Manager for
Rocky Mountain Arsenal

RMA 1076 16



Prepared for:
Program Manager for
State of Colorado

Figure 5.25
Hydrograph of Well Cluster South of the North Boundary Containment/Treatment

RMA 1076 17

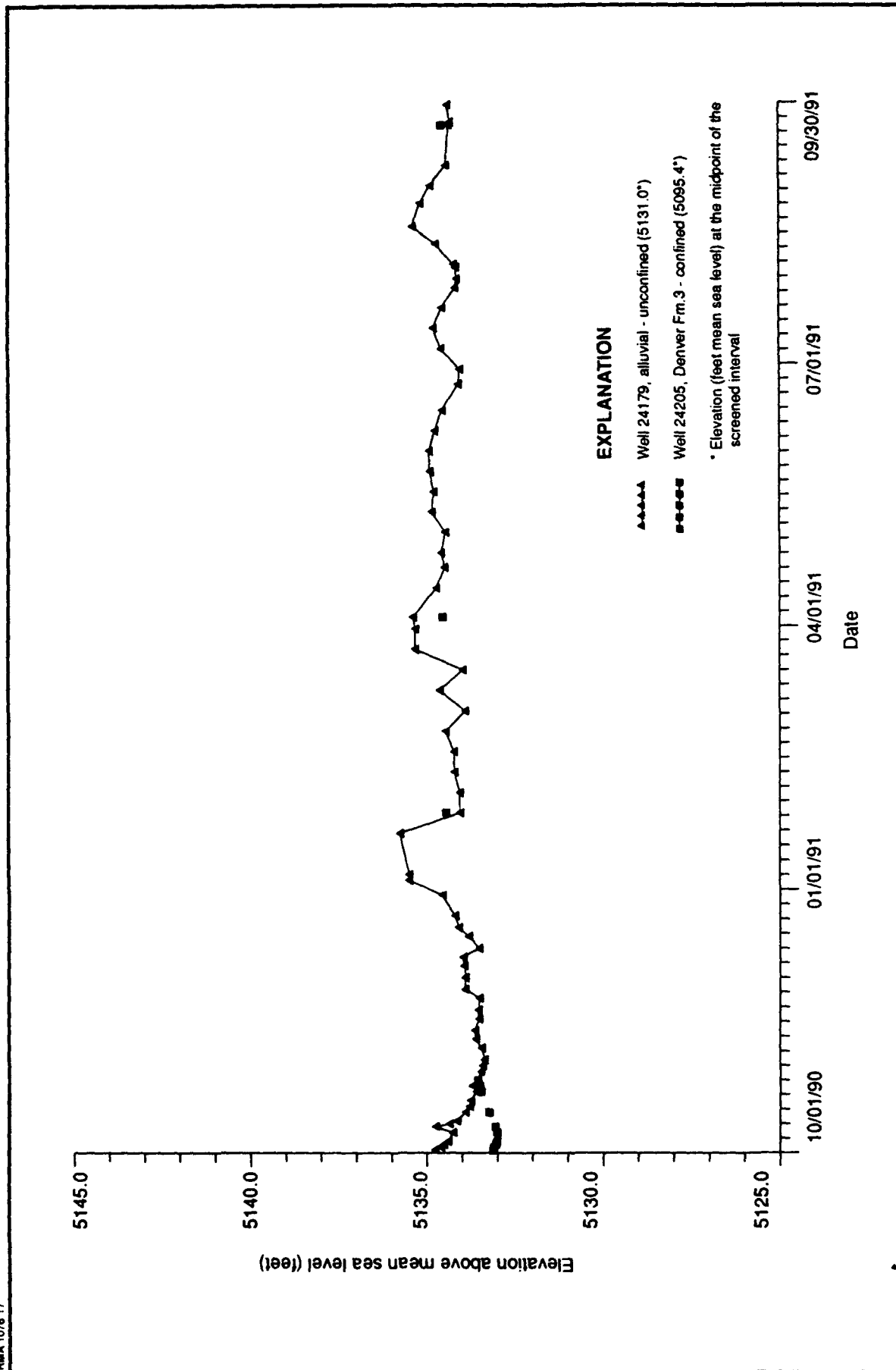
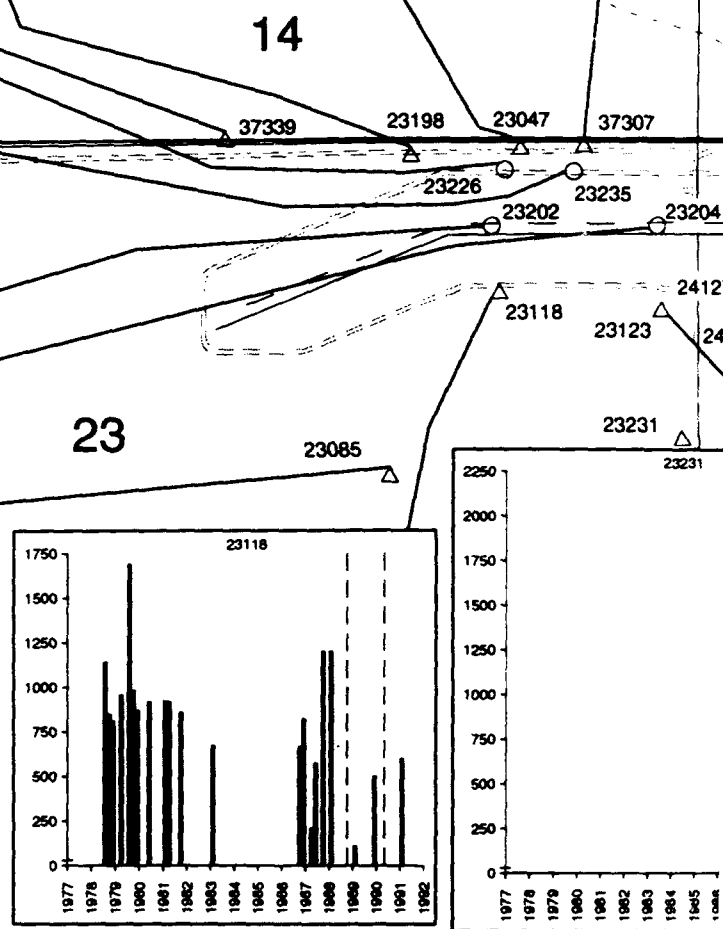
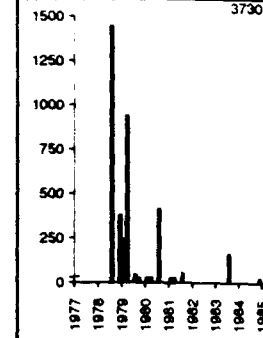
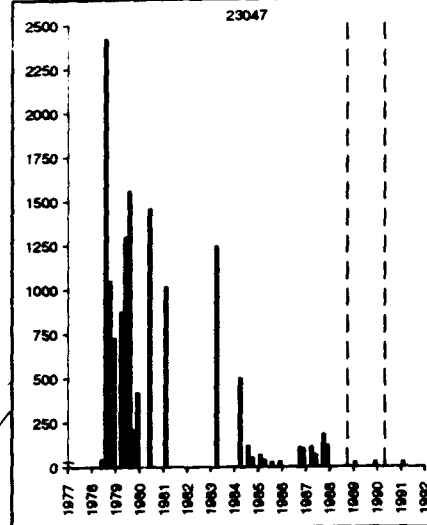
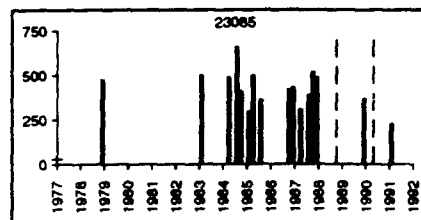
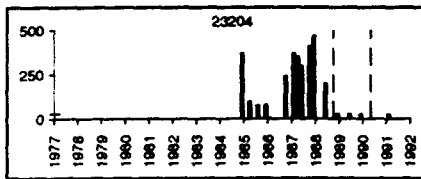
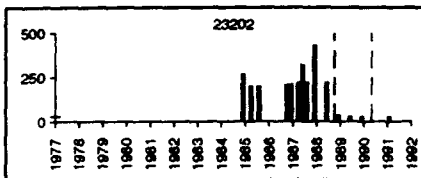
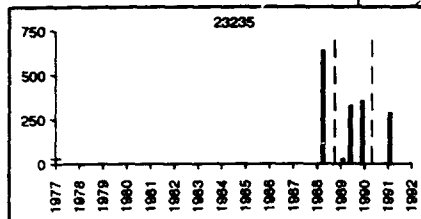
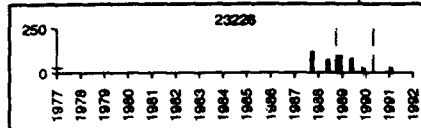
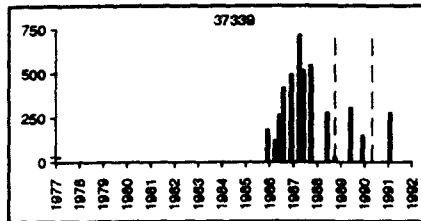
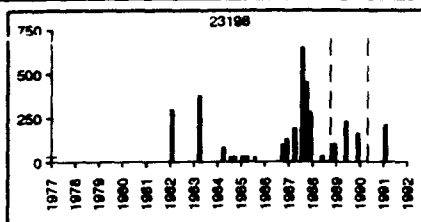


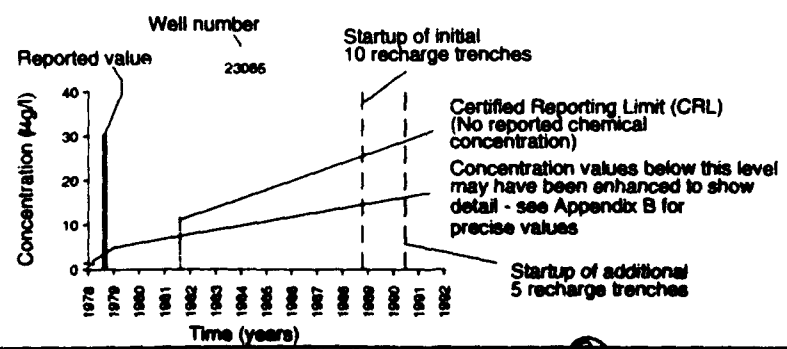
Figure 5.26

Hydrograph of Well Cluster South of the North Boundary Containment/Treatment System Barrier Wall (wells 24179 and 24205)

Prepared for:
Program Manager for
Rocky Mountain Arsenal
Commerce City, Colorado

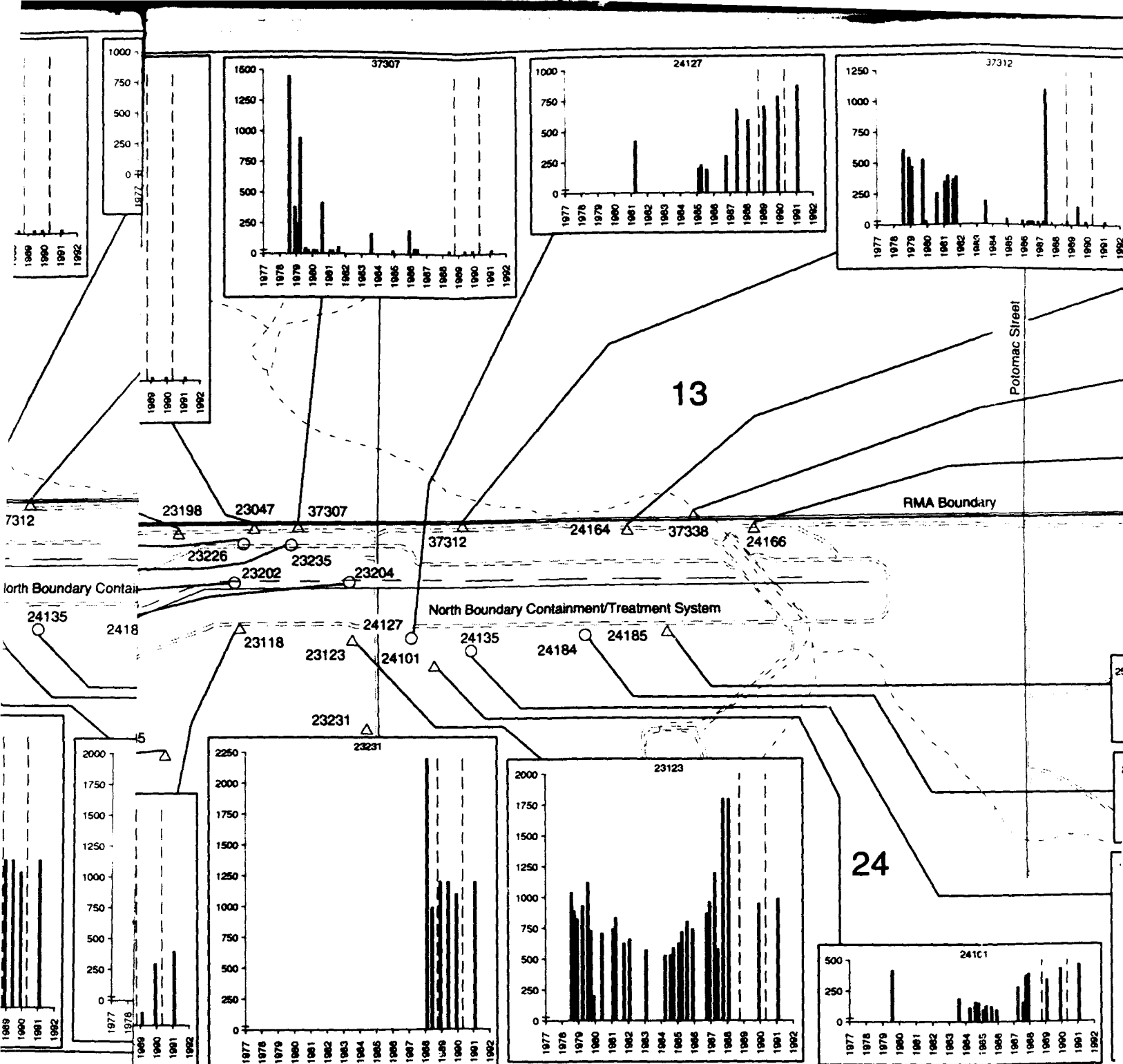


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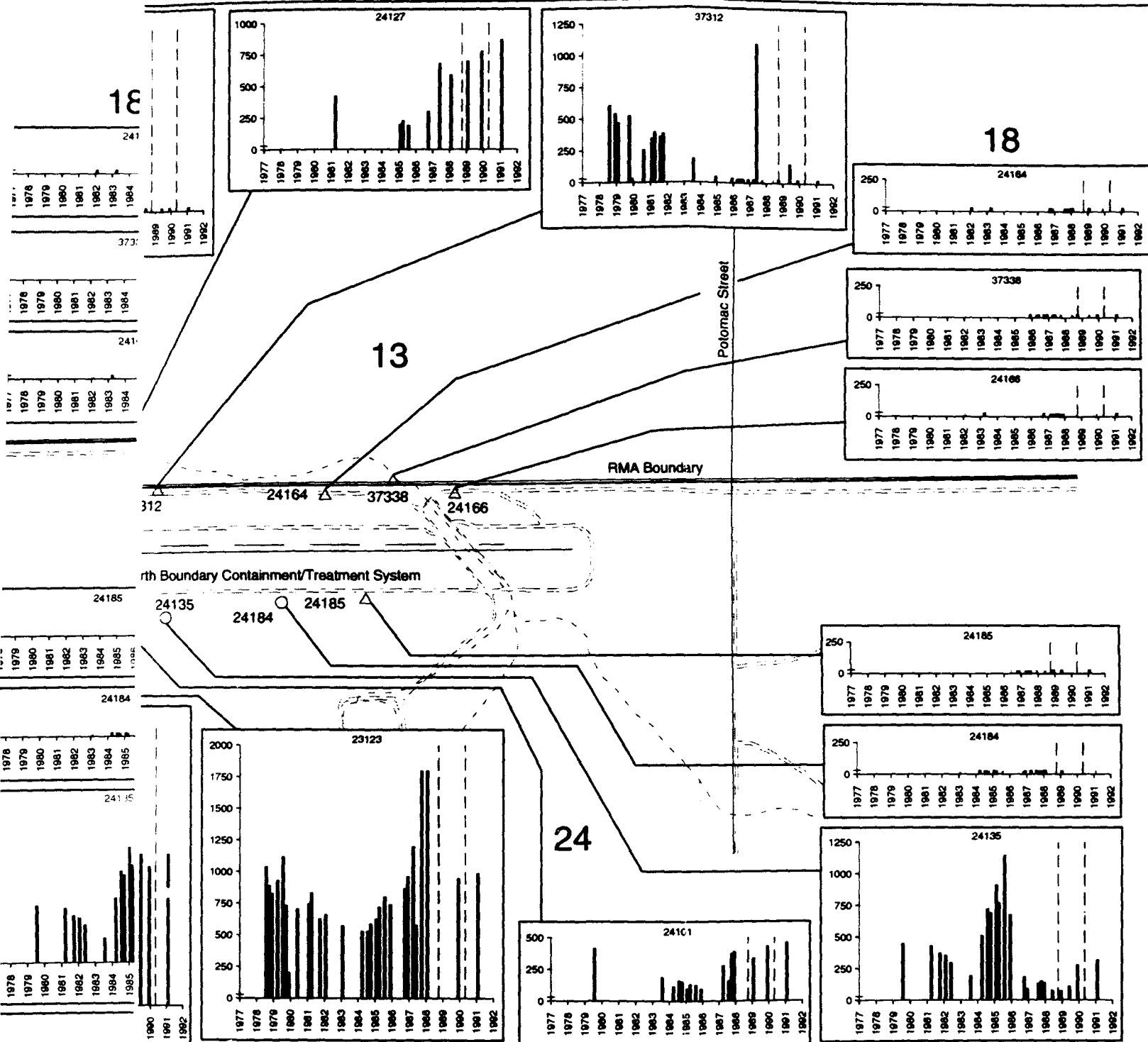
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Program Manager for
Rocky Mountain Arsenal
Commerce City, Colorado
Harding Lawson Associates

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Denver well

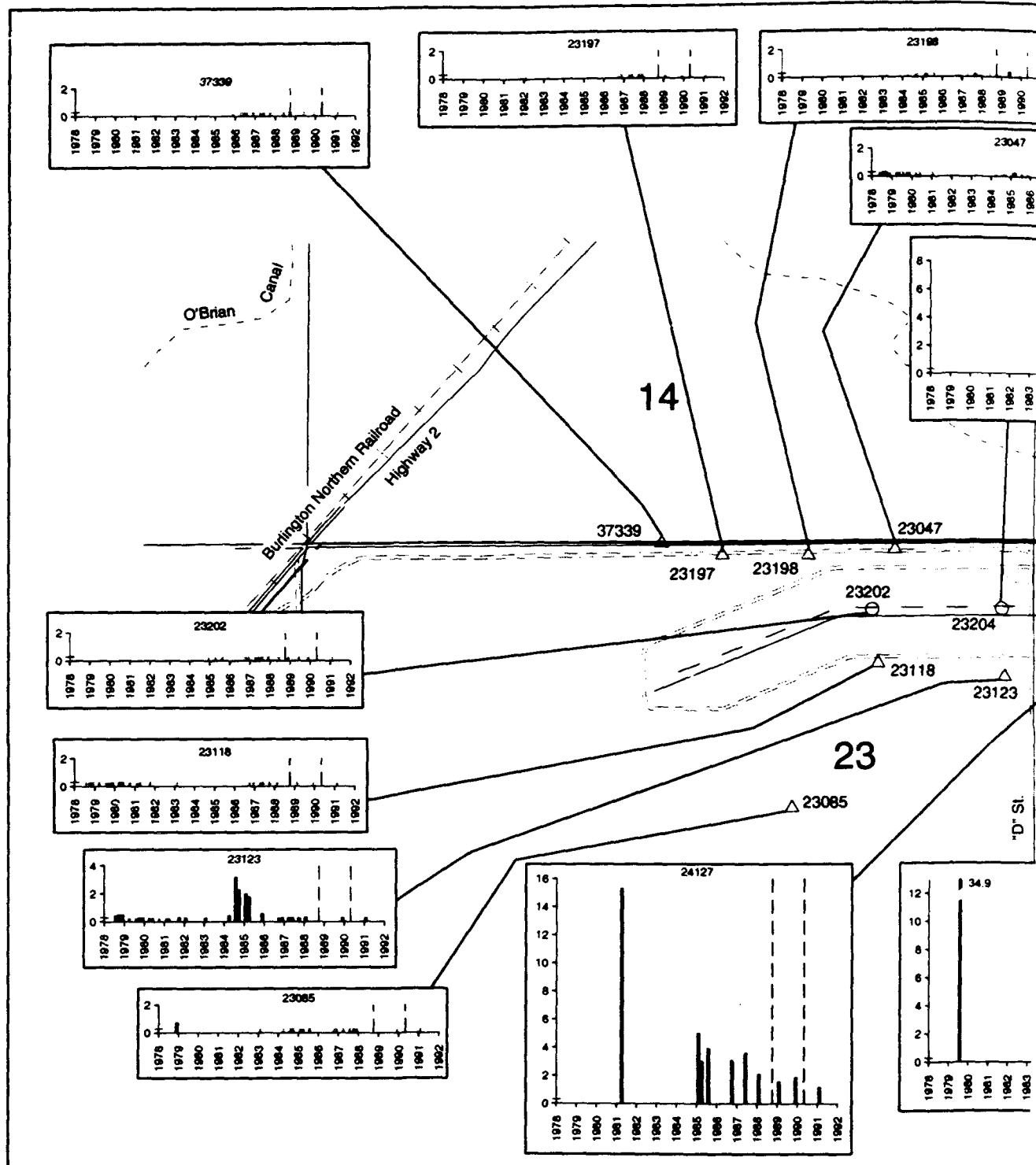
Diisopropylmethylphosphonate (DIMP)
Wells near the North
Boundary Containment/Treatment System

Prepared for:
Program Manager for
Rocky Mountain Arsenal
Commerce City, Colorado
Prepared by:
Harding Lawson Associates

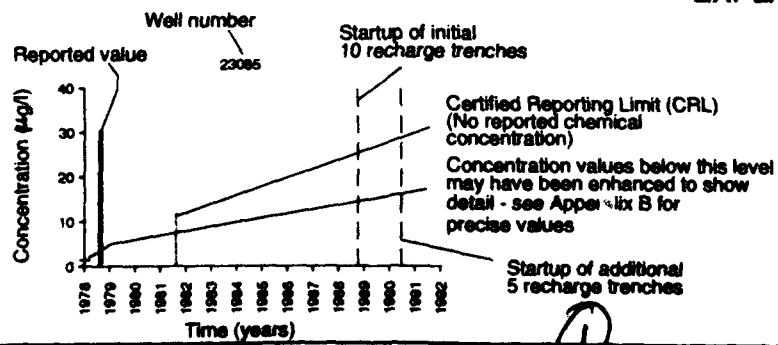
Figure 5.27
Diisopropylmethylphosphonate (DIMP)
Histograms for Wells near the North
Boundary Containment/Treatment System
GWAR FY91

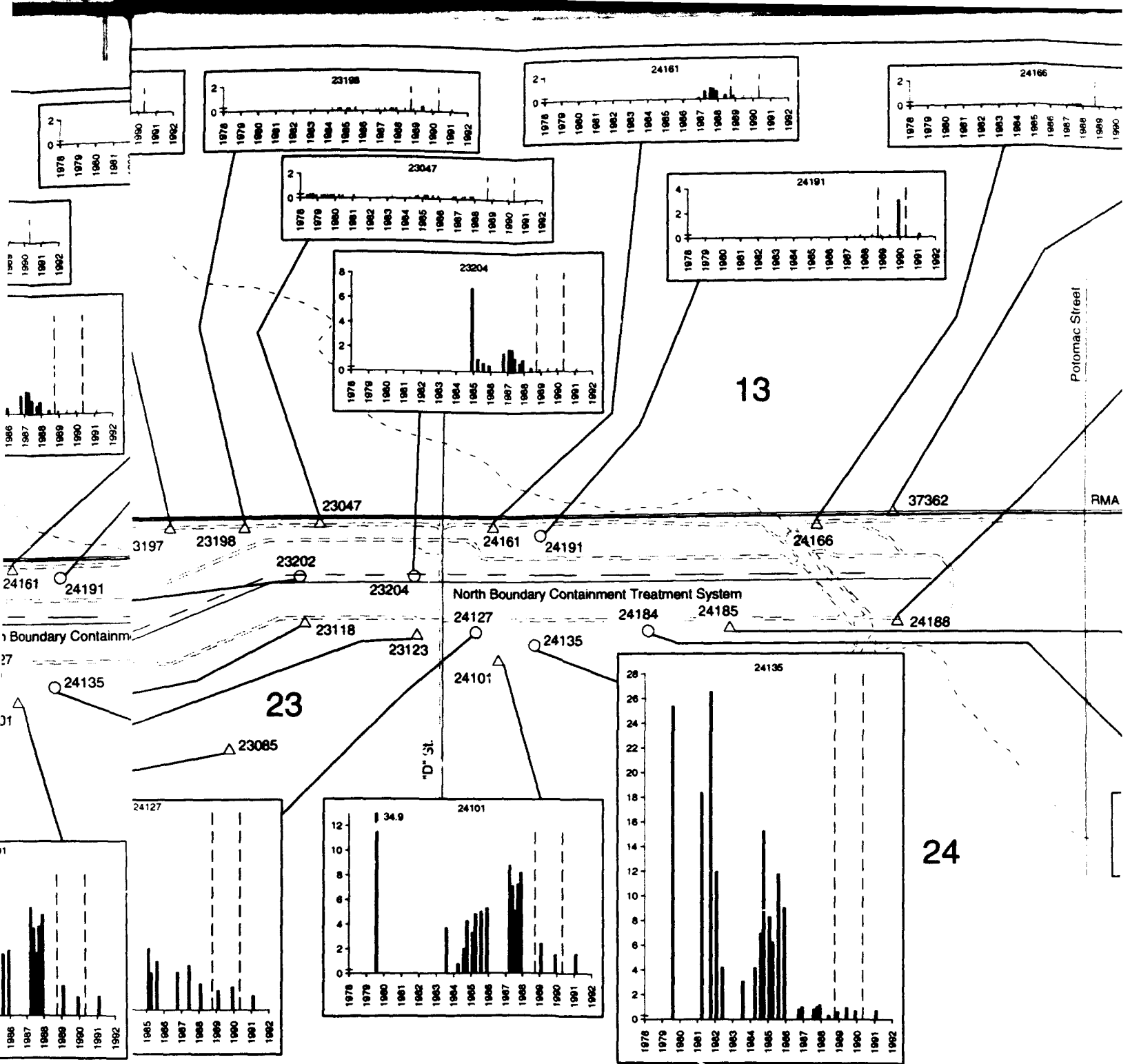
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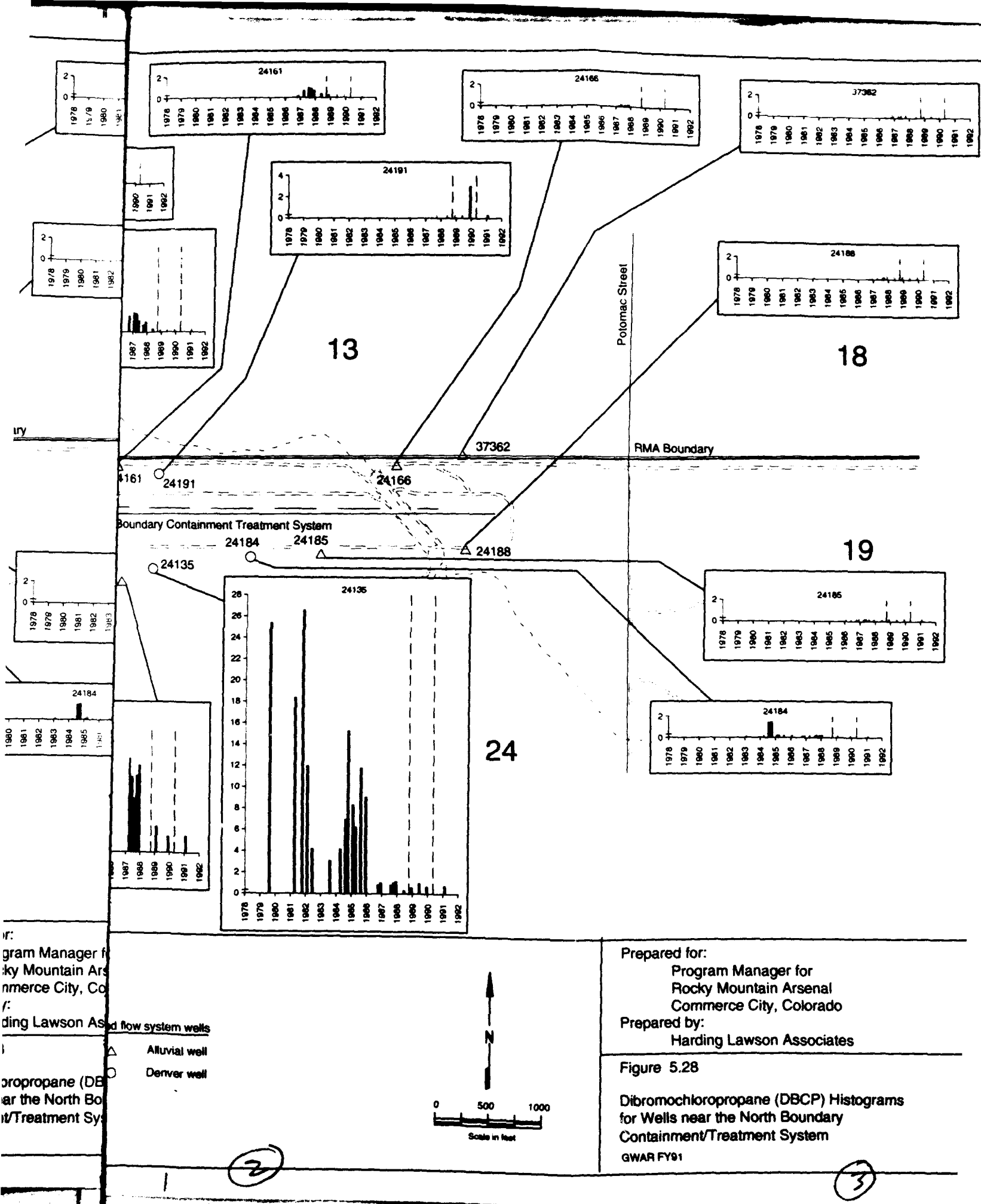
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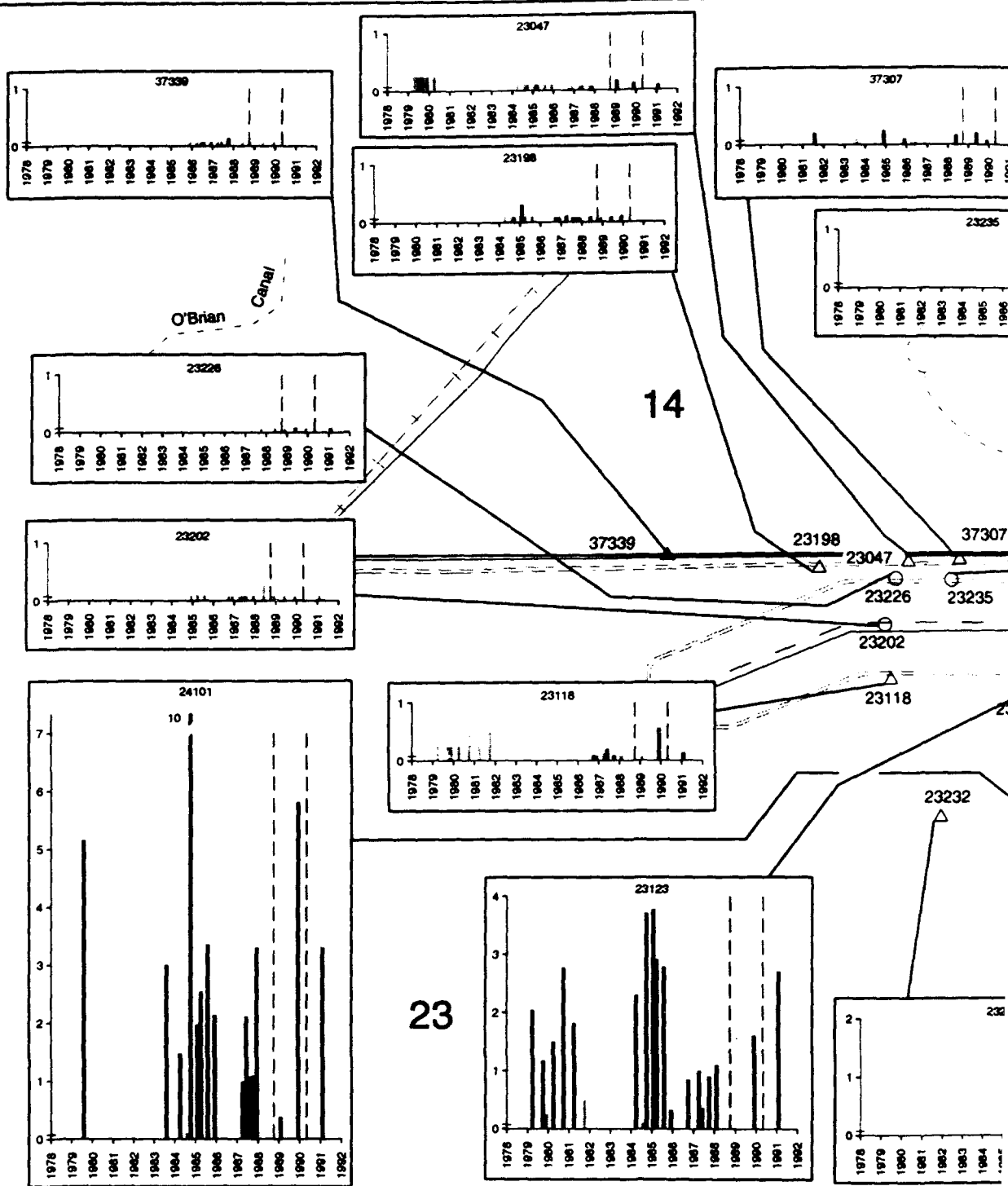
Program Manager for
Rocky Mountain Arsenal
Commerce City, Colorado
Harding Lawson Associates
Dibromochloropropane (DBCP)
near the North Boundary
Containment/Treatment System

Prepared for:
Program Manager for
Rocky Mountain Arsenal
Commerce City, Colorado
Prepared by:
Harding Lawson Associates

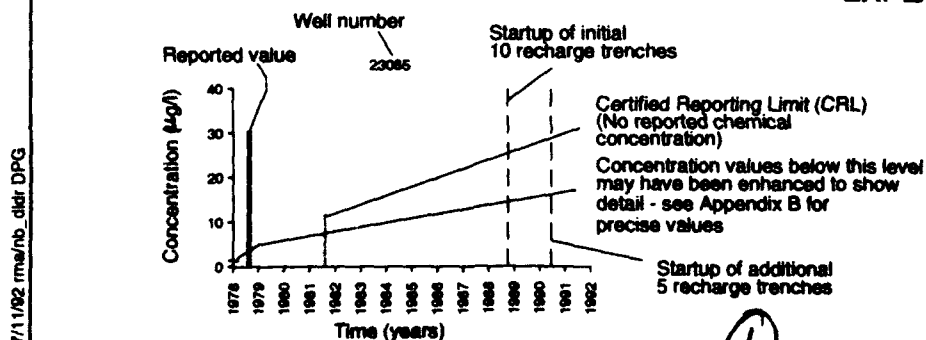
Figure 5.28
Dibromochloropropane (DBCP) Histograms
for Wells near the North Boundary
Containment/Treatment System
GWAR FY91

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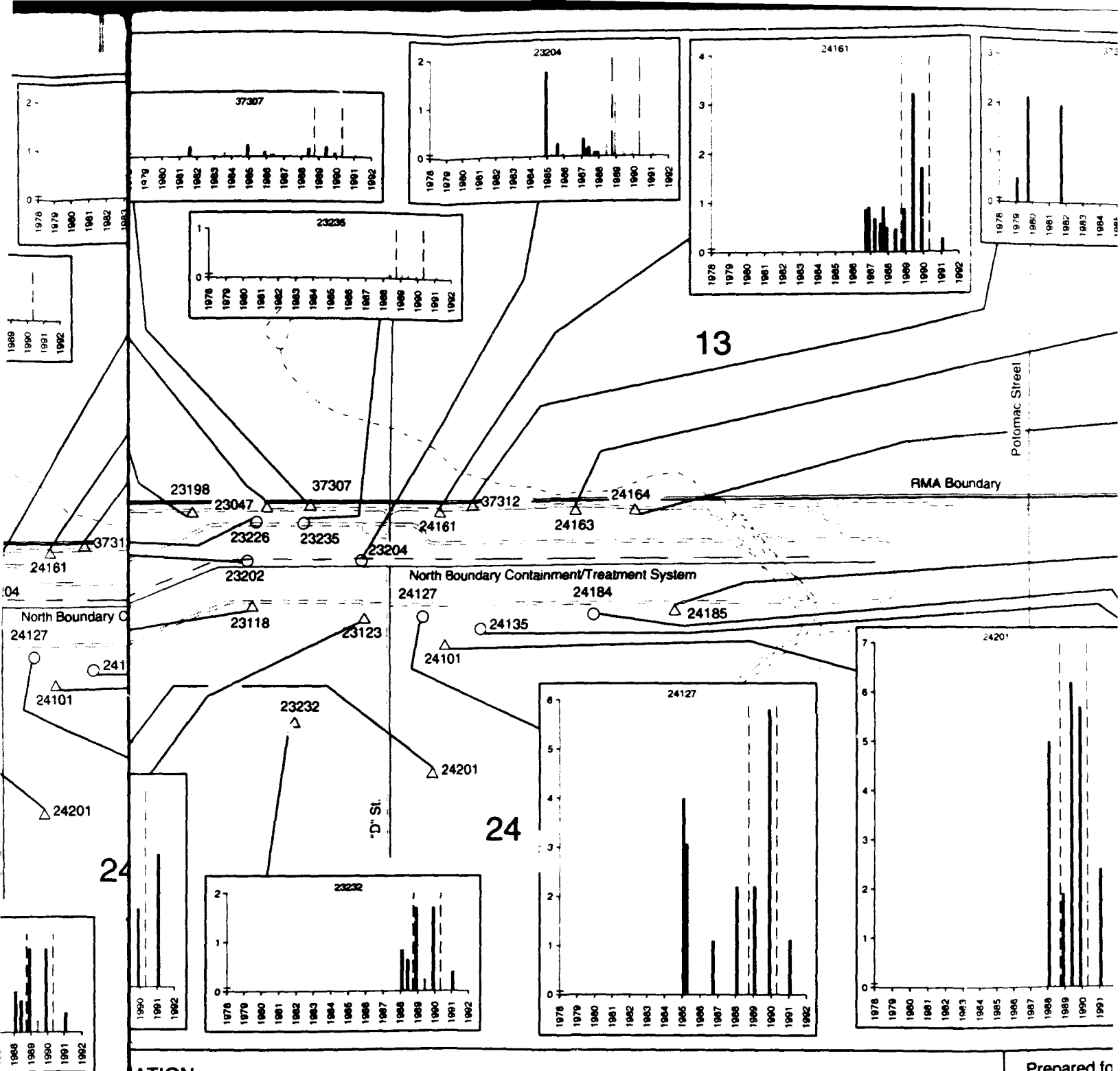
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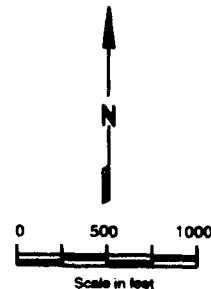


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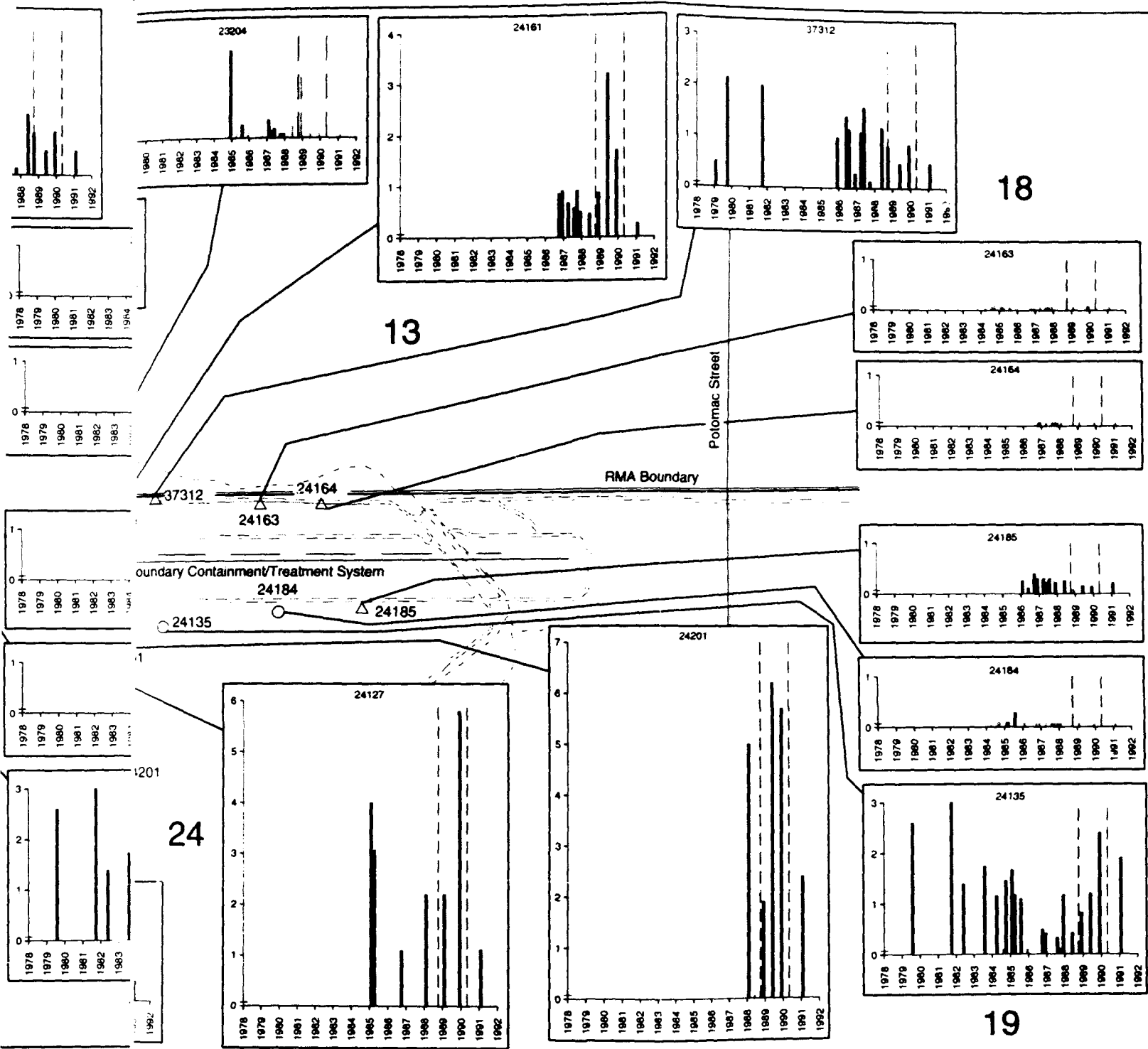
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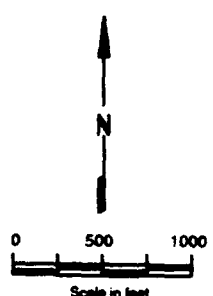


Manager for
Mountain Arsenal
Commerce City, Colorado

Lawson Associates

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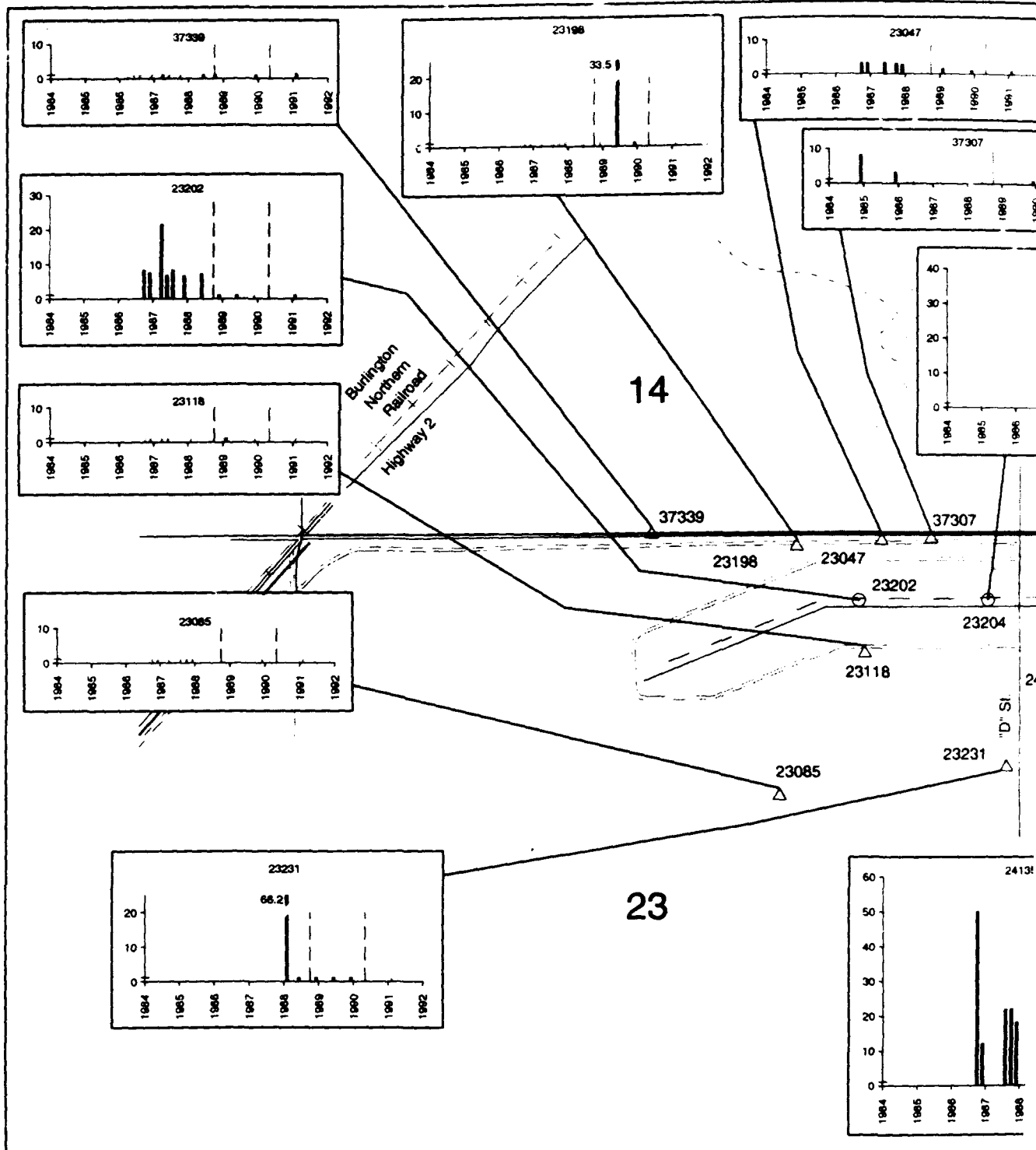
Prepared for:
Program Manager for
Rocky Mountain Arsenal
Commerce City, Colorado
Prepared by:
Harding Lawson Associates

Figure 5.29
Dieldrin Histograms for Wells
Near the North Boundary
Containment/Treatment System

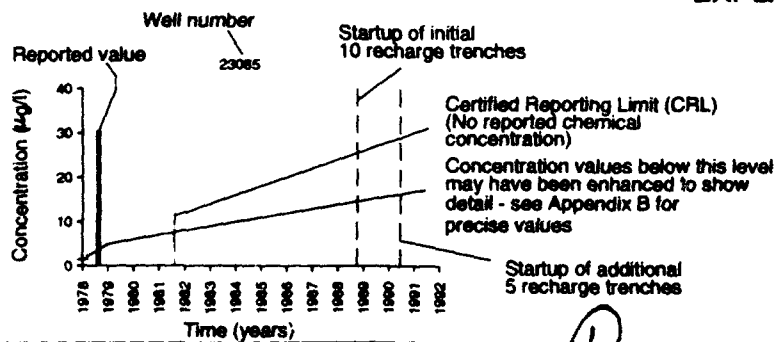
GWAR FY91

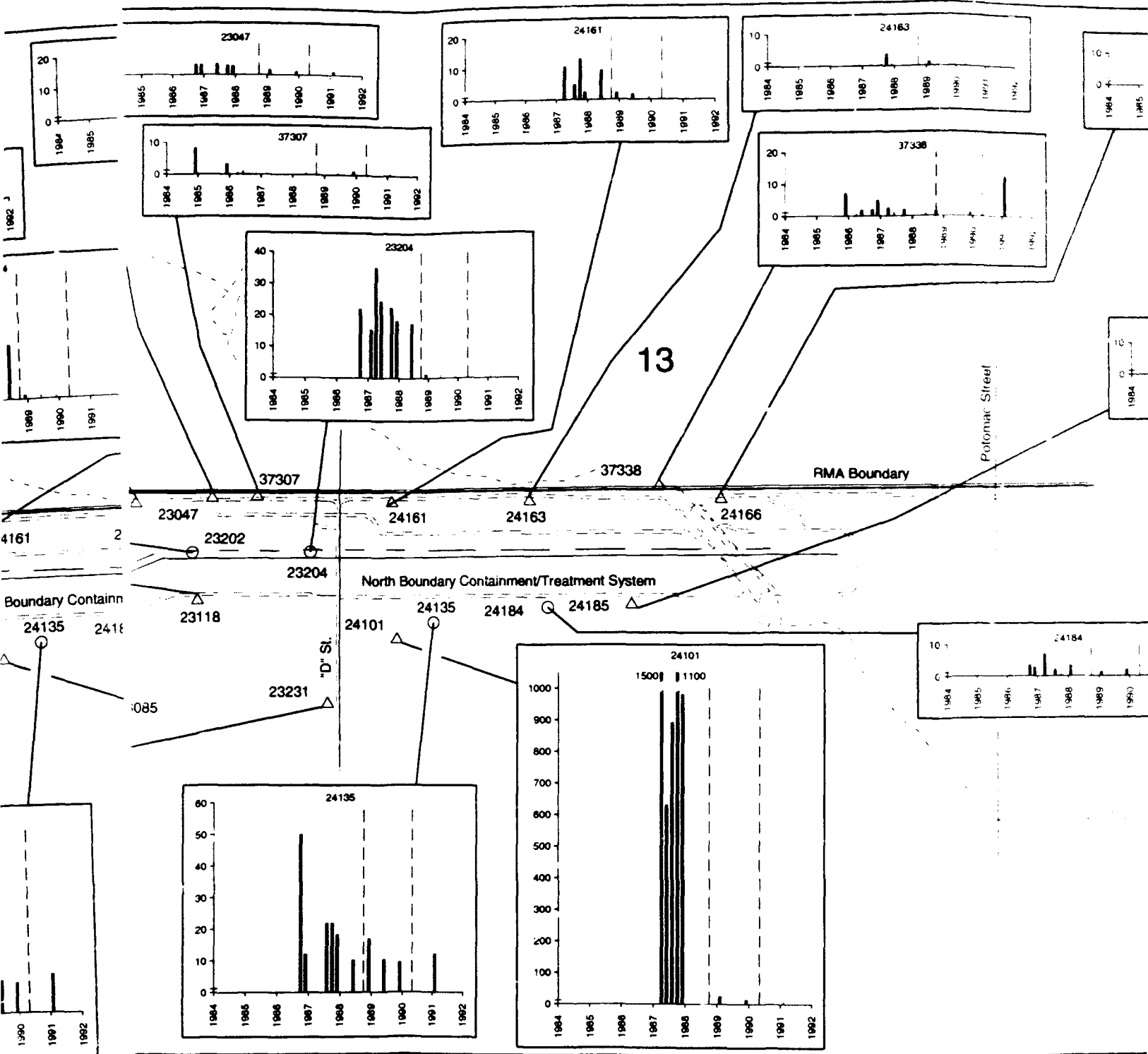
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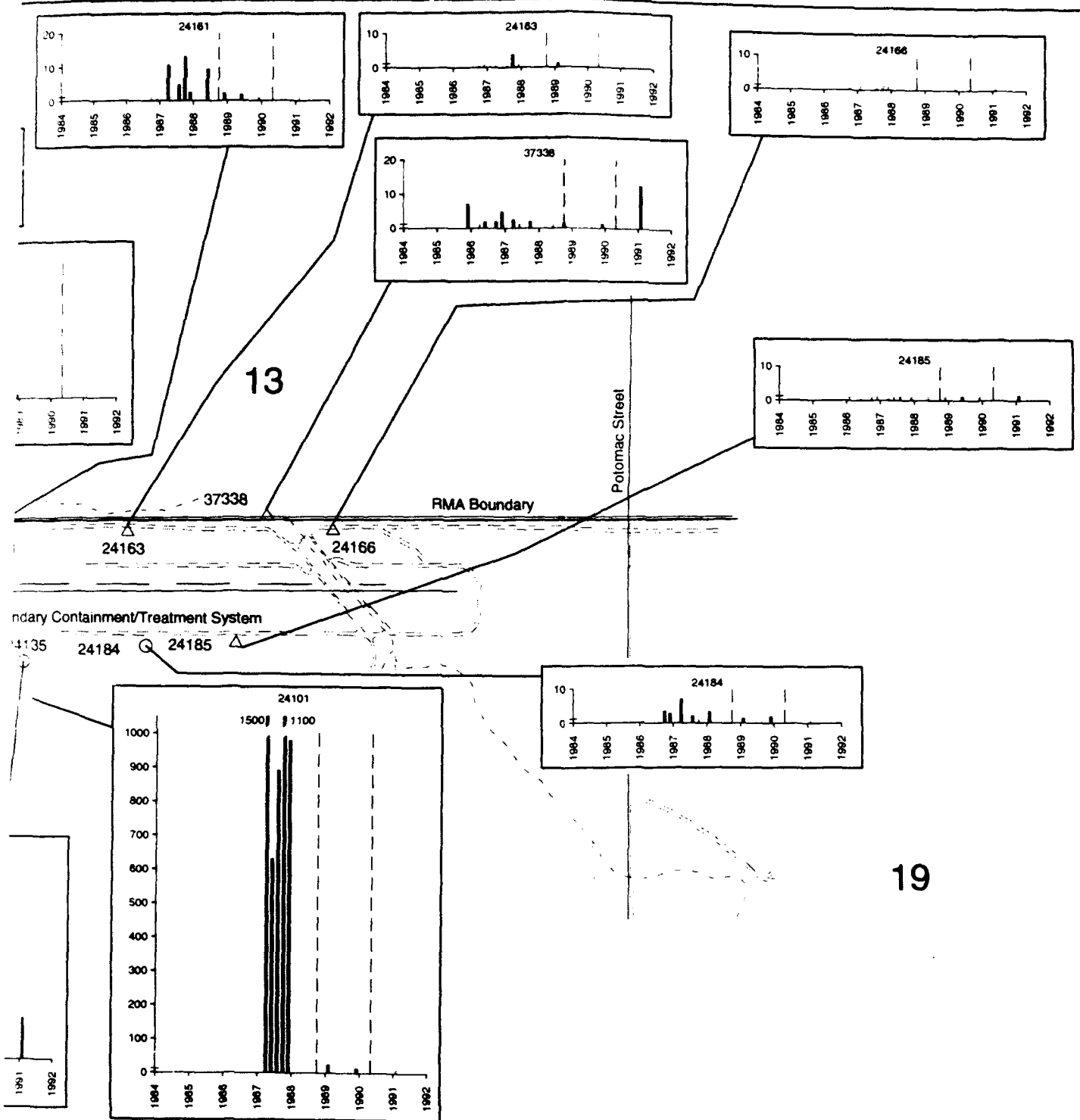
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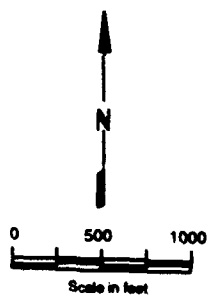


