

RMO II Case Study

AAA Auto Body Garage and Battery Shop

NFA Risk Management
Option Level II (RMO II)
Using ICs and ICs with ECs
Chapter 62-780.680(2), F.A.C.

Four Part Presentation

- **Part 1**
 - ◆ Reminders about RMO II
 - ◆ Site details
 - ◆ Preliminary assessment results
 - ◆ Building blocks for case study
- **Part 2**
 - ◆ Site assessment results
 - ◆ Sampling requirements
- **Part 3**
 - ◆ Data analysis
- **Part 4**
 - ◆ Strategy for achieving NFA with EC/IC

Reminders about RMO II

- **NFA with institutional controls (IC) and, if appropriate, engineering controls (EC).**
 - ♦ EC always requires an IC
 - ♦ Property owner(s) of the source must agree to controls
 - ♦ P.E. certification of EC required
 - ♦ Commercial/Industrial SCTLs acceptable

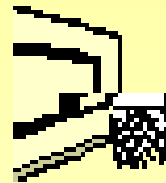
Goal of Case Study

- Use RBCA to achieve closure under RMO II



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- Use RBCA to achieve closure under RMO II



Primary Teaching Points

- Soil sampling intervals
 - ◆ Metals and semi-VOCs
- Carcinogenic PAHs
 - ◆ Toxic equivalency (TE-BaPs)
 - ◆ Total TE-BaP calculation
- Lead and SPLP
 - ◆ Leachability
- Calculation and use of 95% UCL

Contaminated Site Risk Based Corrective Action (RBCA) Flow Process
Chapter 62-780, F.A.C. Risk Management Options - Level II