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Harding L

Figure 5.30
Chloroform Histo
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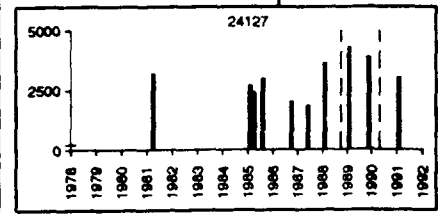
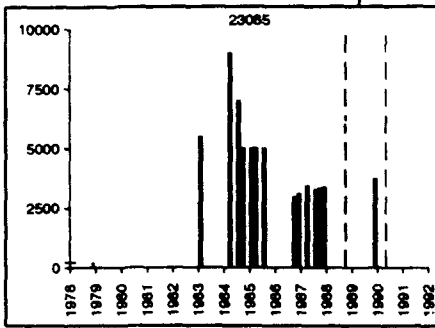
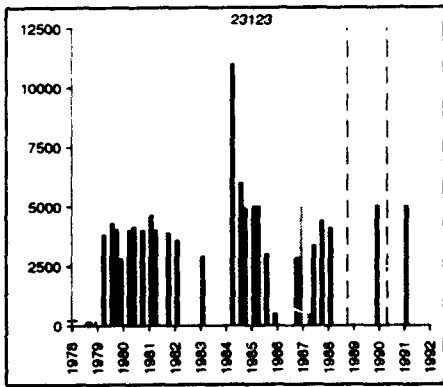
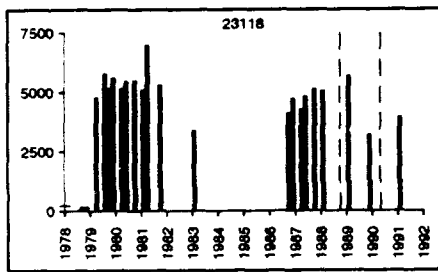
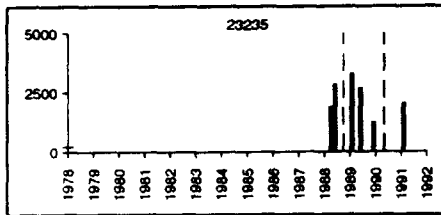
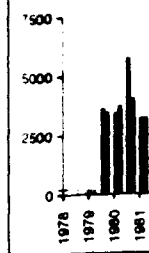
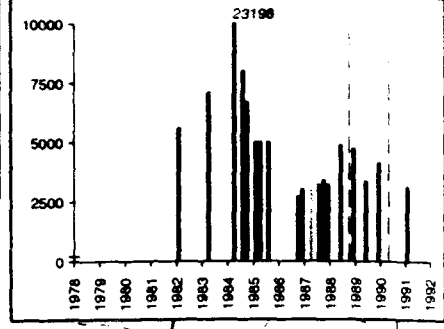
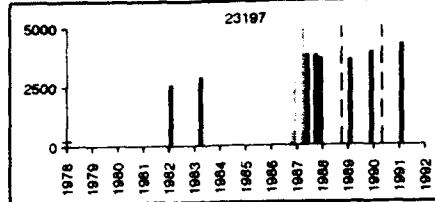
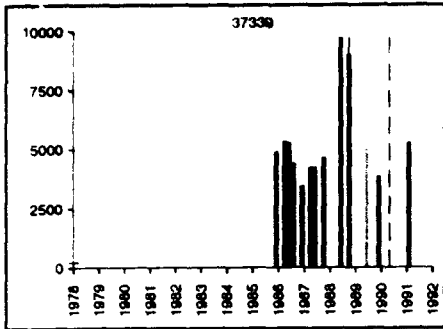


Prepared for:
 Program Manager for
 Rocky Mountain Arsenal
 Commerce City, Colorado
 Prepared by:
 Harding Lawson Associates

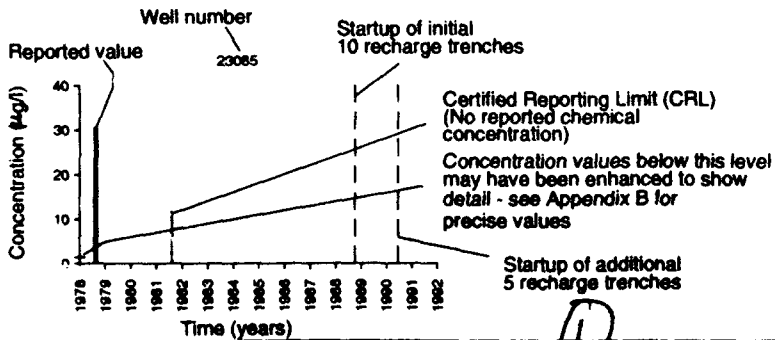
Figure 5.30
 Chloroform Histograms for Wells
 Near the North Boundary
 Containment/Treatment System
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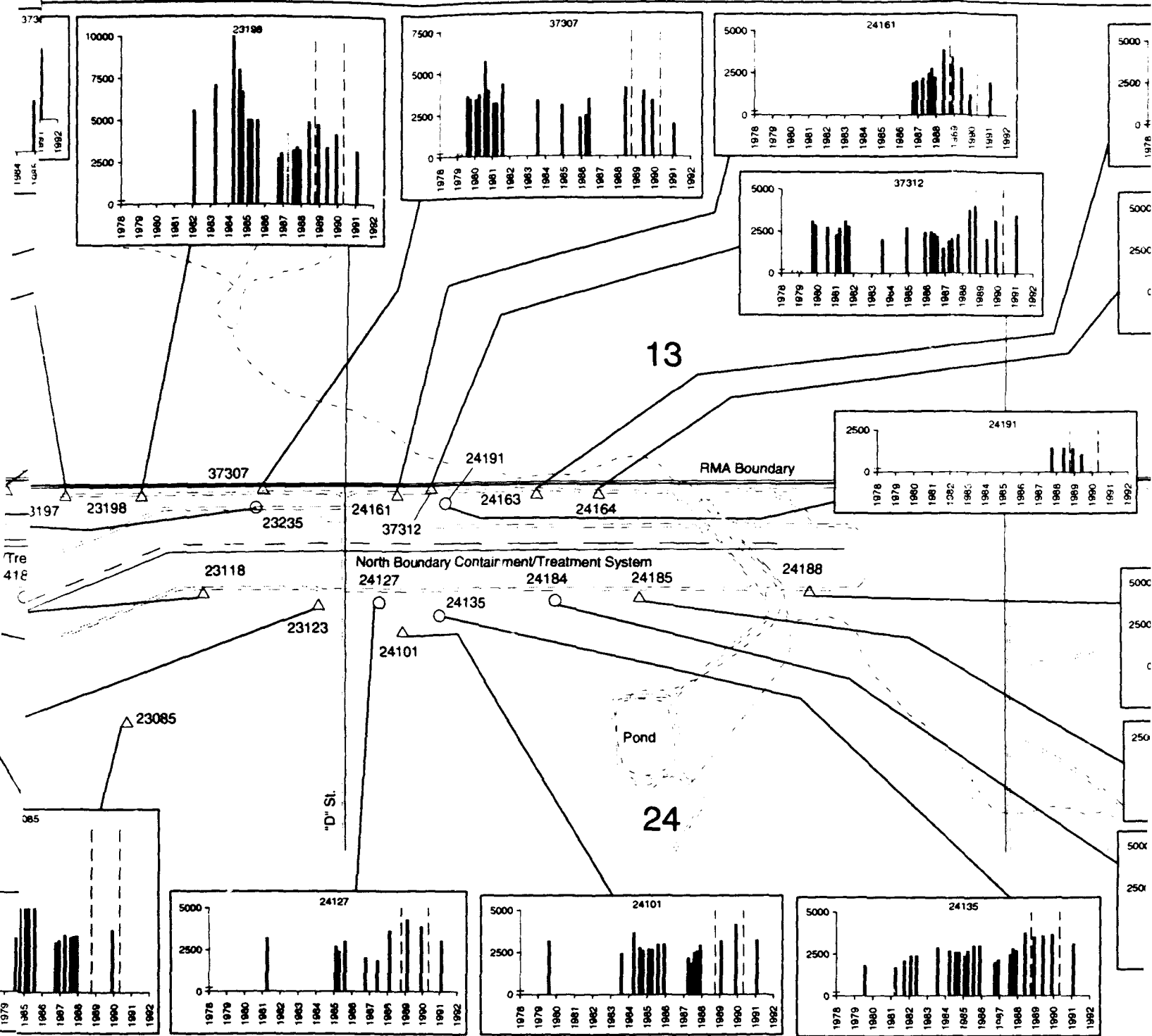
EXPLANATION



Unconfined flow system w

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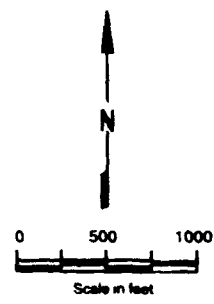
24135 ○ Denver



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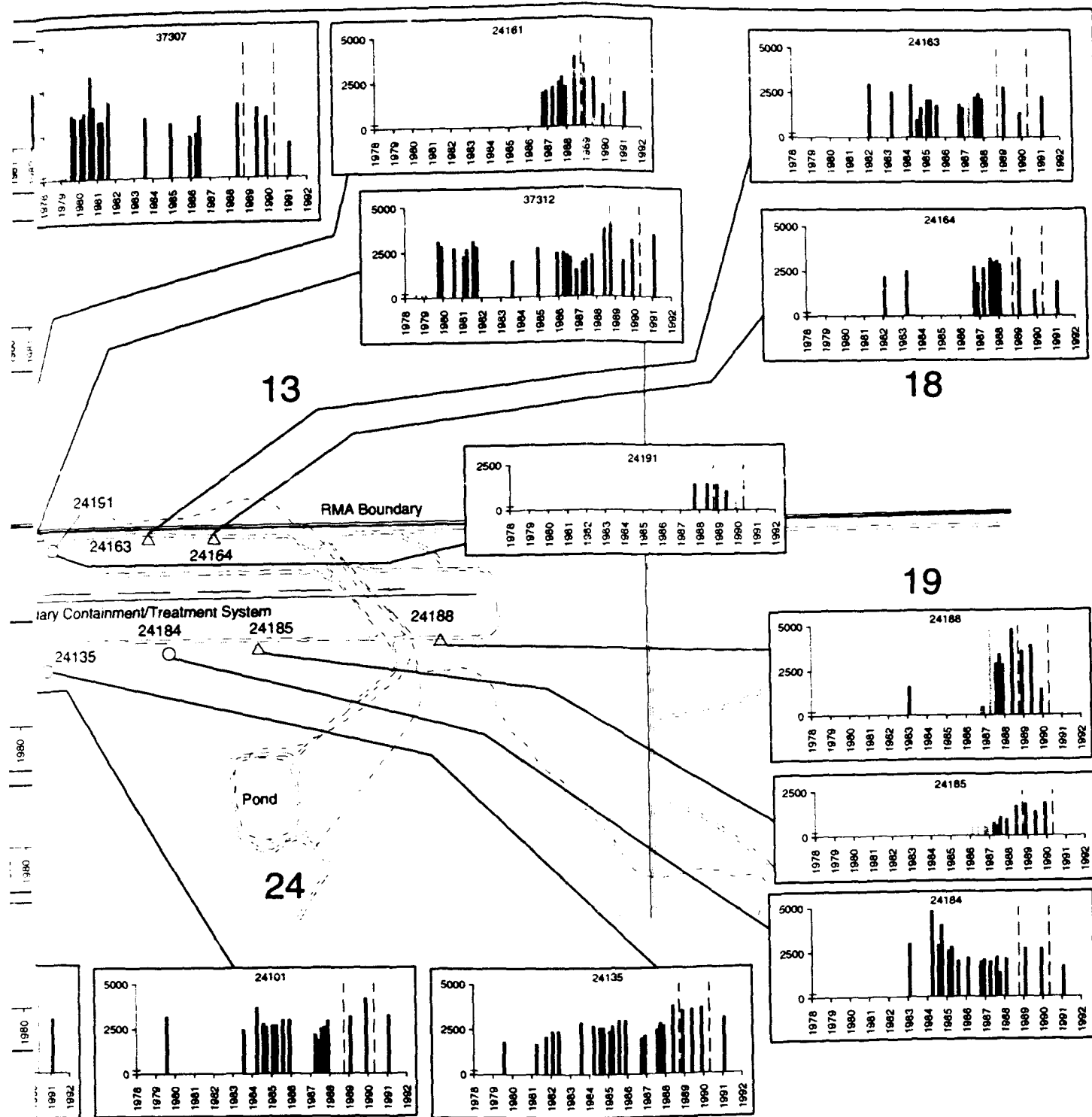
- Unconfined flow system wells
- 23085 Δ Alluvial well
 - 24135 $\circ$ Denver well



Prepared for:
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Prepared by:
Harding I

Figure 5.31
Fluoride Histograms
Near the North E
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Prepared for:
 Program Manager for
 Rocky Mountain Arsenal
 Commerce City, Colorado

Prepared by:
 Harding Lawson Associates

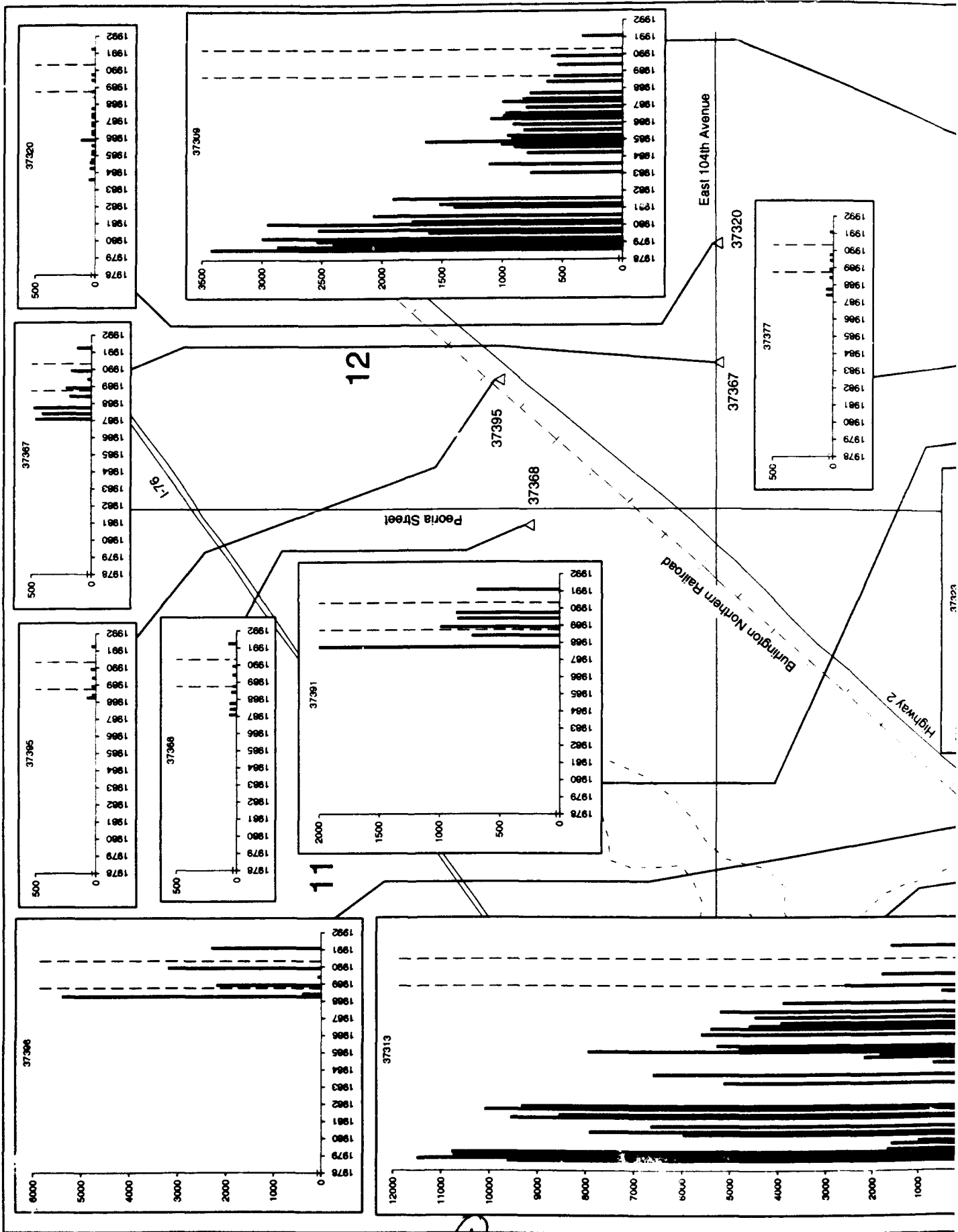
Figure 5.31

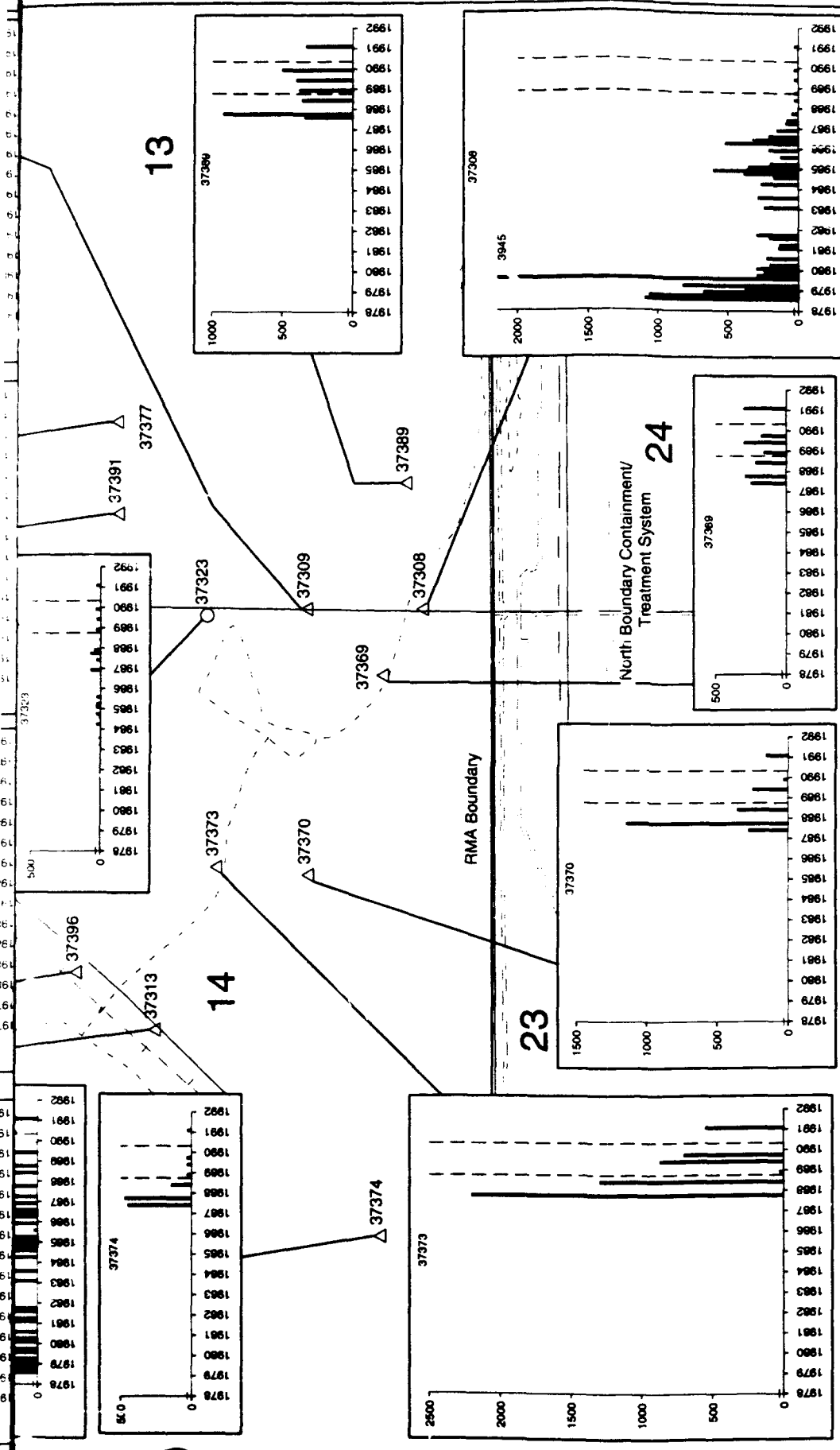
Fluoride Histograms for Wells Near the North Boundary Containment/Treatment System

GWAR FY91

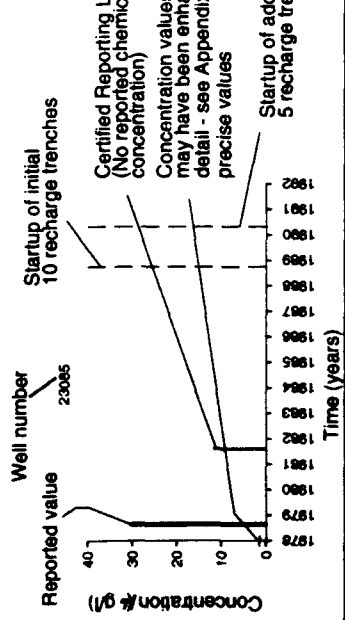
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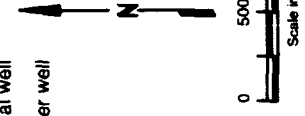


EXPLANATION



Unconfined flow system wells

- 23085 Δ Alluvial well
- 24135 $\circ$ Denver well



Prepared for:

Program Manager for
Rocky Mountain Arsenal
Commerce City, Colorado

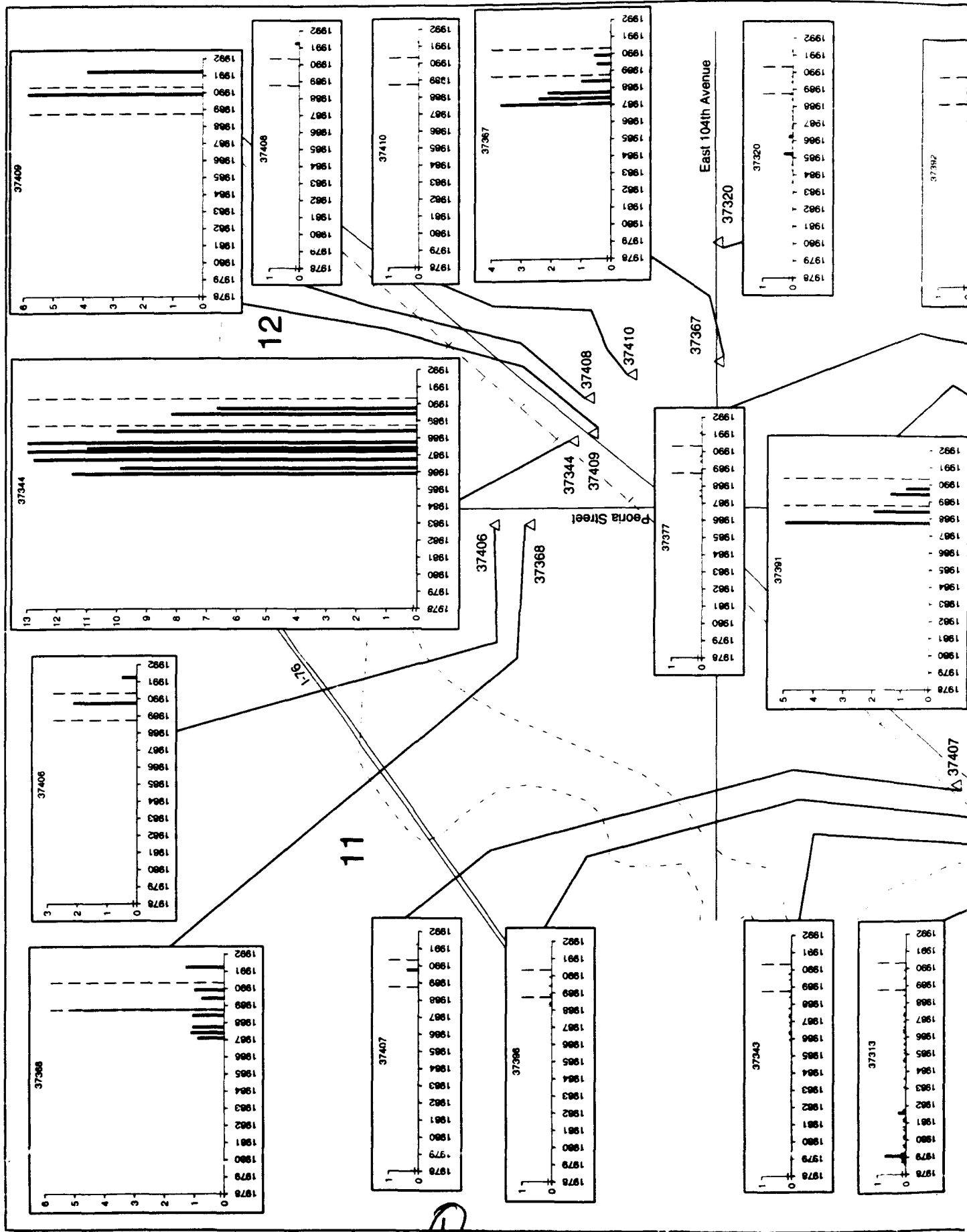
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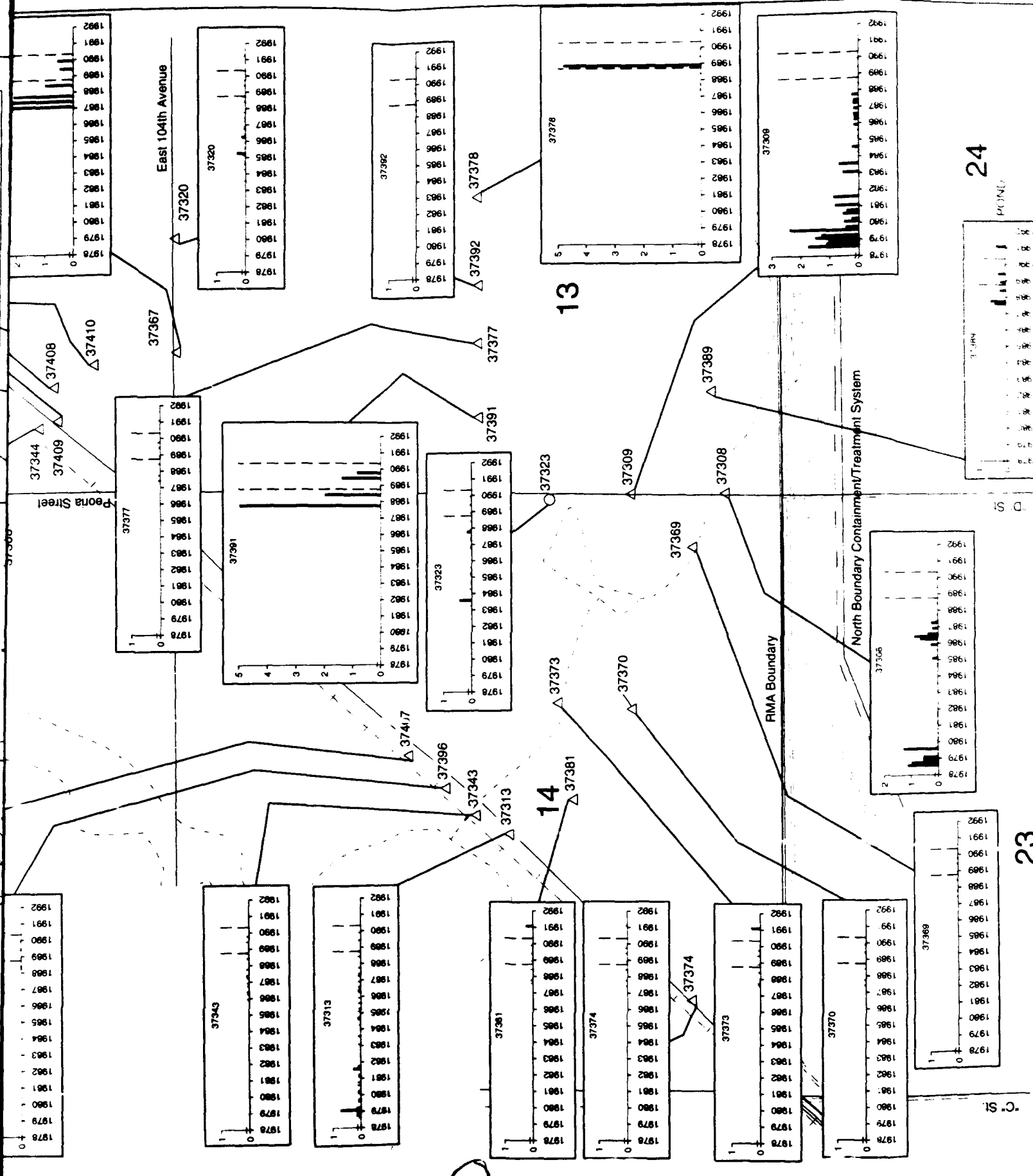
Harding Lawson Associates

Figure 5.32

Diisopropylmethylphosphonate (DIMP)
Histograms for Wells North
of Rocky Mountain Arsenal

GWAR FY91





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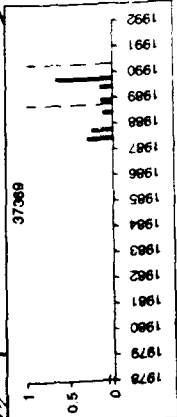
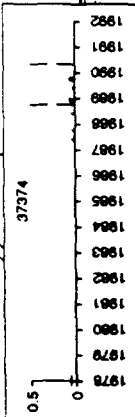
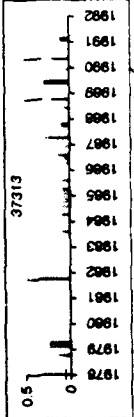
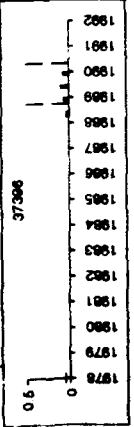
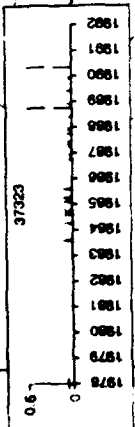
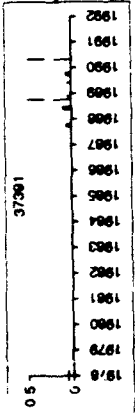
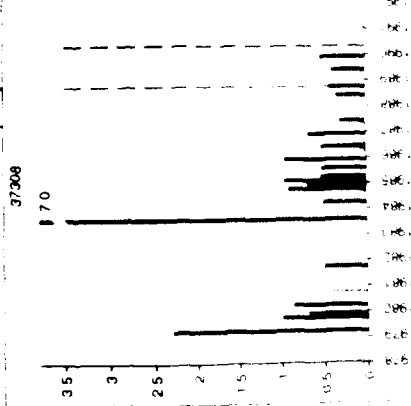
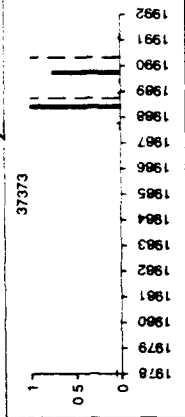
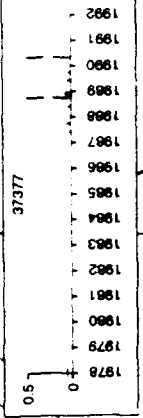
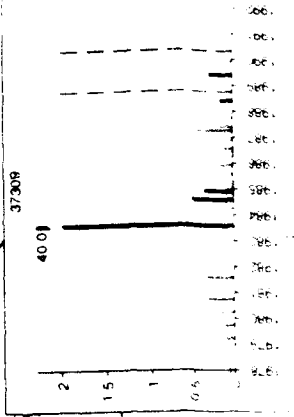
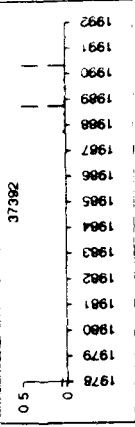
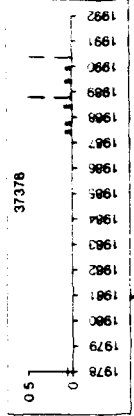
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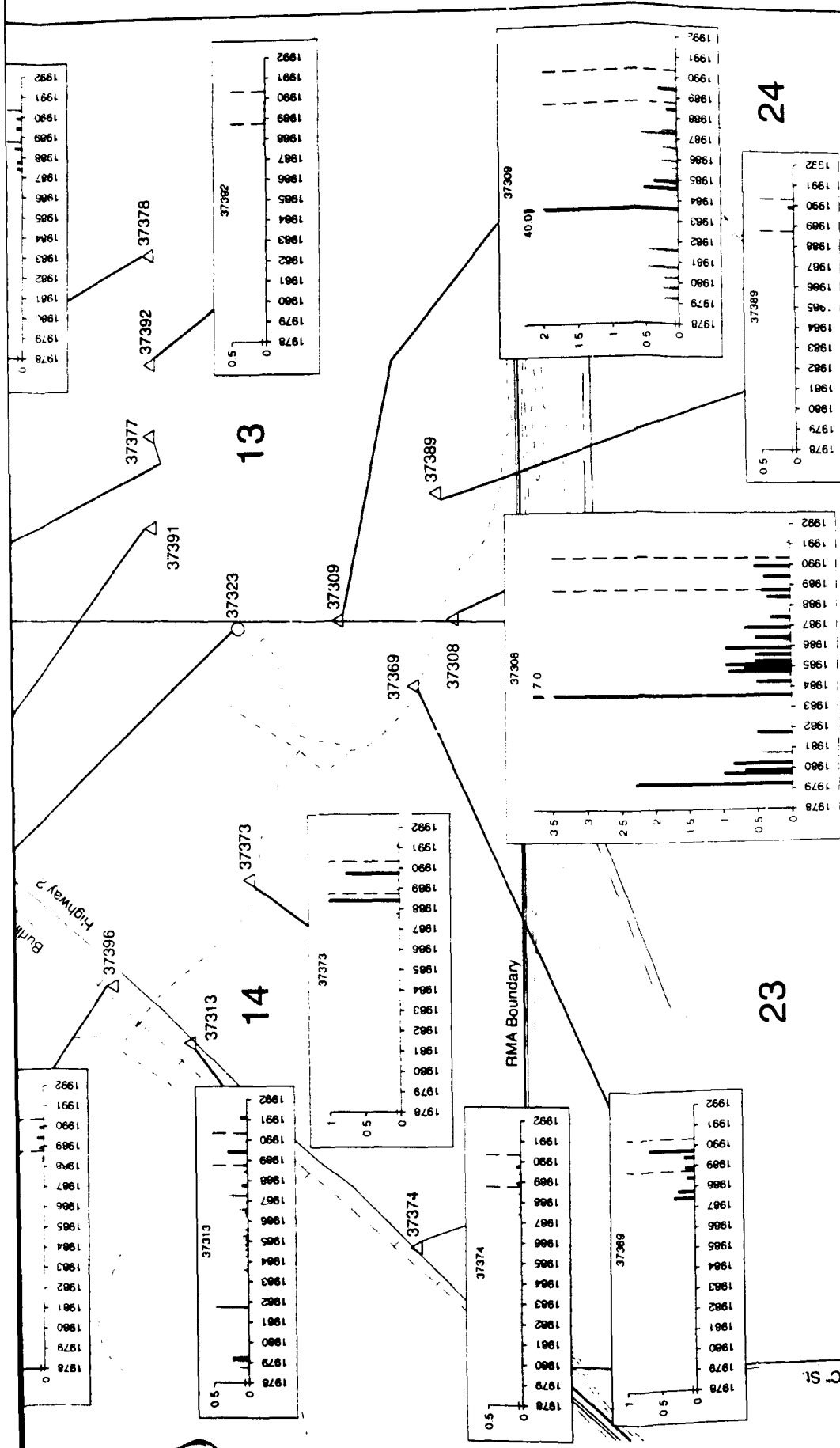
23

13

14

2





Prepared for:
Program Manager for
Rocky Mountain Arsenal
Commerce City, Colorado

Prepared by:
Harding Lawson Associates

Figure 5.34
Dielrin Histograms for Wells
North of Rocky Mountain Arsenal

GWAR FY91

EXPLANATION

Unconfined flow system wells
 23085 Δ Alluvial well
 24135 $\circ$ Denver well

Startup of initial 10 recharge trenches

Startup of additional 5 recharge trenches

Certified Reporting Limit (CRL)
(No reported chemical concentration)
Concentration values below this level may have been enhanced to show detail - see Appendix B for precise values

Reported value

Well number 23085

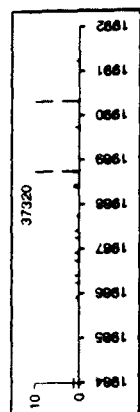
Concentration (#/g)

Time (years)

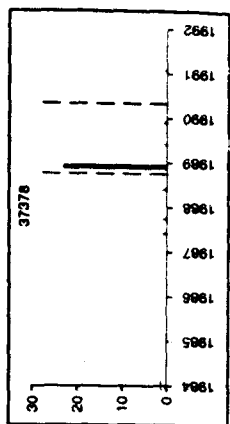
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3

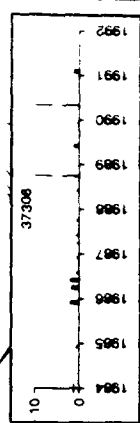
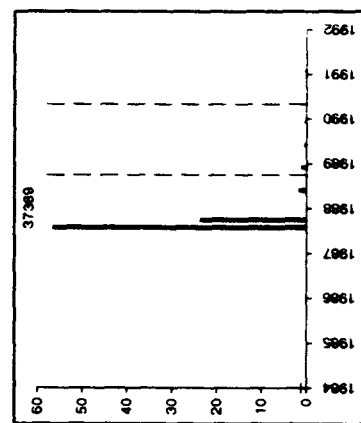
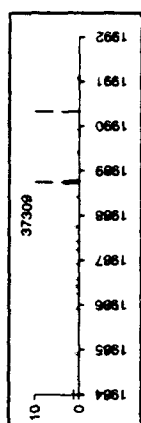
13



37320
37367



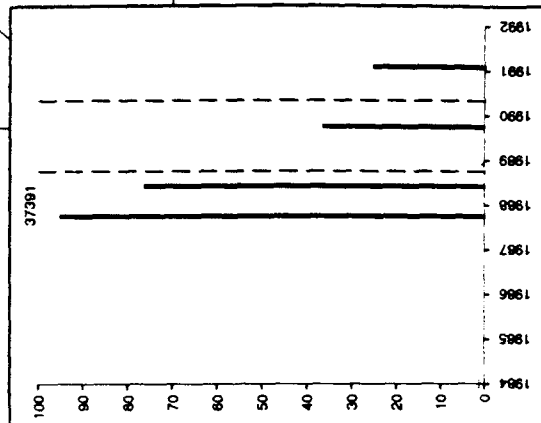
13



2A

POND

Bull. 37344



37391

37323

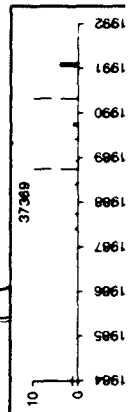
37309

37308

37369

North Boundary Containment/Treatment System

"D" St.



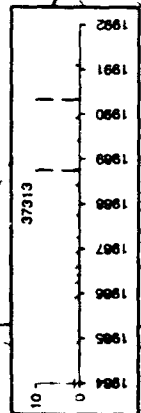
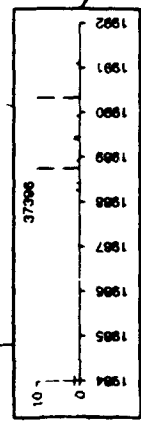
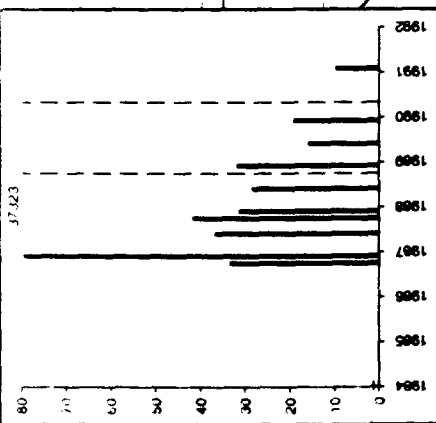
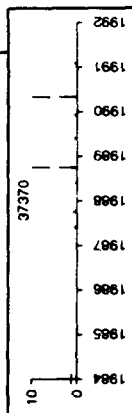
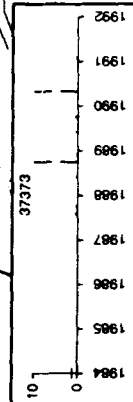
East 104th Avenue

37396

14

37373

37370

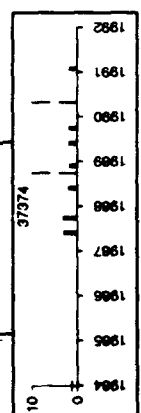


2

FMA Boundary

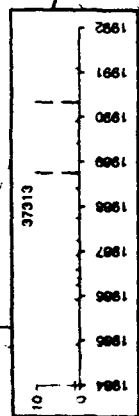
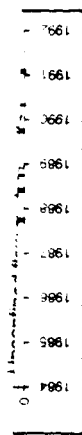
37374

"C" St.

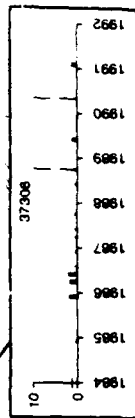
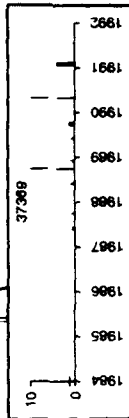
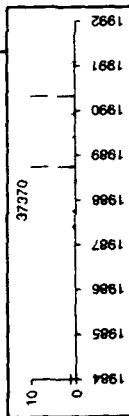
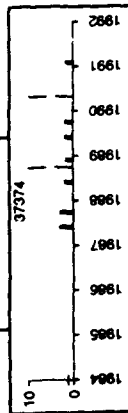
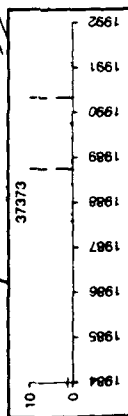
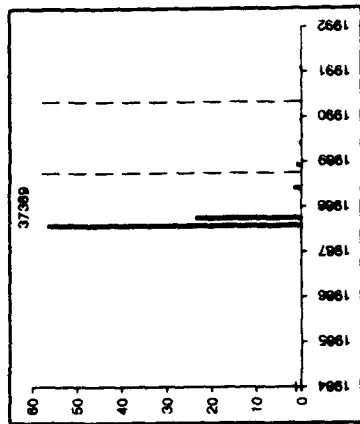
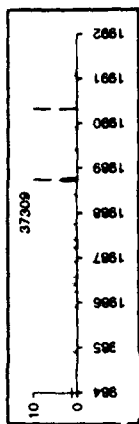


EXPLANATION

Prepared for:



14



24

23

EXPLANATION

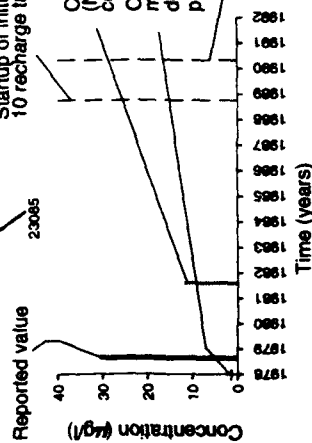
Well number

Startup of initial 10 recharge trenches

Certified Reporting Limit (CRL)
(No reported chemical concentration)

Concentration values below this level may have been enhanced to show detail - see Appendix B for precise values

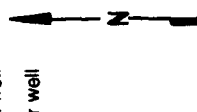
Startup of additional 5 recharge trenches



Unconfined flow system wells

23085 Alluvial well

24135 Denver well



Prepared for:

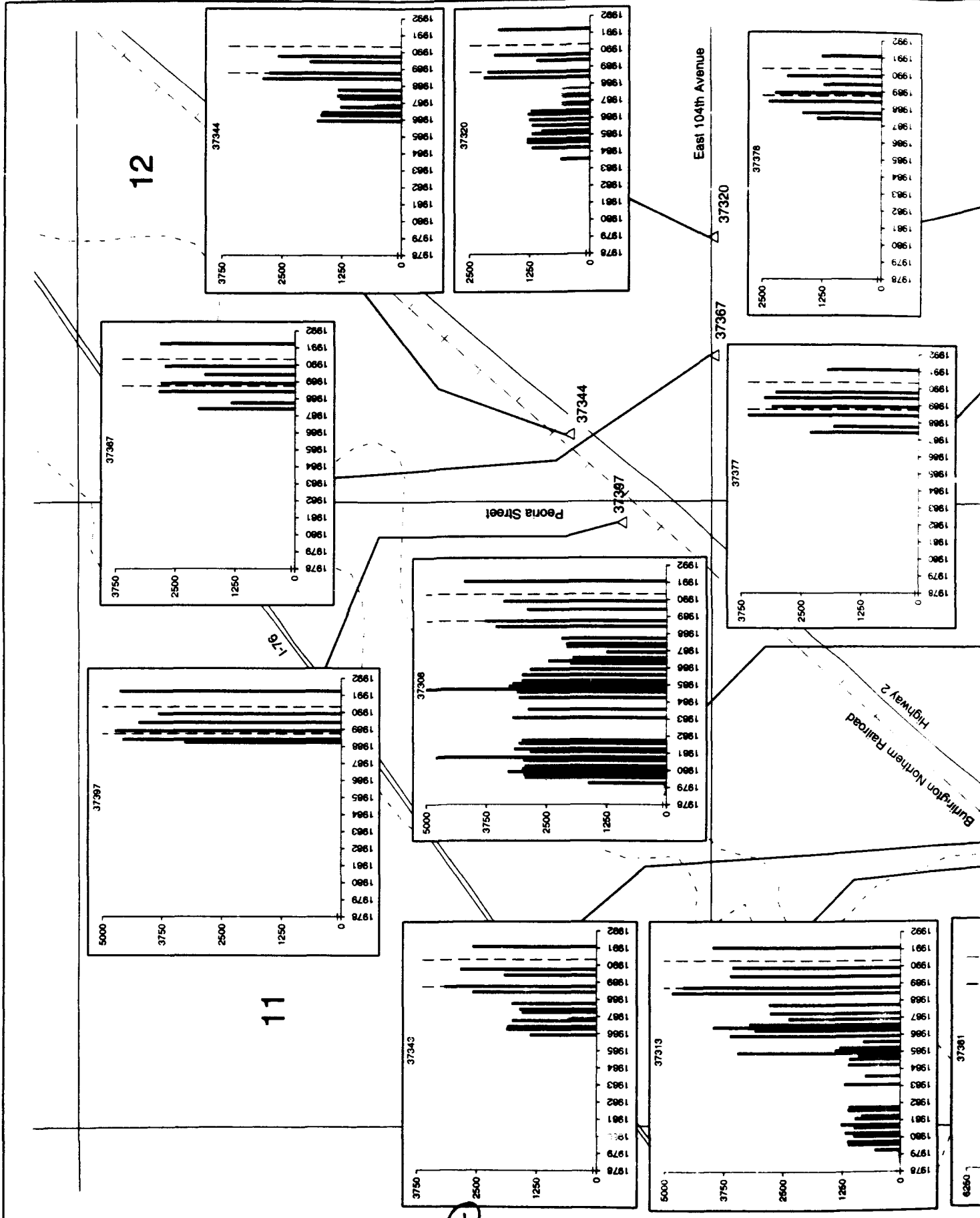
Program Manager for
Rocky Mountain Arsenal
Commerce City, Colorado

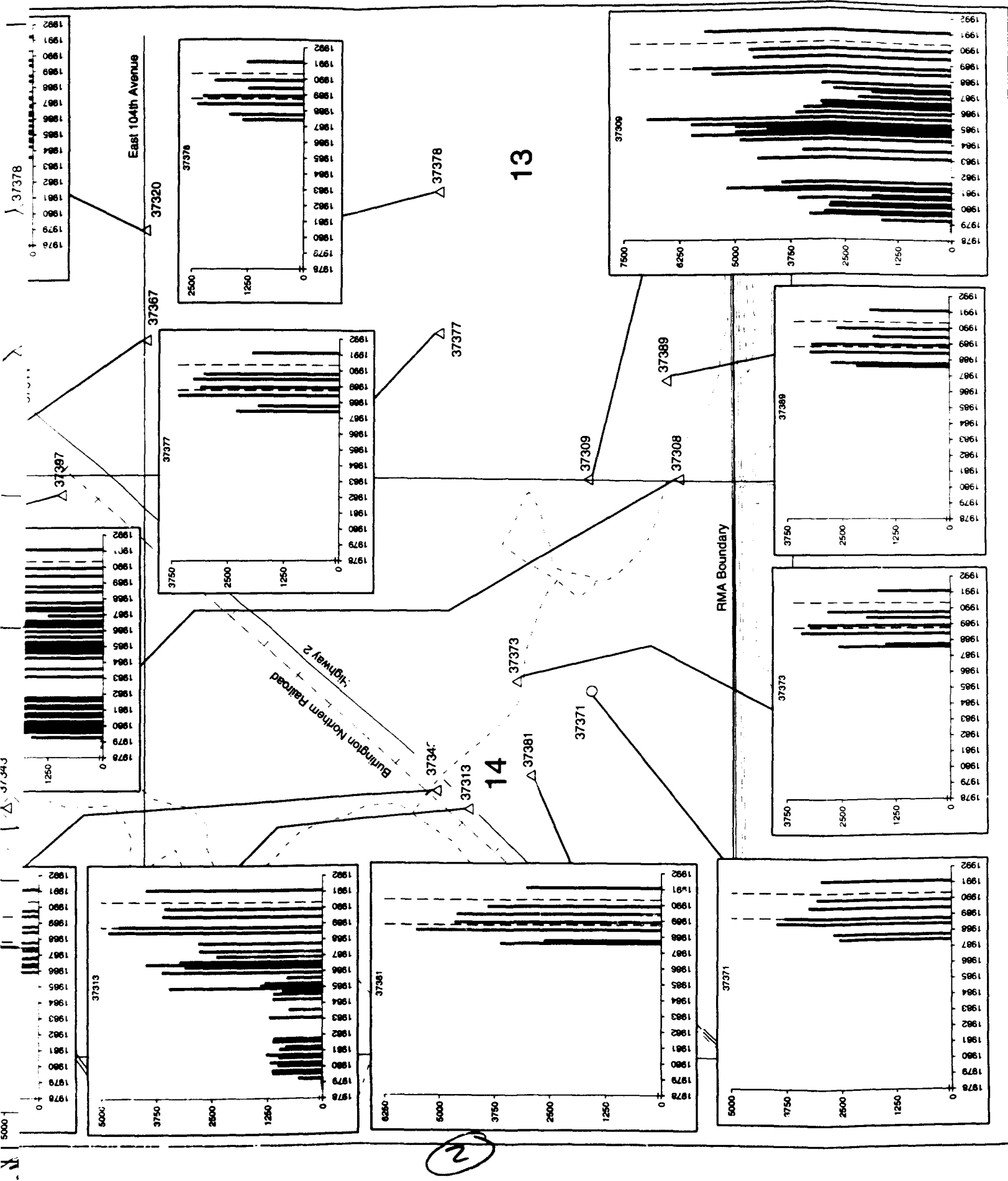
Prepared by:
Harding Lawson Associates

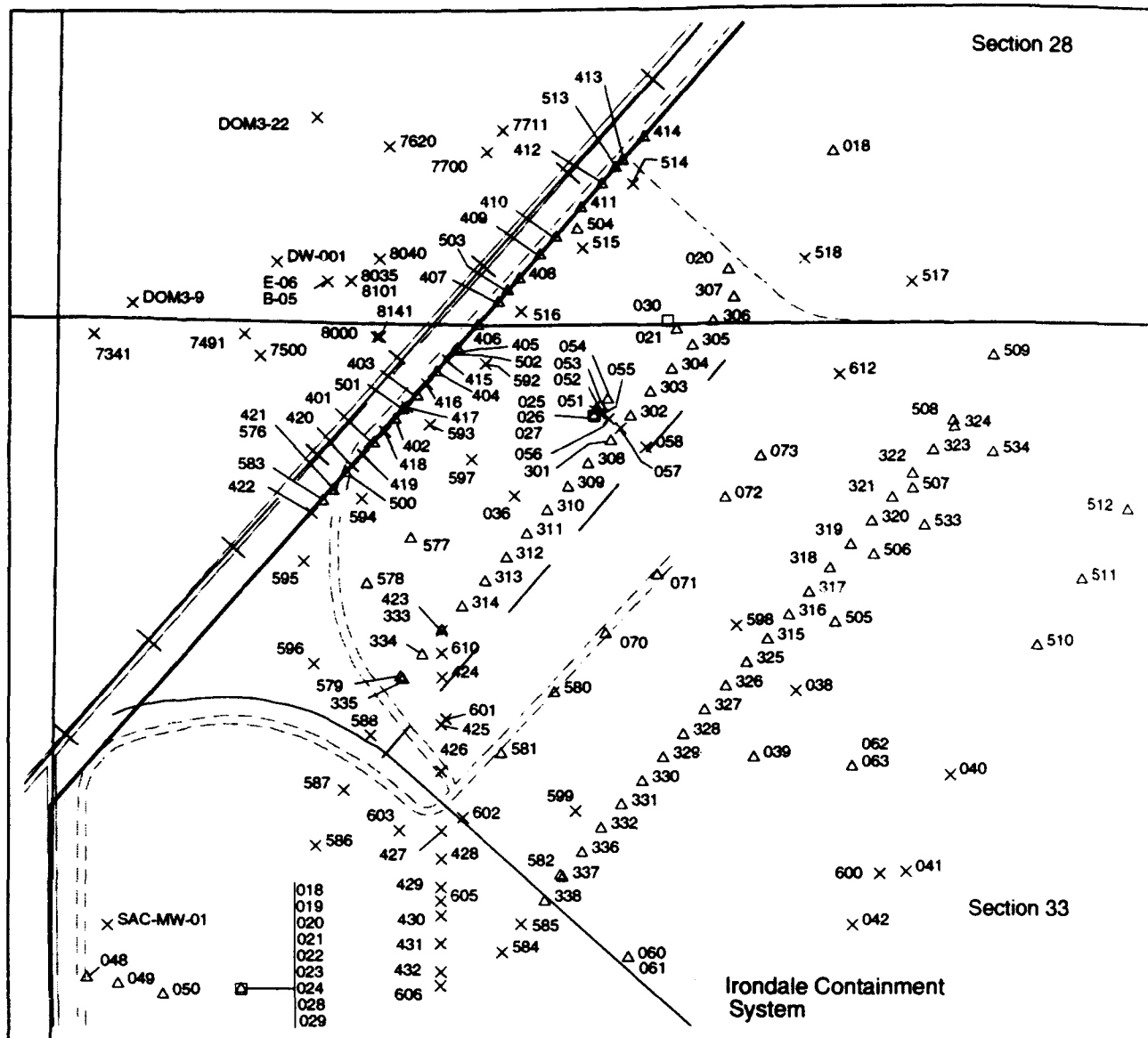
Figure 5.35

Chloroform Histograms for Wells
North of Rocky Mountain Arsenal

GWAF FY91



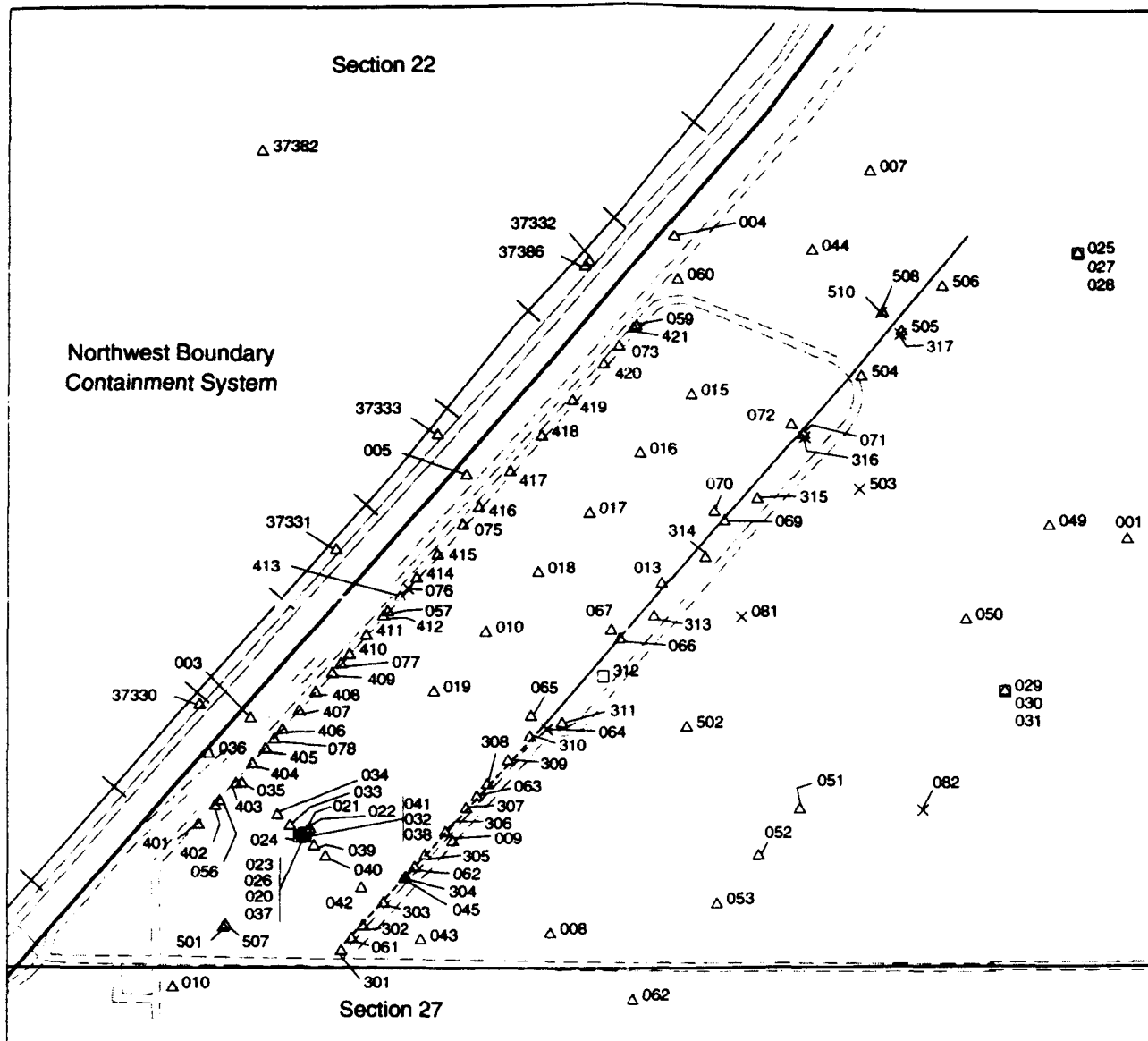




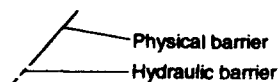
EXPLANATION

Drainage
 Paved road
 Unpaved road

Δ101 Alluvial well
 ○102 Unconfined Denver Formation well
 □103 Confined Denver Formation well
 X104 Not classified (DP Associates, October 1991)



Containment System



Prepared for:

Program Manager for
Rocky Mountain Arsenal
Commerce City, Colorado

Prepared by:

Harding Lawson Associates

Figure 5.37

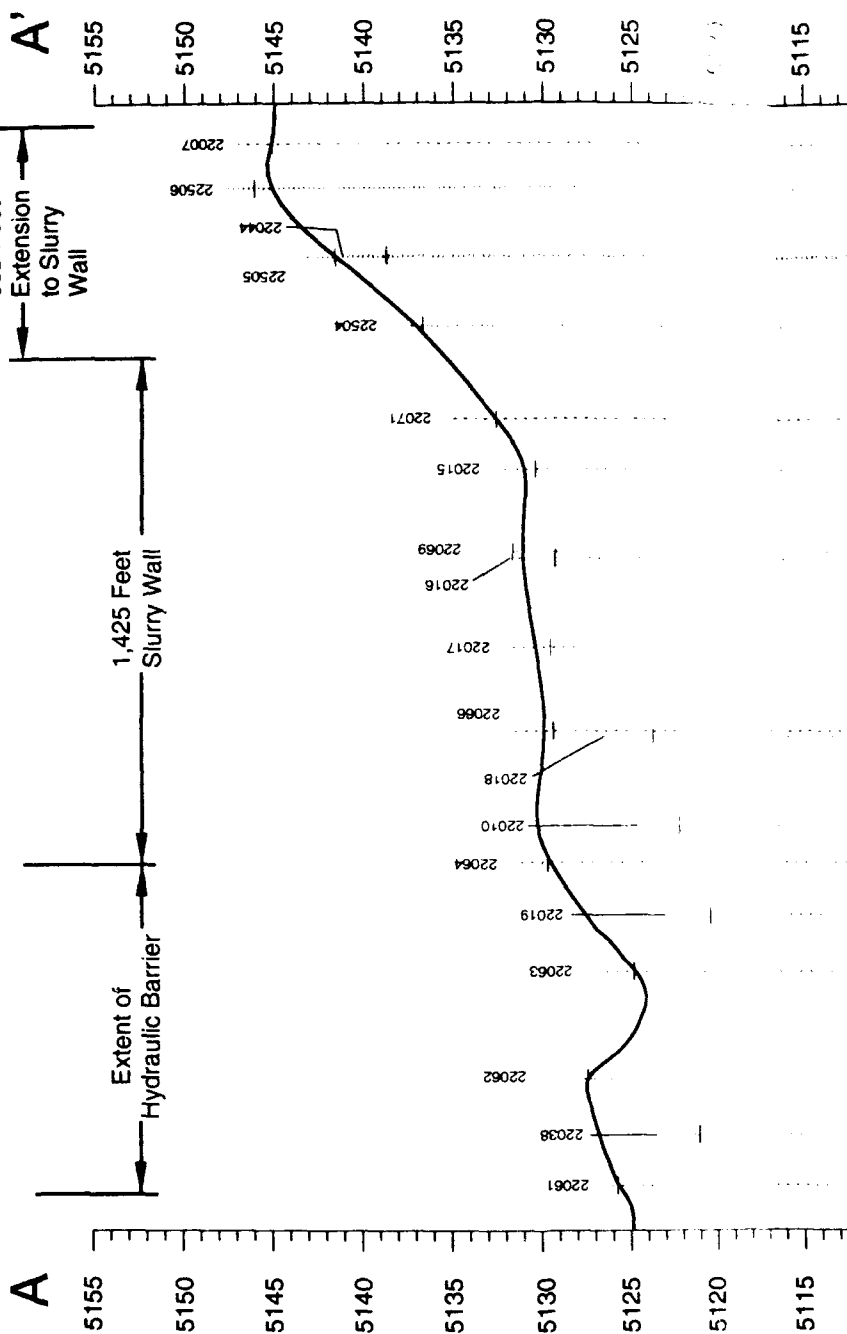
Well Location Maps for the Irondale
Containment System and the Northwest
Boundary Containment System

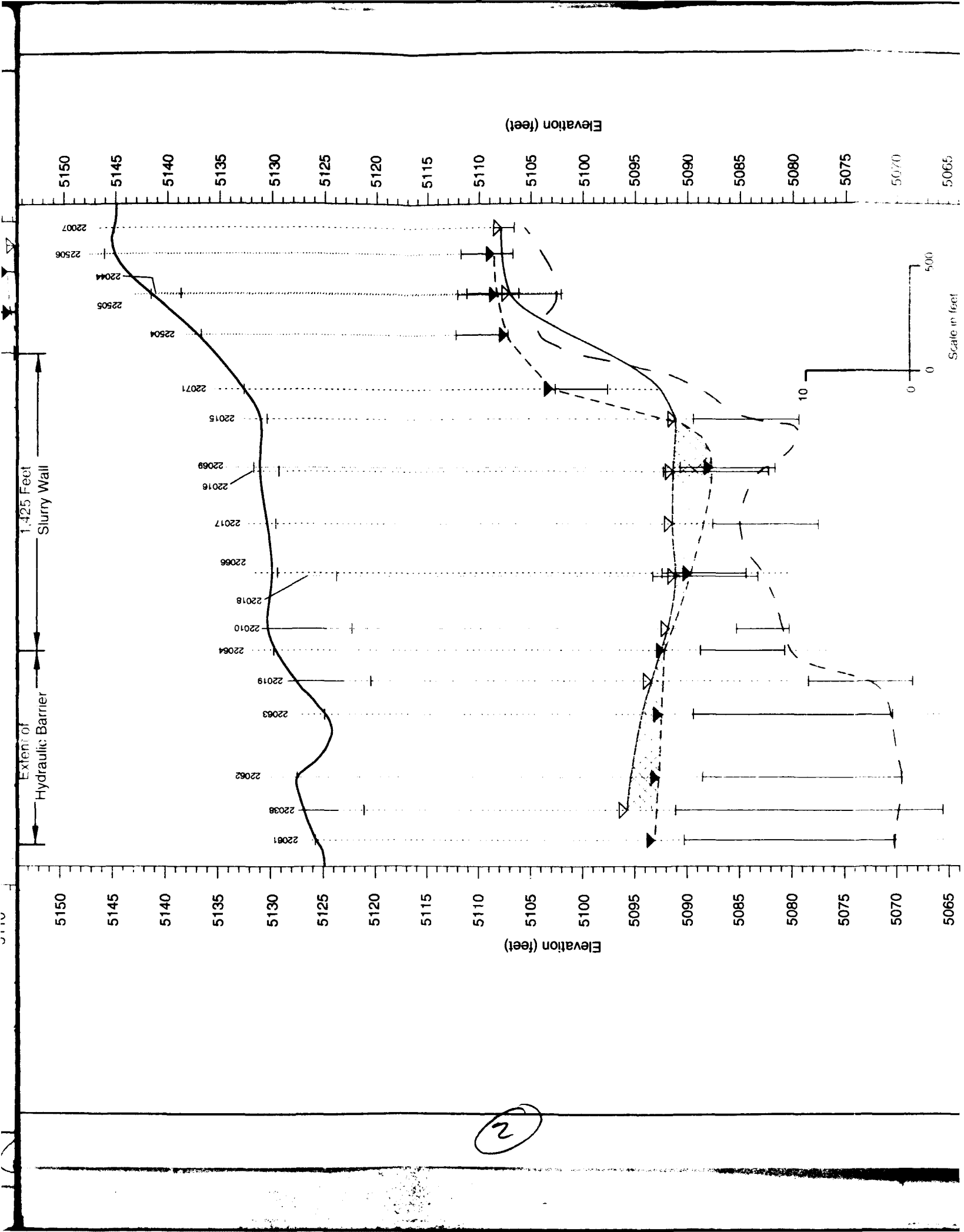
GWAR FY91

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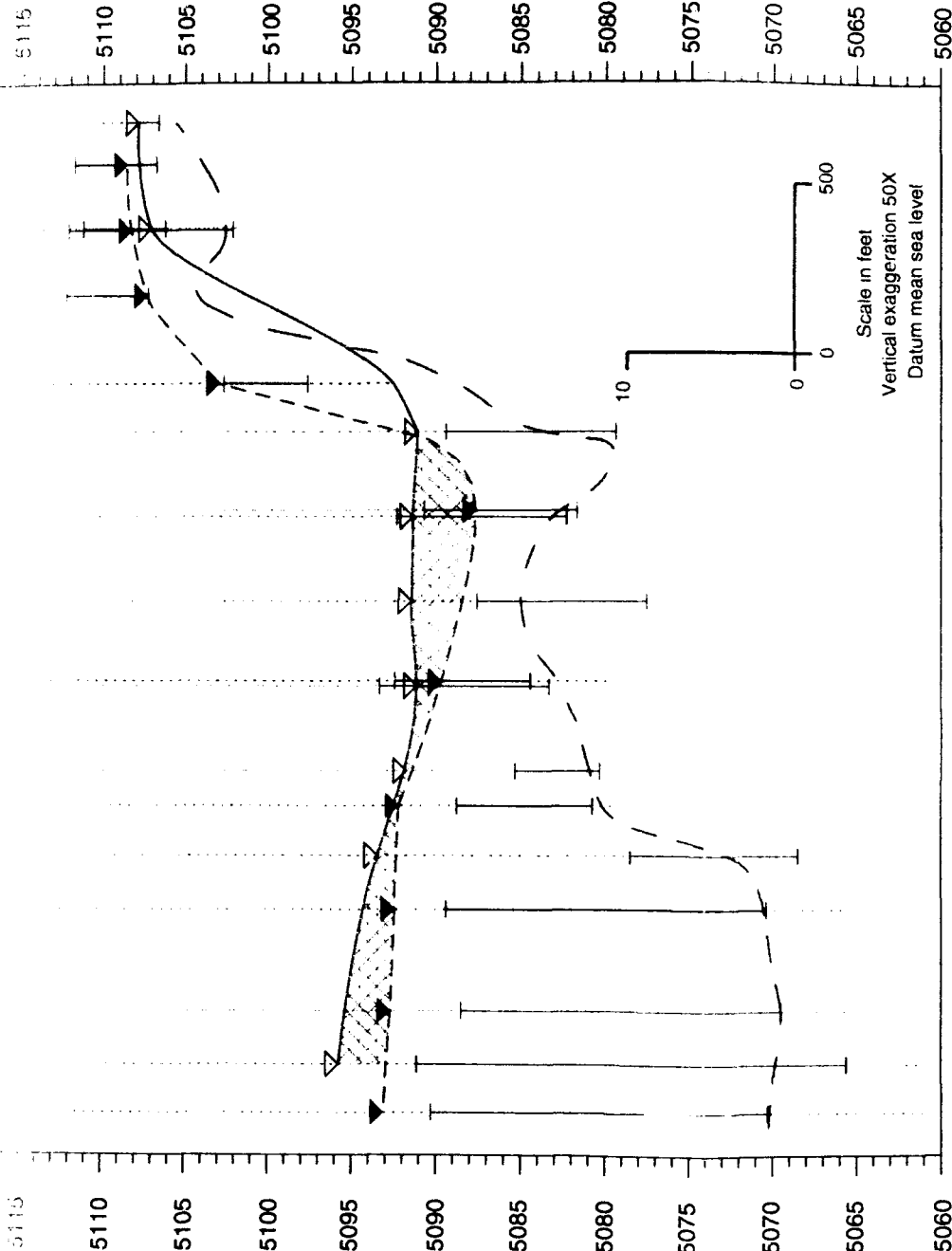
RMA Boundary





Elevation (feet)

Elevation (feet)



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Program Manager for
Rocky Mountain Arsenal
Commerce City, Colorado

Prepared by:

Harding Lawson Associates

Figure 5.38

Cross Section of Approximate Water-Table
Elevations at the Northwest Boundary
Containment/Treatment System from October 1 to
December 31, 1990

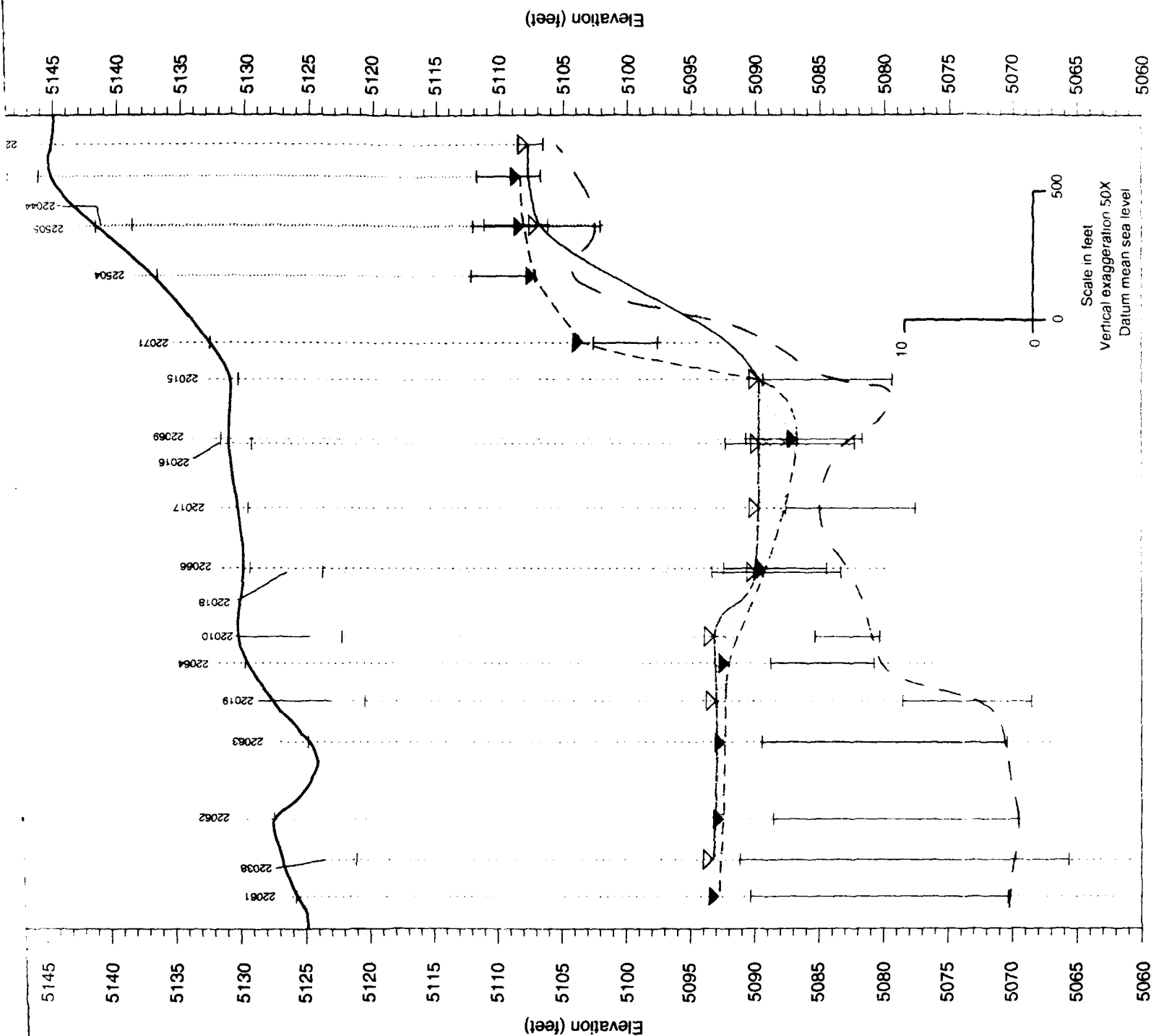
GWAR FY91

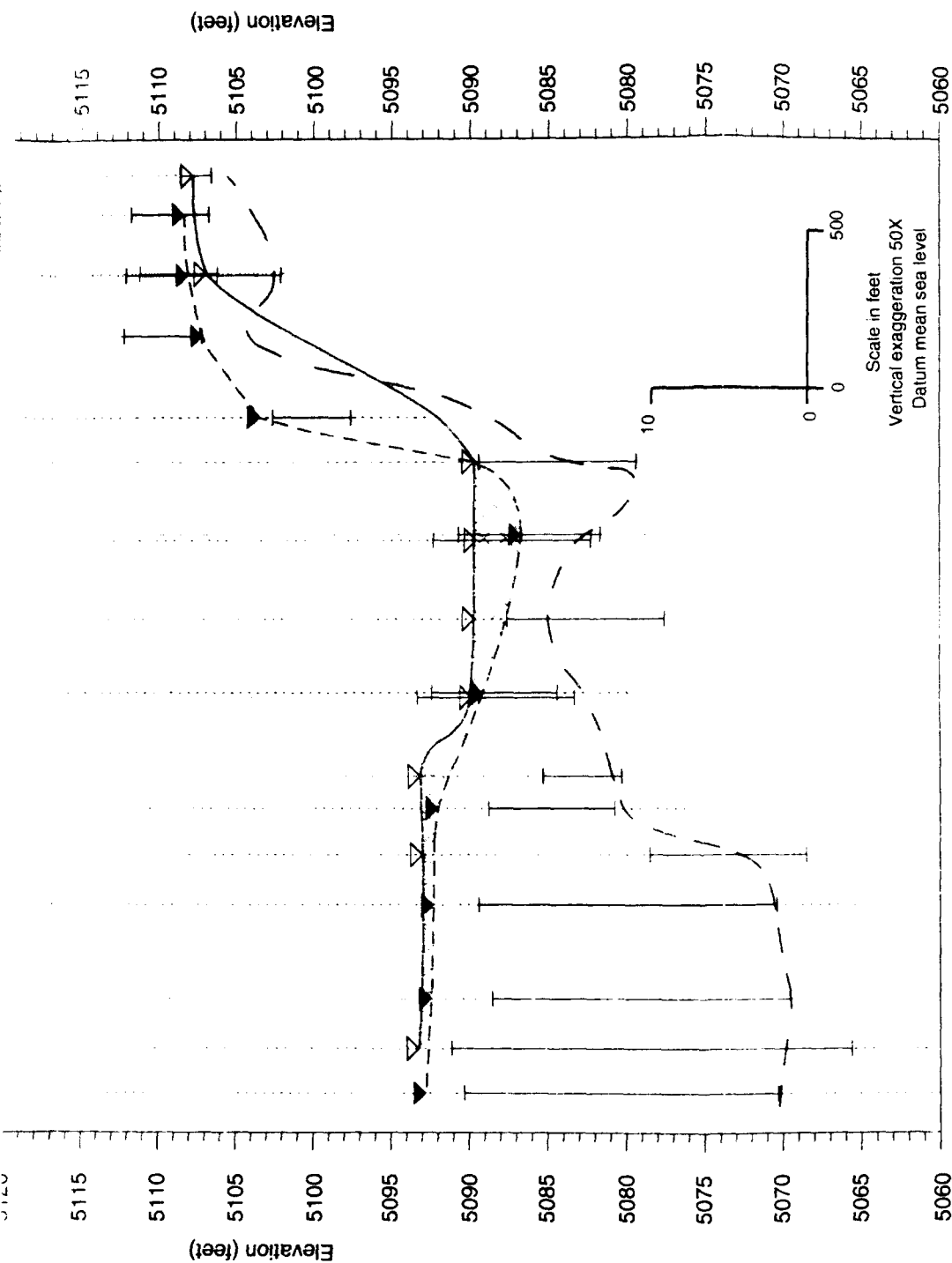
EXPLANATION

- Area of reversed hydraulic gradient
- Bedrock surface at barrier wall
(Source: Waterways Experiment Station,
1987b, plate 1)
- Water elevation upgradient (southeast) of barrier wall
- Water elevation downgradient (northwest) of barrier wall
- Water-level elevation marker southeast of barrier wall
- Water-level elevation marker northwest of barrier wall

- Well number
- Ground surface
(southeast side of barrier wall)
- Ground surface
(northwest side of barrier wall)
- Cased interval
- Screened interval
- Cased interval
- Alluvial well
- Containment system
- Physical barrier
- Hydraulic barrier







EXPLANATION

- Area of reversed hydraulic gradient
- Bedrock surface at barrier wall
(Source: Waterways Experiment Station, 1987b, plate 1)
- Water elevation upgradient (southeast) of barrier wall
- Water elevation downgradient (northwest) of barrier wall
- Water-level elevation marker southeast of barrier wall
- Water-level elevation marker northwest of barrier wall

Prepared for:

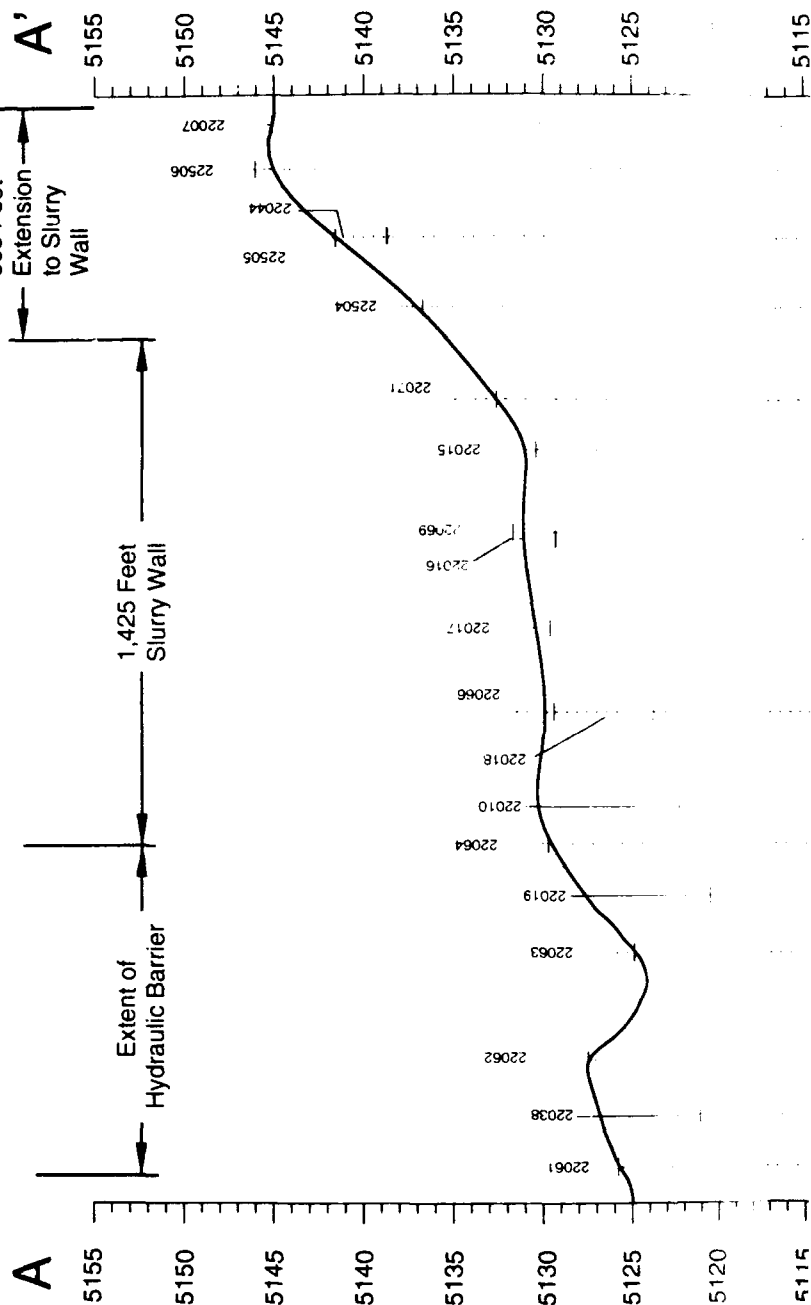
Program Manager for
Rocky Mountain Arsenal
Commerce City, Colorado

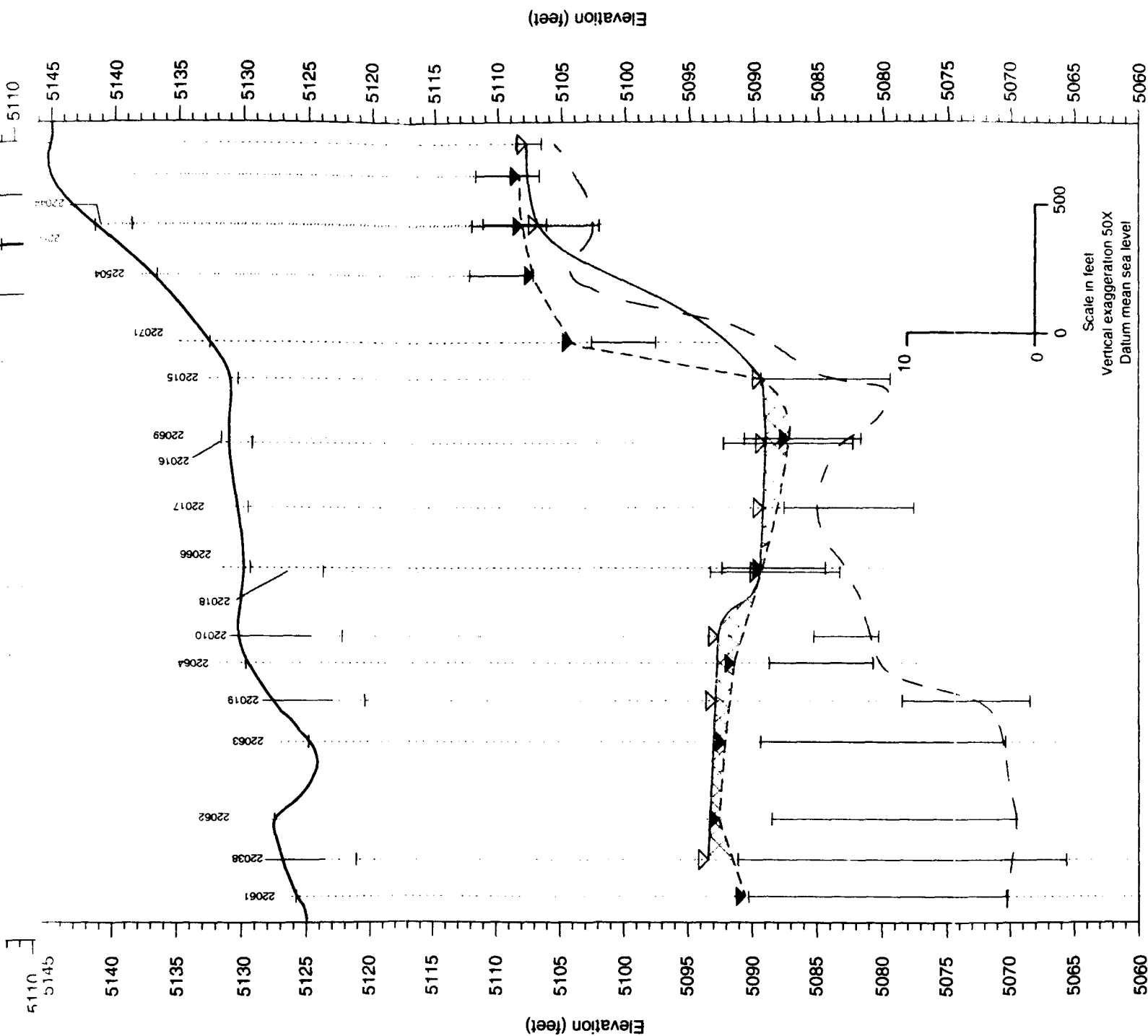
Prepared by:
Harding Lawson Associates

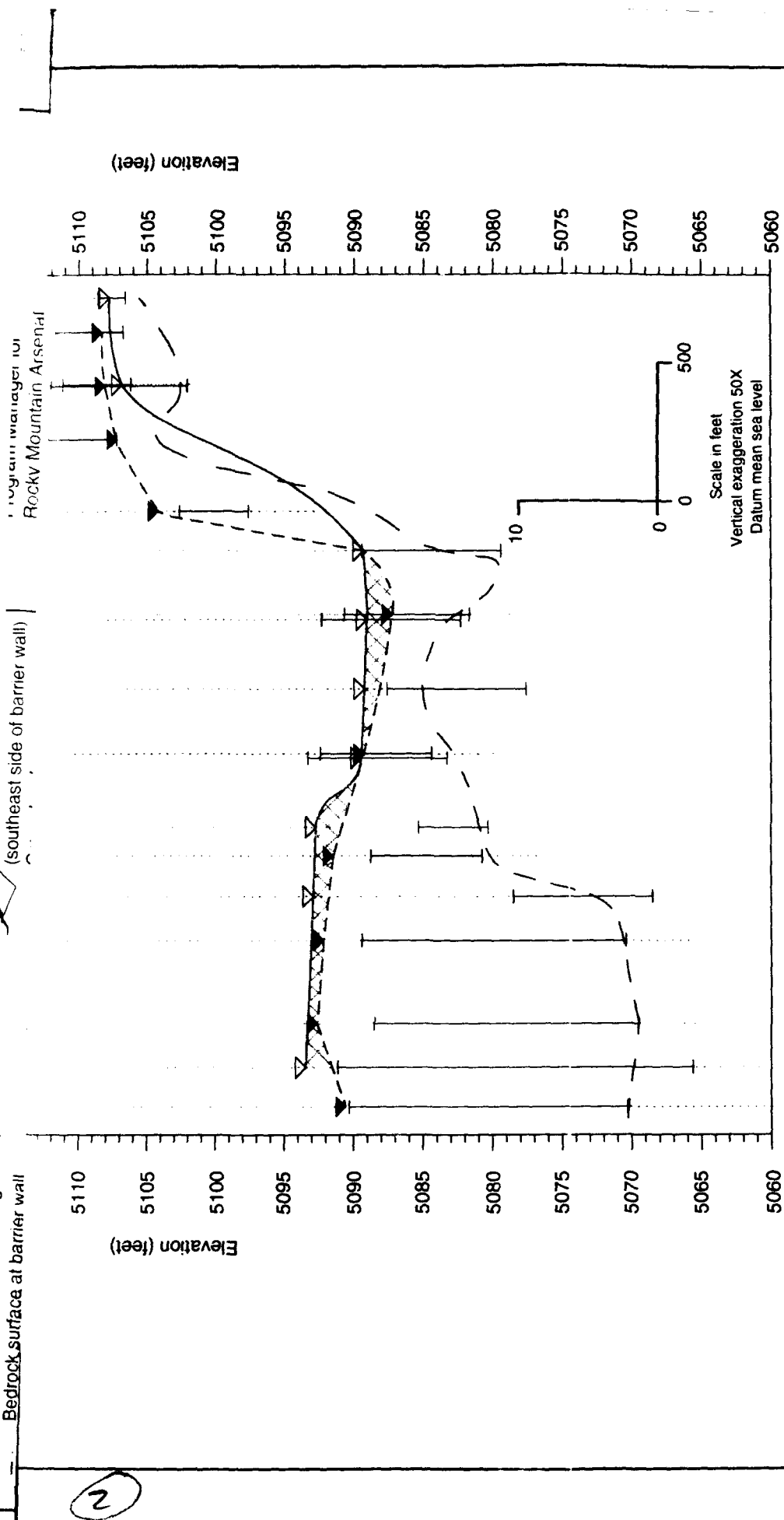
Figure 5.39

Cross Section of Approximate Water-Table
Elevations at the Northwest Boundary
Containment/Treatment System from January 1 to
March 31, 1991
GWAR FY91

RMA Boundary







EXPLANATION

- Area of reversed hydraulic gradient
- Bedrock surface at barrier wall (Source: Waterways Experiment Station, 1987b, plate 1)
- Water elevation upgradient (southeast) of barrier wall
- Water elevation downgradient (northwest) of barrier wall
- Water-level elevation marker southeast of barrier wall
- Water-level elevation marker northwest of barrier wall

- Well number
- Ground surface (southeast side of barrier wall)
- Ground surface (northwest side of barrier wall)
- Cased interval
- Screened interval
- Cased interval
- Alluvial well
- Containment system
- Physical barrier
- Hydraulic barrier

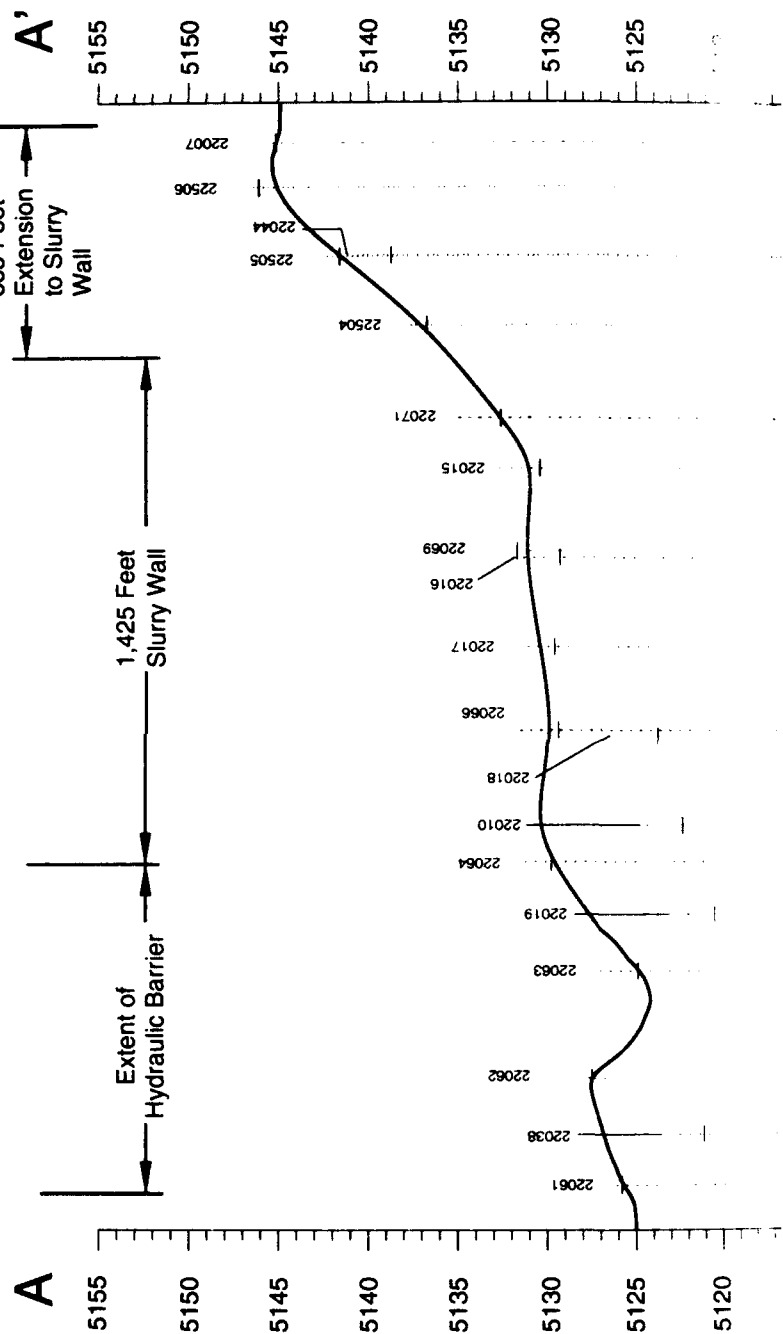
Prepared for:
 Program Manager for
 Rocky Mountain Arsenal
 Commerce City, Colorado

Prepared by:
 Harding Lawson Associates

Figure 5.40
 Cross Section of Approximate Water-Table
 Elevations at the Northwest Boundary
 Containment/Treatment System from April 1 to
 June 30, 1991
 GWAR FY91

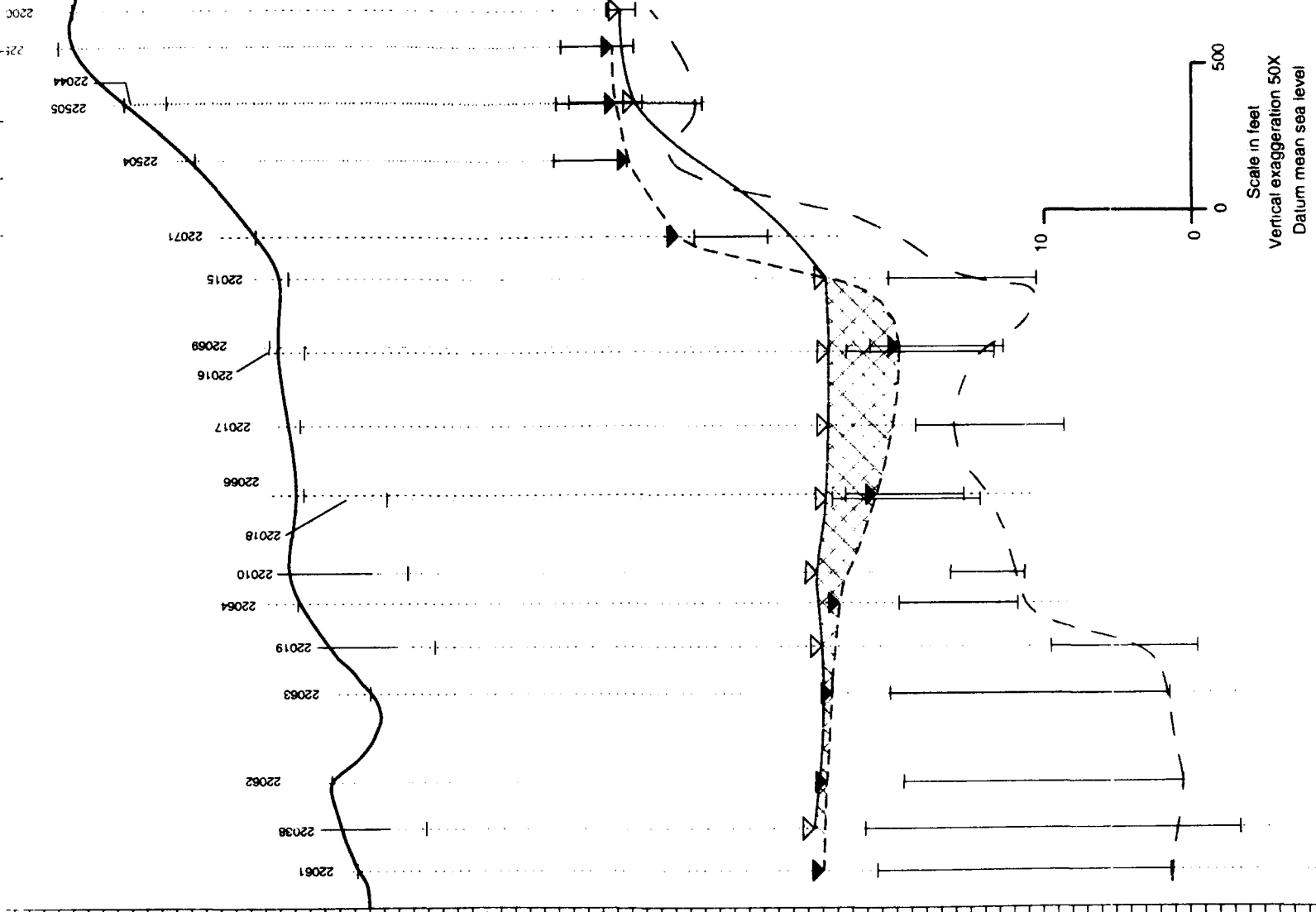
RMA Boundary

Section 22



Elevation (feet)

5145 5140 5135 5130 5125 5120 5115 5110 5105 5100 5095 5090 5085 5080 5075 5070 5065



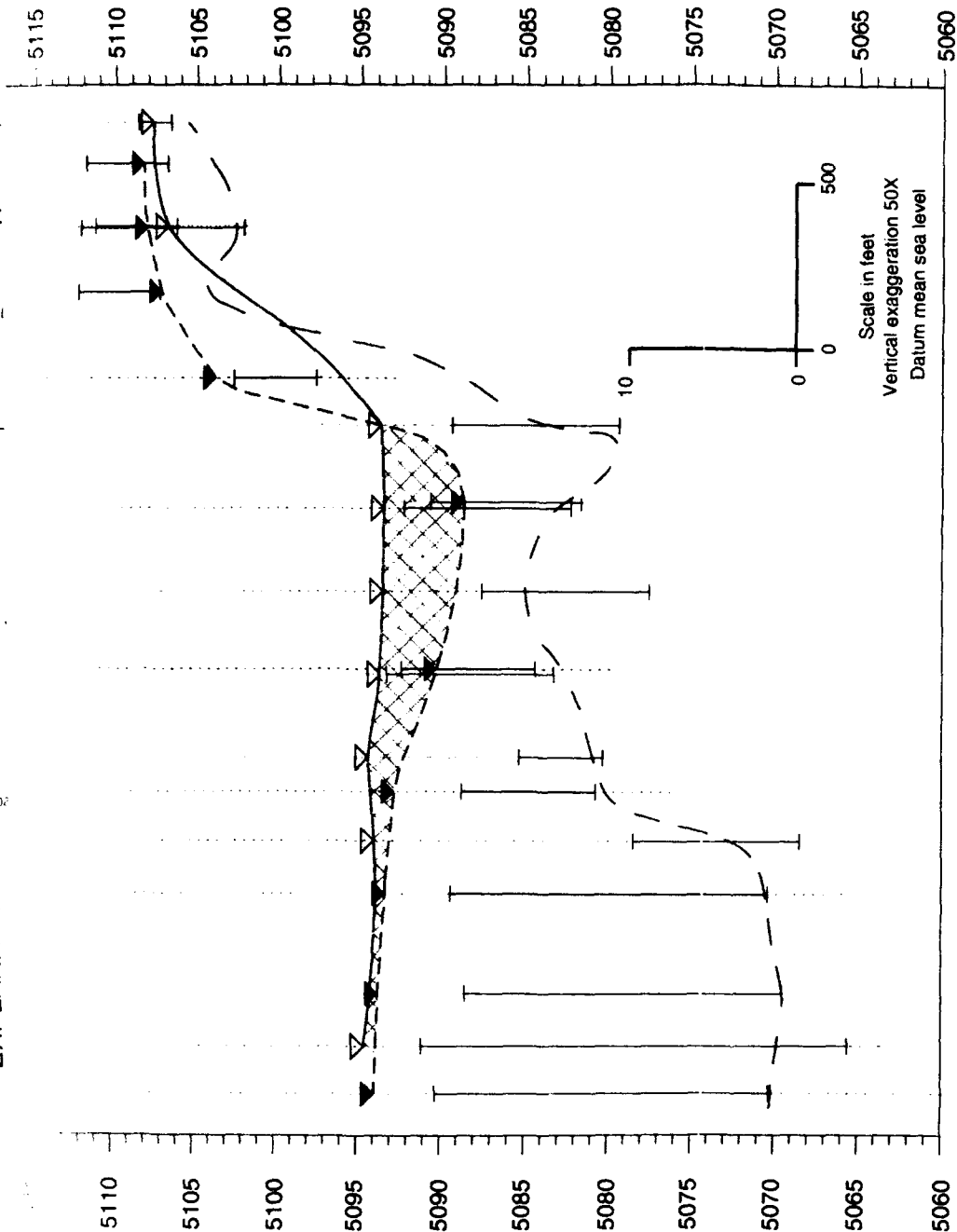
Elevation (feet)

5145 5140 5135 5130 5125 5120 5115 5110 5105 5100 5095 5090 5085 5080 5075 5070 5065

2

Elevation (feet)

Elevation (feet)



EXPLANATION

- Area of reversed hydraulic gradient
- Bedrock surface at barrier wall
(Source: Waterways Experiment Station, 1987b, plate 1)
- Water elevation upgradient (southeast) of barrier wall
- Water elevation downgradient (northwest) of barrier wall
- Water-level elevation marker southeast of barrier wall
- Water-level elevation marker northwest of barrier wall

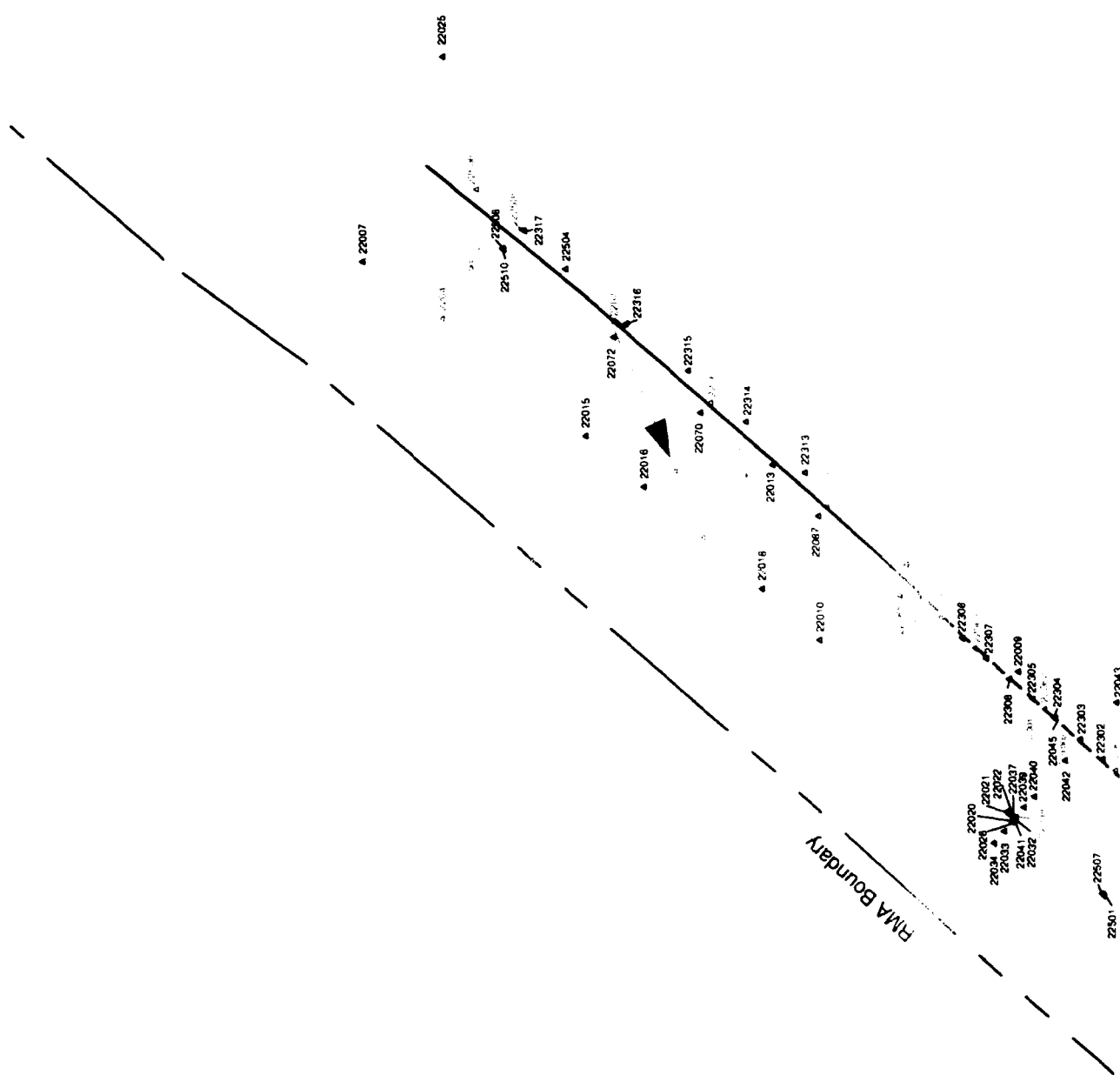
- Well number
- Ground surface (southeast side of barrier wall)
- Ground surface (northwest side of barrier wall)
- Cased interval
- Screened interval
- Alluvial well
- Containment system
- Physical barrier
- Hydraulic barrier

Prepared for:

Program Manager for
Rocky Mountain Arsenal
Commerce City, Colorado
Prepared by:
Harding Lawson Associates

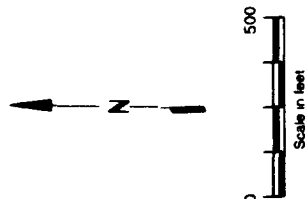
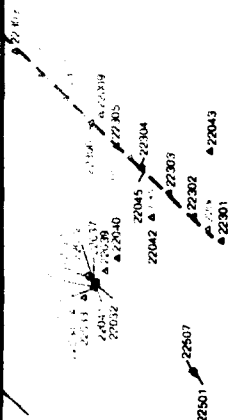
Figure 5.41

Cross Section of Approximate Water-Table
Elevations at the Northwest Boundary
Containment/Treatment System from July 1 to
September 30, 1991
GWAPV91



Section 22
Section 27

2



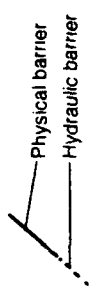
EXPLANATION

▲ 22101 Alluvial well

▲ Direction and magnitude of water-table gradient in feet/feet

Note: Wells in red were utilized in three-point solutions of water-table direction and magnitude.