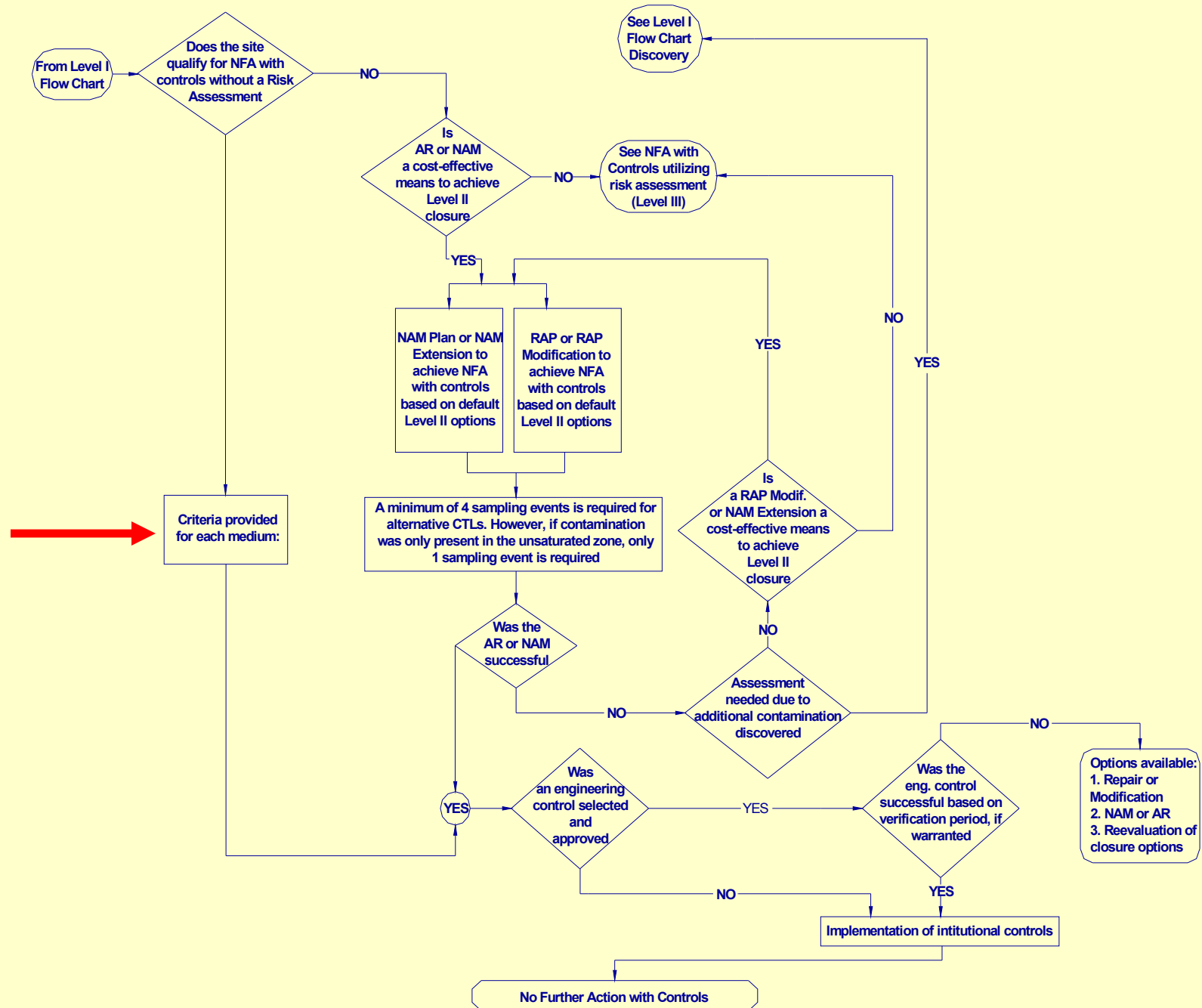


Figure 1 Site Map



History and Site Details

- Active since 1962
 - ◆ Auto repair
 - ◆ Battery sales and service
- Hydraulic auto lifts used until 1986
- Citizen complaint
 - ◆ Possible dumping of used oil onsite, not found
 - ◆ Battery cracking operation discovered
 - ◆ Operator admitted to cracking batteries

Preliminary Assessment

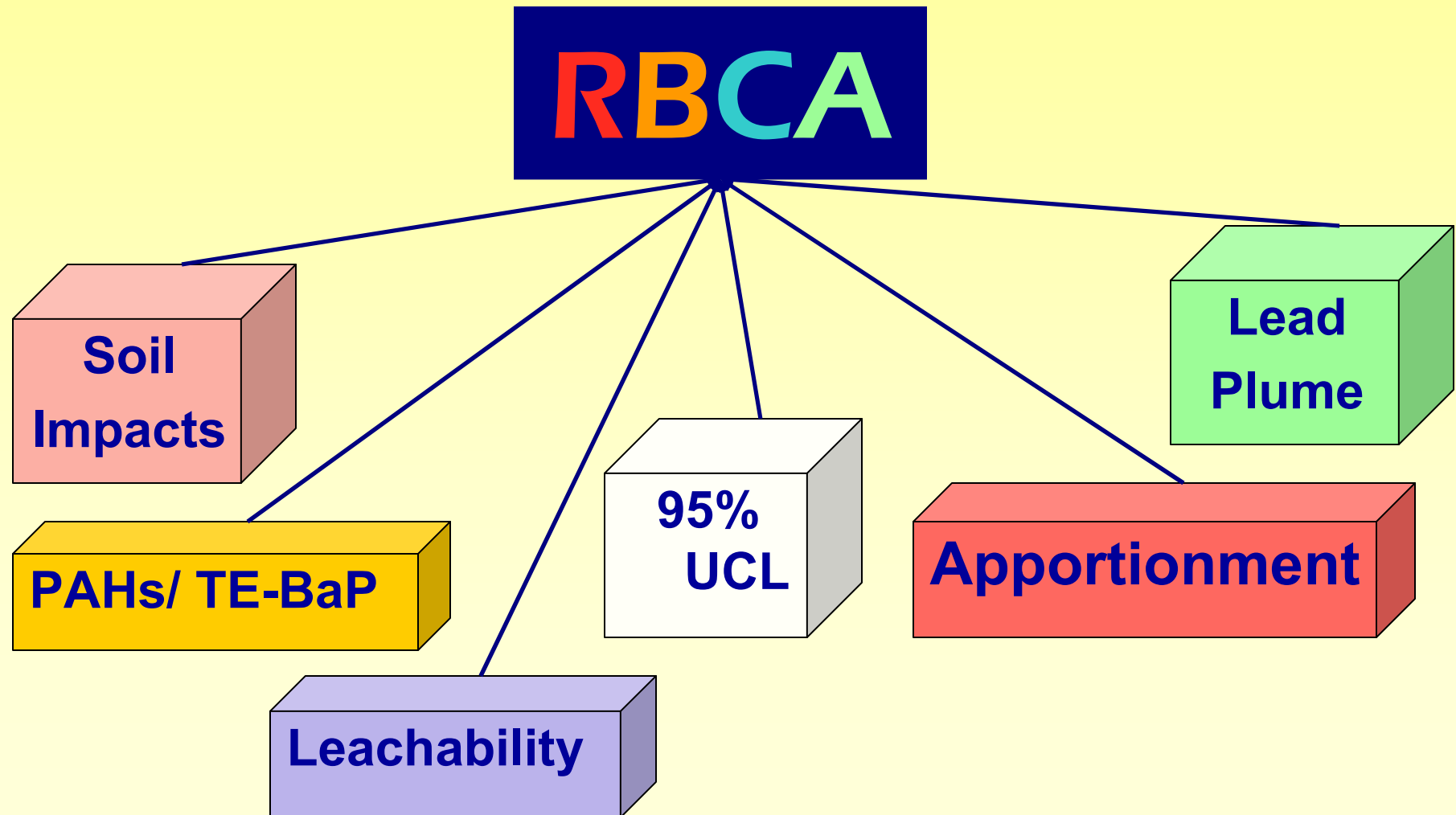
- 5 soil sampling locations and one well
- Groundwater table approximately 2.5' BLS
- Near-surface site geology
 - ♦ Sand and clayey sand
 - ♦ To a depth of 18-20 feet bls
- Dense clay
 - ♦ Present beneath the uppermost granular unit
 - ♦ Considered an uppermost **confining unit** for vertical migration
- Lead present in shallow aquifer above GCTL
- PAHs, lead and PCBs present in site soil above industrial SCTLs