Containment system



Prepared for:

Program Manager for
Rocky Mountain Arsenal
Commerce City, Colorado

Prepared by:

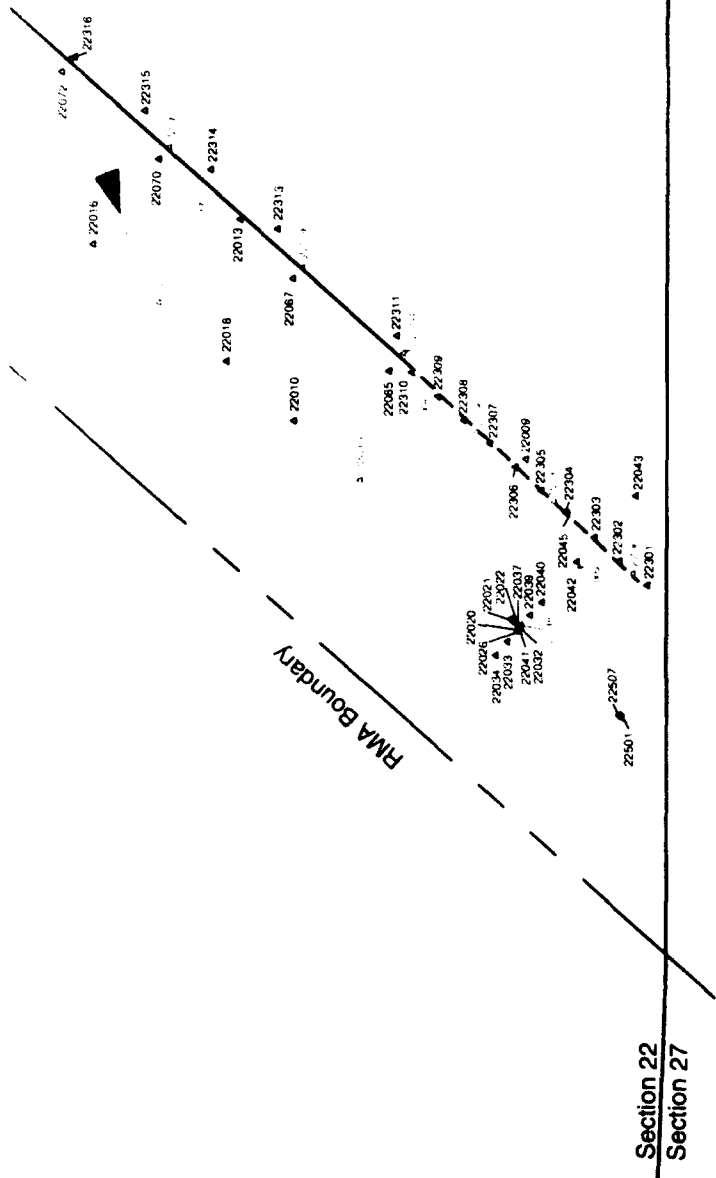
Harding Lawson Associates

Figure 5.43

Direction and Magnitude of Water-Table Gradients in the Vicinity of the Northwest Boundary Containment/Treatment System Barrier Wall from January 1 to March 31, 1991

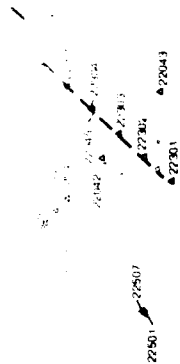
GWAR FY91

3

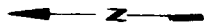


EXPLANATION

Prepared for
Program Manager for
Rocky Mountain Arsenal



Section 22
Section 27



EXPLANATION

• 22101 Alluvial well

Direction and magnitude of water-table gradient in feet/feet

Note: Wells in red were utilized in three-point solutions of water-table direction and magnitude.

Containment system

Physical barrier
Hydraulic barrier

Prepared for:

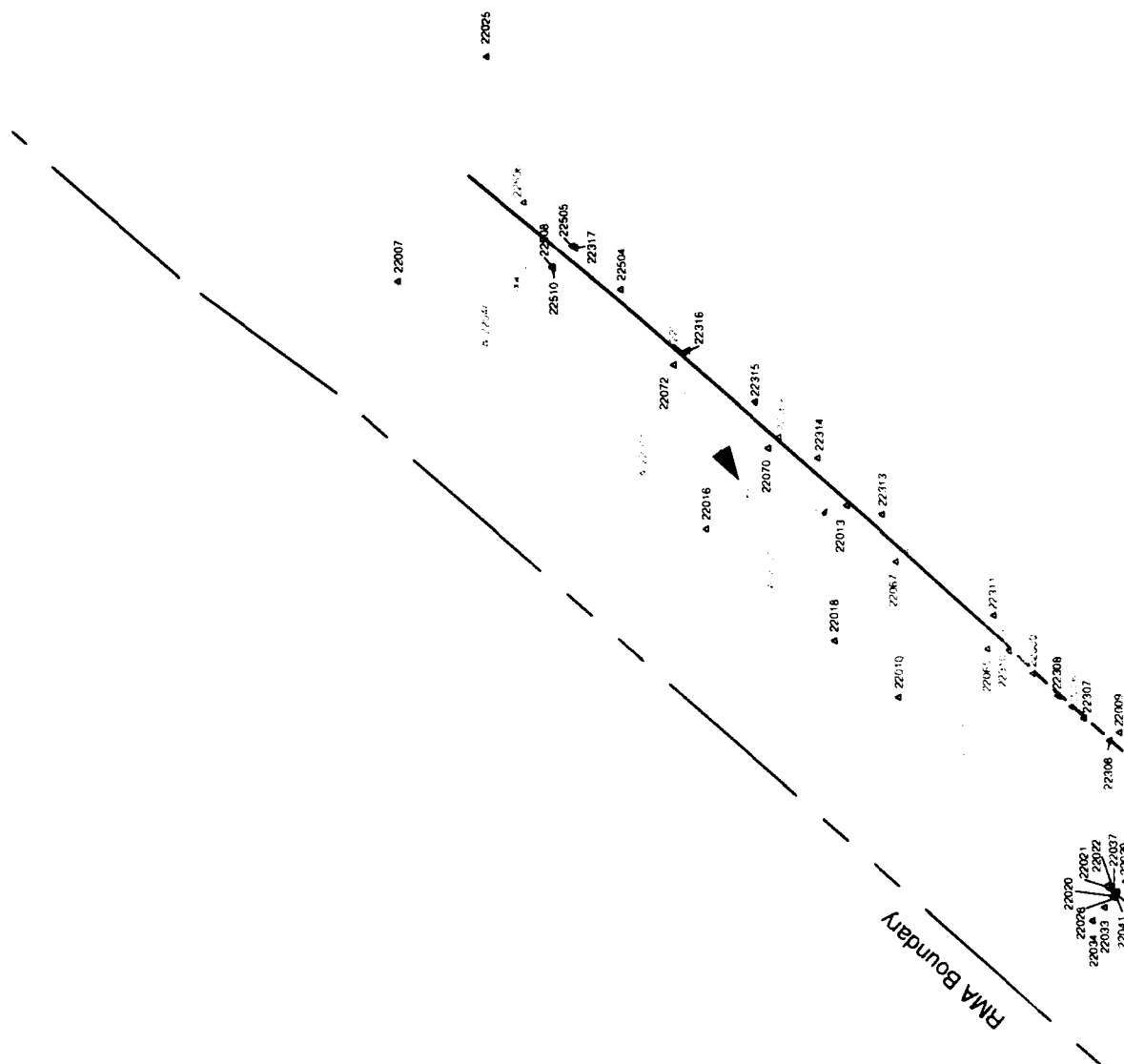
Program Manager for
Rocky Mountain Arsenal
Commerce City, Colorado

Prepared by:
Harding Lawson Associates

Figure 5.44

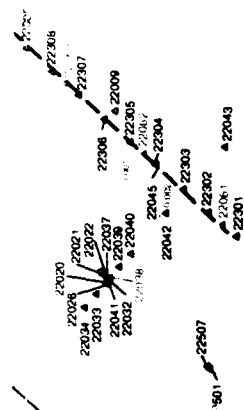
**Direction and Magnitude of Water-Table
Gradients in the Vicinity of the Northwest Boundary
Containment/Treatment System Barrier Wall from
April 1 to June 30, 1991**

GWAB FY91



①

EXPLANATION



Section 22
Section 27

2

EXPLANATION

▲ 22101 Alluvial well

Direction and magnitude of
water-table gradient in feet/feet

Note: Wells in red were utilized in three-point
solutions of water-table direction and
magnitude.

Containment system

Physical barrier
Hydraulic barrier

Prepared for:

Program Manager for
Rocky Mountain Arsenal
Commerce City, Colorado

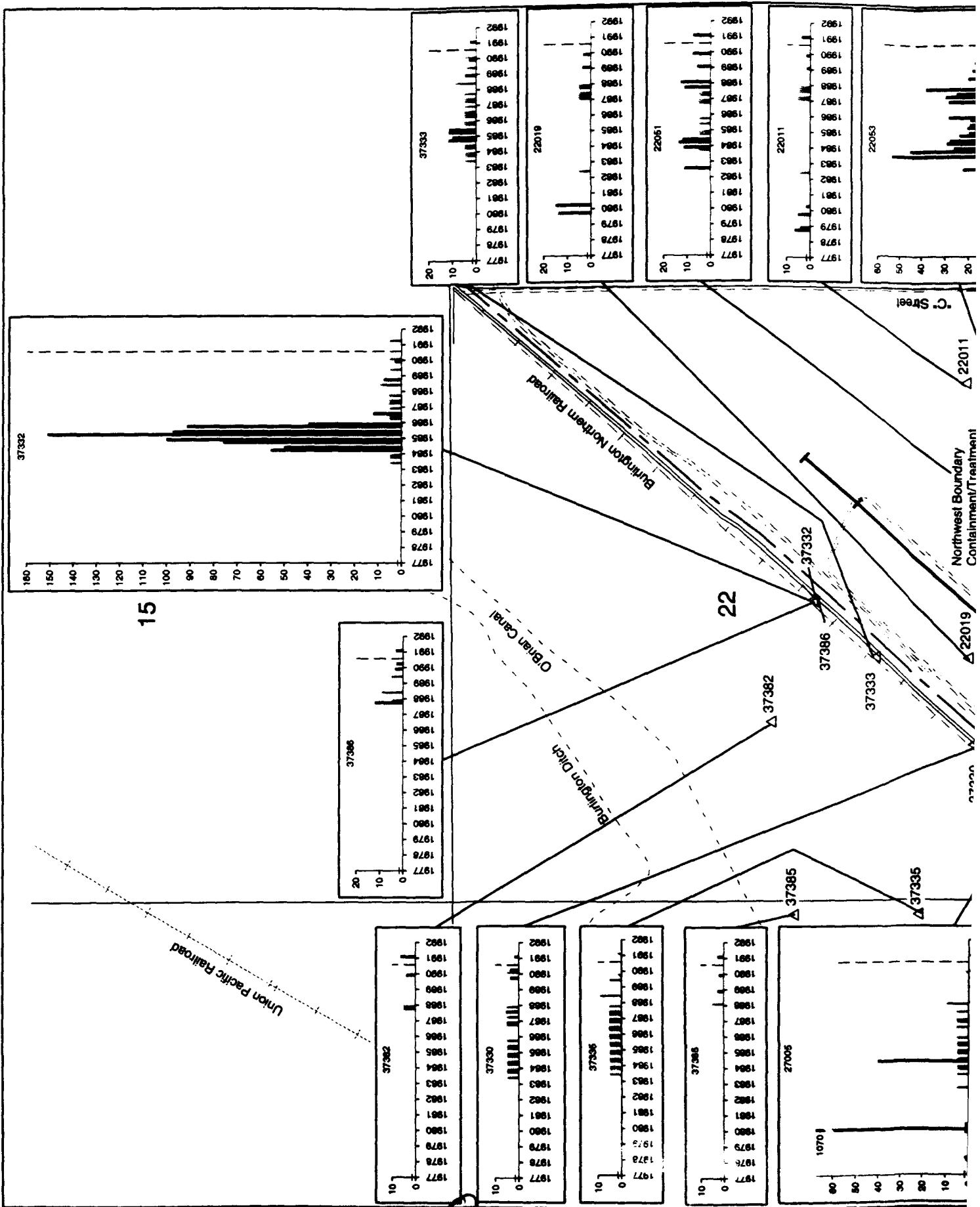
Prepared by:

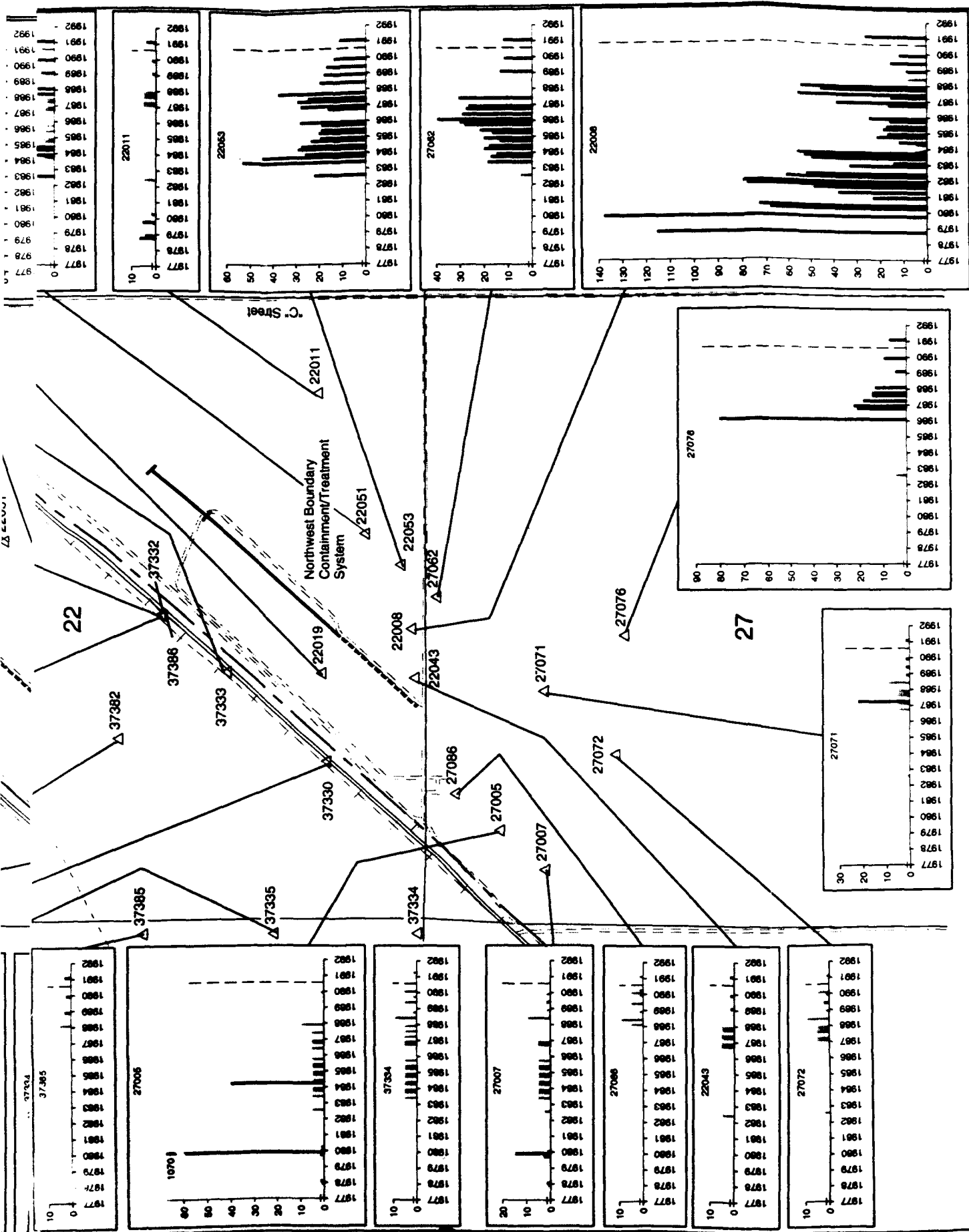
Harding Lawson Associates

Figure 5.45

Direction and Magnitude of Water-Table
Gradients in the Vicinity of the Northwest Boundary
Containment/Treatment System Barrier Wall from
July 1 to September 30, 1991
GWAR FY91

3





EXPLANATION

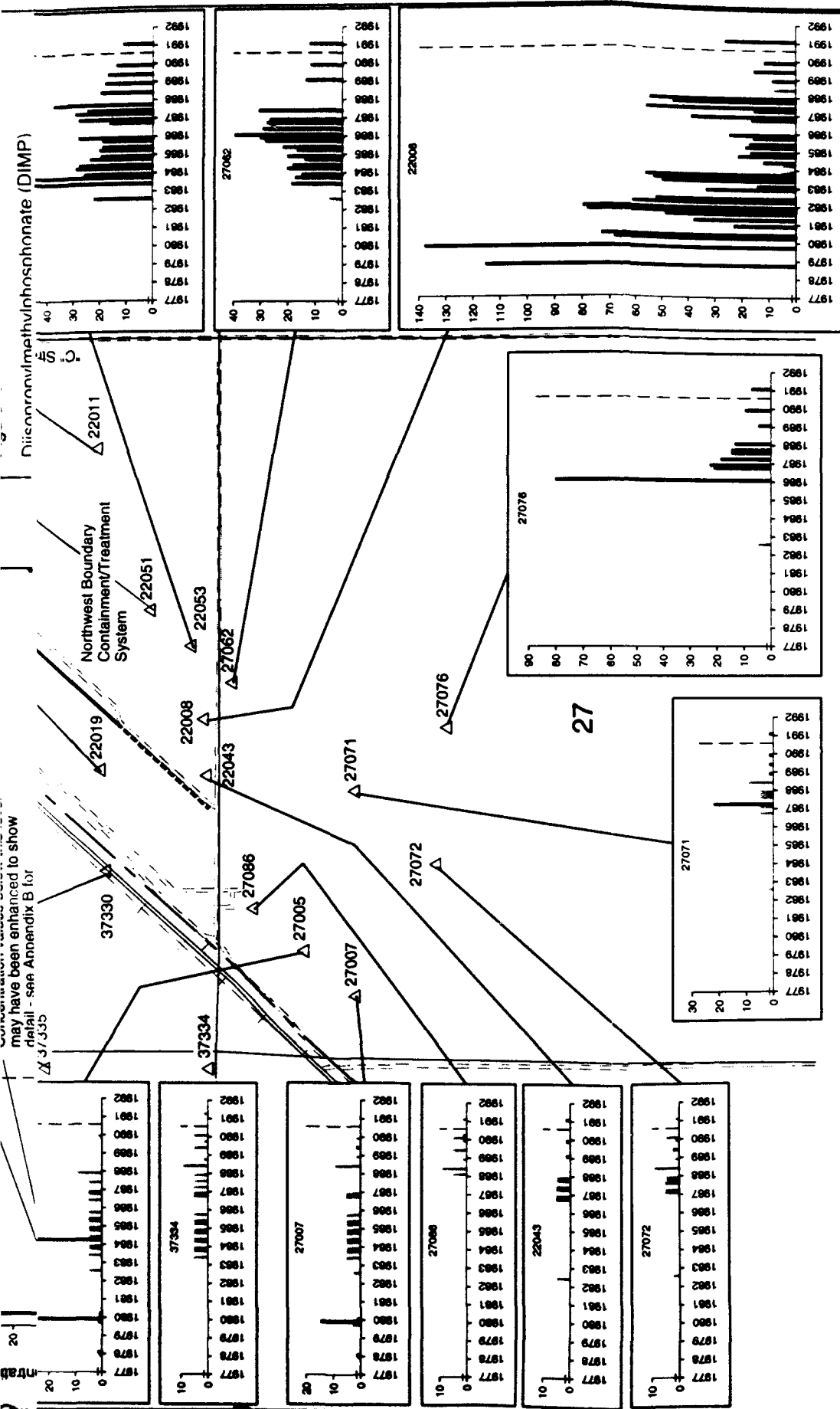
Well number
Reported value 2005
Startup of slurry wall extension 2005

Unconfined flow system wells

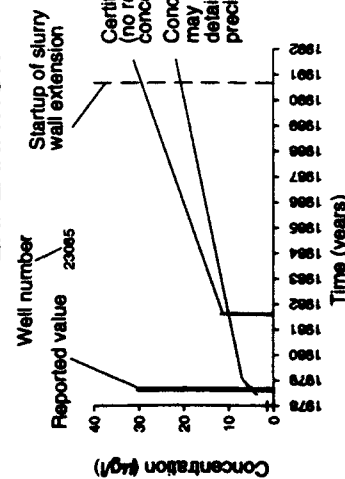
23085 Δ Alluvial well
24135 $\circ$ Denver well

Prepared for:

Program Manager for
Rocky Mountain Arsenal
Commerce City, Colorado
Prepared by:
Landing Services Associates



EXPLANATION



Prepared for:

Program Manager for
Rocky Mountain Arsenal
Commerce City, Colorado

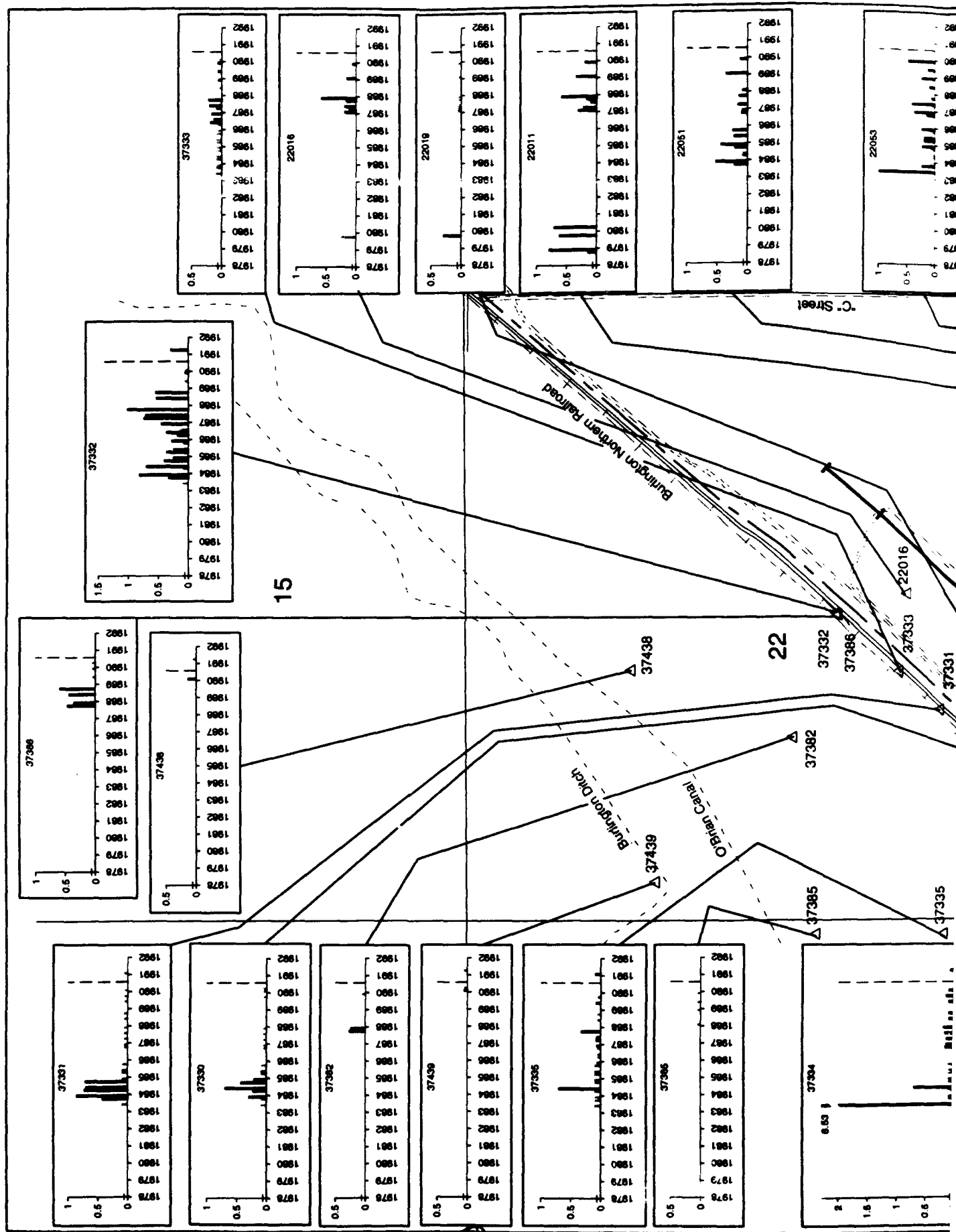
Prepared by:

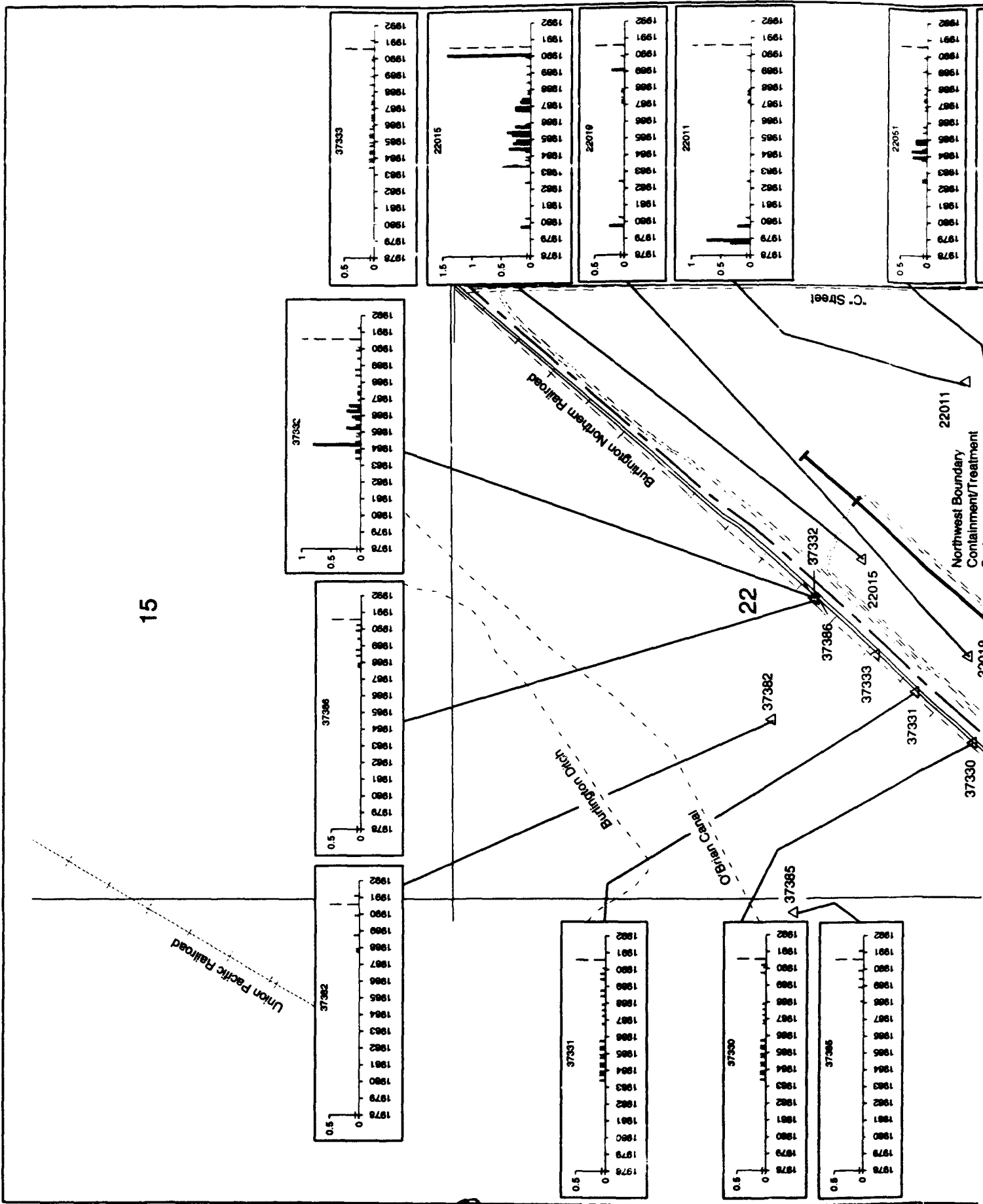
Harding Lawson Associates

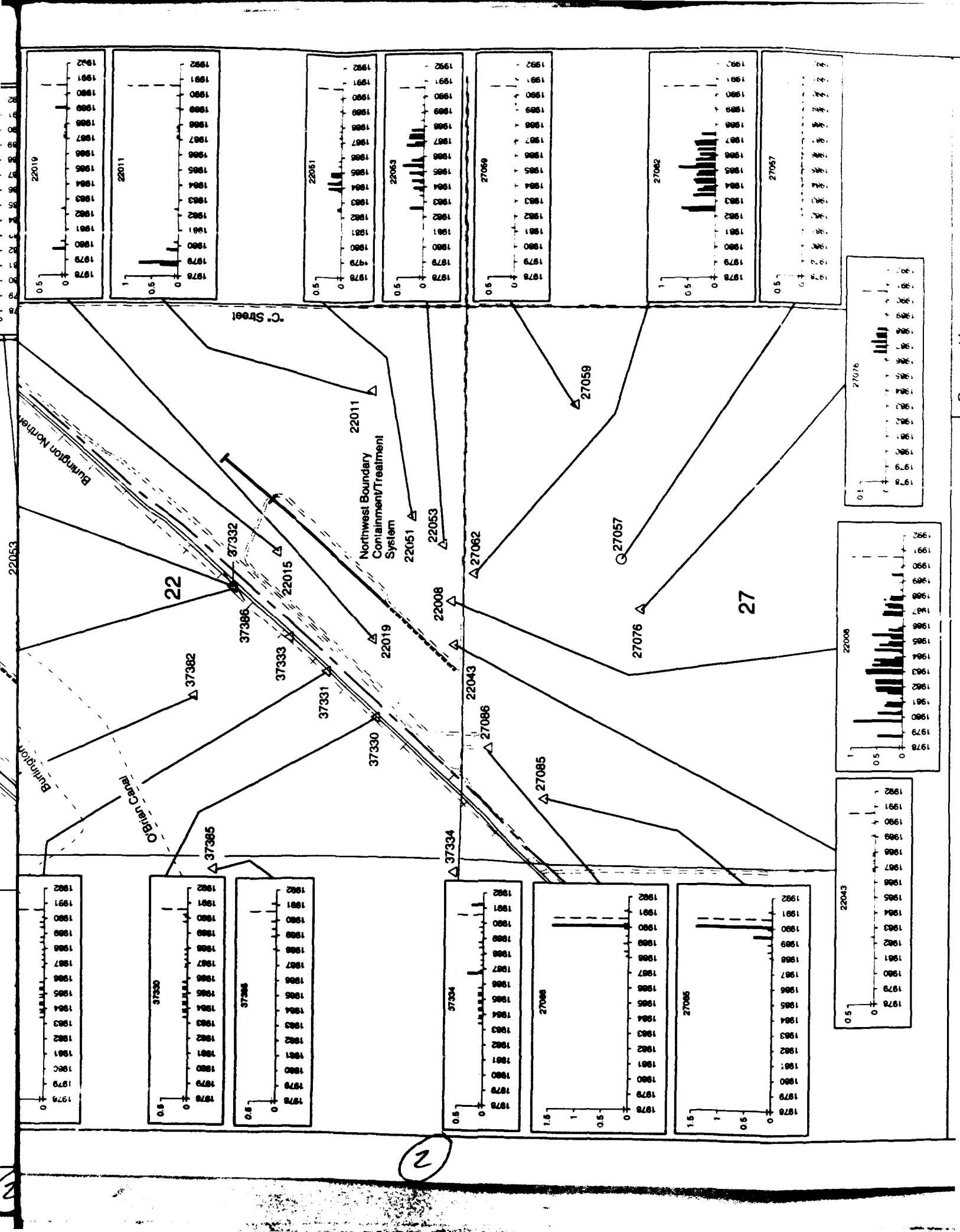
Figure 5.46

Diisopropylmethylphosphonate (DIMP)
Histograms for Wells near the Northwest
Boundary Containment/Treatment System

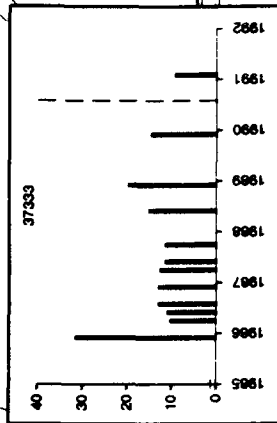
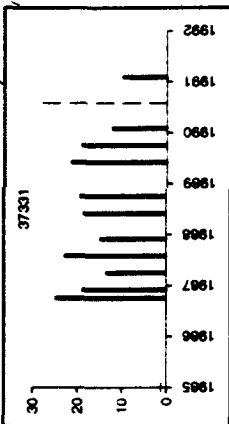
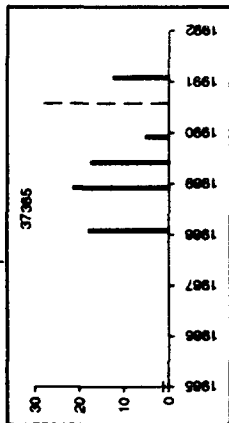
GWAR FY91







Union Pacific Railroad



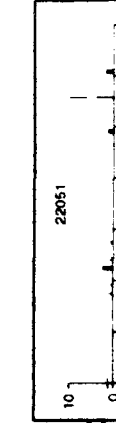
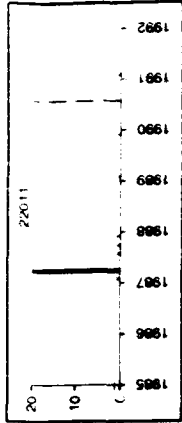
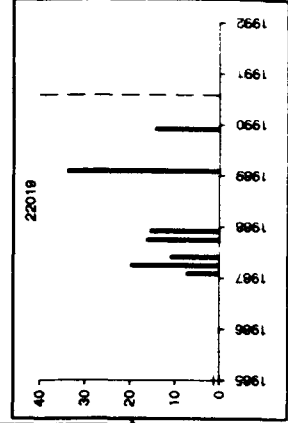
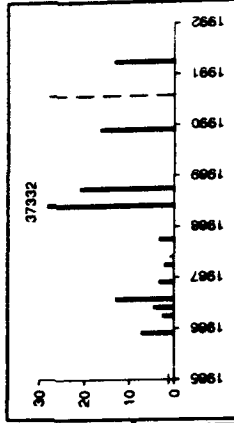
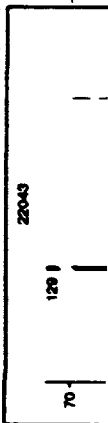
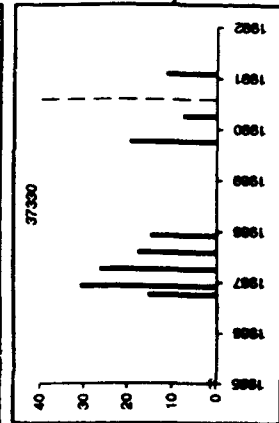
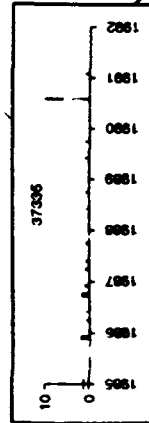
RMA Boundary

Burlington Ditch

Burlington Northern Railroad

O'Brien Canal

C Street



22011

Northwest Boundary Containment/Treatment System

22051

22053

22008

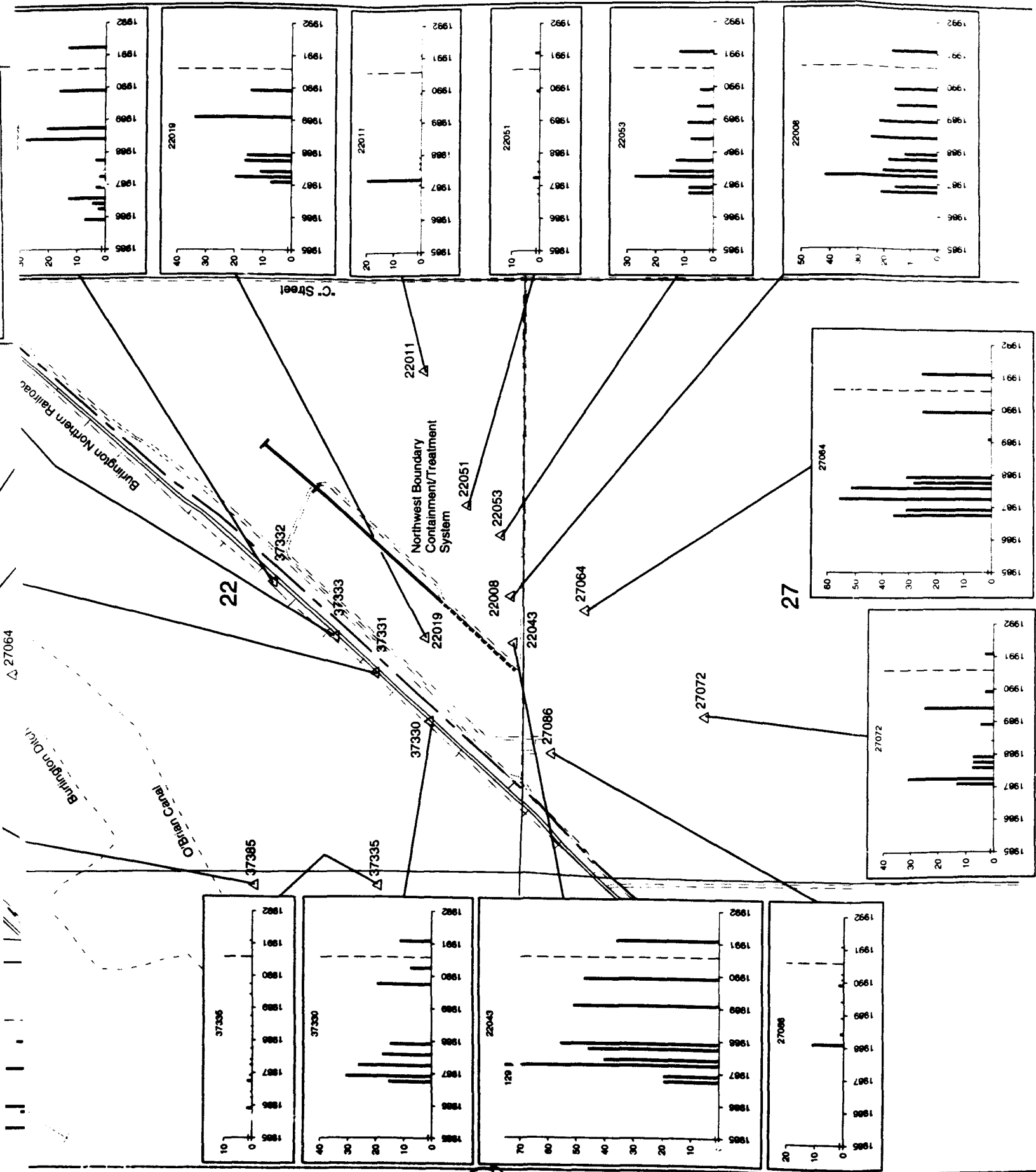
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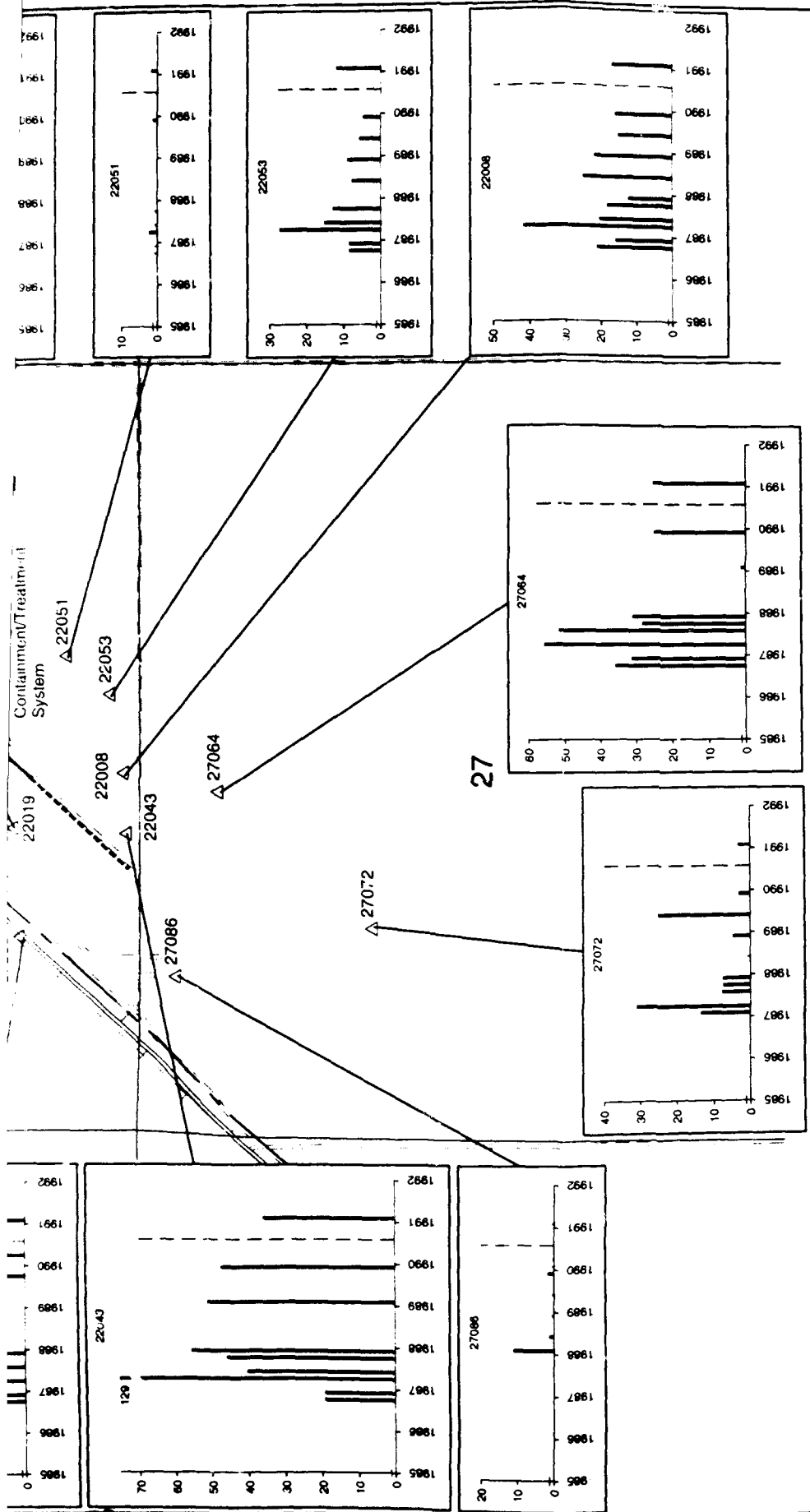
37330

37335

37385

22





Prepared for:
Program Manager for
Rocky Mountain Arsenal
Commerce City, Colorado

Prepared by:
Harding Lawson Associates

Figure 5.49
Chloroform Histograms for Wells
near the Northwest Boundary
Containment/Treatment System

GWAR FY91

Unconfined flow system wells

23085 Δ Alluvial well
24135 $\circ$ Denver well

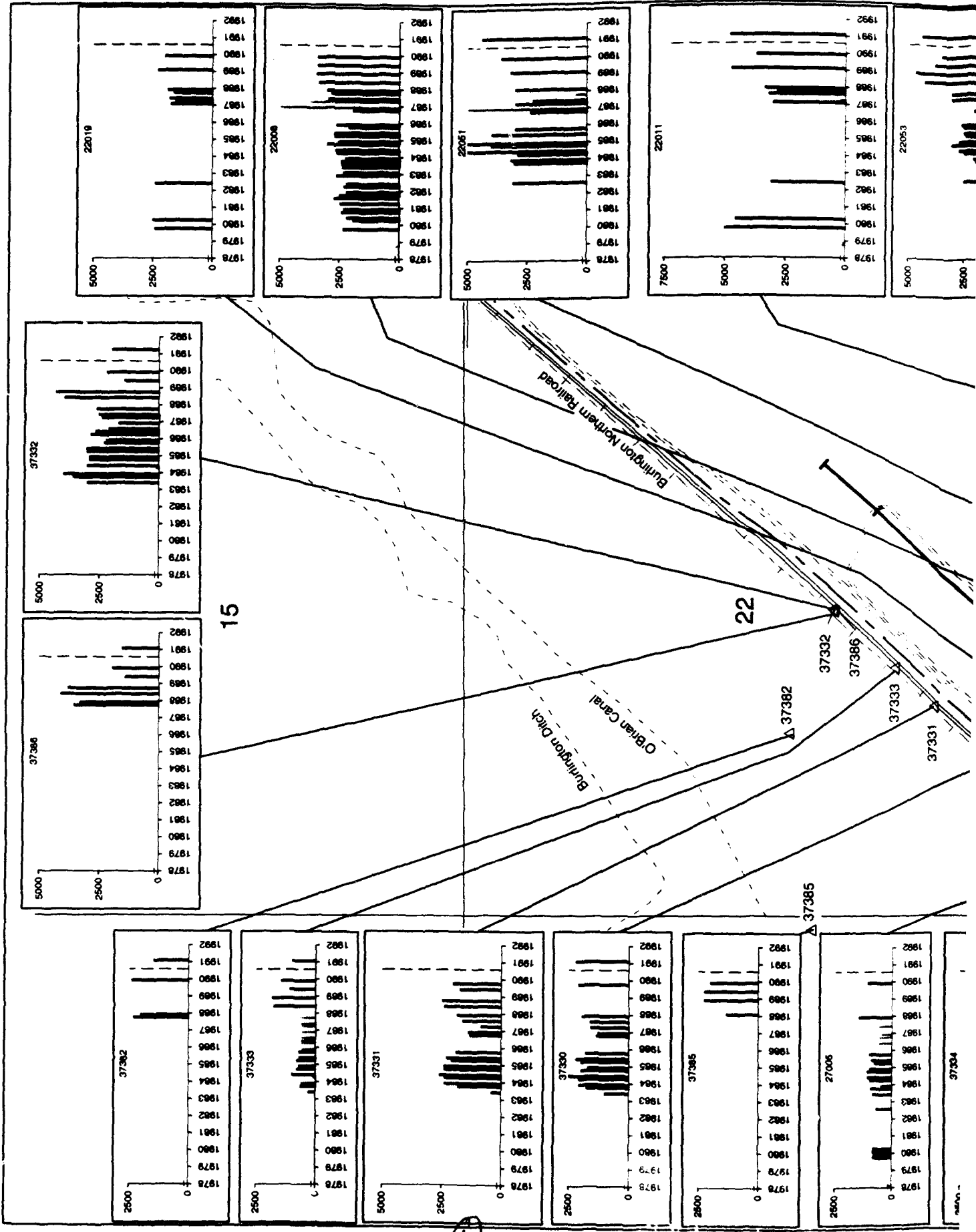
Physical barrier
Hydraulic Barrier
Slurry wall extension

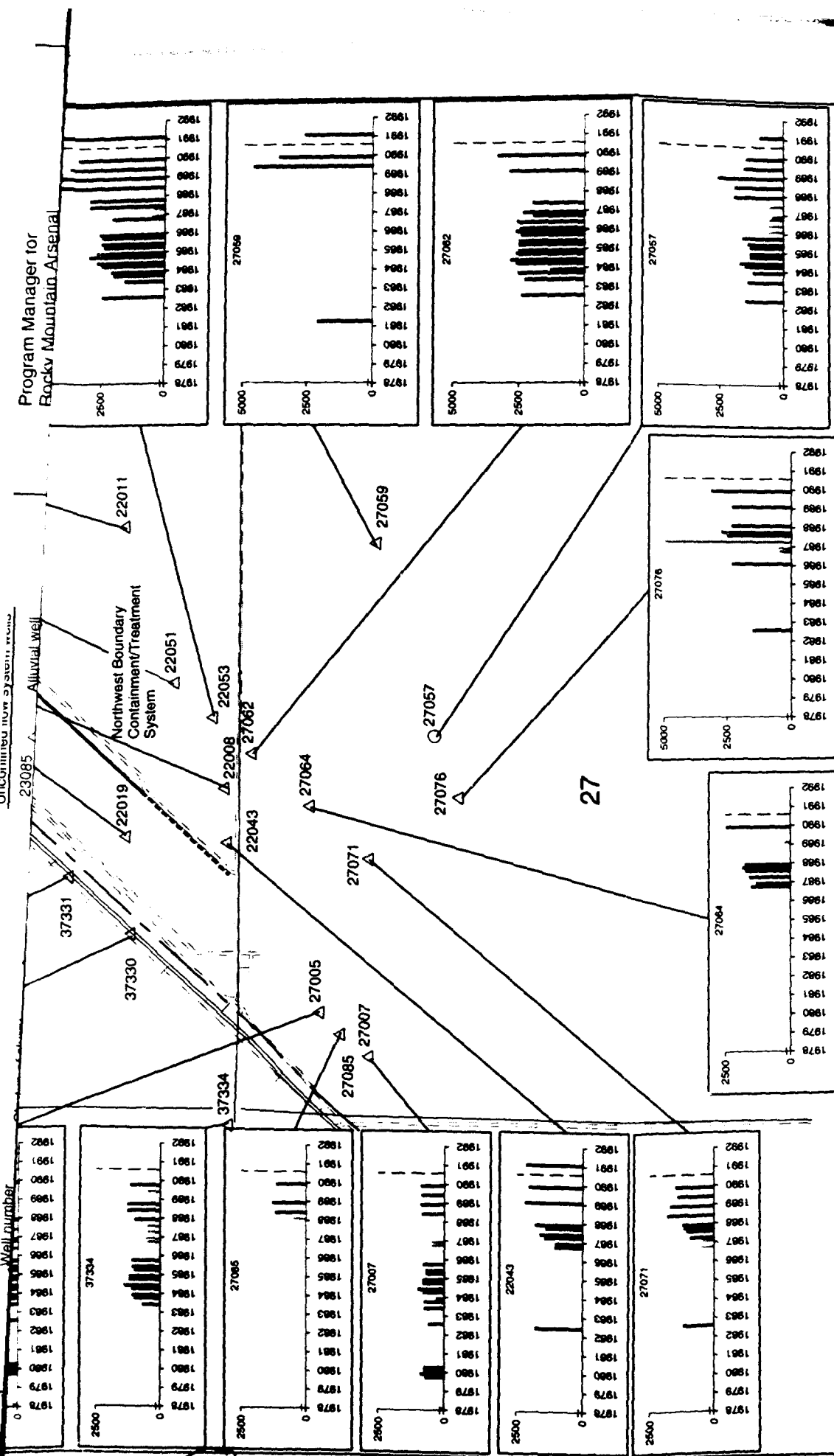
EXPLANATION

Well number
Reported value
Startup of slurry wall extension
Certified Reporting Limit (CRL)
(no reported chemical concentration)
Concentration values below this level may have been enhanced to show detail - see Appendix B for precise values

Scale in feet
0 500 1000

Time (years)
1978 1979 1980 1981 1982 1983 1984 1985 1986 1987 1988 1989 1990 1991 1992





Program Manager for
Rocky Mountain Arsenal

Prepared by:
Commerce City, Colorado

Harding Lawson Associates

Figure 5.50
Fluoride Histograms for Wells near the Northwest Boundary Containment/Treatment System

GWAR FY91

Unconfined flow system wells

23085 Alluvial well

24135 Denver well

EXPLANATION

Well number

Reported value

Startup of slurry wall extension

Certified Reporting Limit (CRL) (no reported chemical)

Concentration values below this level may have been enhanced to show detail - see Appendix B for

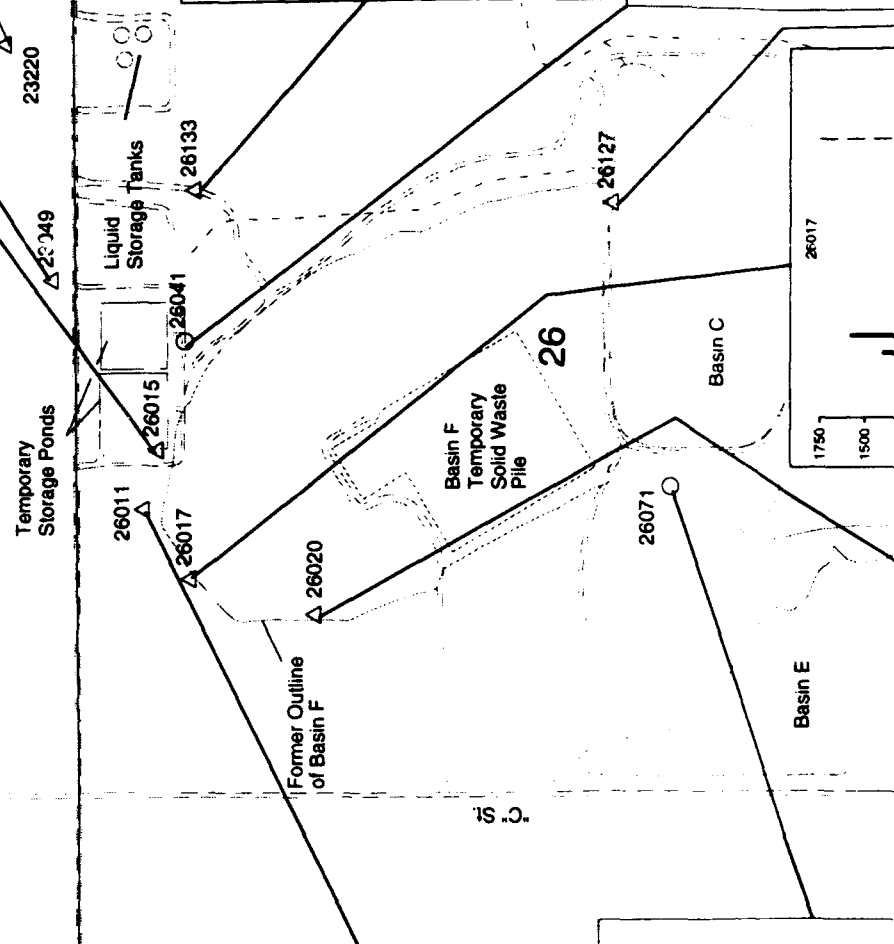
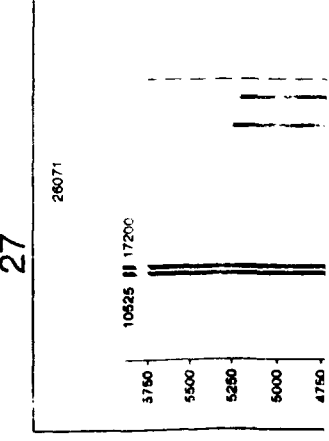
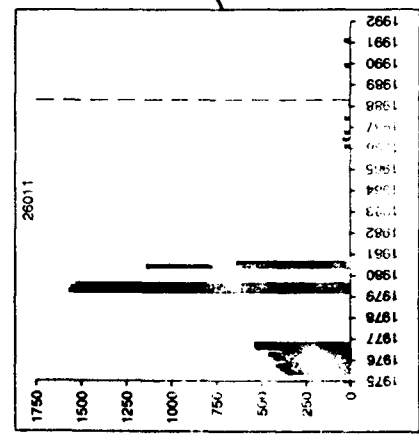
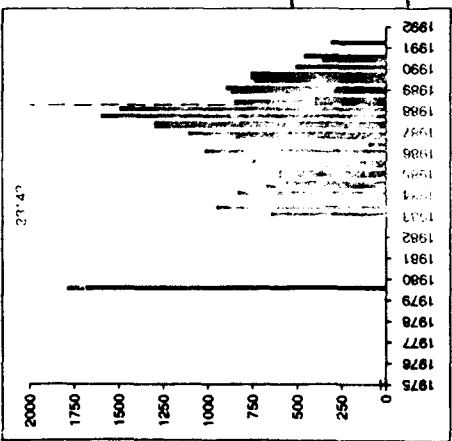
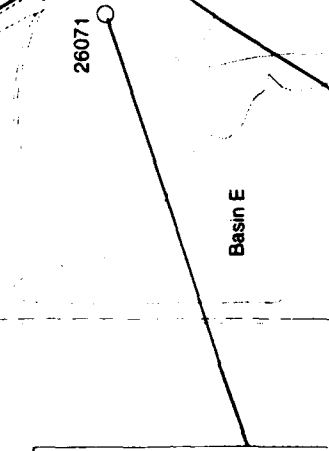
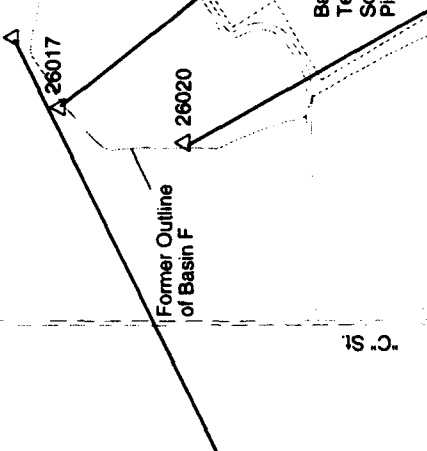
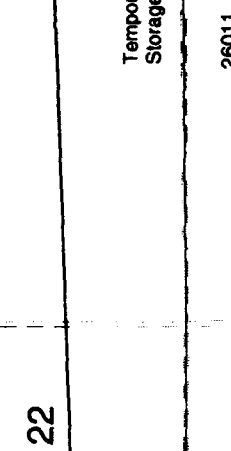
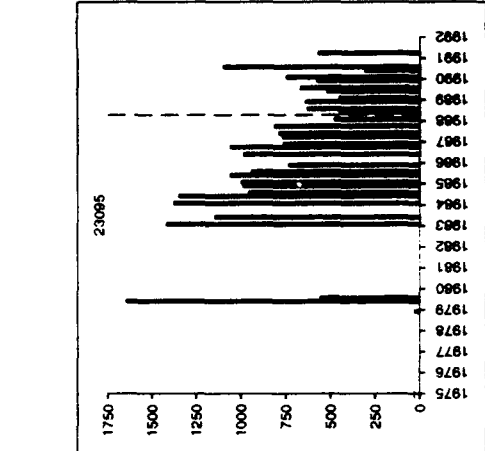
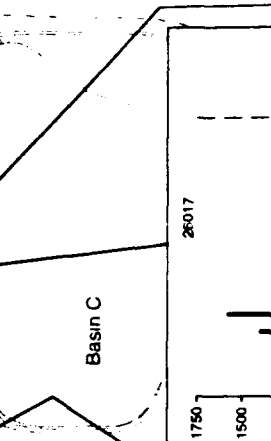
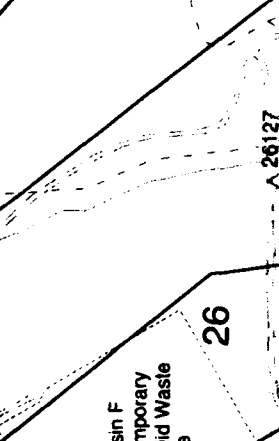
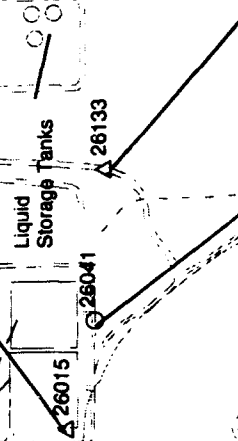
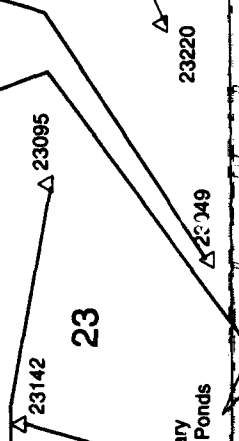
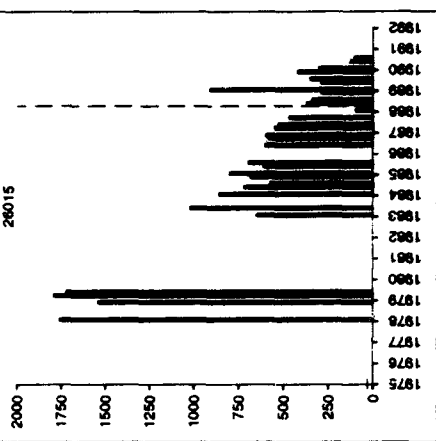
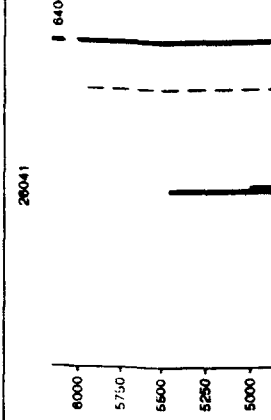
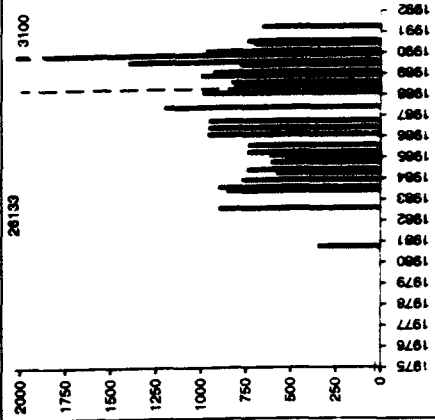
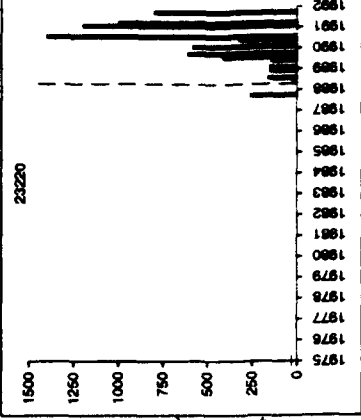
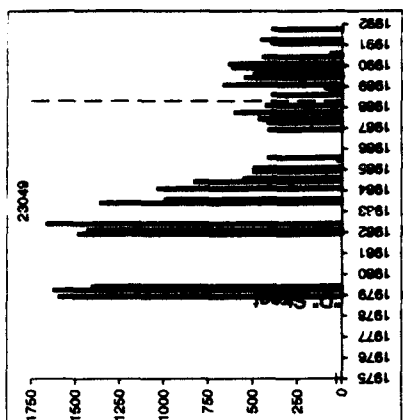
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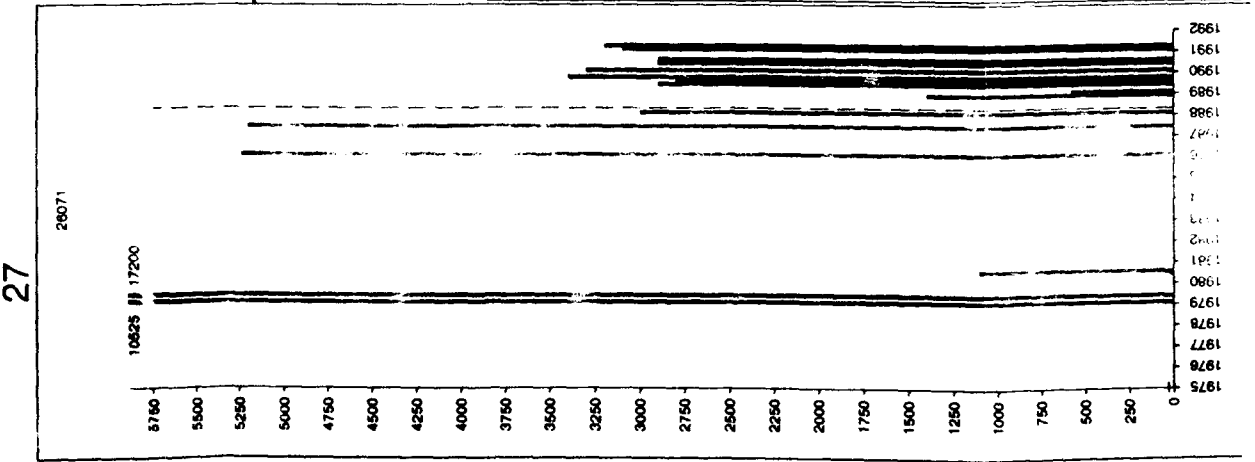
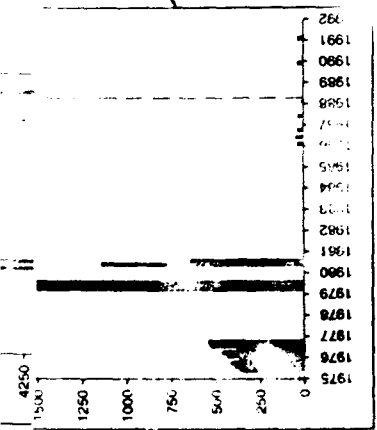
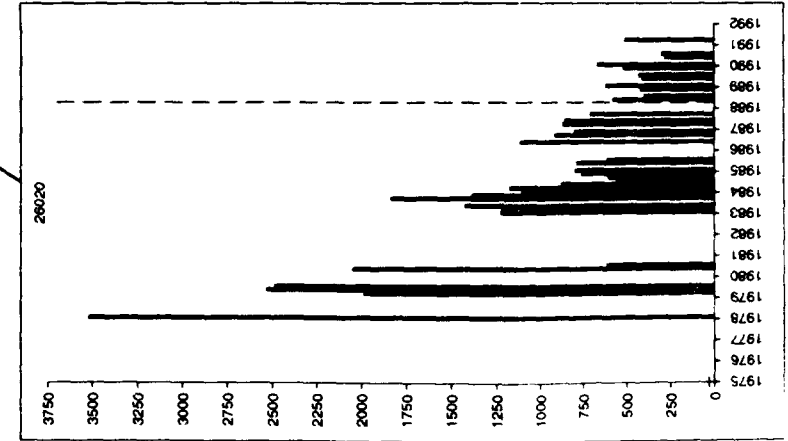
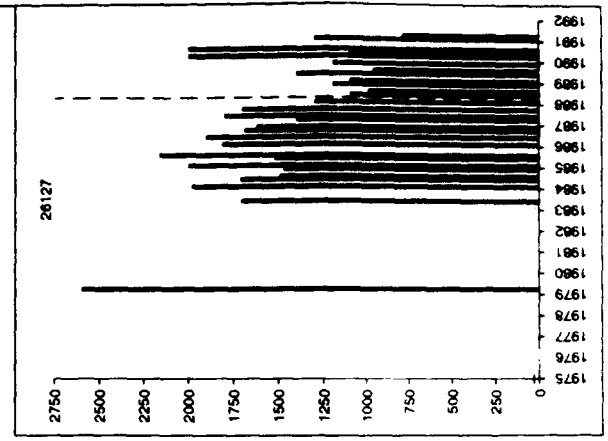
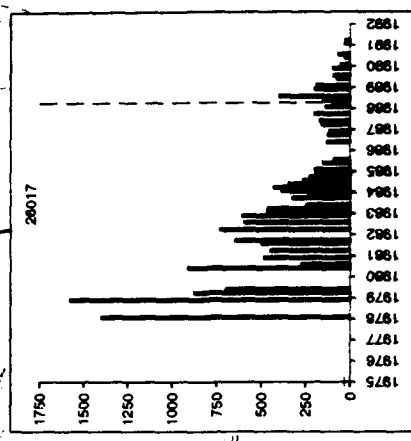
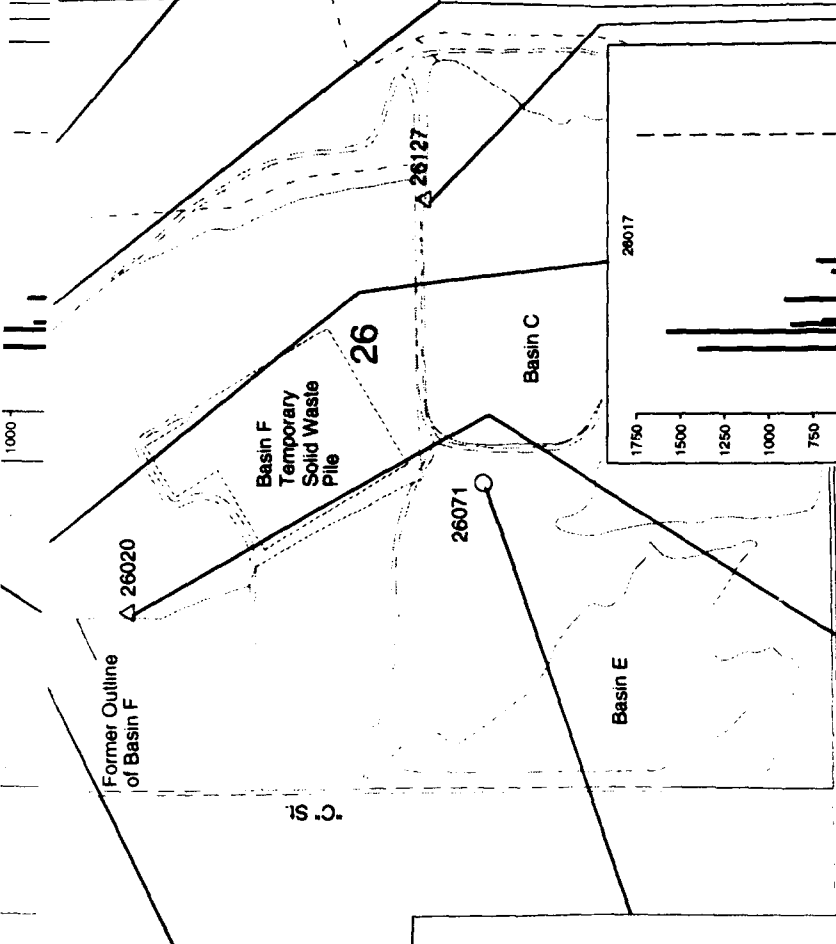
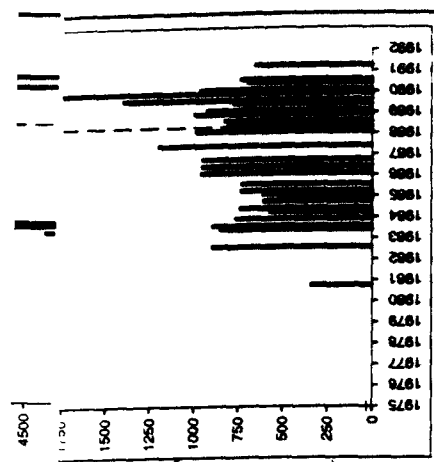
Hydraulic Barrier

Slurry wall extension

Scale in feet

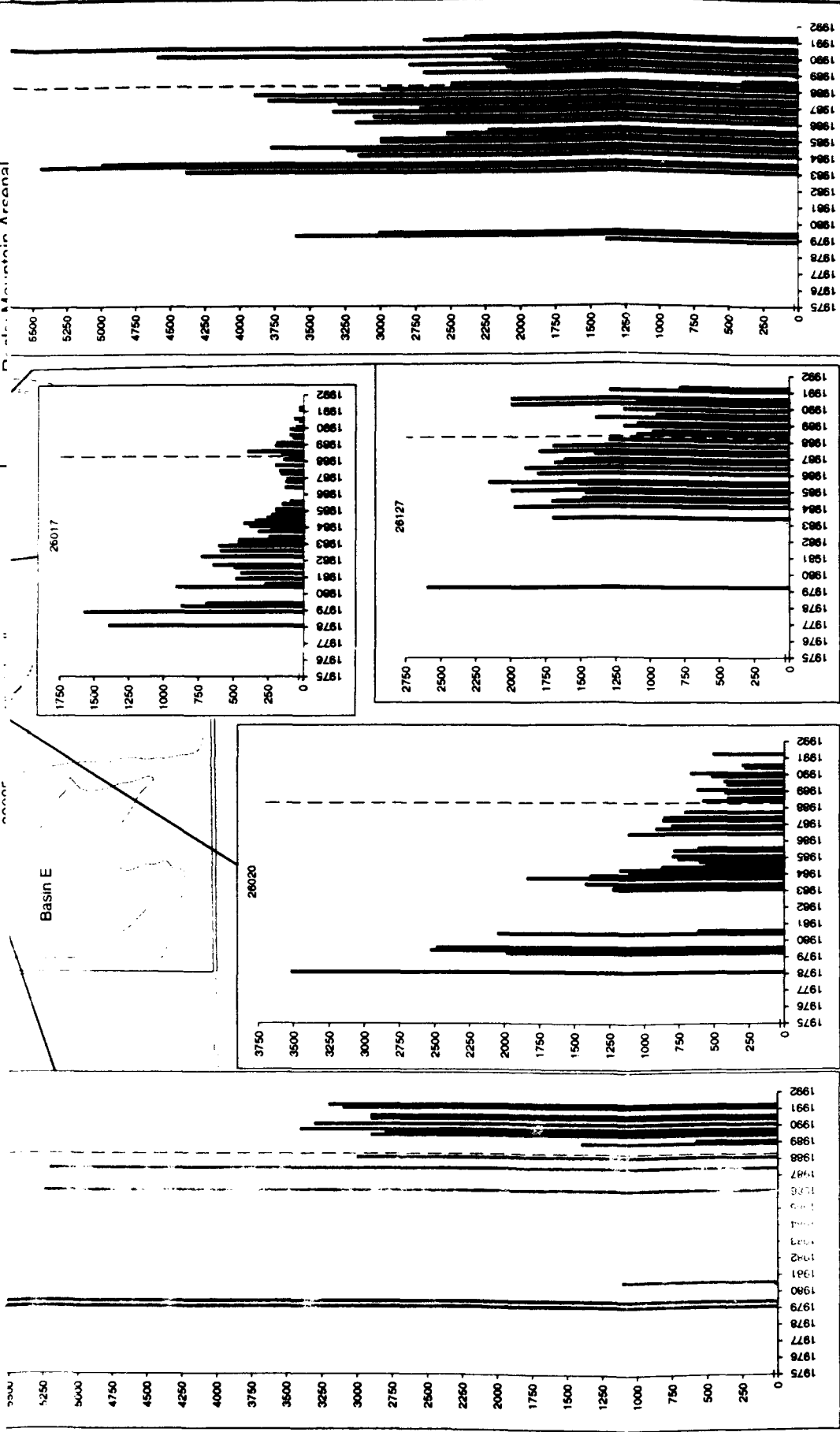
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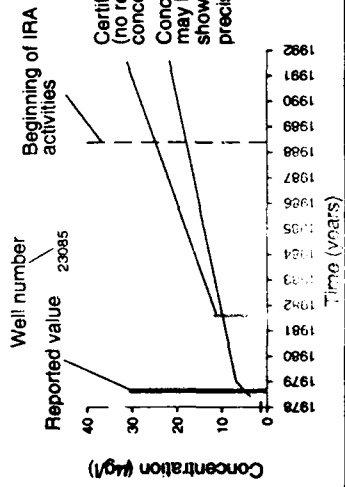


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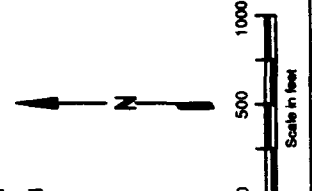
EXPLANATION



Unconfined flow system wells

- 23085 Δ Alluvial well
- 24135 $\circ$ Denver well

Certified Reporting Limit (CRL)
(no reported chemical concentration)
Concentration values below this level may have been enhanced to show detail - see Appendix B for precise values



Prepared for:

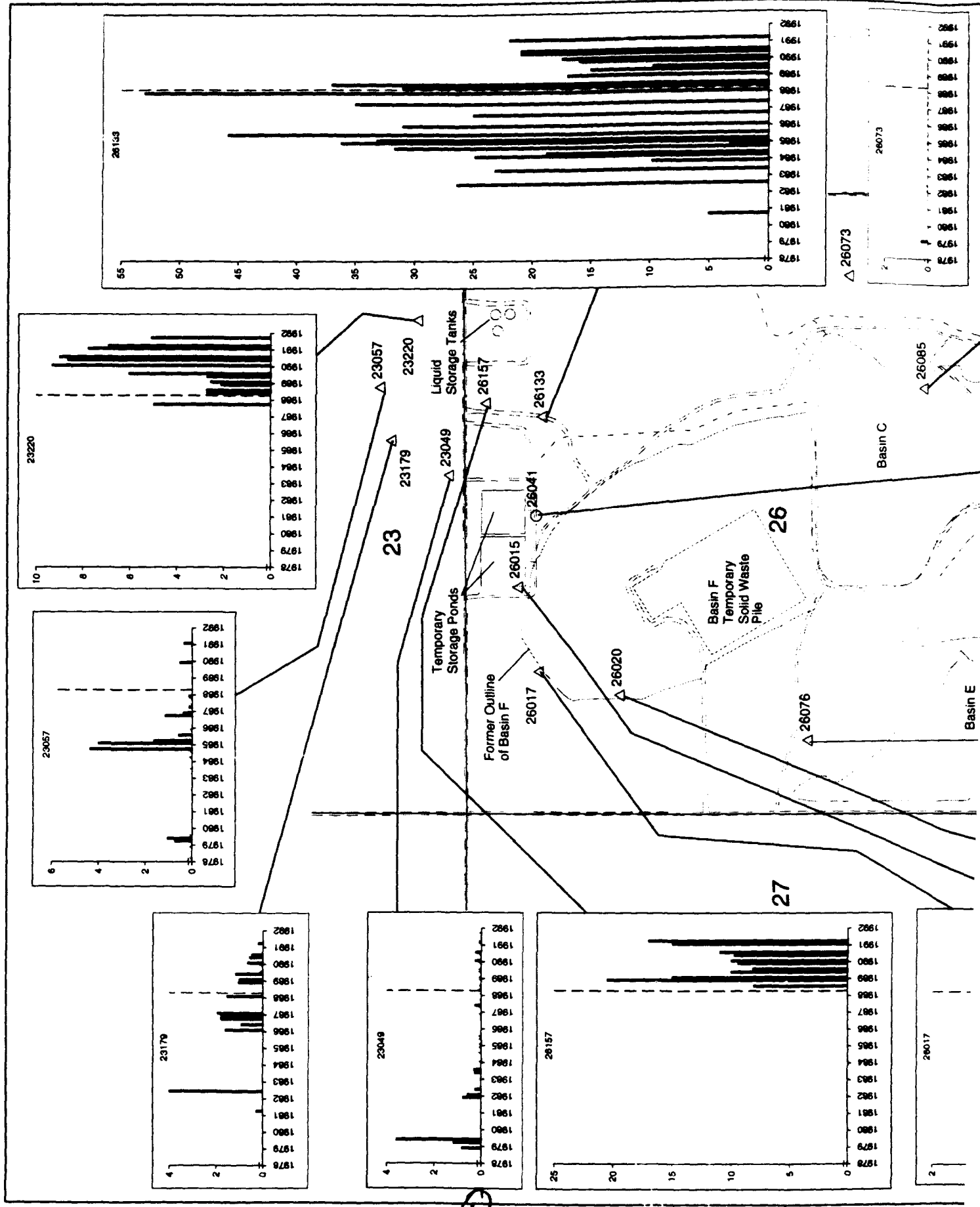
Program Manager for
Rocky Mountain Arsenal
Commerce City, Colorado
Prepared by:
Harding Lawson Associates

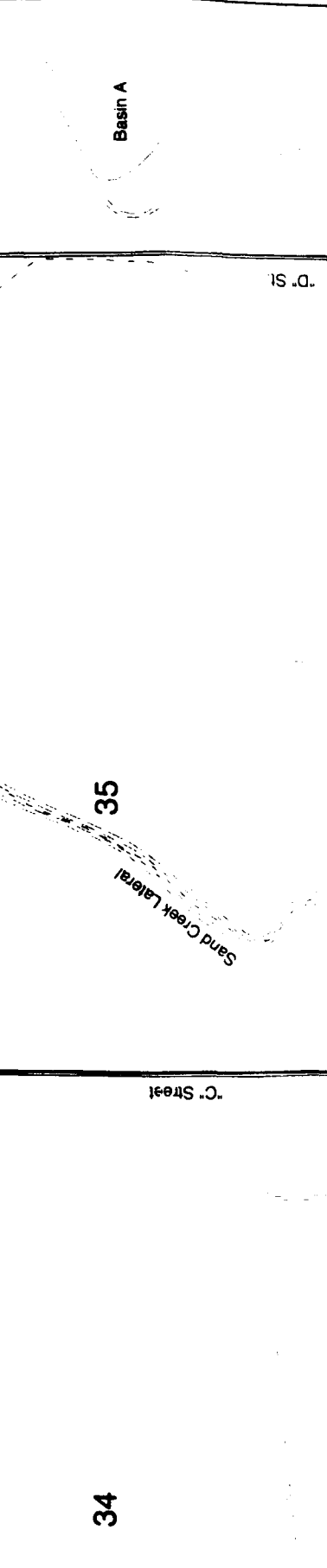
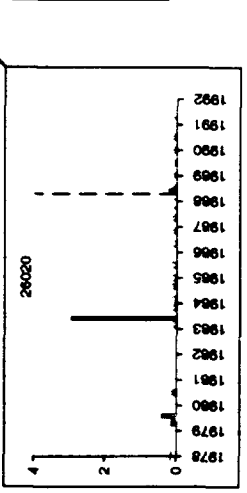
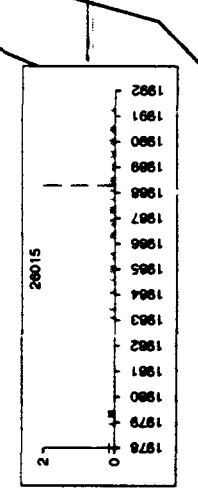
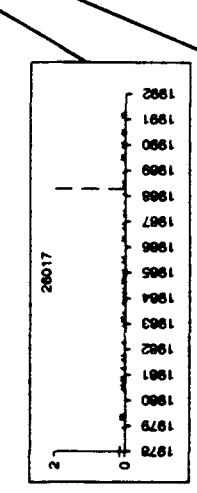
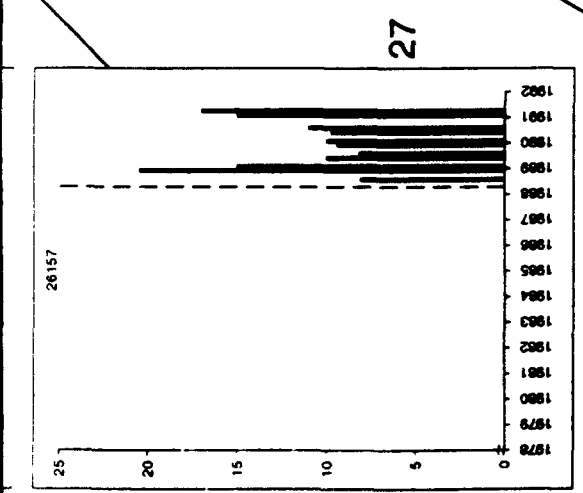
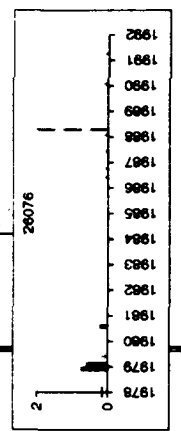
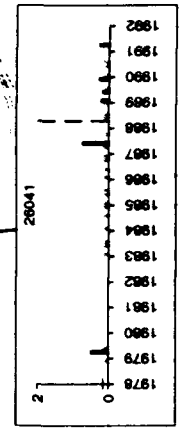
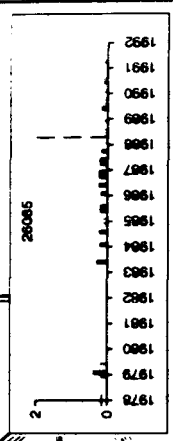
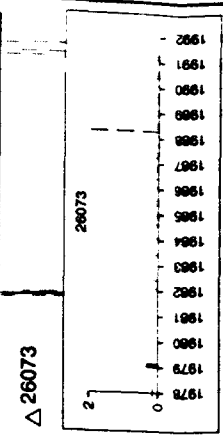
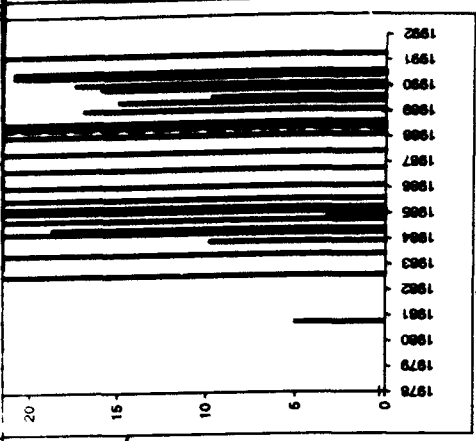
Figure 5.51

Diisopropylmethylphosphonate (DIMP)
Histograms for Wells near Basin F

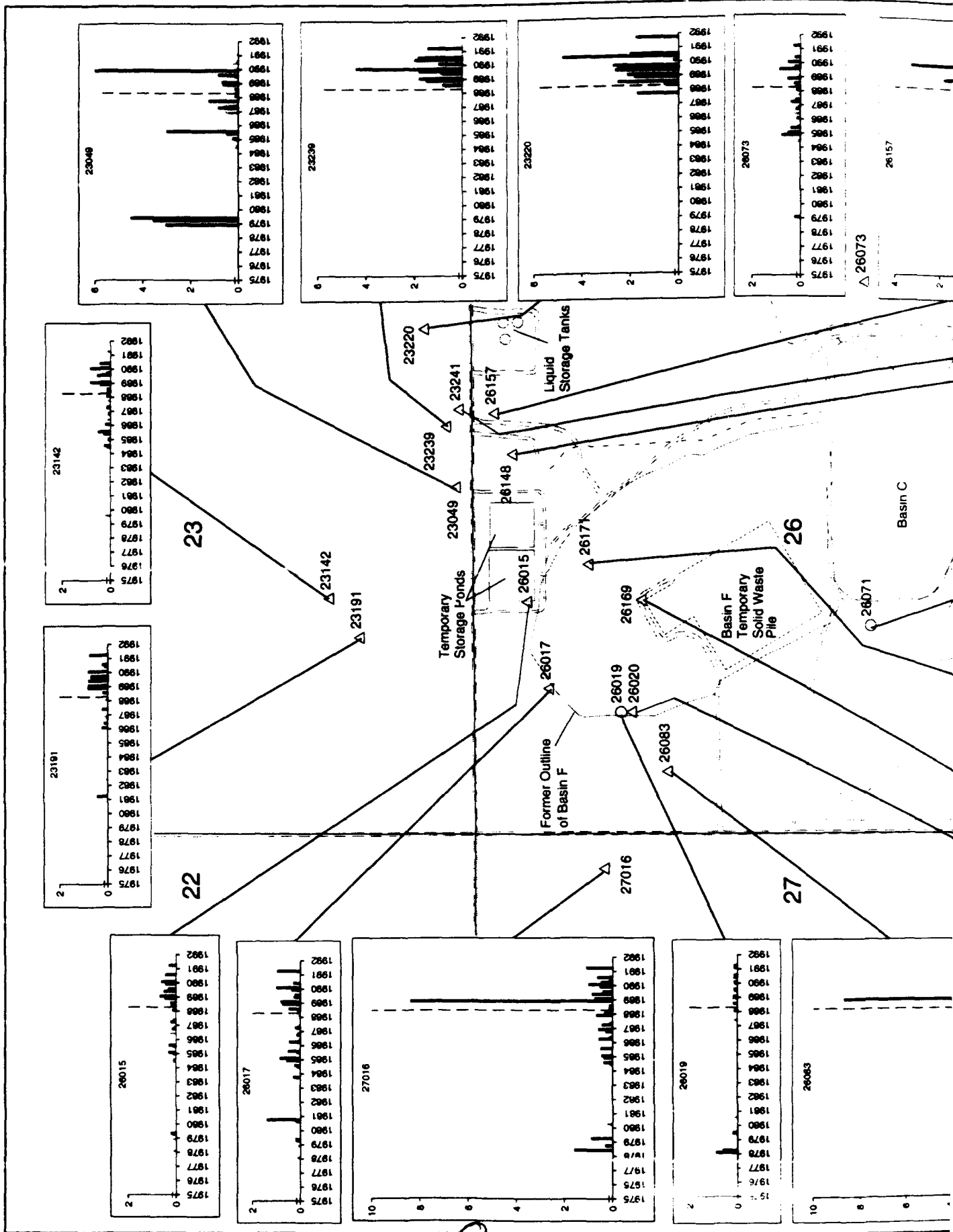
GWAR FY91

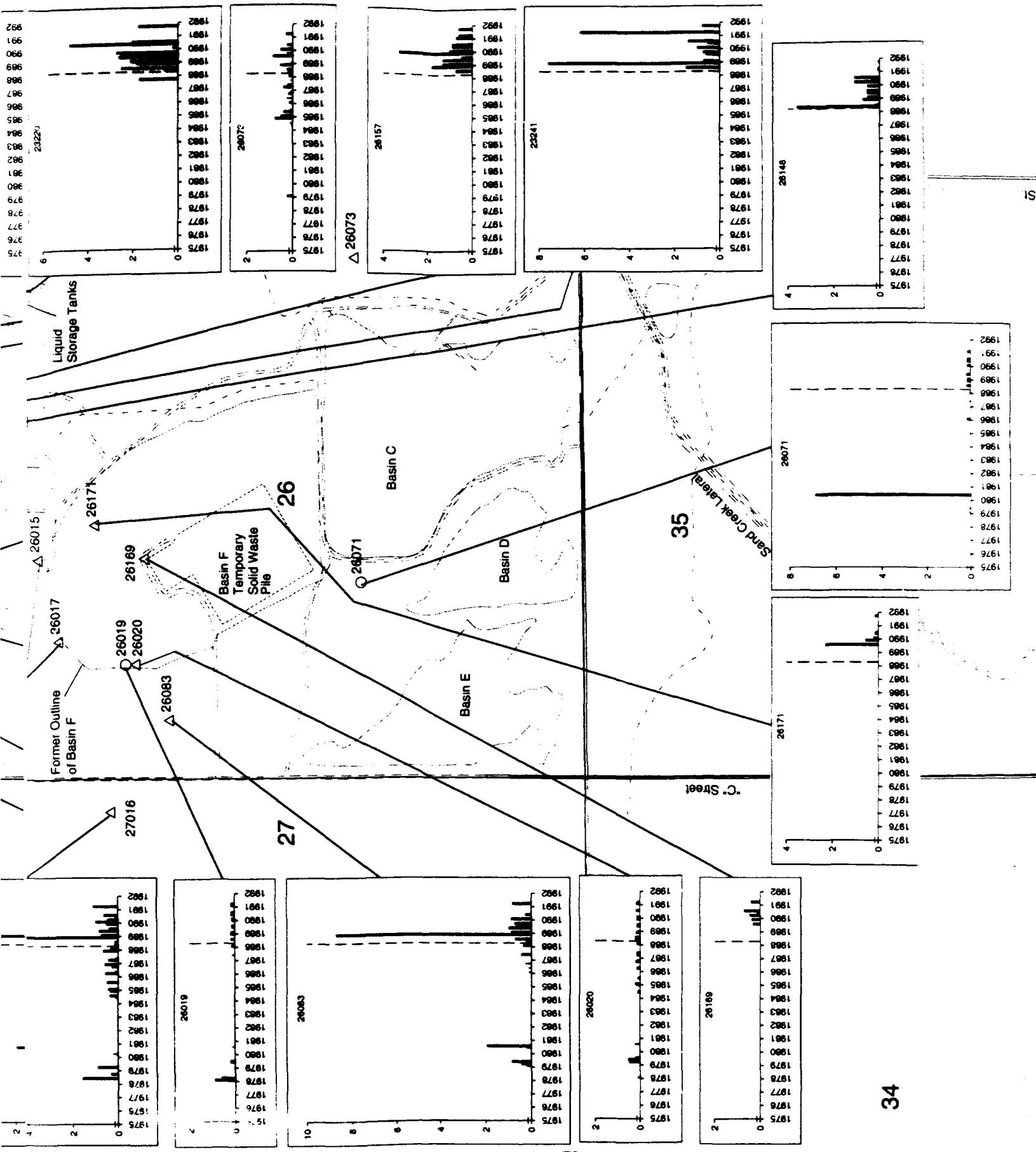
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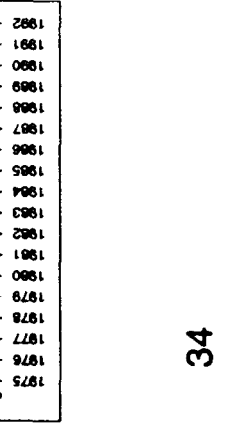
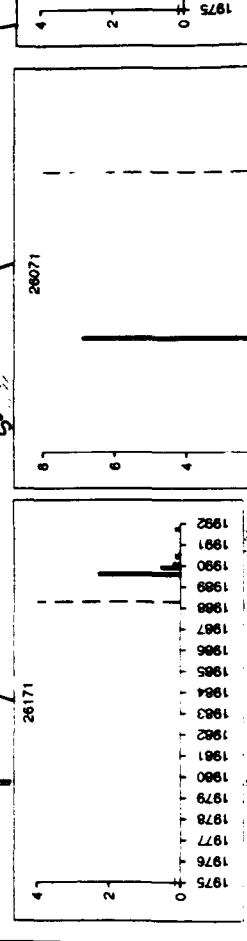
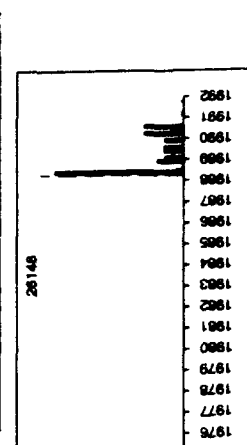
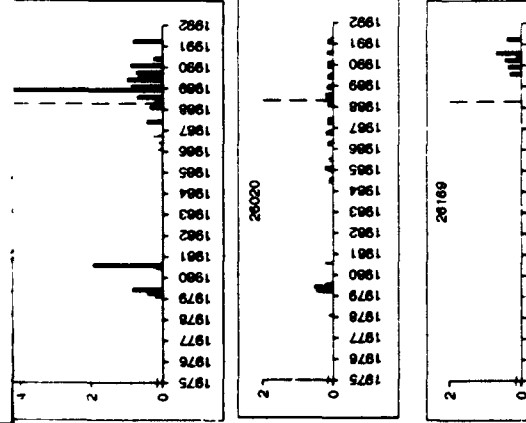
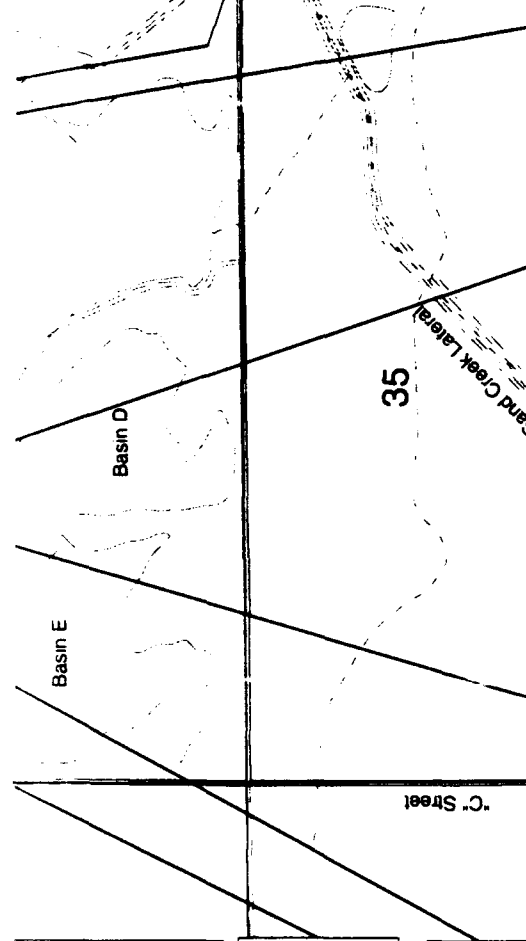
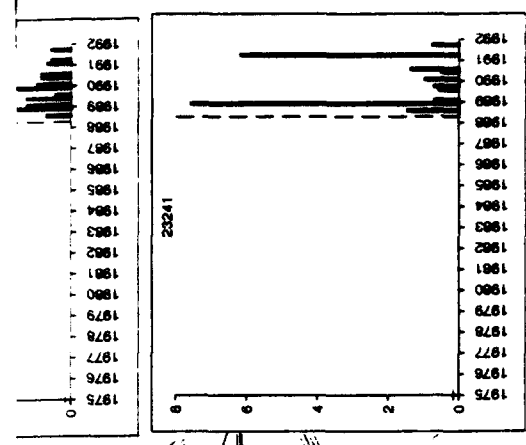
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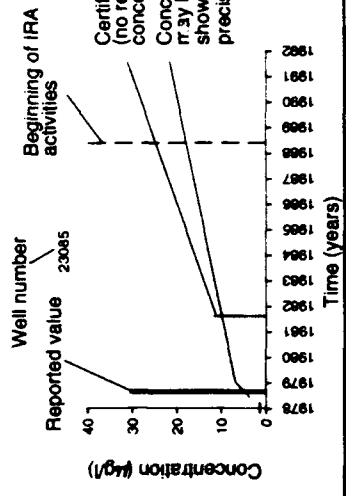
2

2



34

EXPLANATION



Unconfined flow system wells

- 23085 Δ Alluvial well
- 24135 $\circ$ Denver well

Concentration values below this level may have been enhanced to show detail - see Appendix B for precise values

Prepared for:

Program Manager for
Rocky Mountain Arsenal
Commerce City, Colorado

Prepared by:

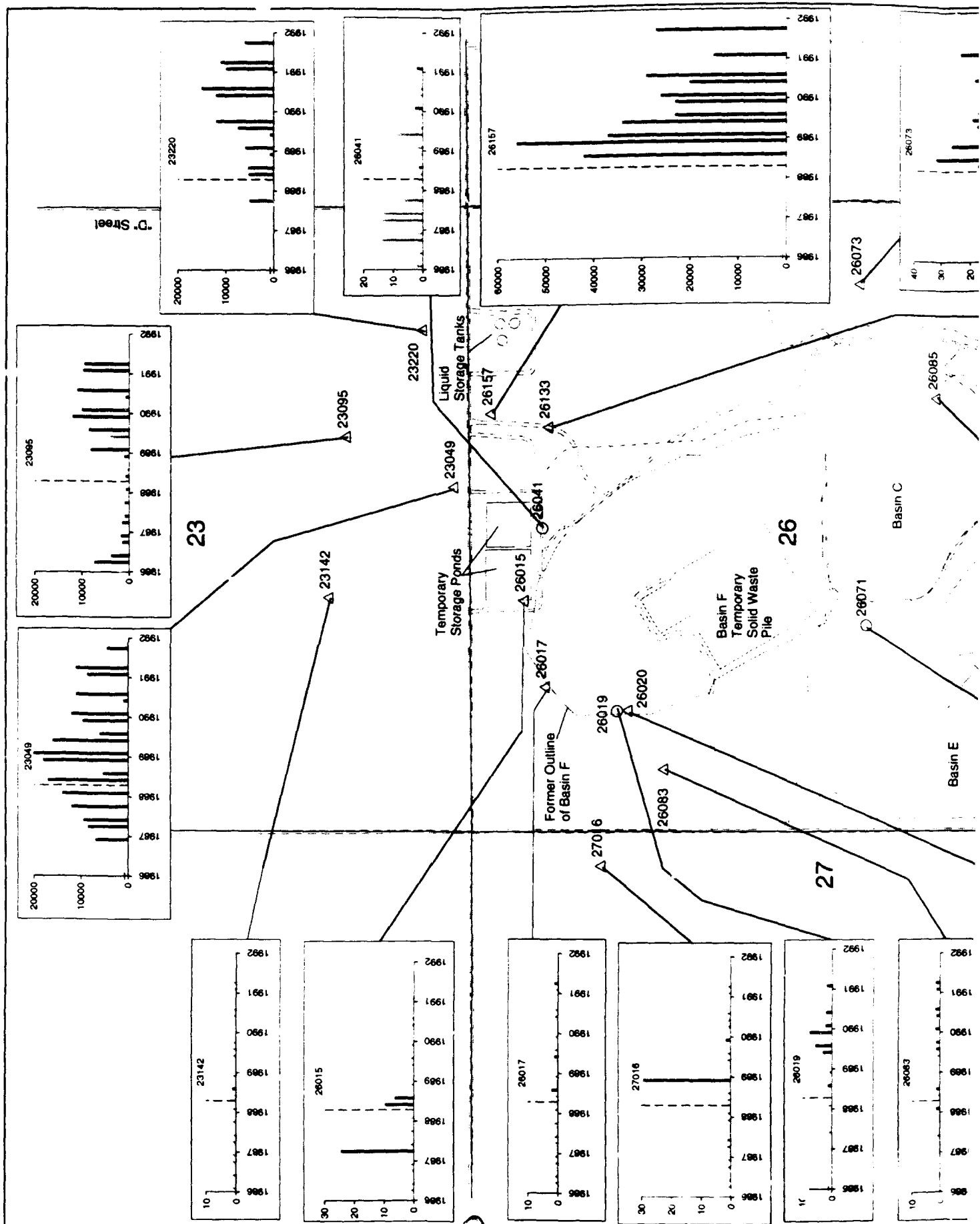
Harding Lawson Associates

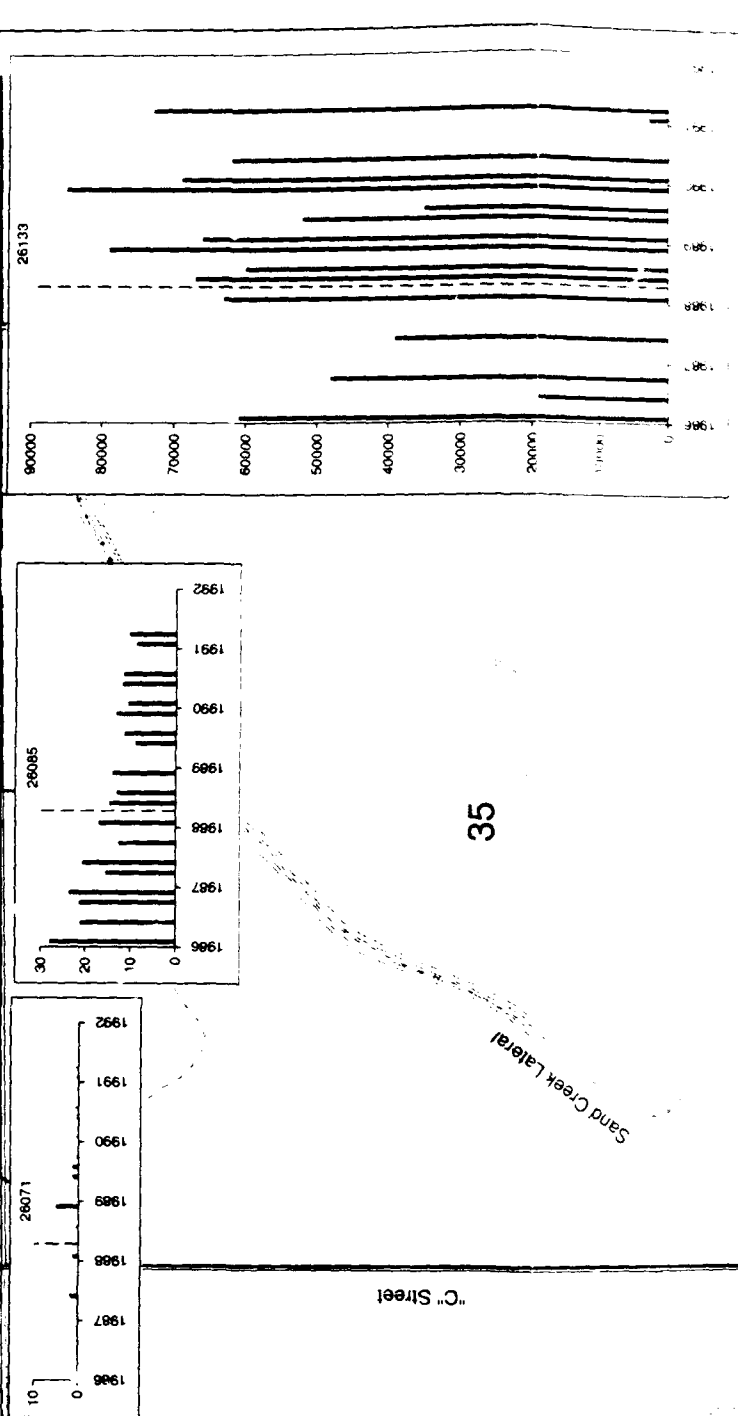
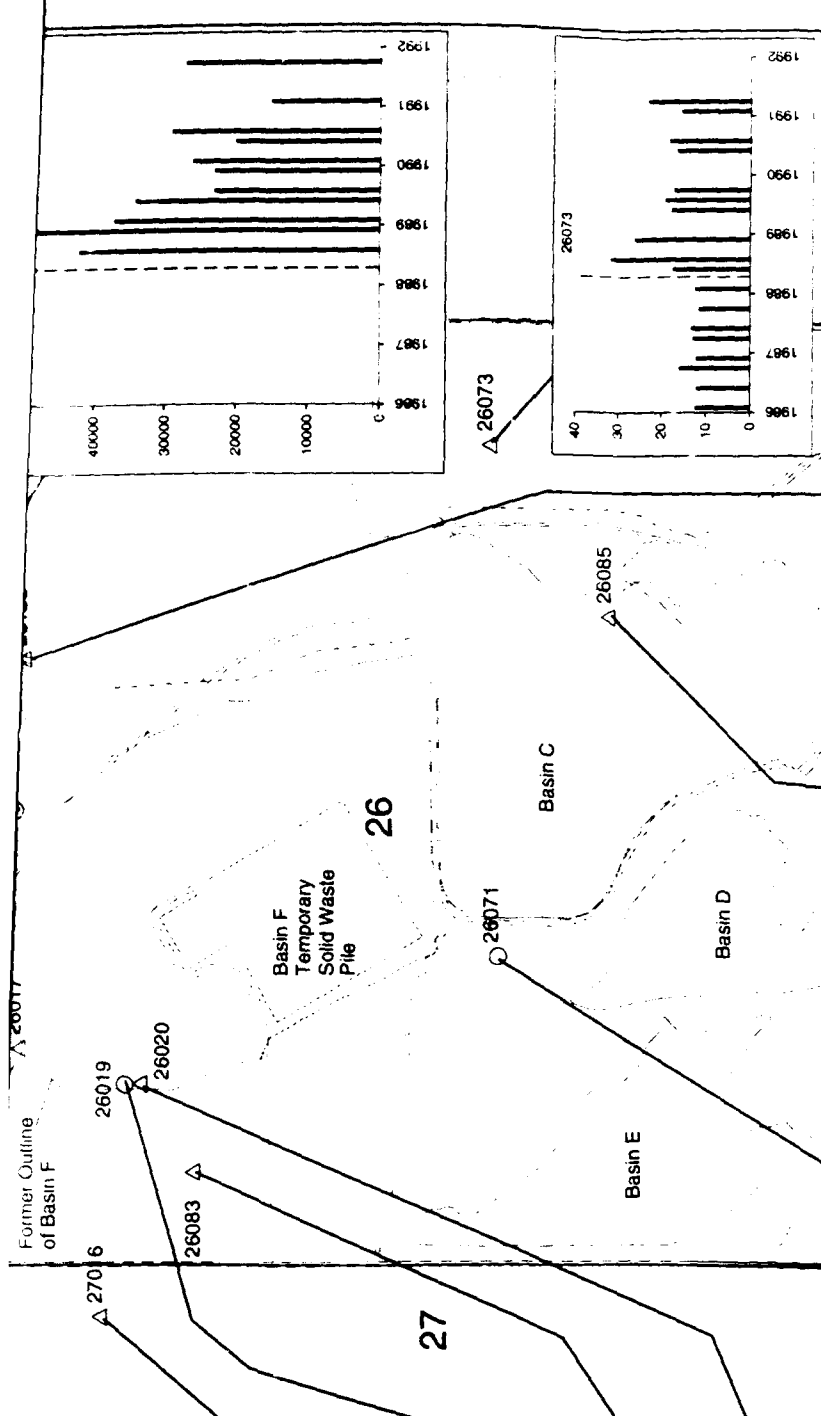
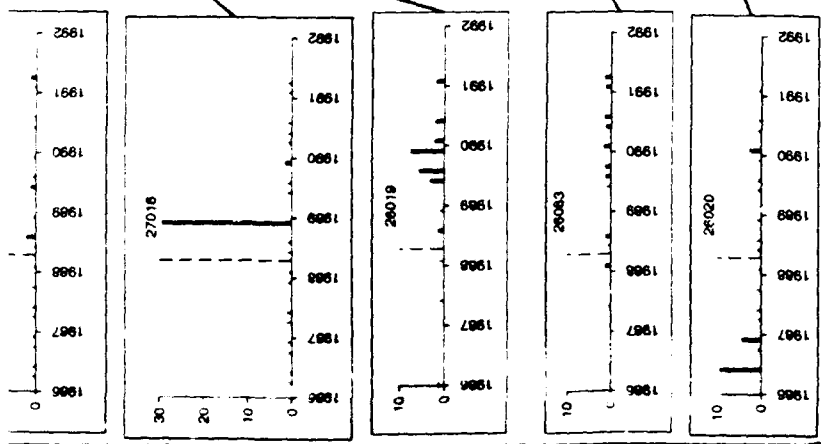
Figure 5.53

Dieldrin Histograms for Wells near Basin F

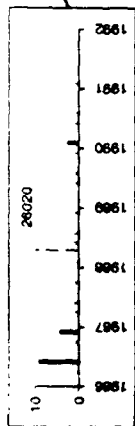
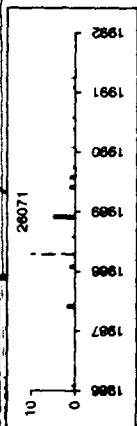
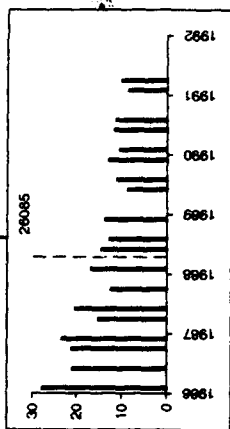
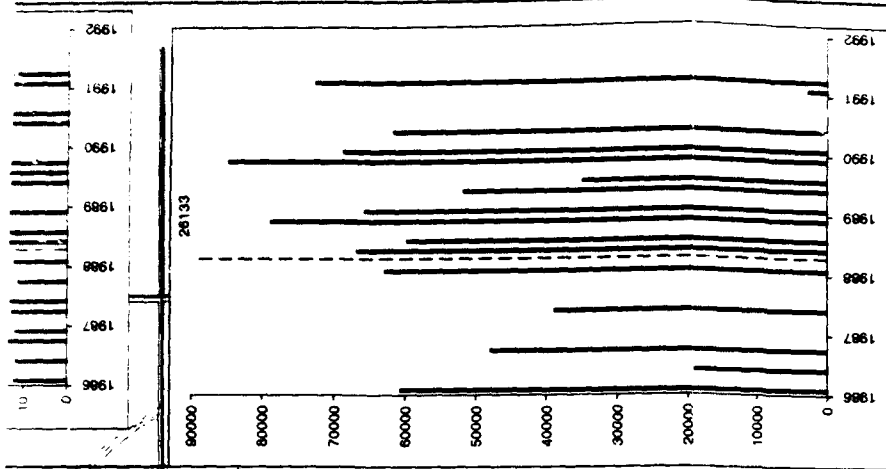
GWAR FY91

7/1/92 11:44:44 PM





Prepared for:



"C" Street

35

34

Sand Creek Lateral

EXPLANATION

Unconfined flow system wells

23085 Δ Alluvial well
24135 $\circ$ Denver well

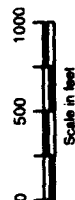
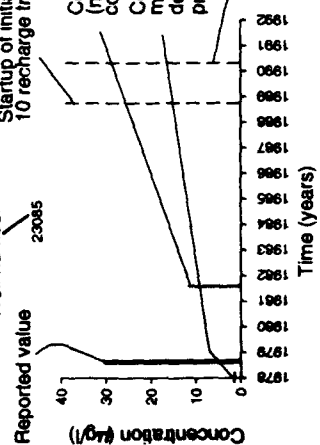
Startup of initial
10 recharge trenches

Well number
23085

Certified Reporting Limit (CRL)
(no reported chemical
concentration)

Concentration values below this level
may have been enhanced to show
detail - see Appendix B for
precise values

Startup of additional
5 recharge trenches



Prepared for:

U.S. Army Program Manager for
Rocky Mountain Arsenal
Commerce City, Colorado

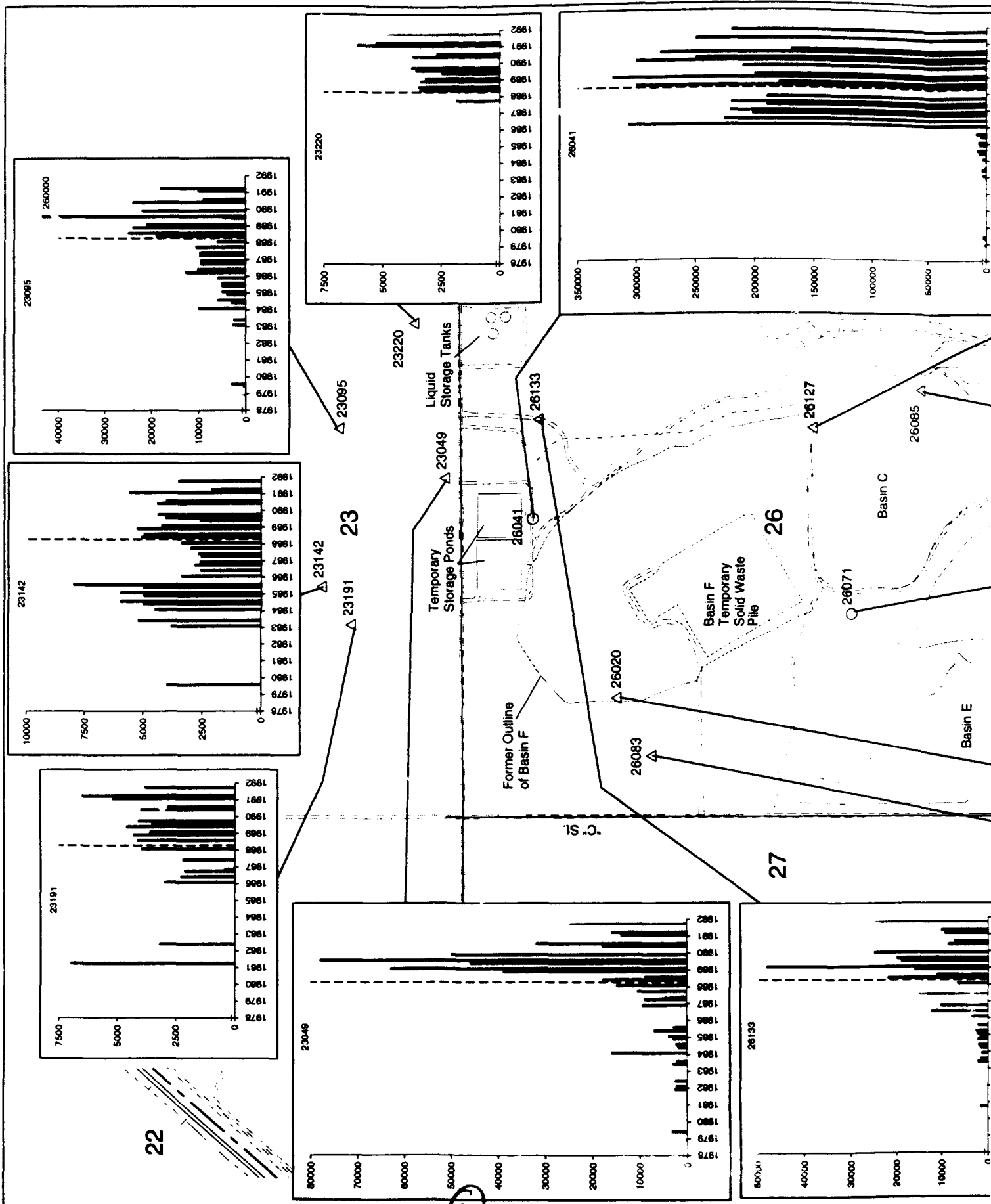
Prepared by:

Harding Lawson Associates

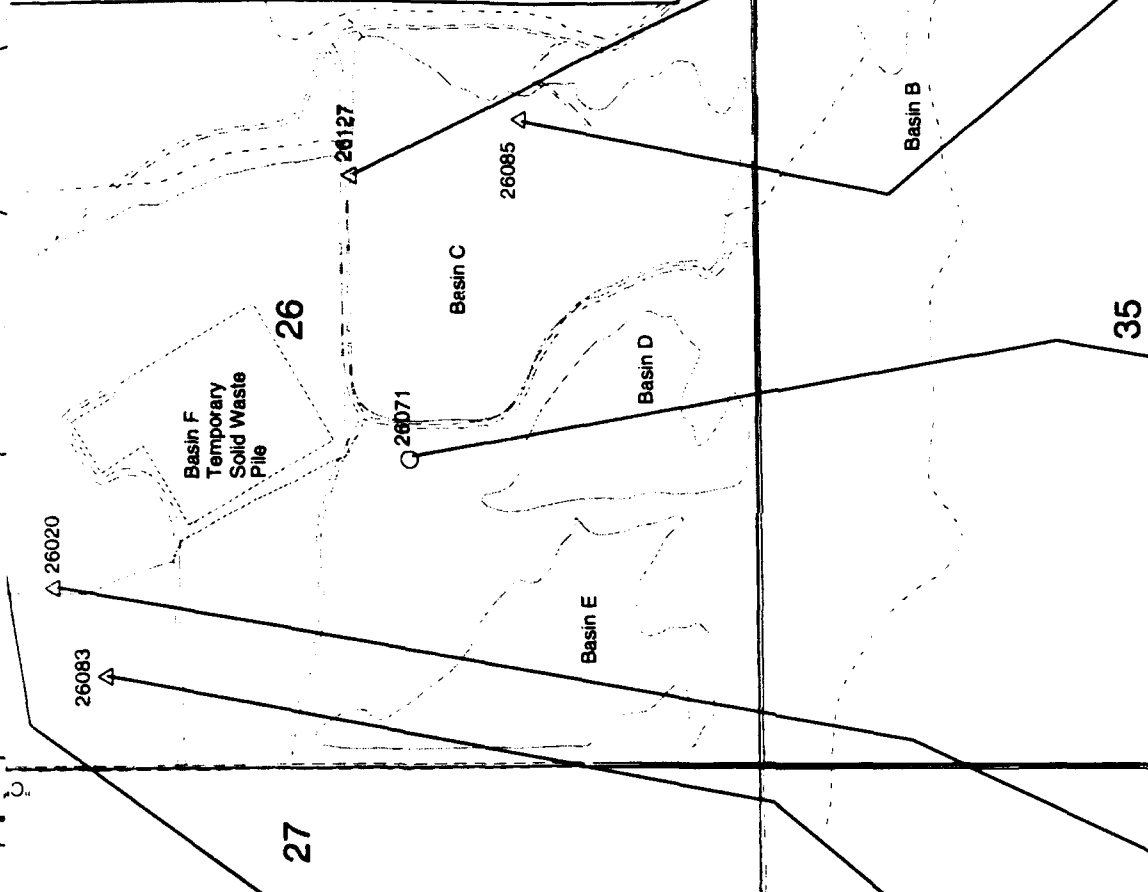
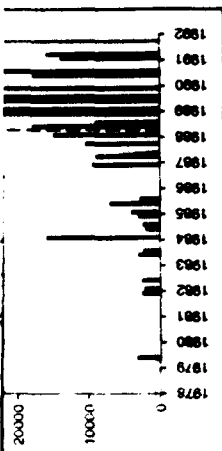
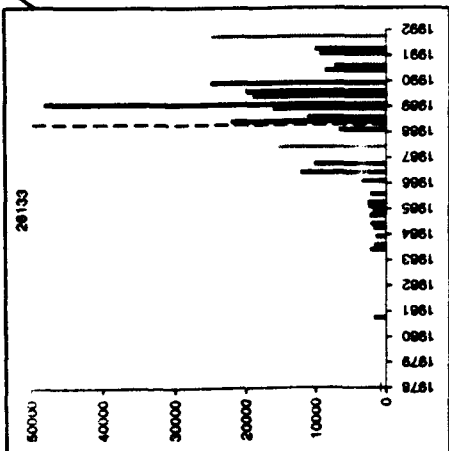
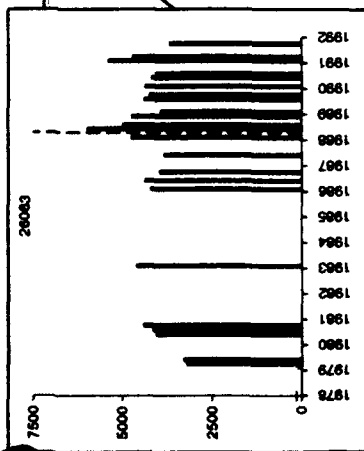
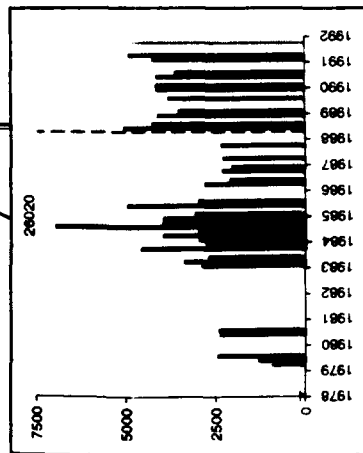
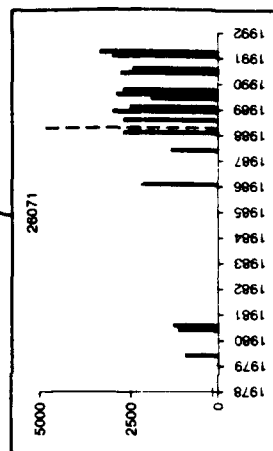
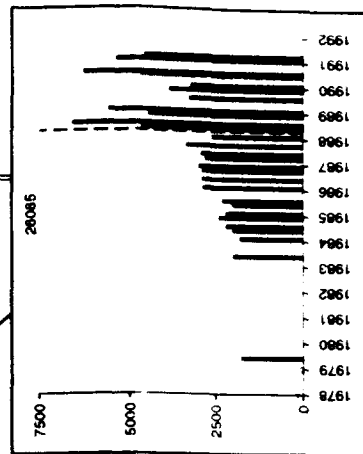
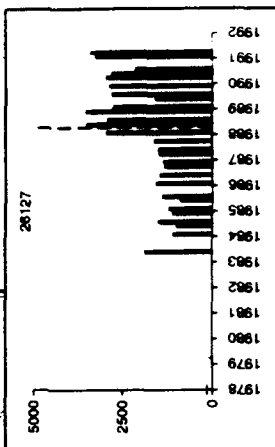
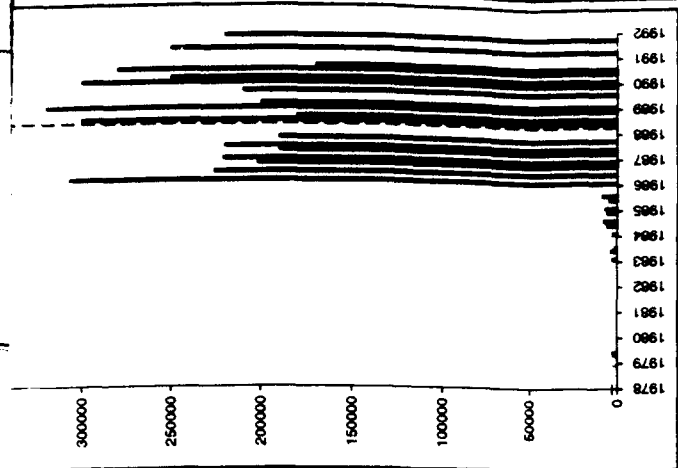
Figure 5.54

Chloroform Histograms for Wells near Basin F

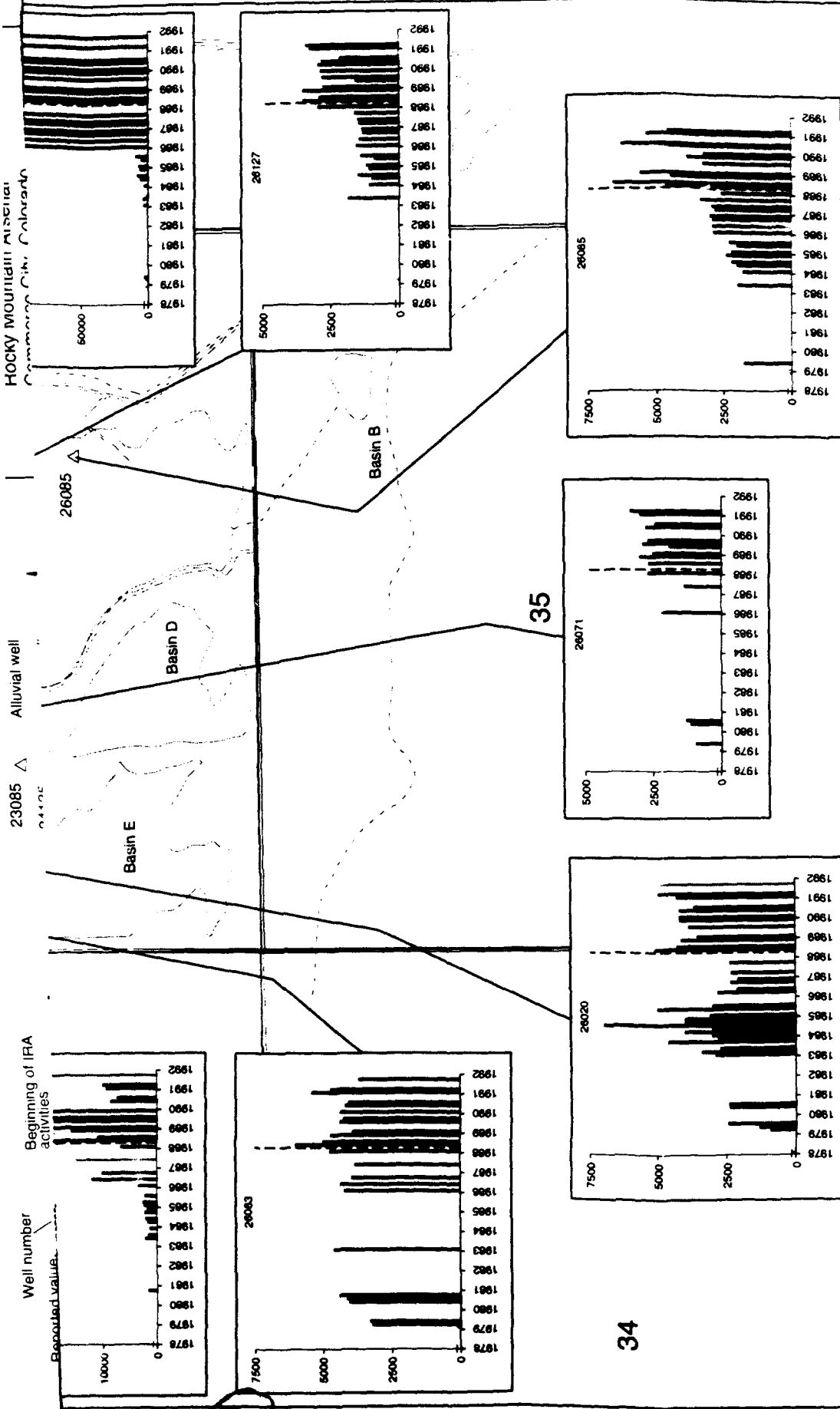
GWAR FY91



①



2



Prepared for:

Program Manager for
Rocky Mountain Arsenal
Commerce City, Colorado

Prepared by:

Harding Lawson Associates

Figure 5.55

Fluoride Histograms for Wells near Basin F

GWAR FY91

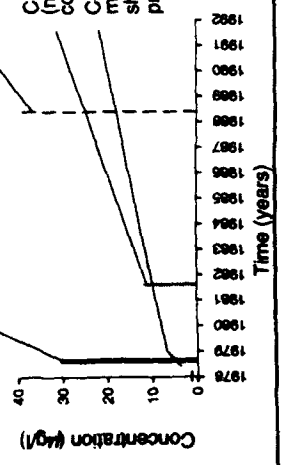
Unconfined flow system wells

- 23085 △ Alluvial well
- 24135 ○ Denver well

EXPLANATION

Well number
Reported value 23085

Beginning of IRA activities
Certified Reporting Limit (CRL) (no reported chemical concentration)
Concentration values below this level may have been enhanced to show detail - see Appendix B for precise values



①

2165000 E

225000 N

28

220000 N

29

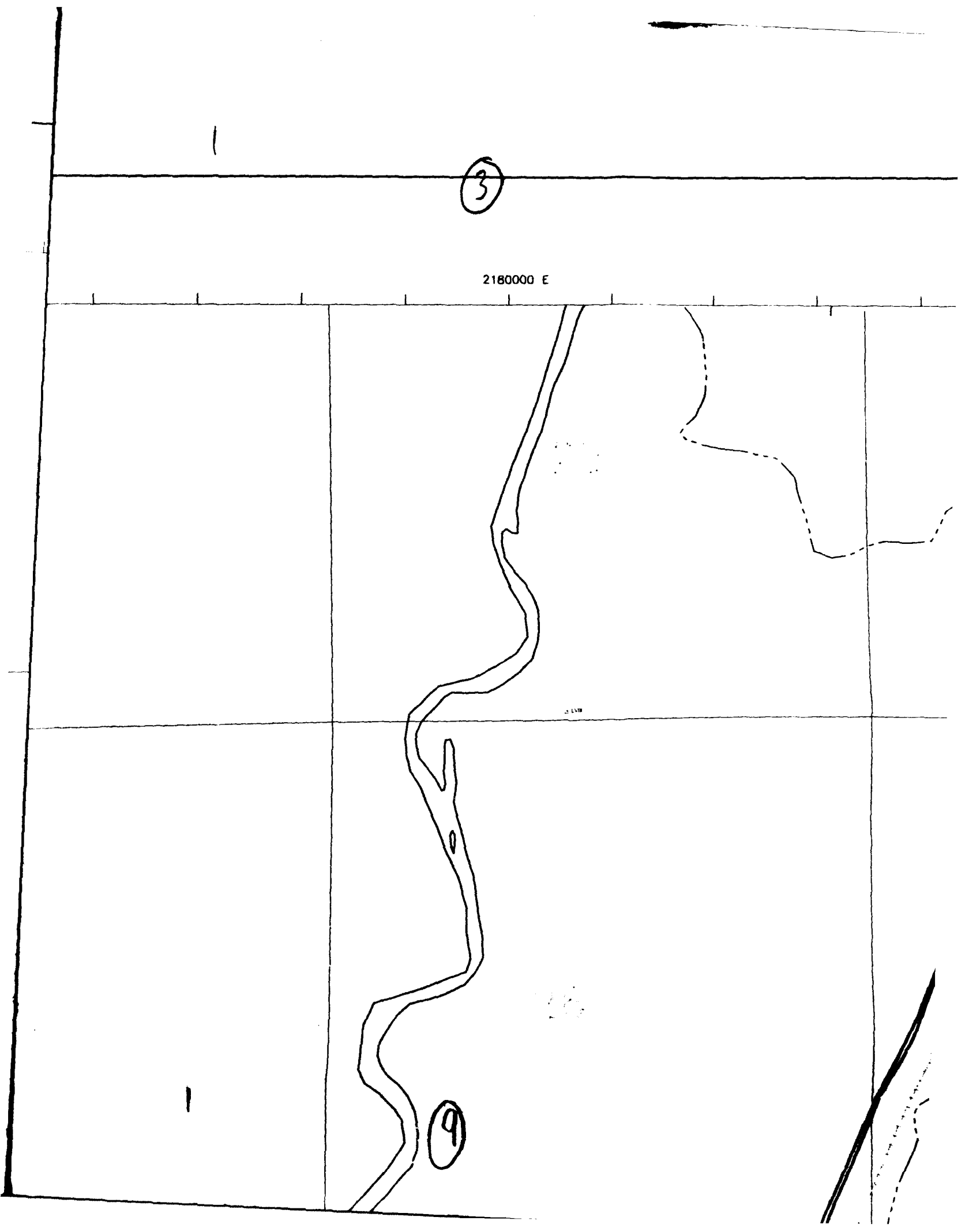
⑦

2170000 E

2175000 E

②

⑧



3

2180000 E

9

1

47

2185000 E

2190000 E

R 67 W

R 66 W

FULTON LATERAL

THIRD CREEK

FULTON DITCH

10

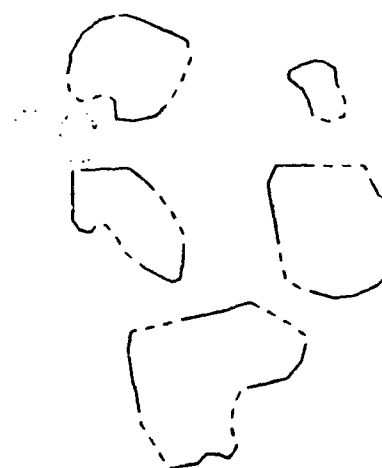
5

2190000 E

2195000 E

66 W

ELTON DITCH



4V

11

23

6

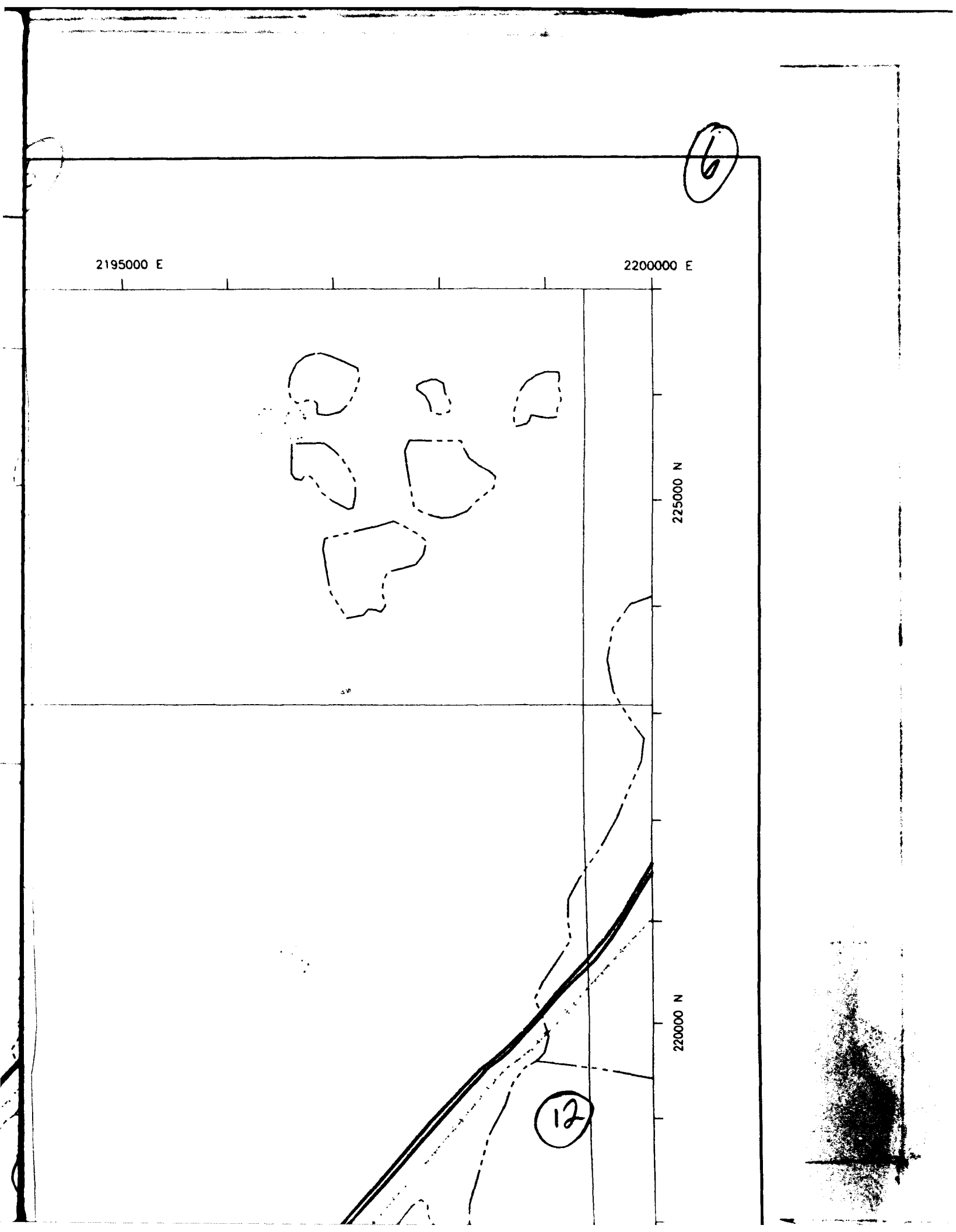
2195000 E

2200000 E

225000 N

220000 N

12





(12)

20000

220000 N

⑦

215000 N

T 1 S

T 2 S

210000 N

⑬

8

14

L-08
L-03
17356
X-DTH-2

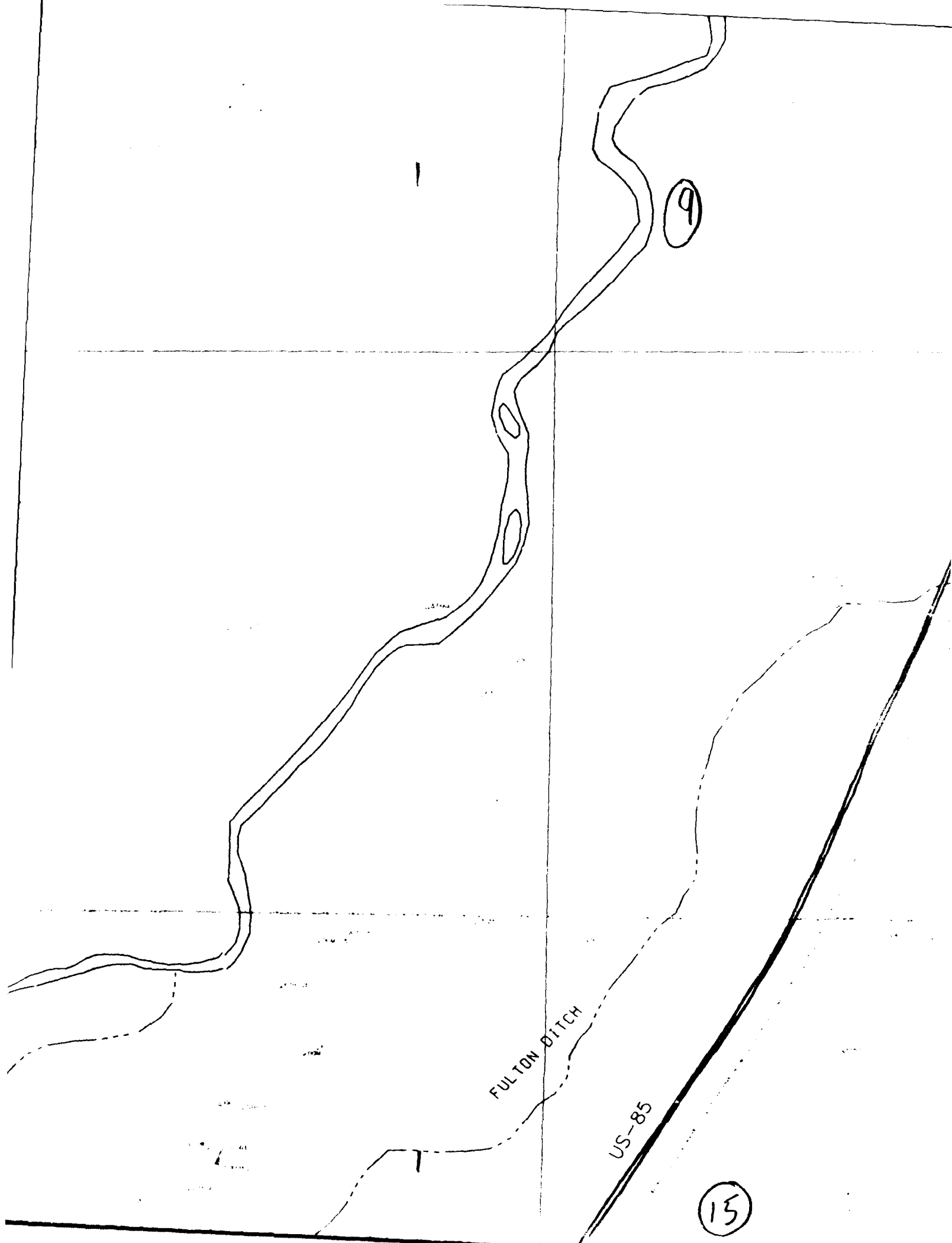
X-DTH-1

X-DTH-1

X-DTH-2

X-DTH-1

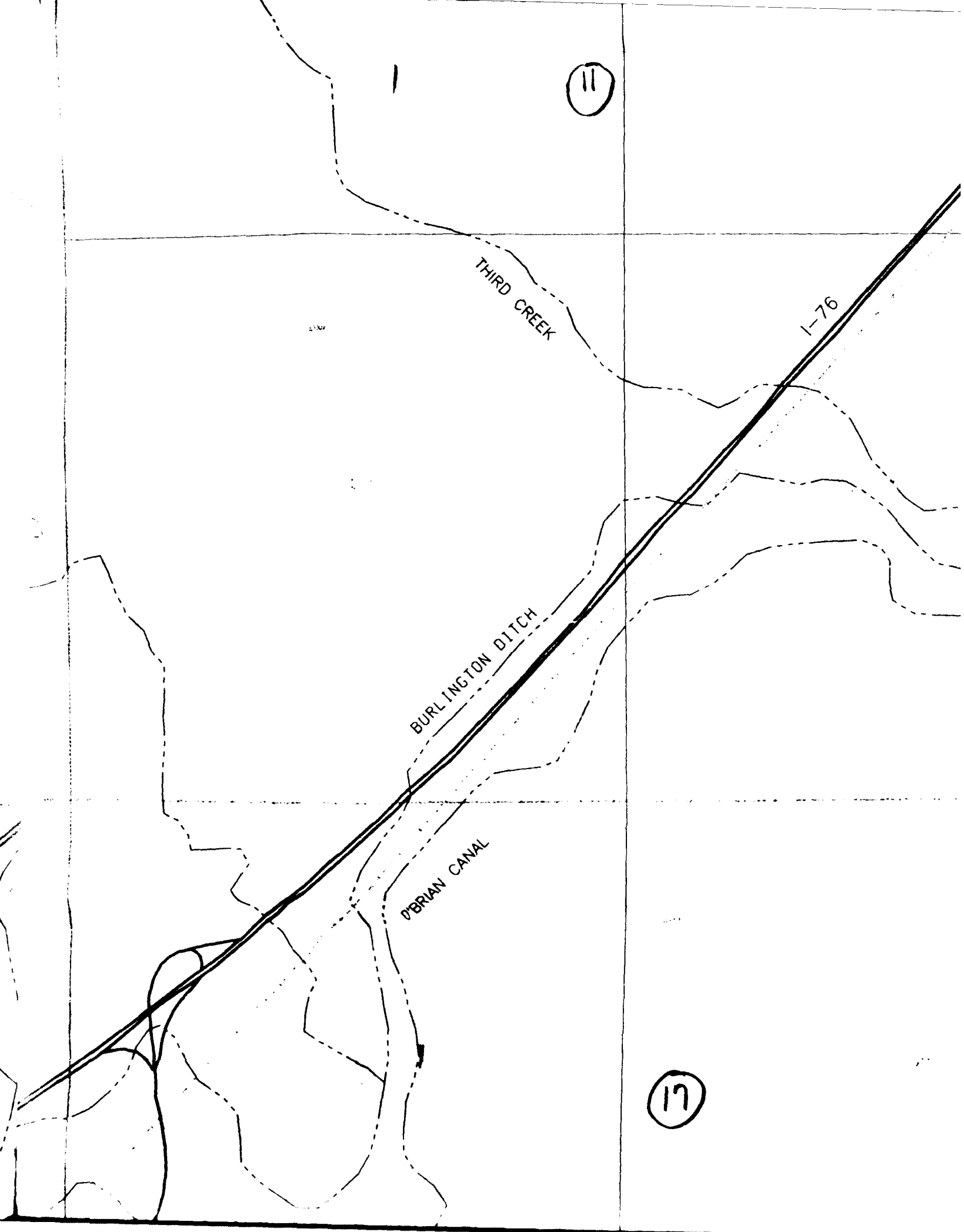
X-DTH-3



10

EAST 120TH AVENUE

16



11

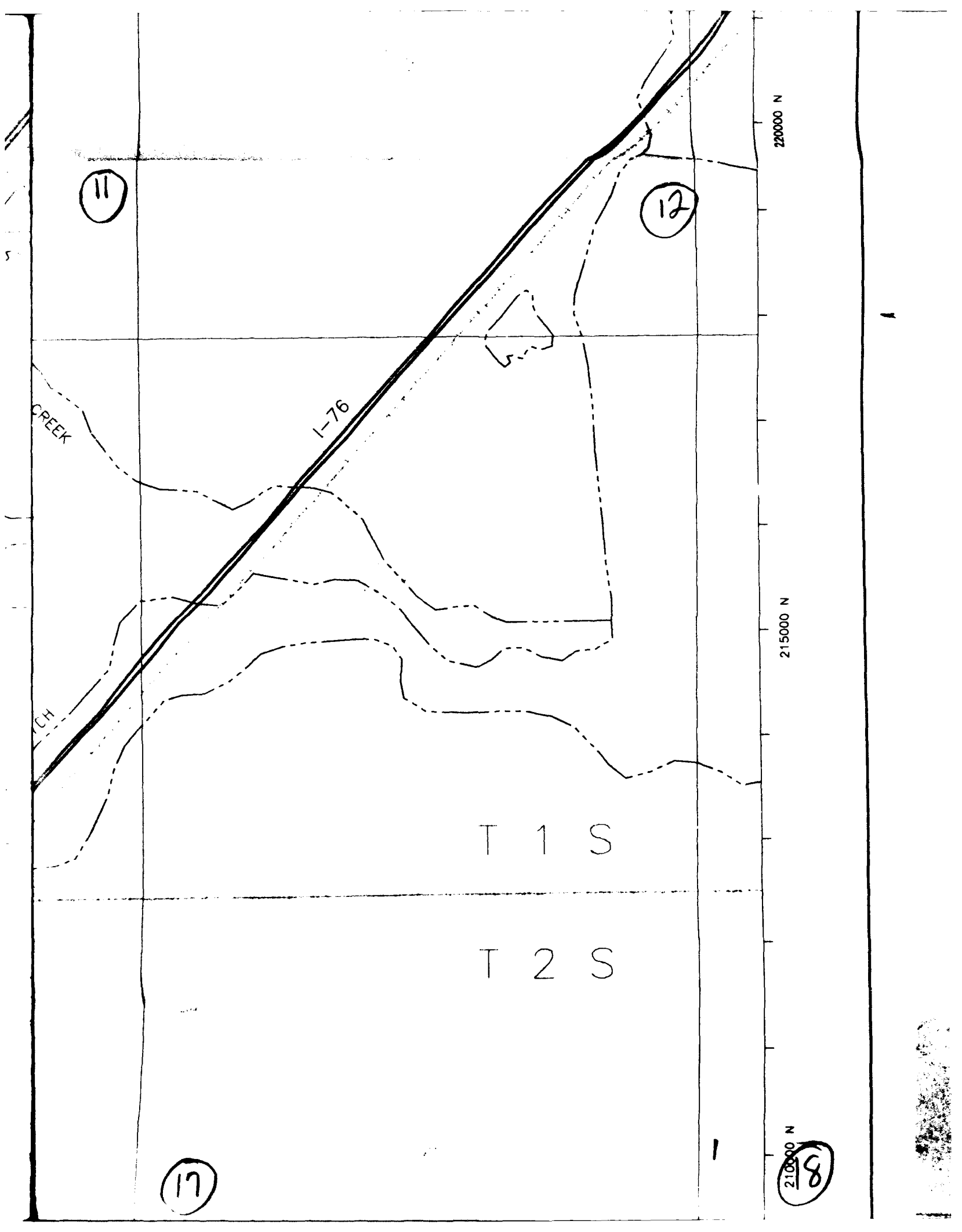
THIRD CREEK

1-76

BURLINGTON DITCH

O'BRIAN CANAL

17



210000 N

13

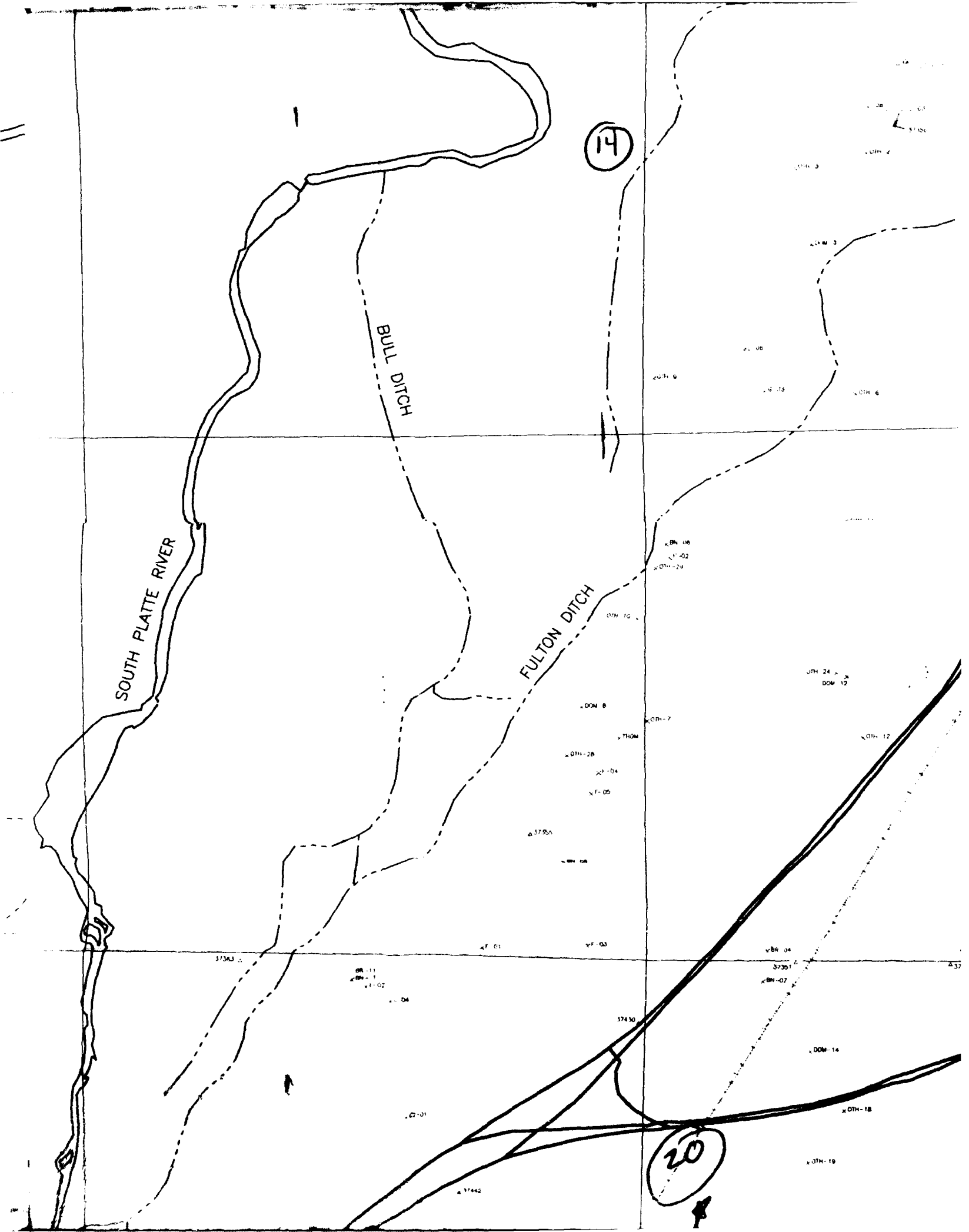
205000 N

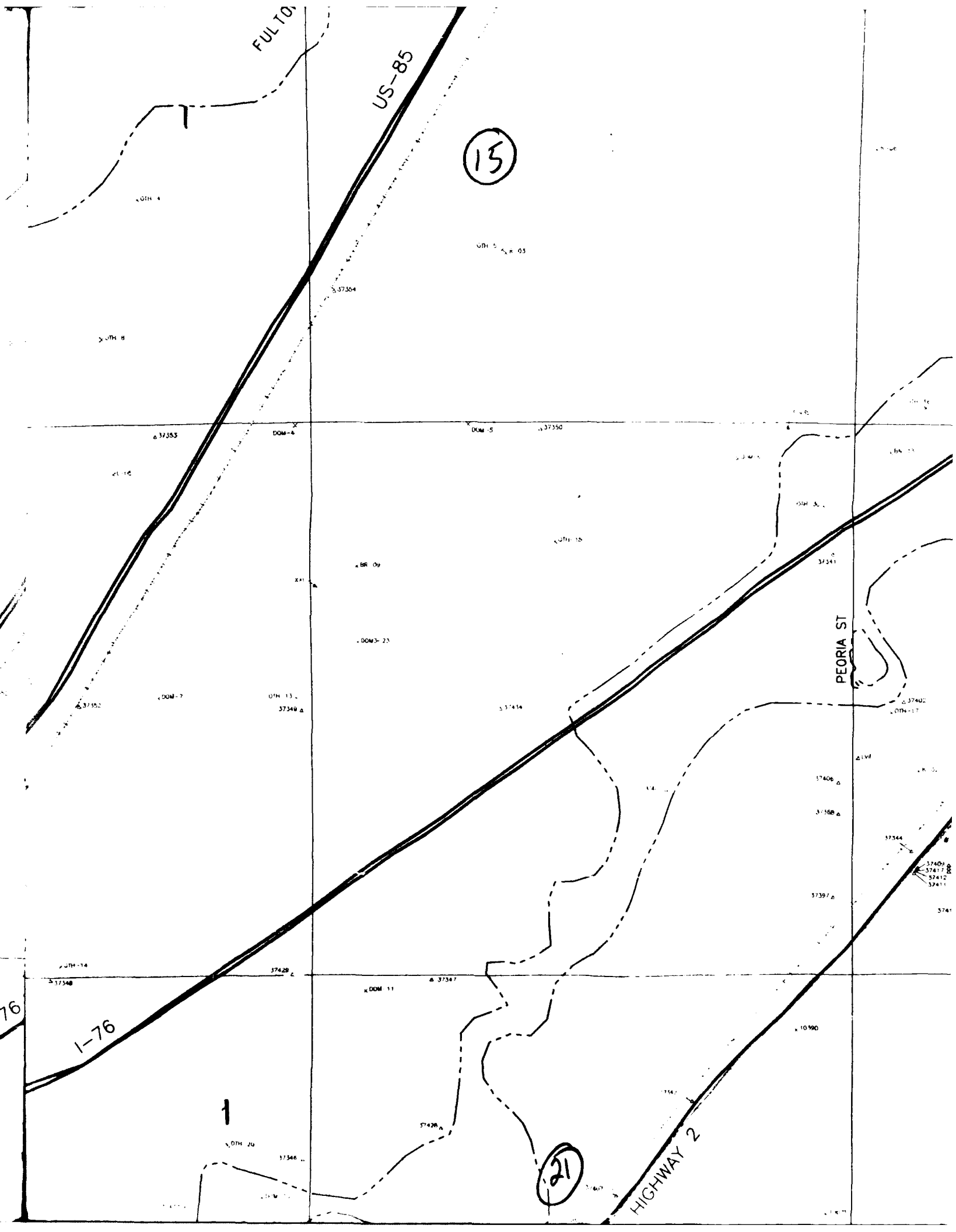
SOUTH PLATTE RIVER

200000 N

19

373m





16

1

16-06

16-16

16-04

16-13

16-06

PEORIA ST

16-02

16-17

16-04

16-02

16-04

16-04

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16-04

POTOMAC STREET

EAST 104TH AVENUE

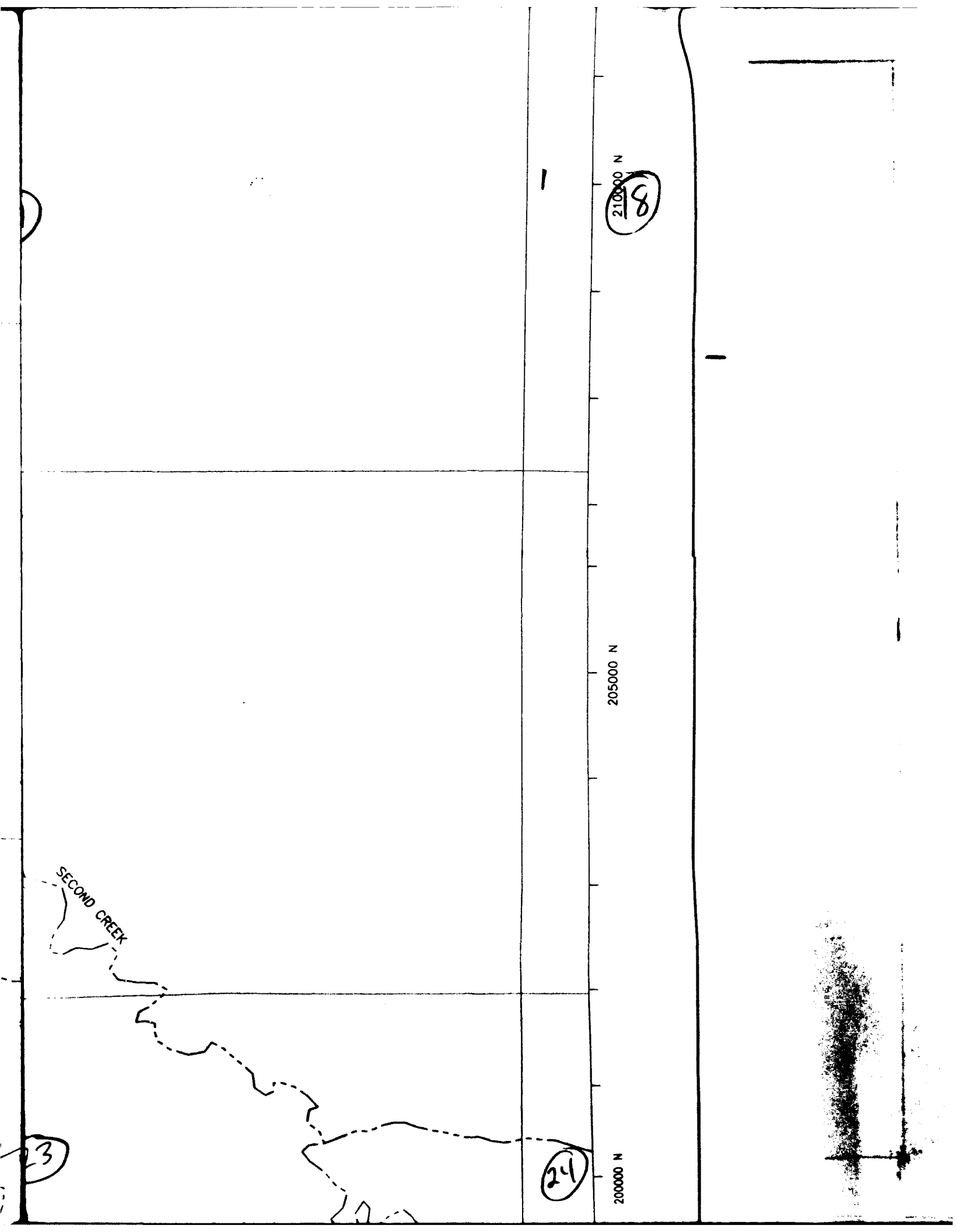
22

17

CHAMBERS ROAD

SECOND CREEK

23



200000 N

195000 N

19

DOMS-20

X0-01

I-76

X0-02

BR-06

DOMS-14

X0-01

X0-03

X0-04

X1-02

DOMS-25

X0-07

37363

X0-01

X0-02

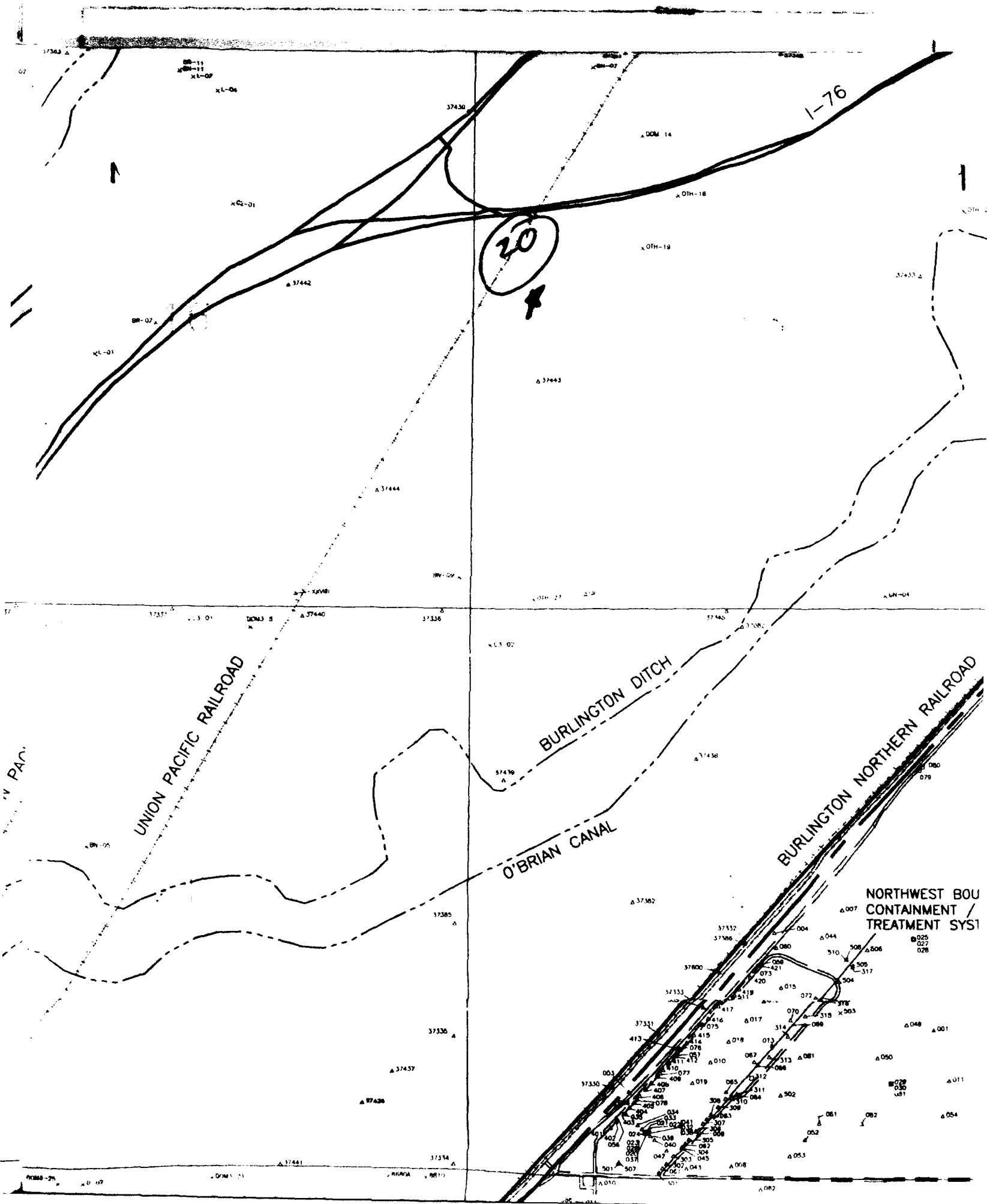
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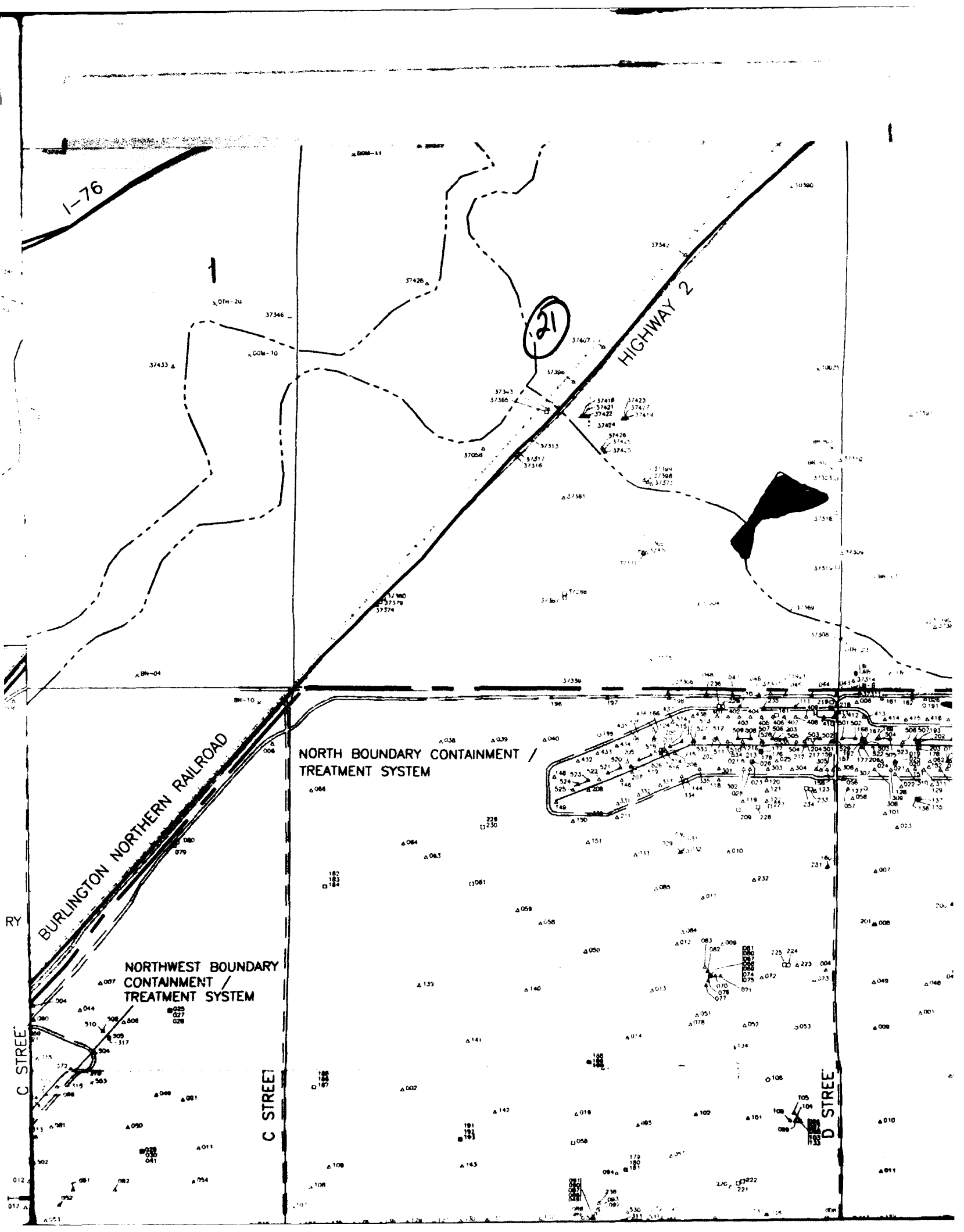
X1-01

X0-01

X0-00

37361





22





23

214
215
216

217
218
219

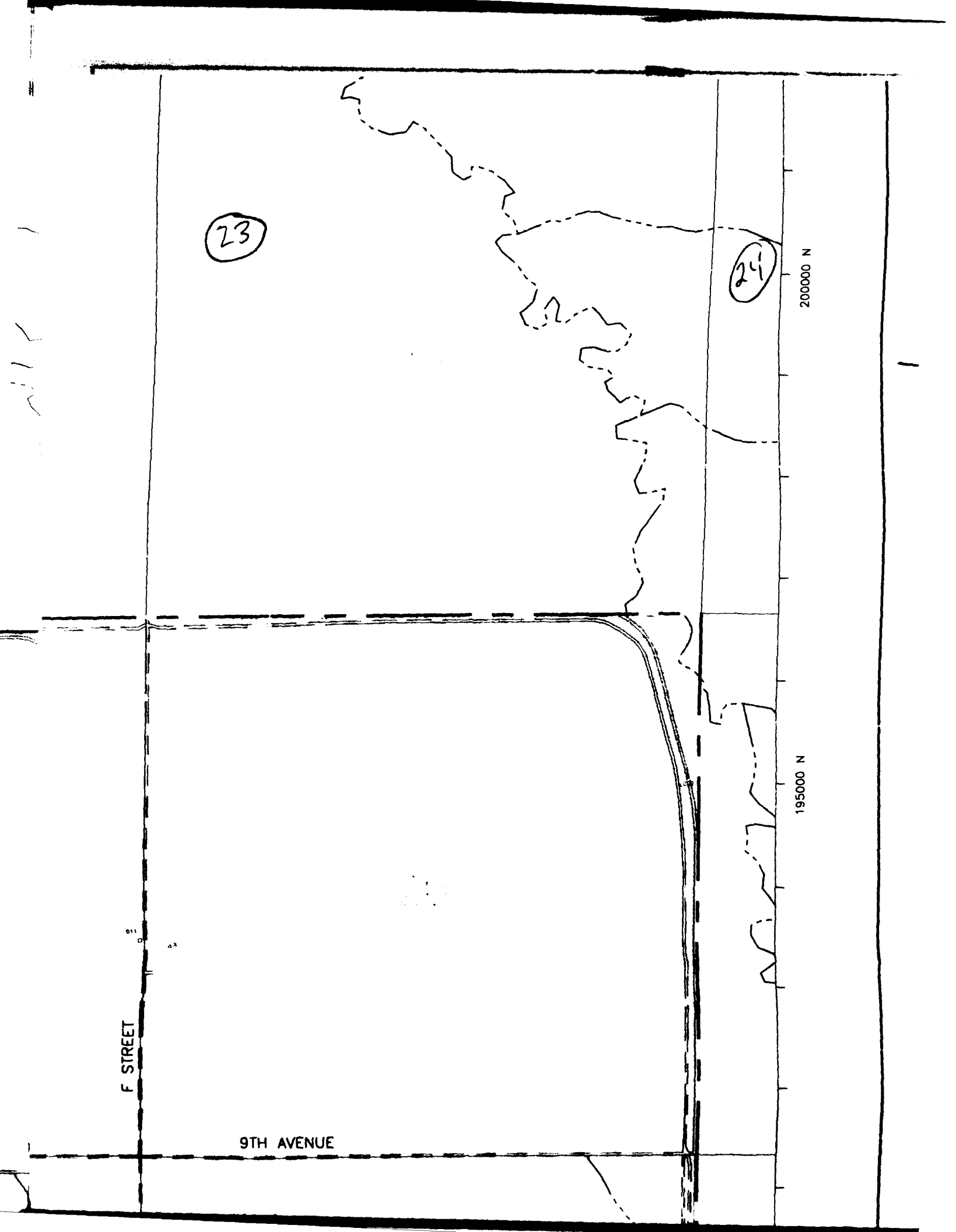
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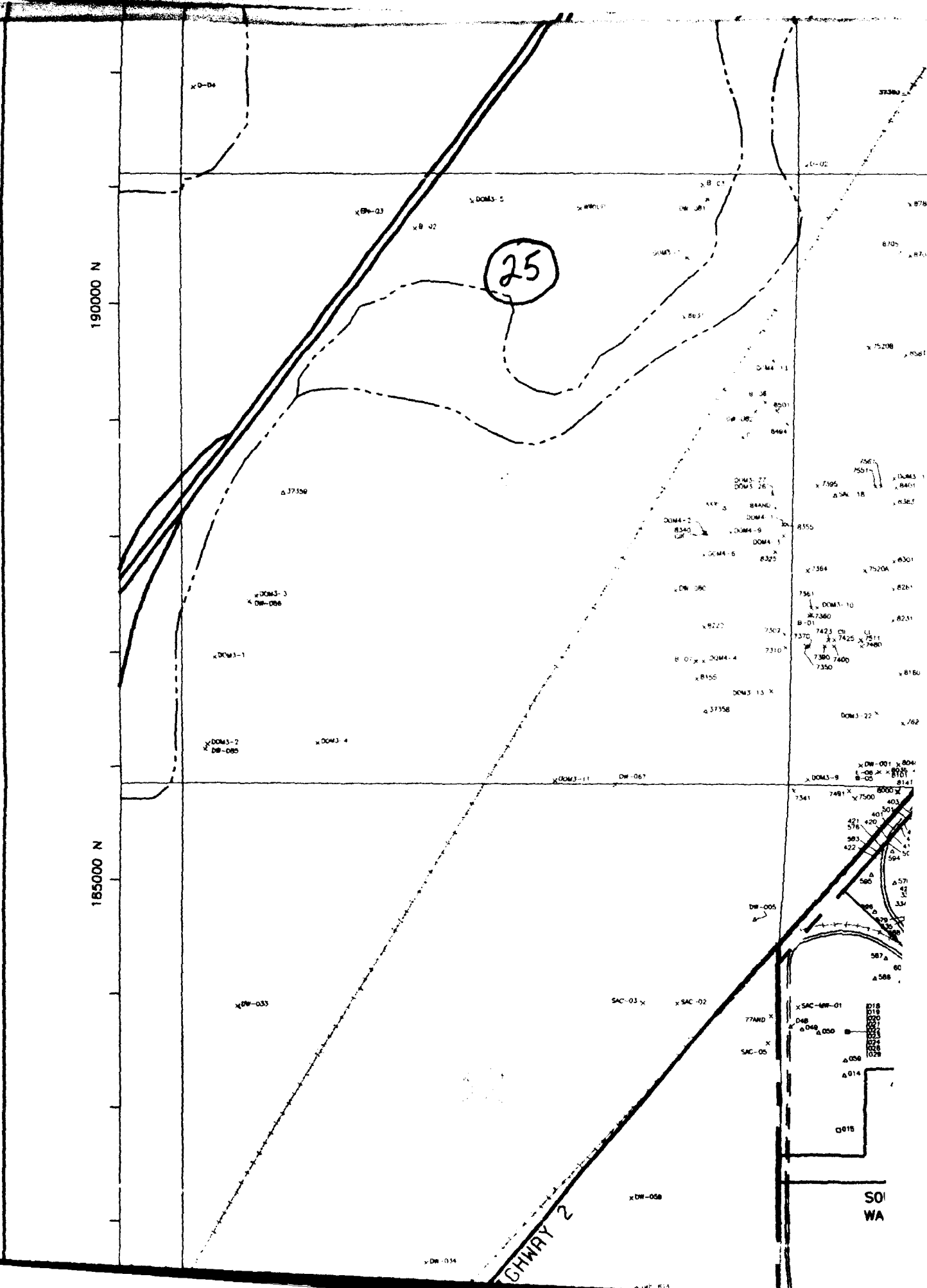
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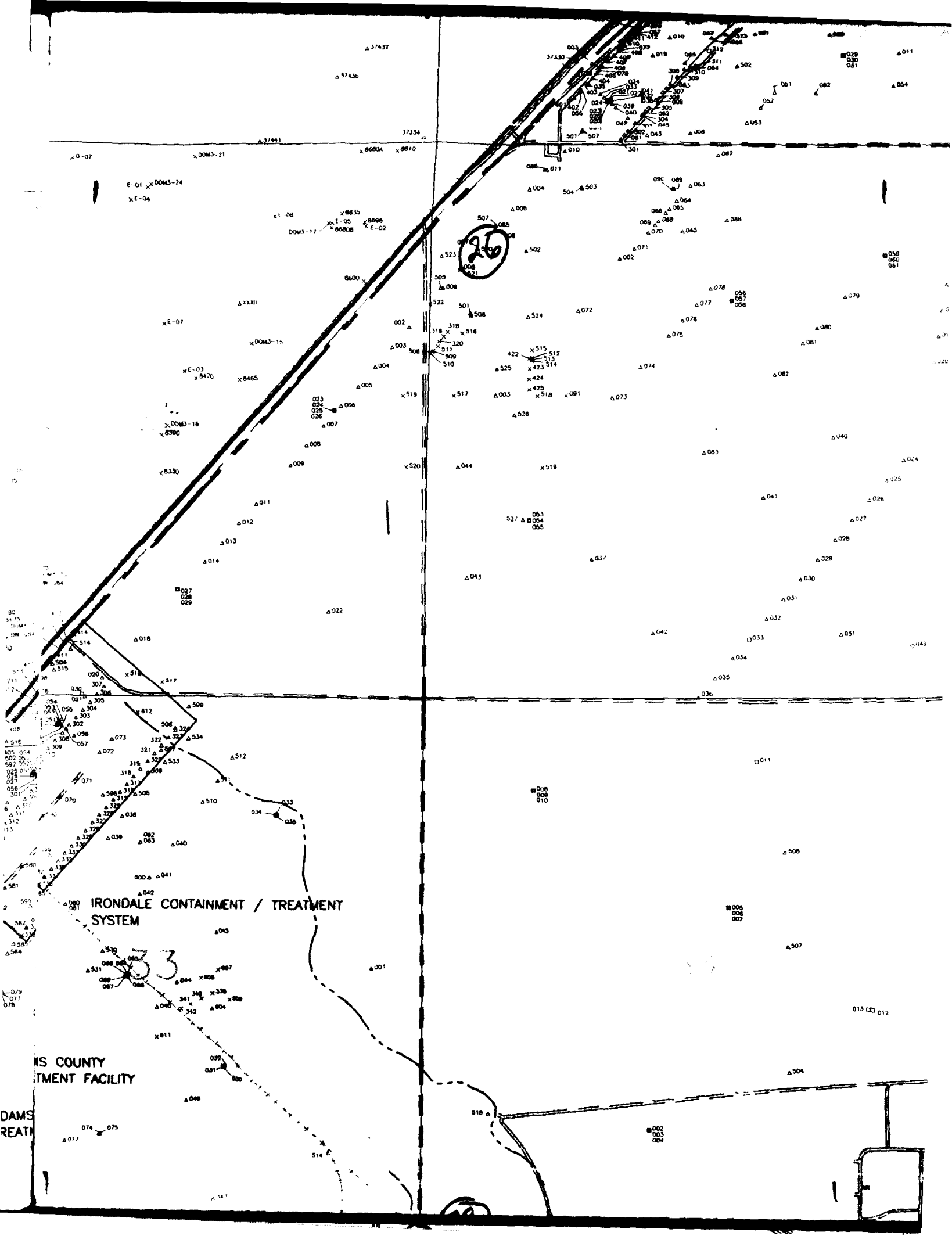
213

F STREET

9TH AVENUE







E-01
E-04

E-05
E-02

E-07

E-03

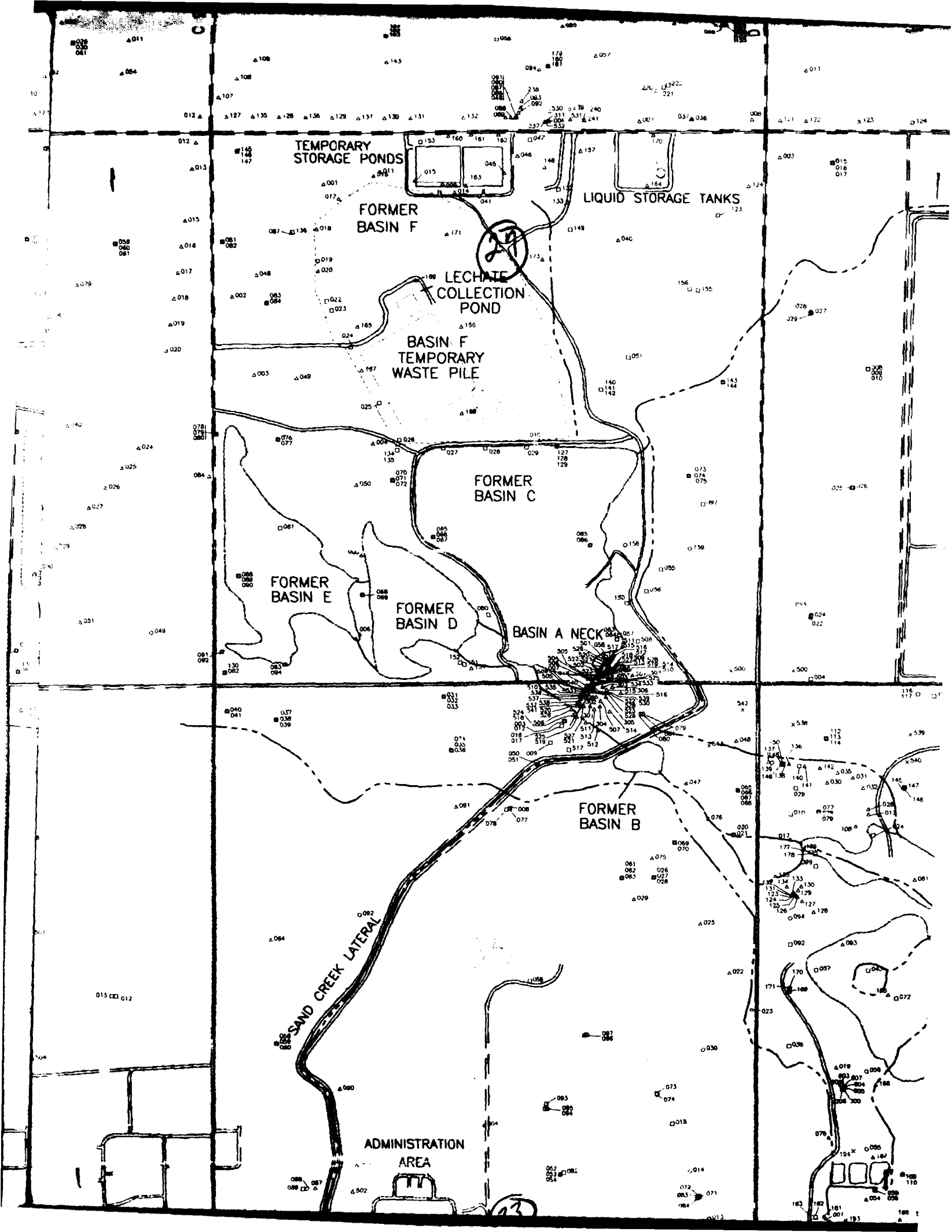
E-06

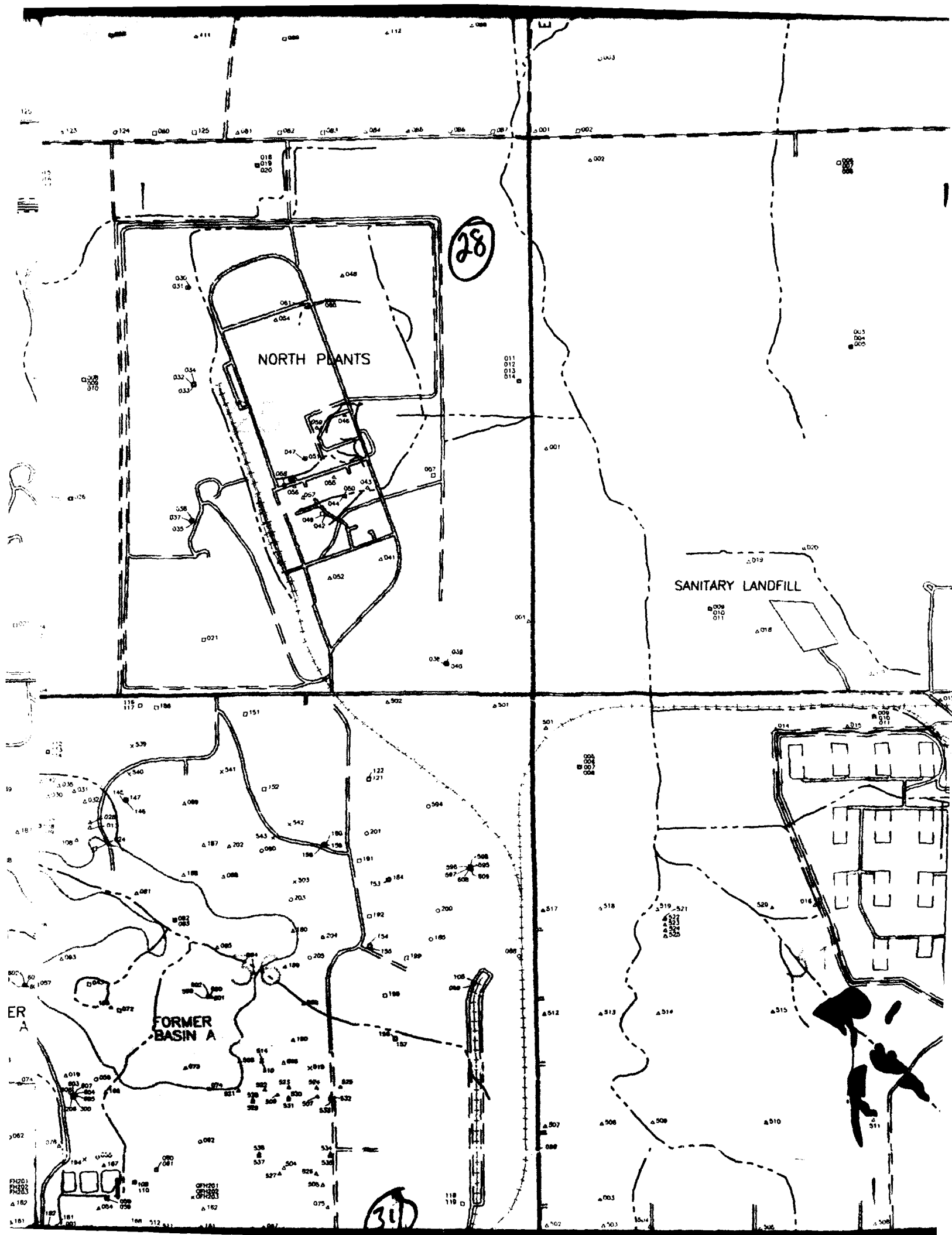
E-08

IRONDALE CONTAINMENT / TREATMENT
SYSTEM

S COUNTY
TMENT FACILITY

DAMS
REAT





F STREET

9TH AVENUE

29

002
003

003
004
005

SANITARY LANDFILL

008
010
011

8TH AVENUE

STORAGE AREA

32

001
002
003

519
521
522
523
524
525

514

515

510

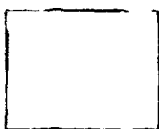
511



9TH AVENUE

29

002
0003



8TH AVENUE

0001
002
003

STORAGE AREA

32

190000 N

30

185000 N

180000 N

175000 N

T 2 S
T 3 S

31

HIGHWAY 2

MAIN
ENTRANCE

QUEBEC STREET

U.S. POST OFFICE

x DW-034

Δ 198-814

x DW-072

Δ 002

x DW-030

SAC MW-02

DW-008

Δ 007
Δ 006
Δ 008

Δ 004
Δ 003
Δ 002

x DW-070

198-508
198-517

SAC MW-03

x DW-051

DW-304

Δ 044

x DW-106

x DW-062

x DW-077

SAC MW-11

SAC-14

Δ 043
Δ 042

x DW-073

198-508
198-506

x DW-104

x DW-076

x DW-035

x DW-110

Δ 001

x DW-036

CDW-805 x CDW-805

x DW-103

SAC MW-04

x DW-066

x DW-028

Δ 006

Δ 005

x DW-025

x DW-102
CDW-102

x DW-060

x CDW-800
CDW-801
CDW-802

37

x NMW-09

ADAMS COUNTY
TREATMENT FACILITY

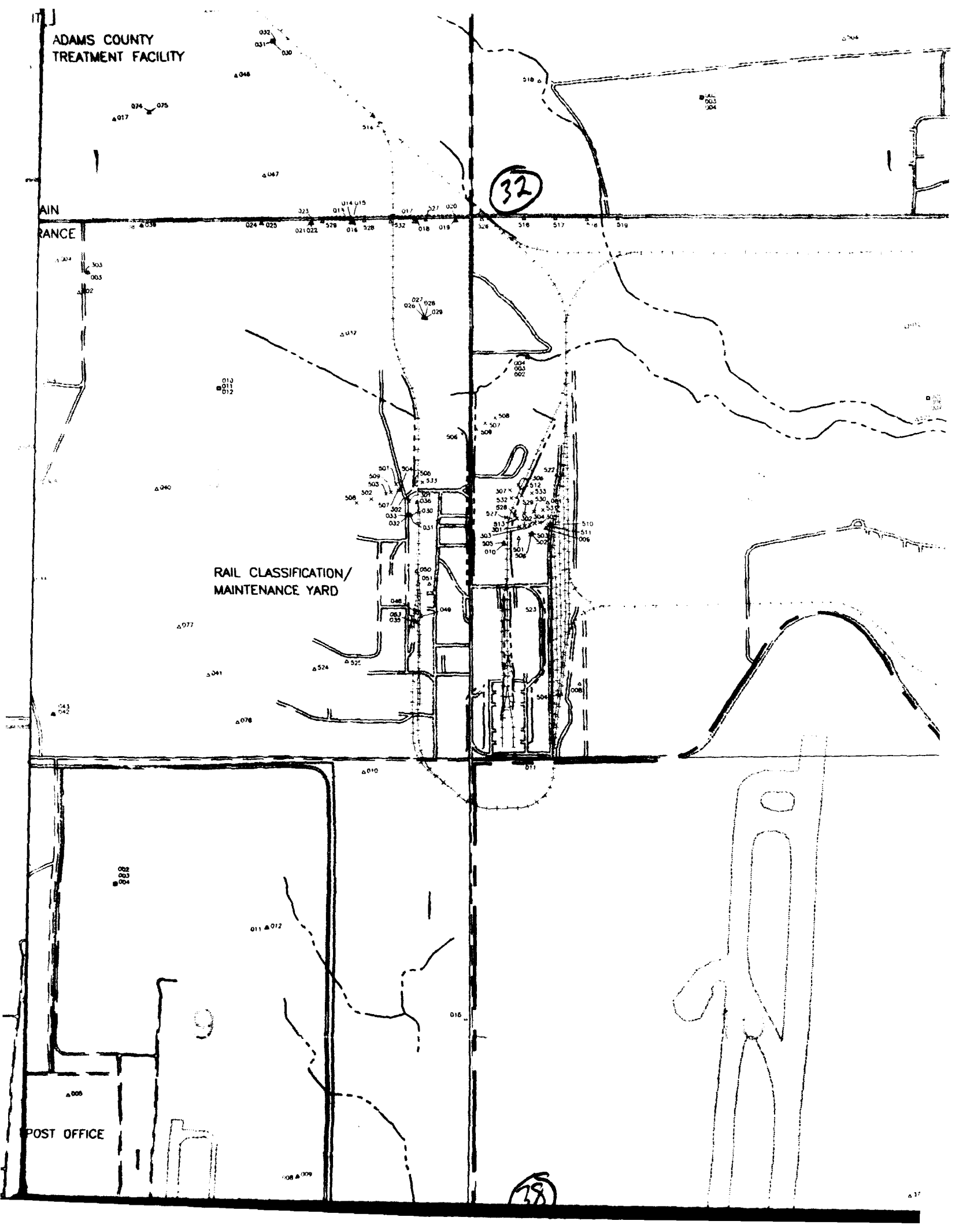
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RANCE

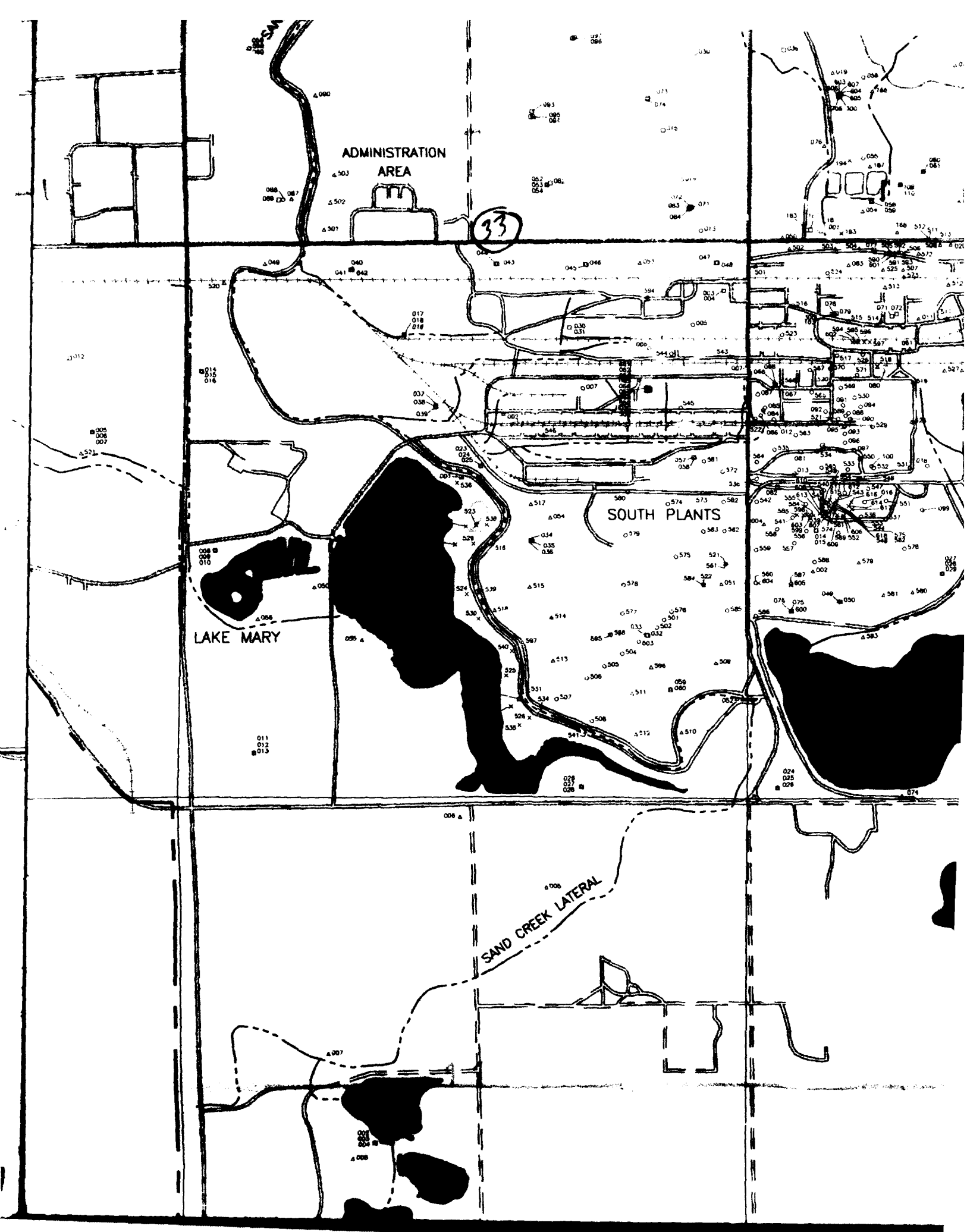
RAIL CLASSIFICATION/
MAINTENANCE YARD

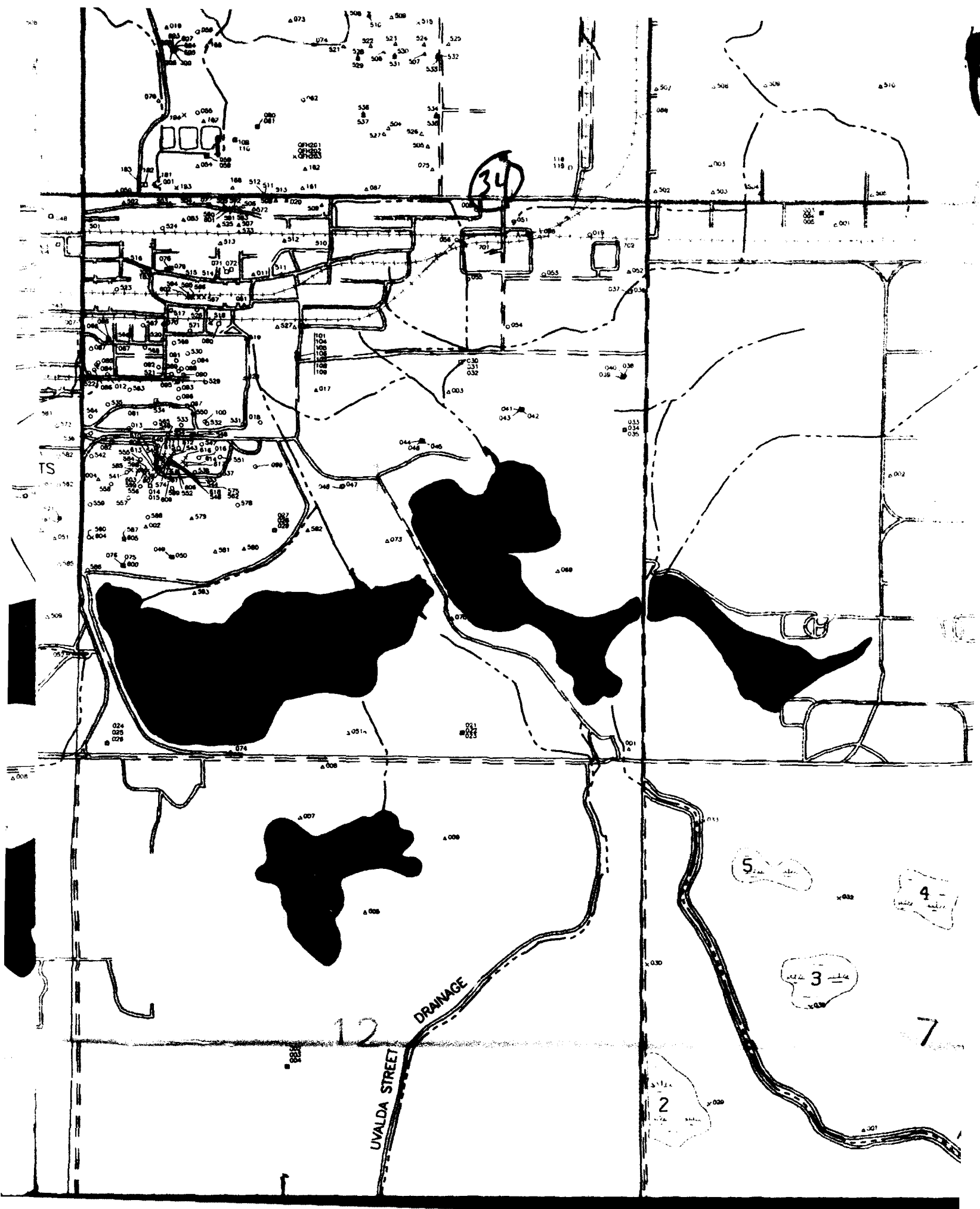
POST OFFICE

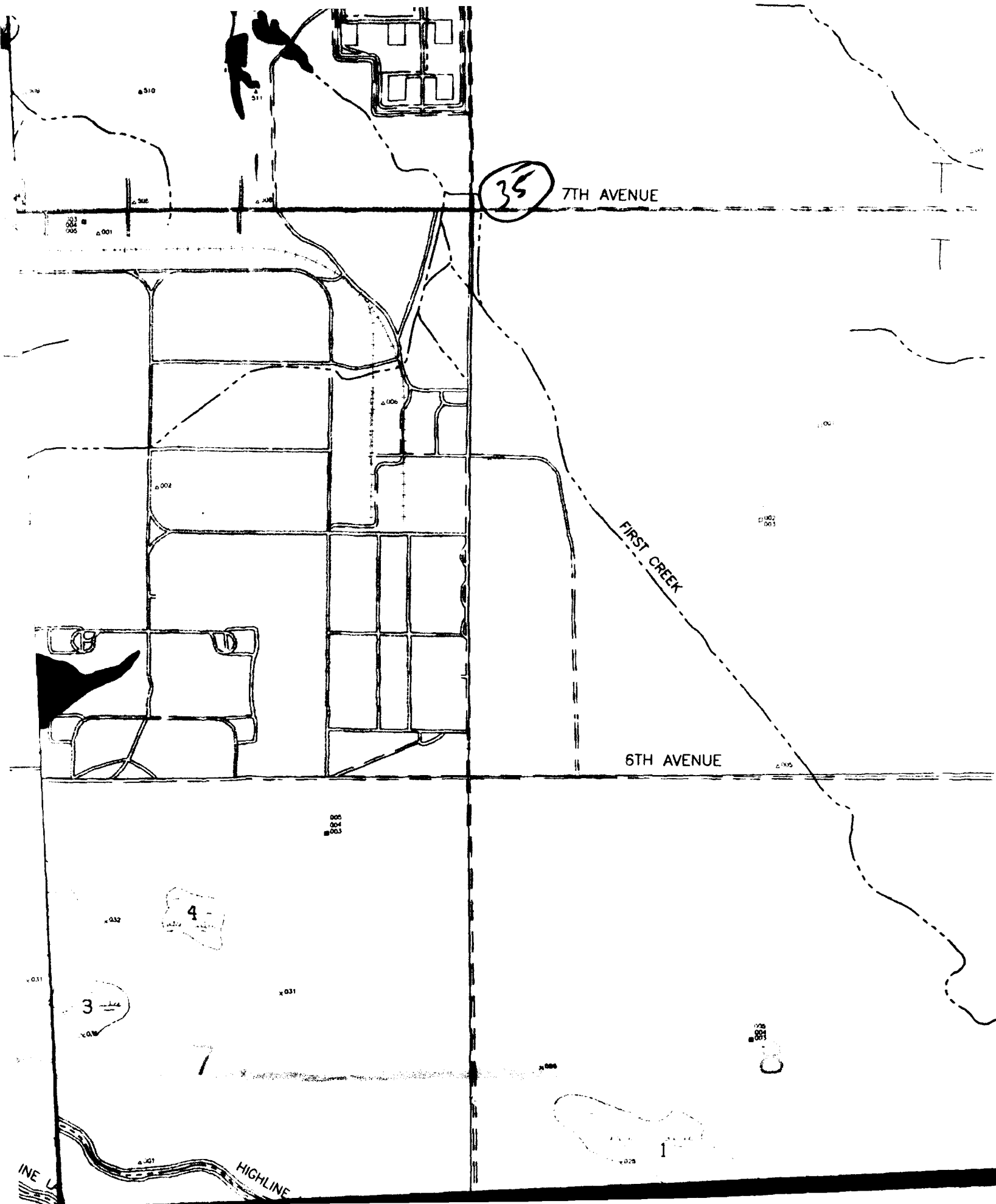
32

38









35

7TH AVENUE

T 2 S

36

T 3 S

180000 N

FIRST CREEK

6TH AVENUE

175000 N



2.002

37

CDM-600
CDM-601
CDM-602

DOZ
SAC MW-0A

170000 N

165000 N

2165000 E

I-270

FTTHAWP03
FTTHAWP03

FTTHAWP02
FTTHAWP02

SAC MW-05

FTTHAWP01
FTTHAWP01

FT MW-06

FT MW-01

FT MW-07

FT MW-05

FT MW-04

FT MW-03

LS MW-06

LS MW-04

LS MW-01

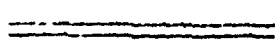
SAC MW-0A



Wetlands



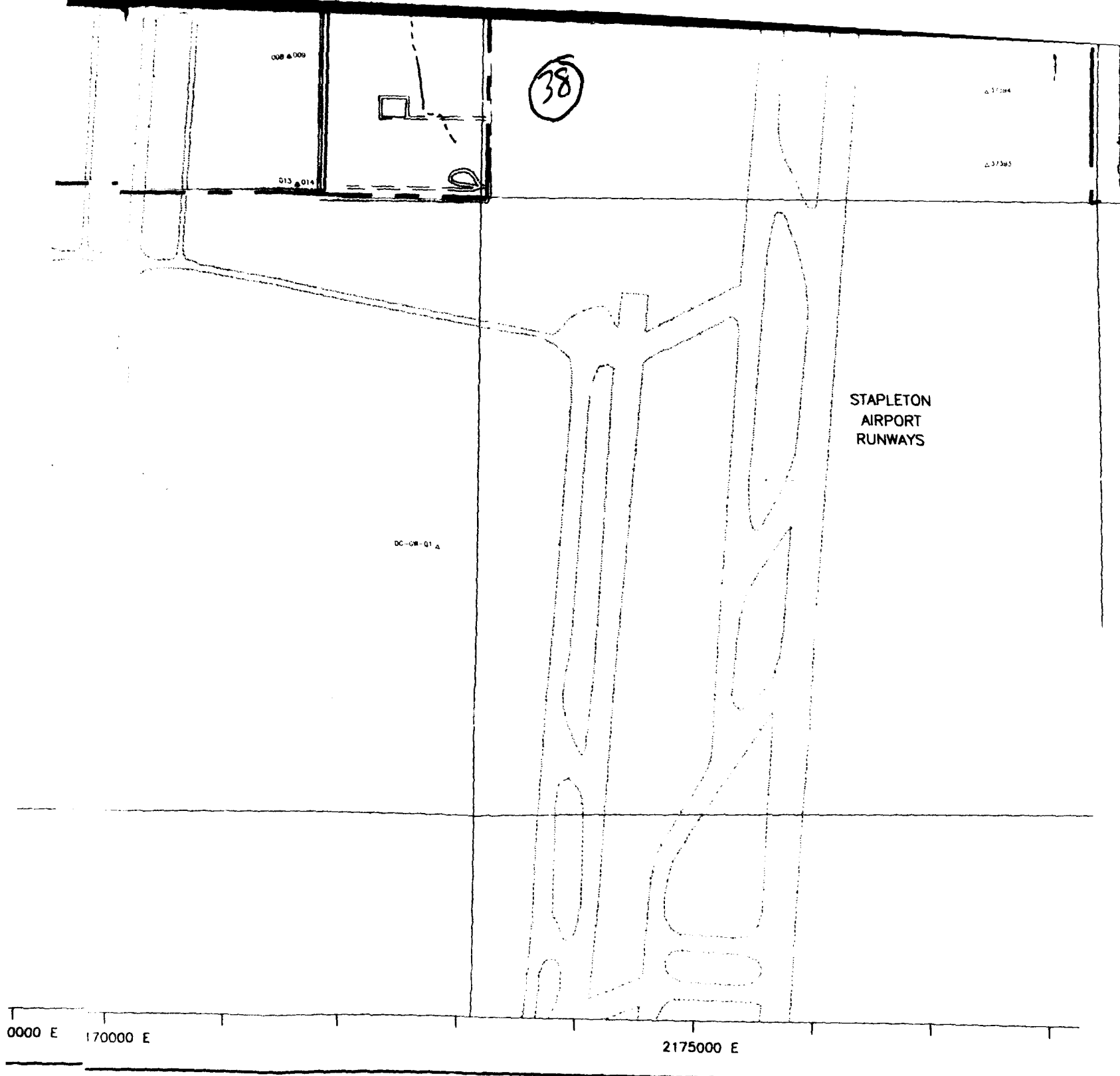
Ditch or Stream



Paved Road



Unpaved Road



EXPLANATION

Se Section Number

Ar Arsenal Boundary

Rd Railroad

- ▲¹⁰¹ Alluvial Well
- ¹⁰¹ Arapahoe Well
- ¹⁰² Unconfined Denver Formation Well
- ¹⁰³ Confined Denver Formation Well

HAVANA
INTERCI

Δ 37304

Δ 37303

HAVANA STREET
INTERCEPTOR

(79)

001 a

STAPLETON
AIRPORT
RUNWAYS

2180000 E

Containment systems

er Formation Well

Formation Well

P Associates, October 1991)

Physical barrier

Hydraulic barrier

Recharge trenches

40

001

R 67 W

R 66 W

185000 E

2190000 E

Nte:

The onpost well identification number shown have been abbreviated. The full well identification number contains the section number before the number shown on this map. For example, the complete well identification number for well 012 in onpost section 3 is 0012.

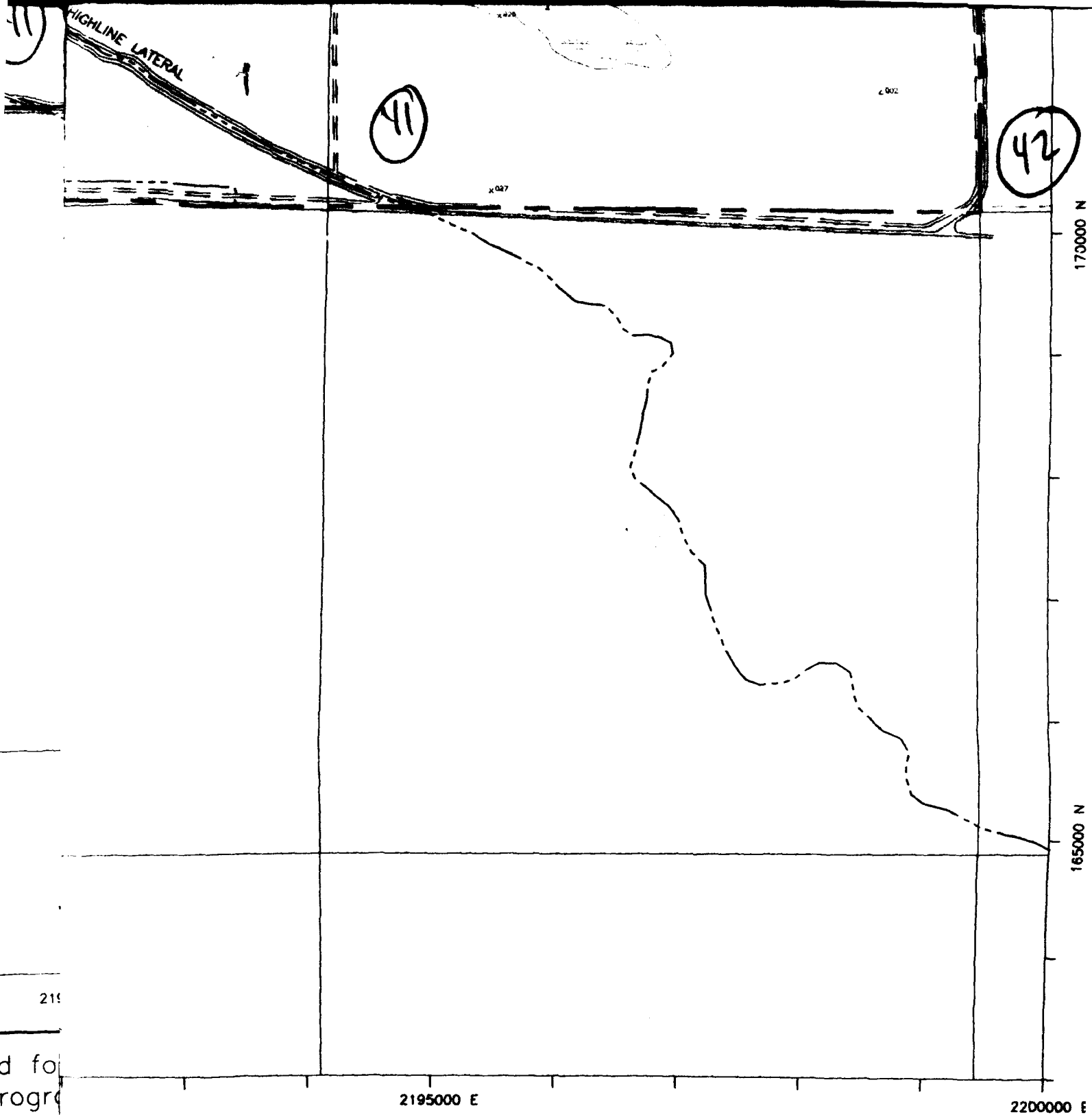


Prep

Pre

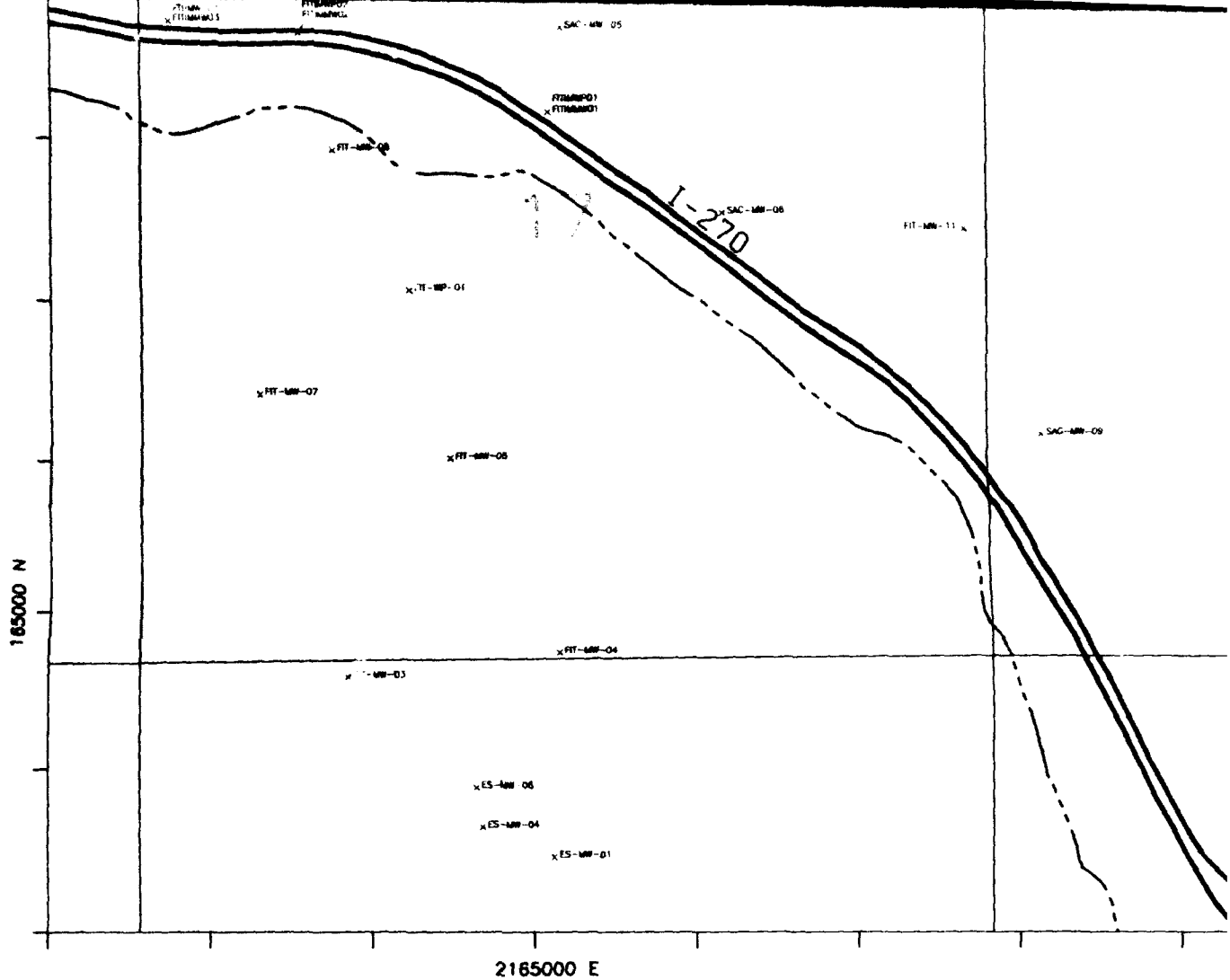
Pla

47
GWA



Prepared for:
Program Manager for
Rocky Mountain Arsenal
Commerce City, Colorado
Prepared by:
Harding Lawson Associates

Plate 1
Comprehensive Monitoring Program



Wetlands

Ditch or Stream

Paved Road

Unpaved Road

Modified from R. L. Stollar & Associates, 1989.
Contributed to by D. P. Associates and TETIME.

43

9/5/92 rmd/newplate jwo

AD-01-01

STAPLETON
AIRPORT
RUNWAYS

16

DC-01-01

21700

2170000 E

2175000 F

EXPLANATION

- Section Number
- Arsenal Boundary
- Railroad

- Alluvial Well
- Arapahoe Well
- Unconfined Denver Formation We
- Confined Denver Formation Well
- Not Classified (DP Associates, O

44

STAPLETON
AIRPORT
RUNWAYS

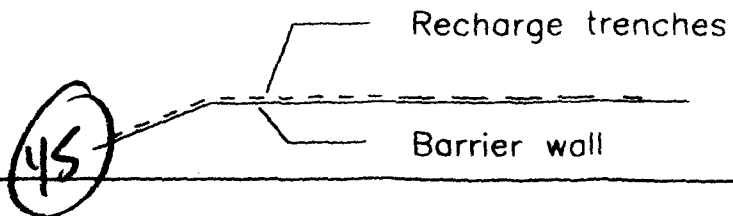
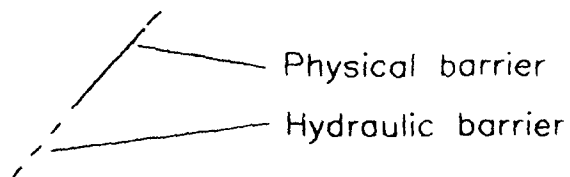
2180000 E

Containment systems

Over Formation Well

Over Formation Well

(DP Associates, October 1991)



R 67 W

R 66 W

21850

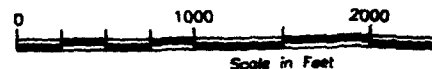
2185000 E

2190000 E

Items

Note:

The onpost well identification number shown have been abbreviated. The full well identification number contains the section number before the number shown on this map. For example, the complete well identification number for well 012 in onpost section 3 is 03012.



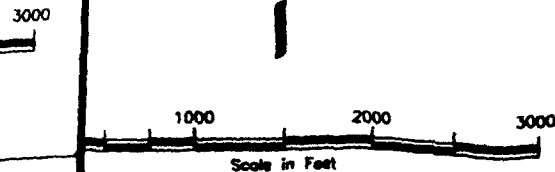
116

18

66 W

190000 E

2195000 E



Prepared for:

Program Manager for
Rocky Mountain Arsenal
Commerce City, Colorado

Prepared by:

Harding Lawson Associates

Plate 1

Comprehensive Monitoring Program
Regional Rocky Mountain Arsenal
Well Location Map, September 199



GWAR FY91

2195000 E

2200000 E

165000 N

Prepared for:

Program Manager for
Rocky Mountain Arsenal
Commerce City, Colorado

Prepared by:

Harding Lawson Associates

Plate 1

Comprehensive Monitoring Program
Regional Rocky Mountain Arsenal
Well Location Map, September 1992

47
GWAR FY91

48

①

2165000 E

2170000 E

2175000

215000 N

32

33

34

T 1 S

T 2 S

210000 N

5

37356 3

205000 N

8

South Platte River

9

10

200000 N

④

37363 3

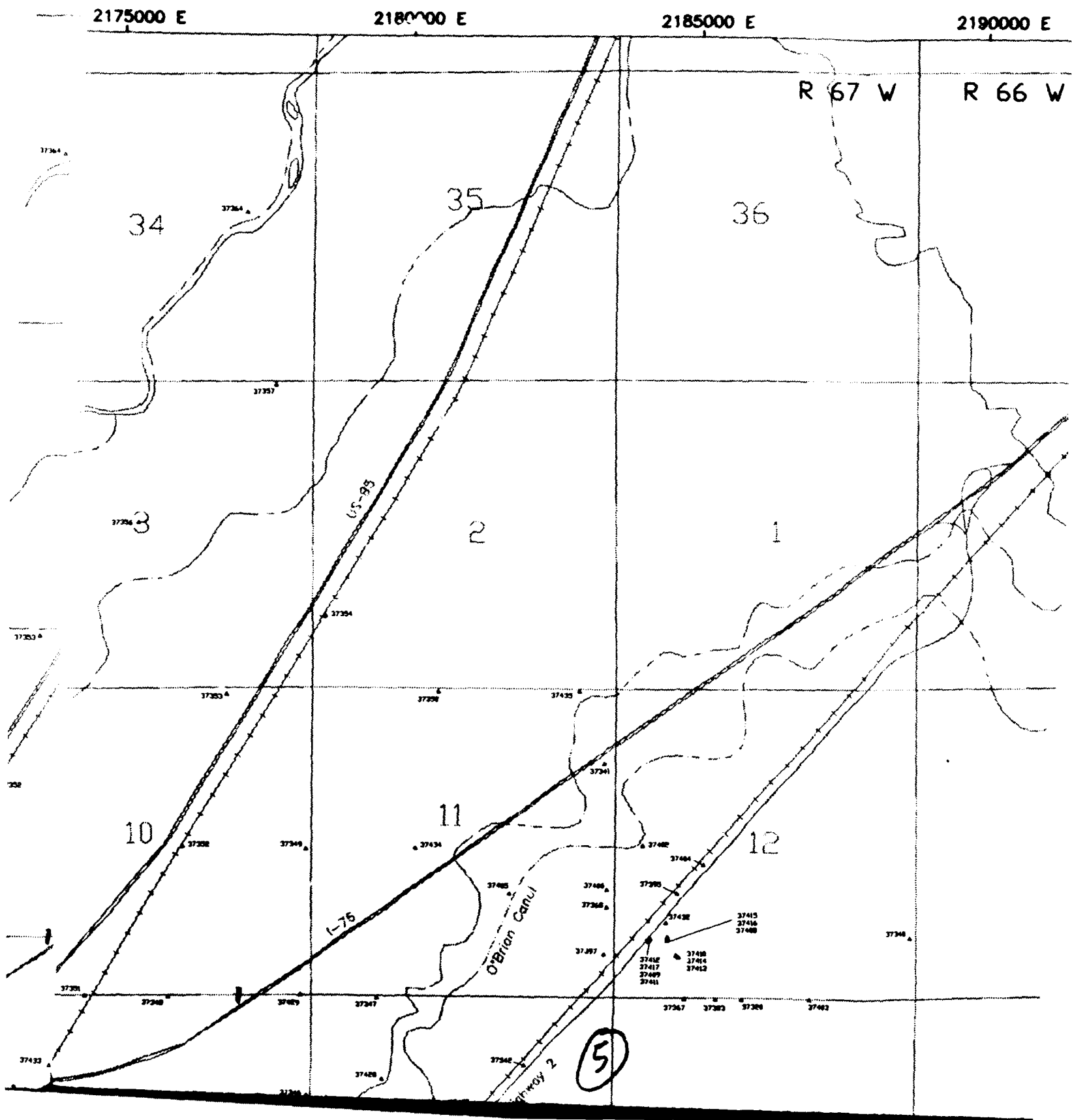
37355

37354

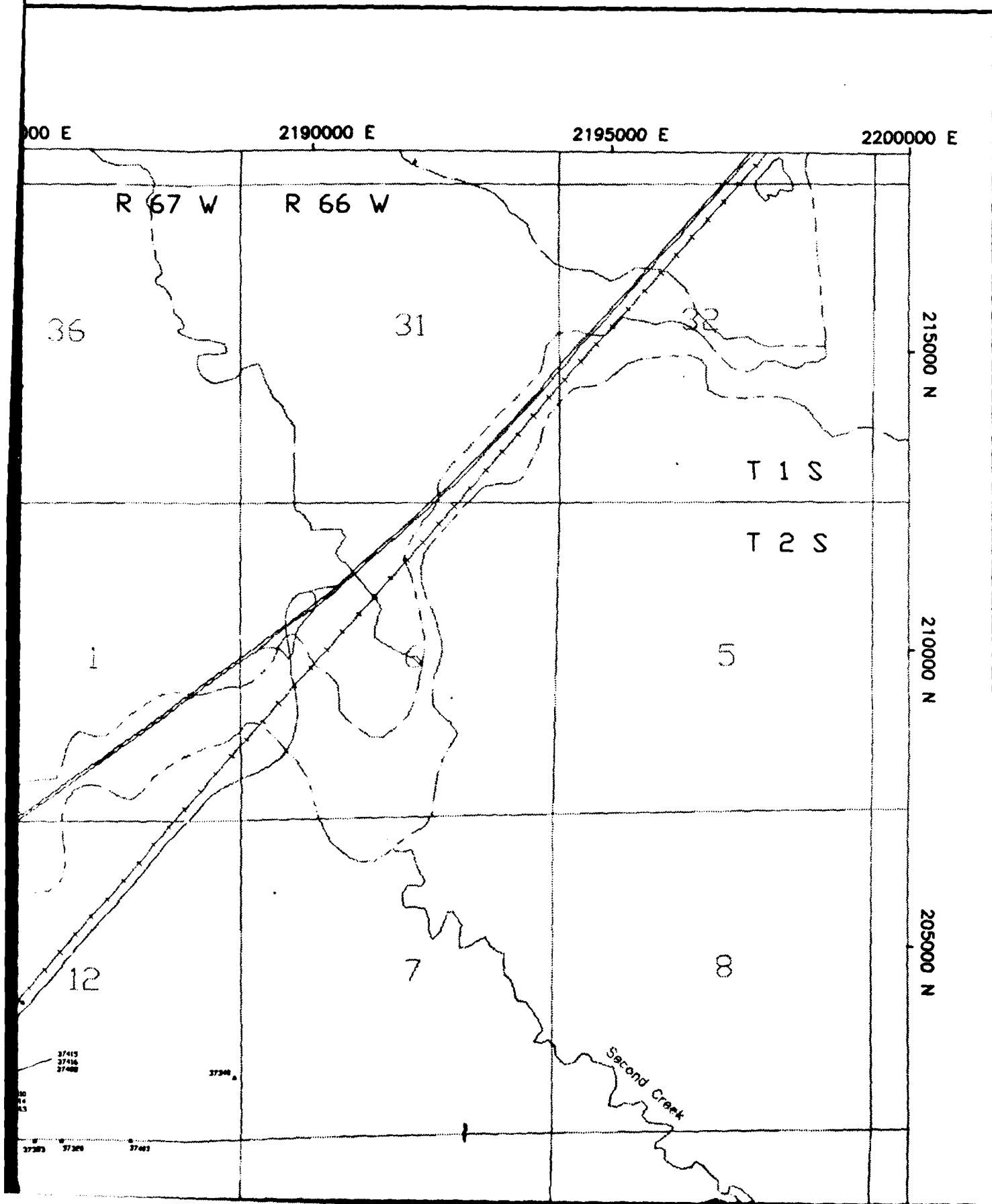
37428

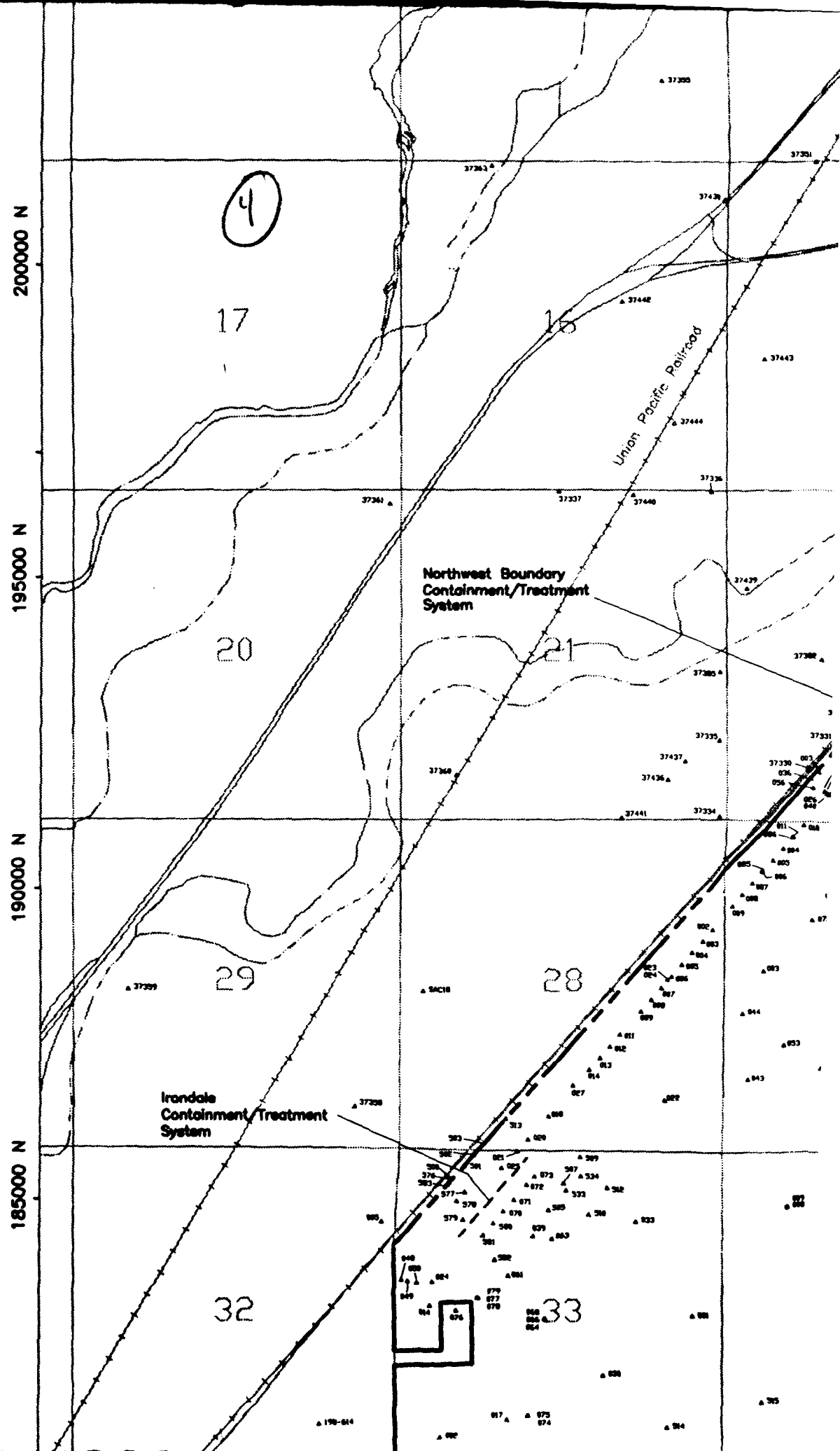
37440

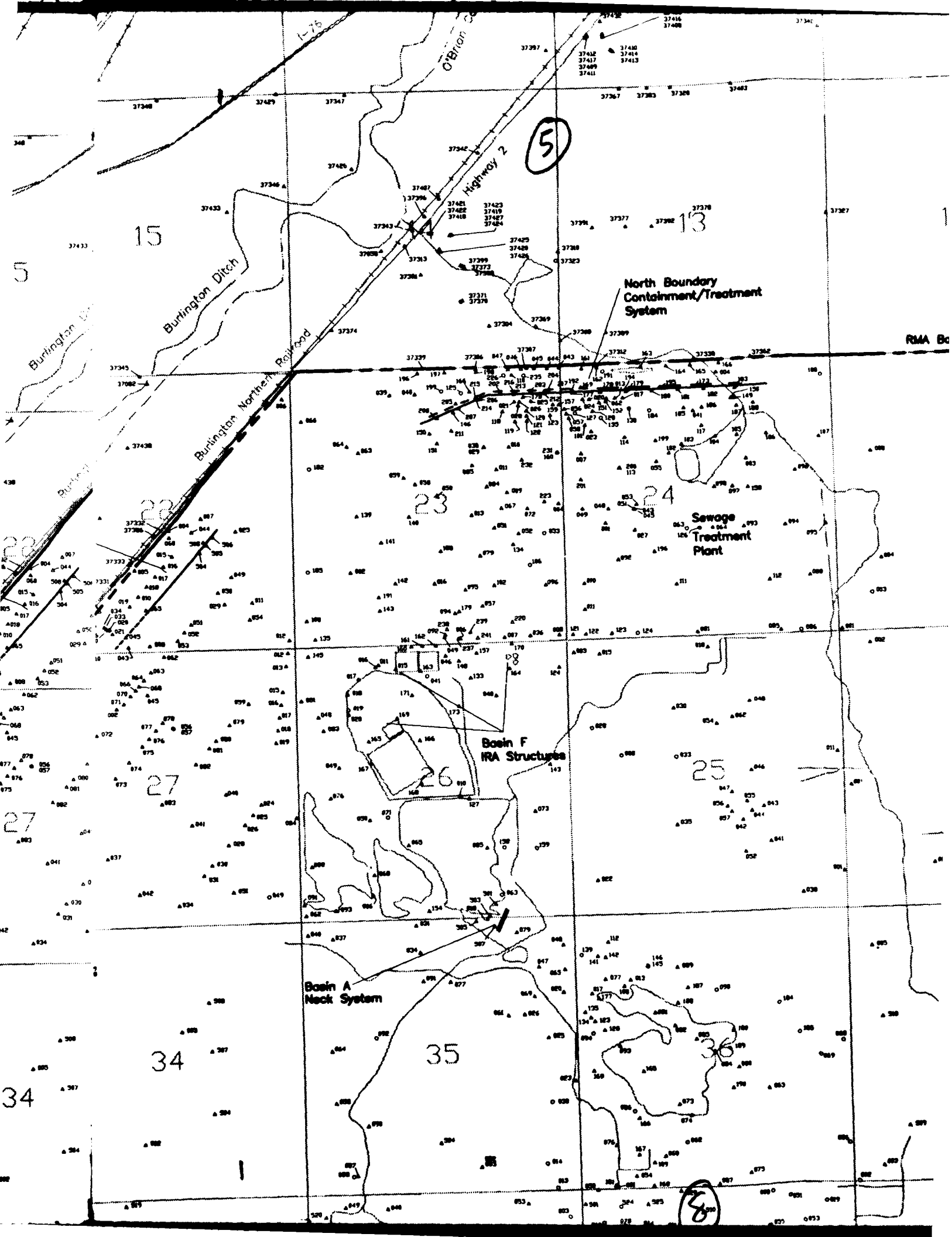
⑤

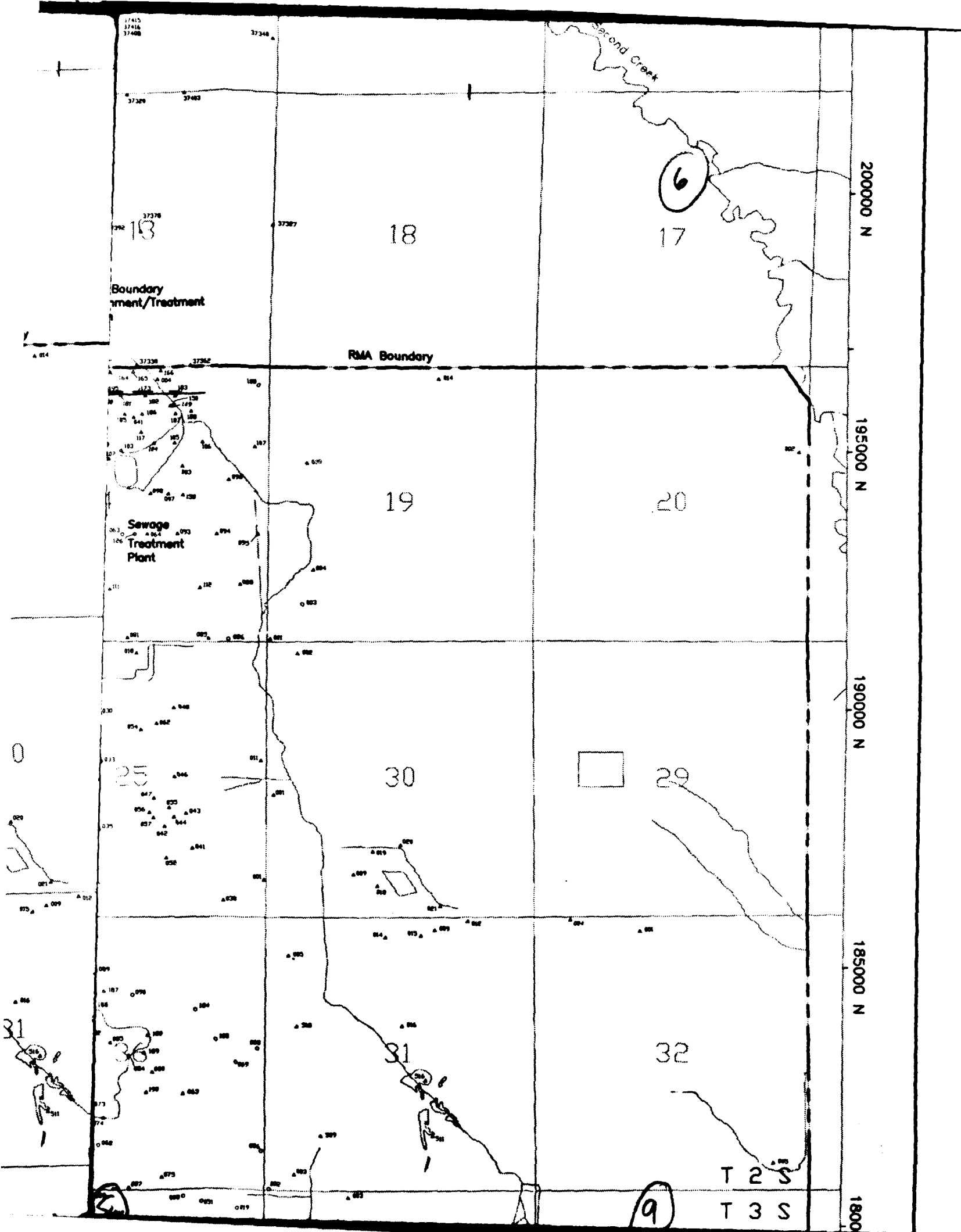


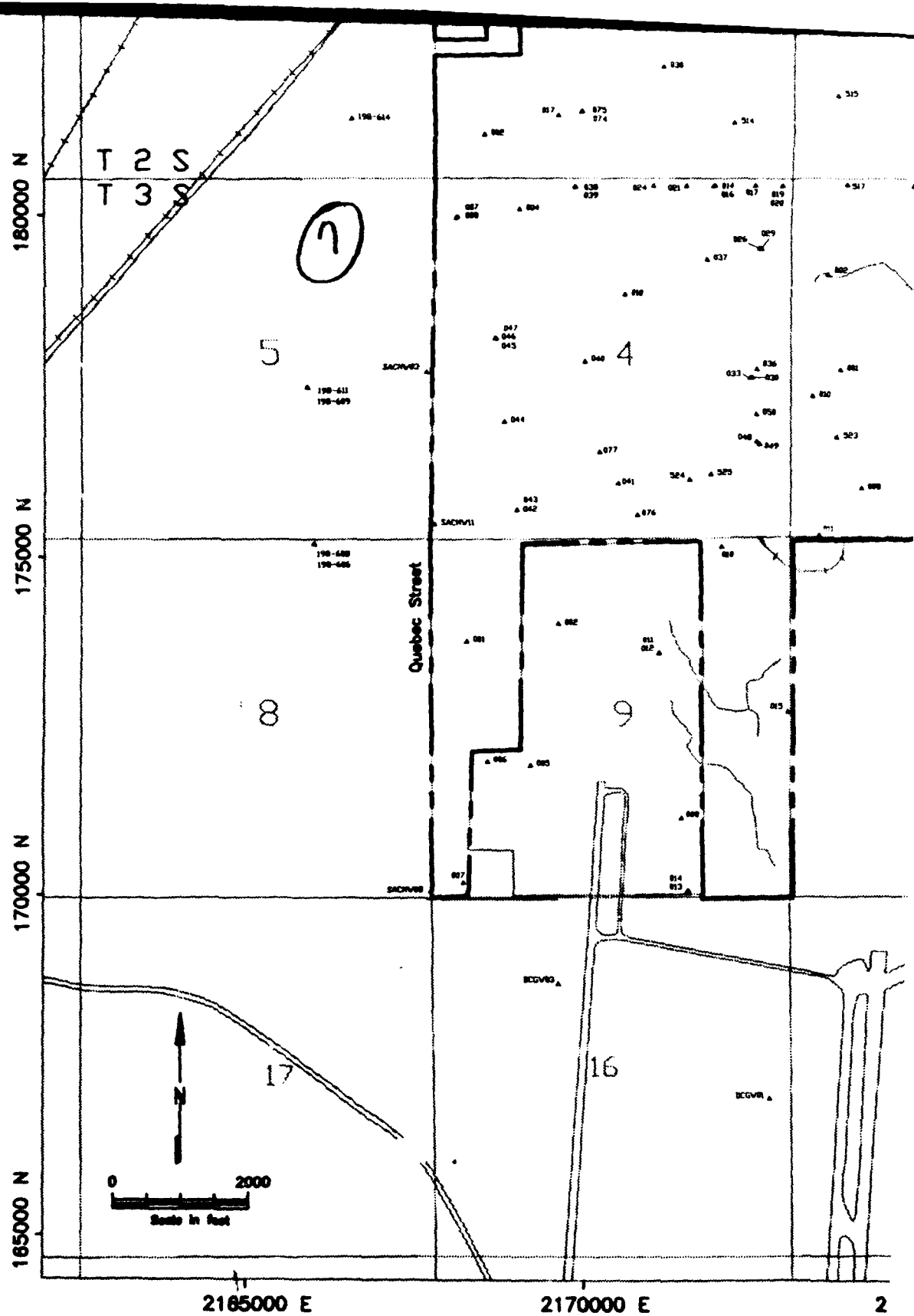
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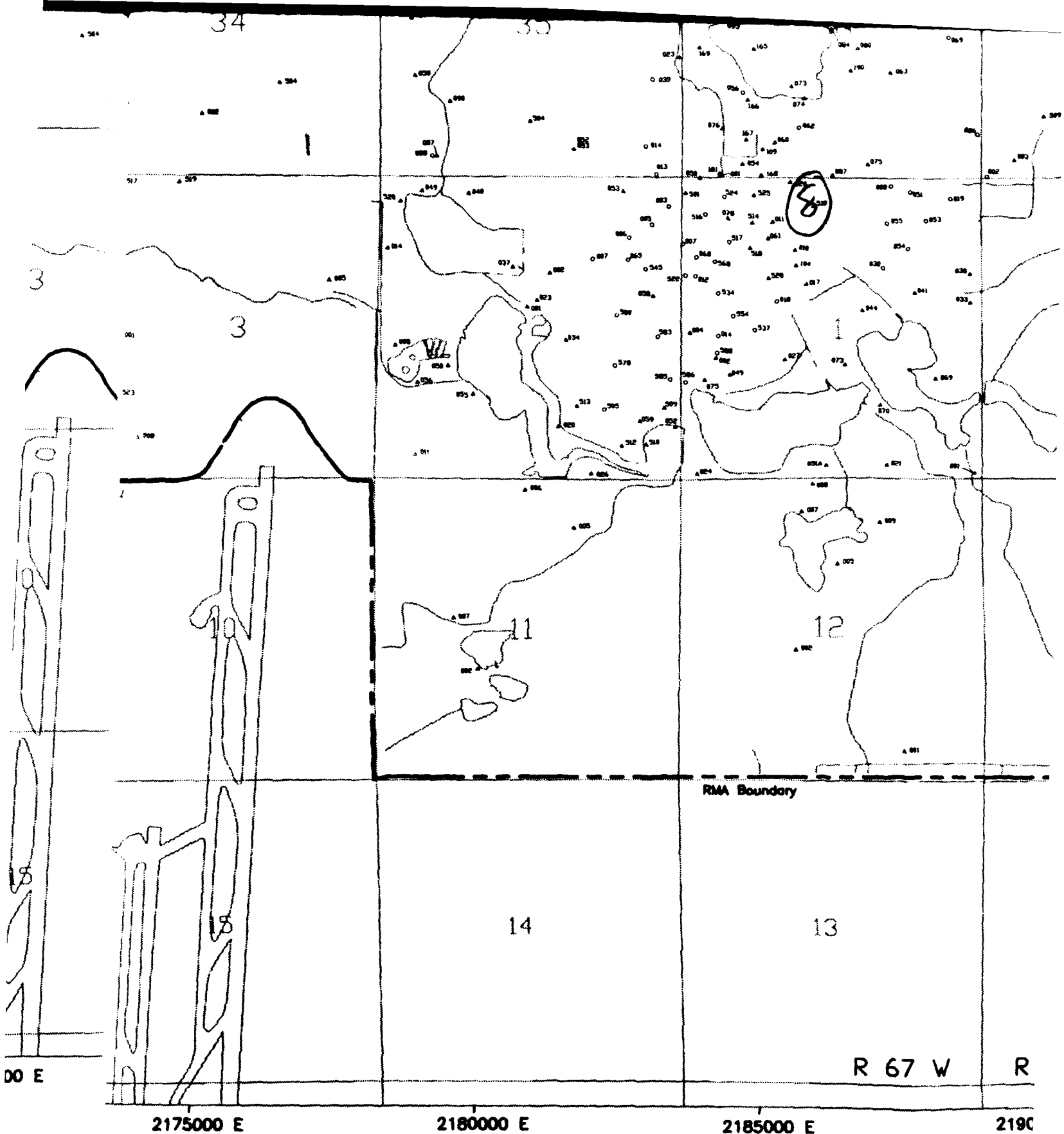






EXPLA

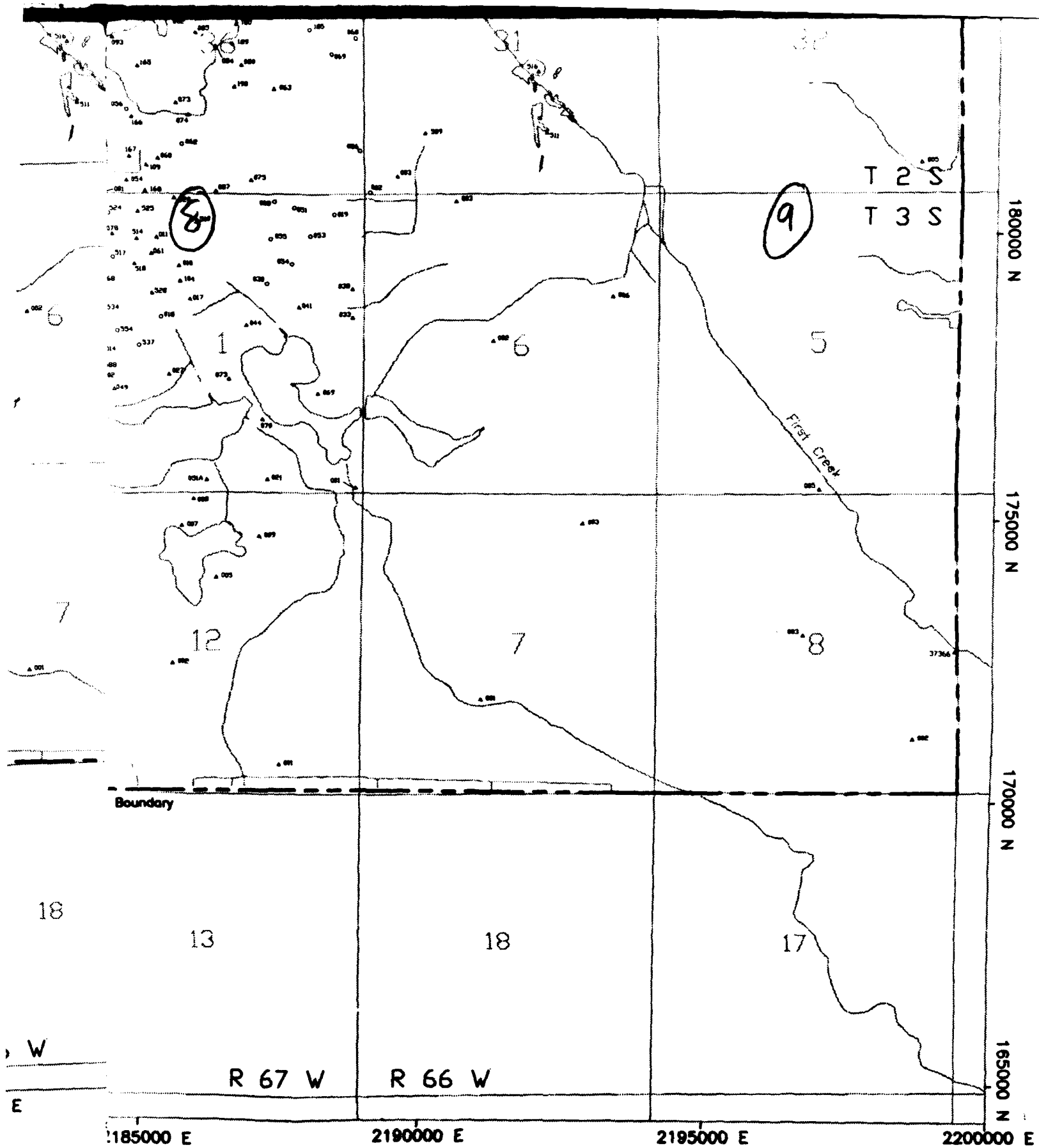
Unconfined flow system



ATION

PLANATION

Containment system



Prep

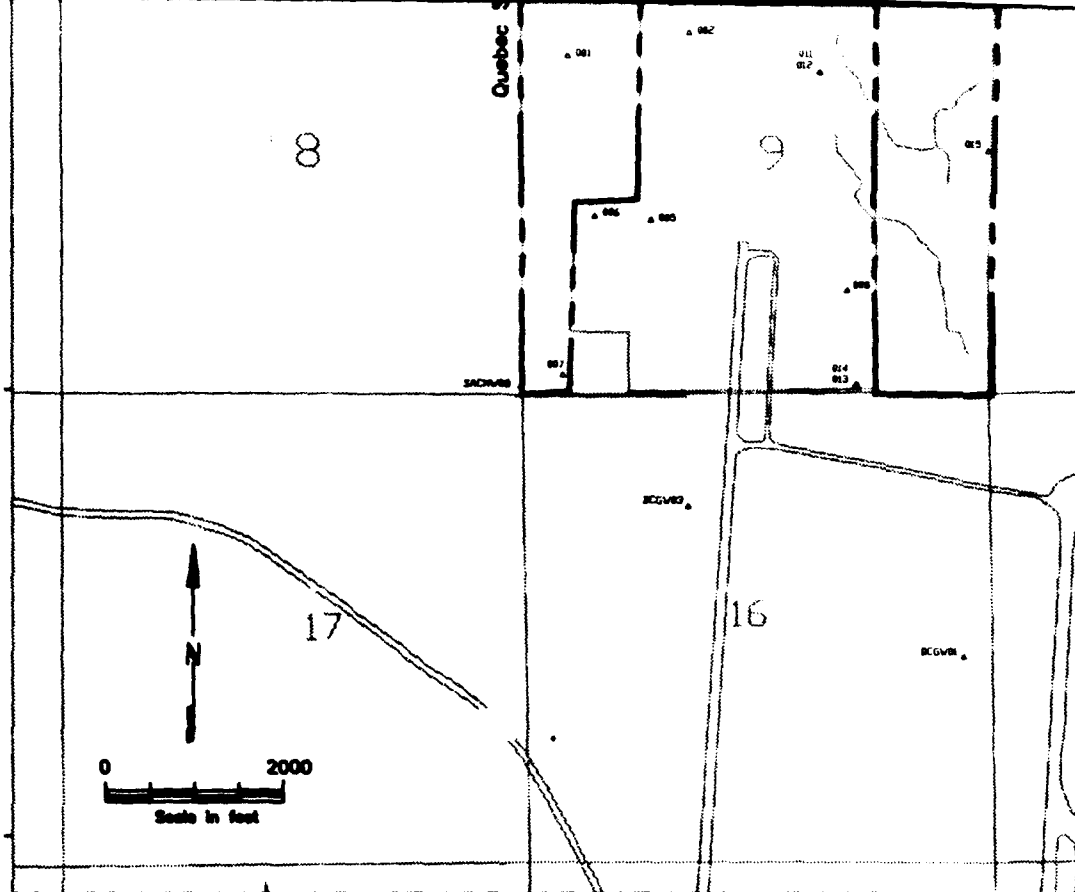
Prepared for:
Program Manager for
Rocky Mountain Arsenal

170000 N

165000 N

2165000 E

2170000 E



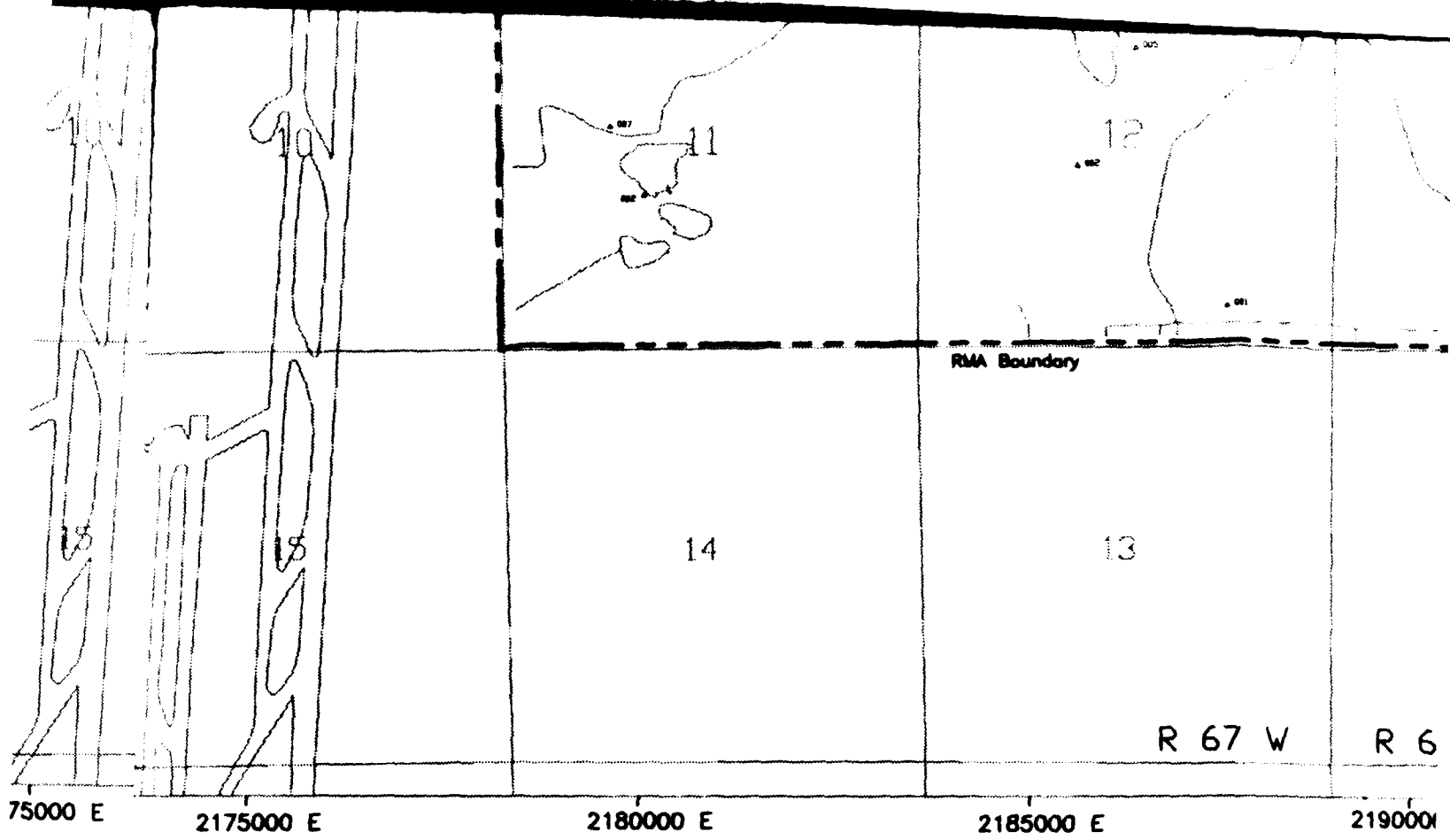
EXPL

Unconfined flow system

- Alluvial wells
- Denver wells
- × Not classified
(D.P. Associates, October 1991)

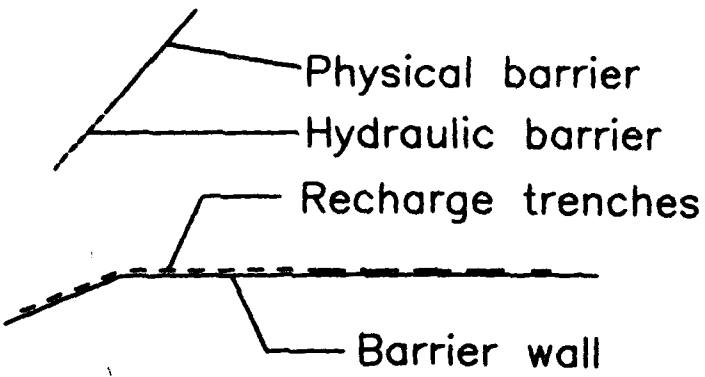
Note: For onpost wells, the section number
the three-digit well number shown
(i.e., wells in Section 3 - 03001)

10



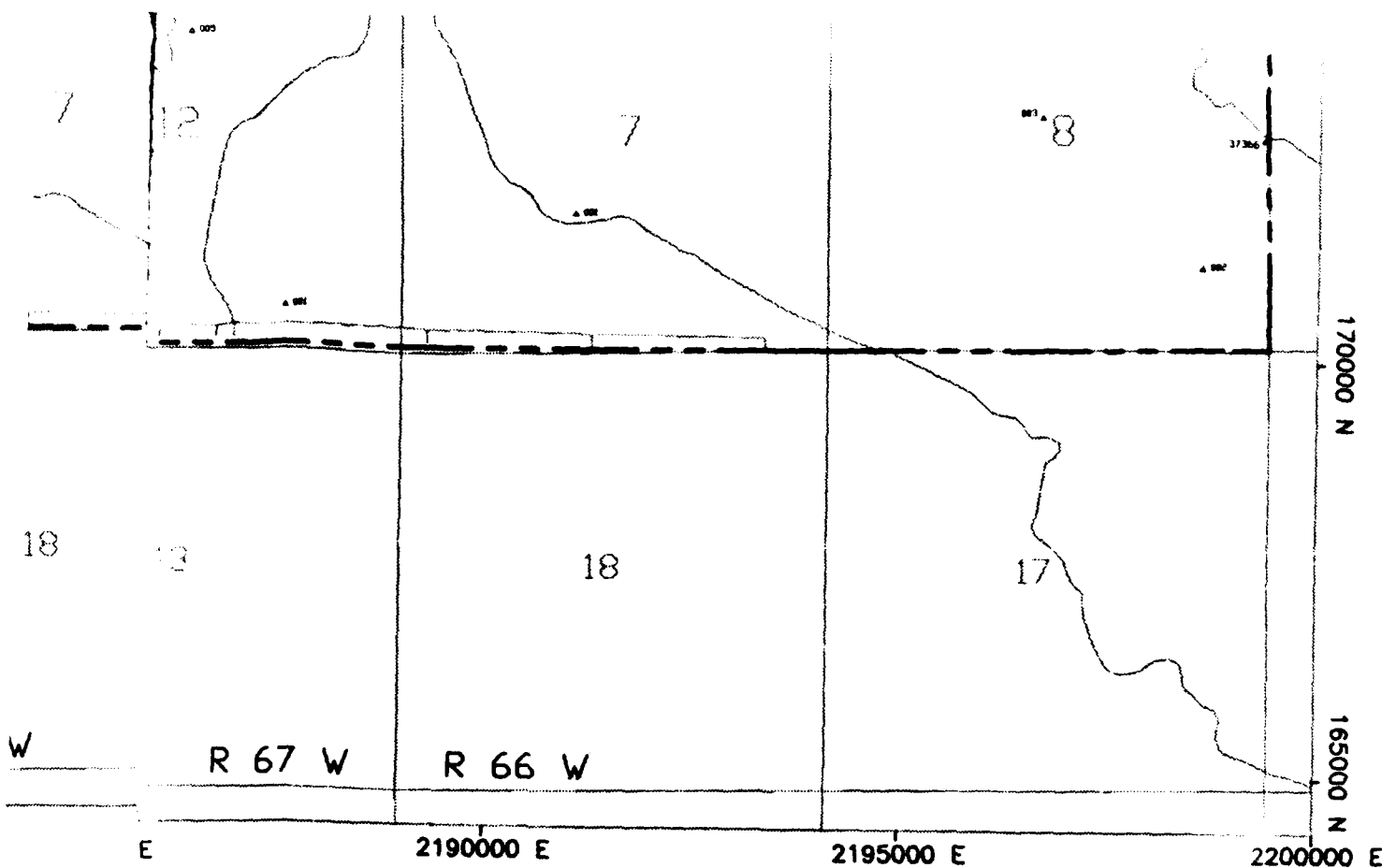
NATPLANATION

Containment system



cedes r precedes

11



Prep n Prep rier rrier nches	Prepared for: Program Manager for Rocky Mountain Arsenal Commerce City, Colorado Prepared by: Harding Lawson Associates
Plate Winter Monit Groun GWAR F	Plate 2 Winter 1990/1991 Water-level Monitoring Network, Unconfined Groundwater Flow System GWAR FY91

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