Where are we in the process?

- Further assessment needed
- Based on preliminary results, site remediation likely
- Owner willing to implement IC and EC as necessary

RBCA

Case Building Blocks



End of Part I

Questions?

Figure 2 - Soil Sampling Locations



Table 1

Contaminants Detected in Shallow Soil Samples

Sample ID	Bap	Baa	Bbf	Bkf	Chrysene	Ip	Bp	Lead	PCB
SS-1	0.71	< 0.07	0.2	< 0.07	1.0	< 0.07	0.12	7520	< 0.5
SS-2	0.3	< 0.07	0.7	< 0.07	< 0.07	< 0.07	< 0.07	850	1.8
SS-3	0.413	0.25	0.12	< 0.07	0.25	< 0.07	0.097	35	< 0.5
SS-4	< 0.07	< 0.07	0.08	< 0.07	< 0.07	< 0.07	< 0.07	41	< 0.5
SS-5	0.6	0.21	0.65	0.25	1.2	0.16	0.125	8400	< 0.5
SS-6	0.3	< 0.07	0.7	< 0.07	< 0.07	< 0.07	< 0.07	120	75
SS-7	< 0.07	< 0.07	0.1	< 0.07	< 0.07	< 0.07	< 0.07	81	< 0.5
SS-8	< 0.07	< 0.07	0.082	< 0.07	< 0.07	< 0.07	< 0.07	675	< 0.5
SS-9	0.1	0.078	0.14	< 0.07	0.1	< 0.07	0.071	28	< 0.5
SS-10	0.151	< 0.07	0.094	< 0.07	< 0.07	< 0.07	< 0.07	77	< 0.5
SS-11	< 0.07	< 0.07	0.12	< 0.07	< 0.07	< 0.07	< 0.07	82	< 0.5
SS-12	0.085	0.14	< 0.07	< 0.07	< 0.07	< 0.07	< 0.07	50	< 0.5
SS-13	< 0.07	< 0.07	< 0.07	< 0.07	< 0.07	< 0.07	< 0.07	33	< 0.5
SS-14	< 0.07	0.08	< 0.07	< 0.07	< 0.07	< 0.07	< 0.07	71	< 0.5
SS-15	0.68	0.38	0.12	< 0.07	0.1	< 0.07	0.13	63	42
SCTL	0.7	#	#	#	#	#	52000	1400	2.6

Bold and Shaded values are above direct exposure criteria for industrial/commercial scenario

Table 1
Contaminants Detected in Shallow Soil Samples

Sample ID	Bap	Baa	Bbf	Bkf	Chrysene	Ip	Bp	Lead	PCB
SS-1	0.71	< 0.07	0.2	< 0.07	1.0	< 0.07	0.12	7520	< 0.5
SS-5	0.6	0.21	0.65	0.25	1.2	0.16	0.125	8400	< 0.5
SS-6	0.3	< 0.07	0.7	< 0.07	< 0.07	< 0.07	< 0.07	120	75
SS-15	0.68	0.38	0.12	< 0.07	0.1	< 0.07	0.13	63	42
SCTL	0.7	#	#	#	#	#	52000	1400	2.6

Bold and Shaded values are above direct exposure criteria for industrial/commercial scenario

Note for Carcinogenic PAHs

CONVERT
CARCINOGENIC PAHS TO
BENZO(A)PYRENE
EQUIVALENTS

Before

COMPARISON
TO DIRECT EXPOSURE
SCTL FOR
BENZO(A)PYRENE



Use the approach described in the February 2005 Final Technical
Report: Development of Cleanup Target Levels for Chapter 62-777,
F.A.C.

Figure 3 - PAHs in Shallow Soil

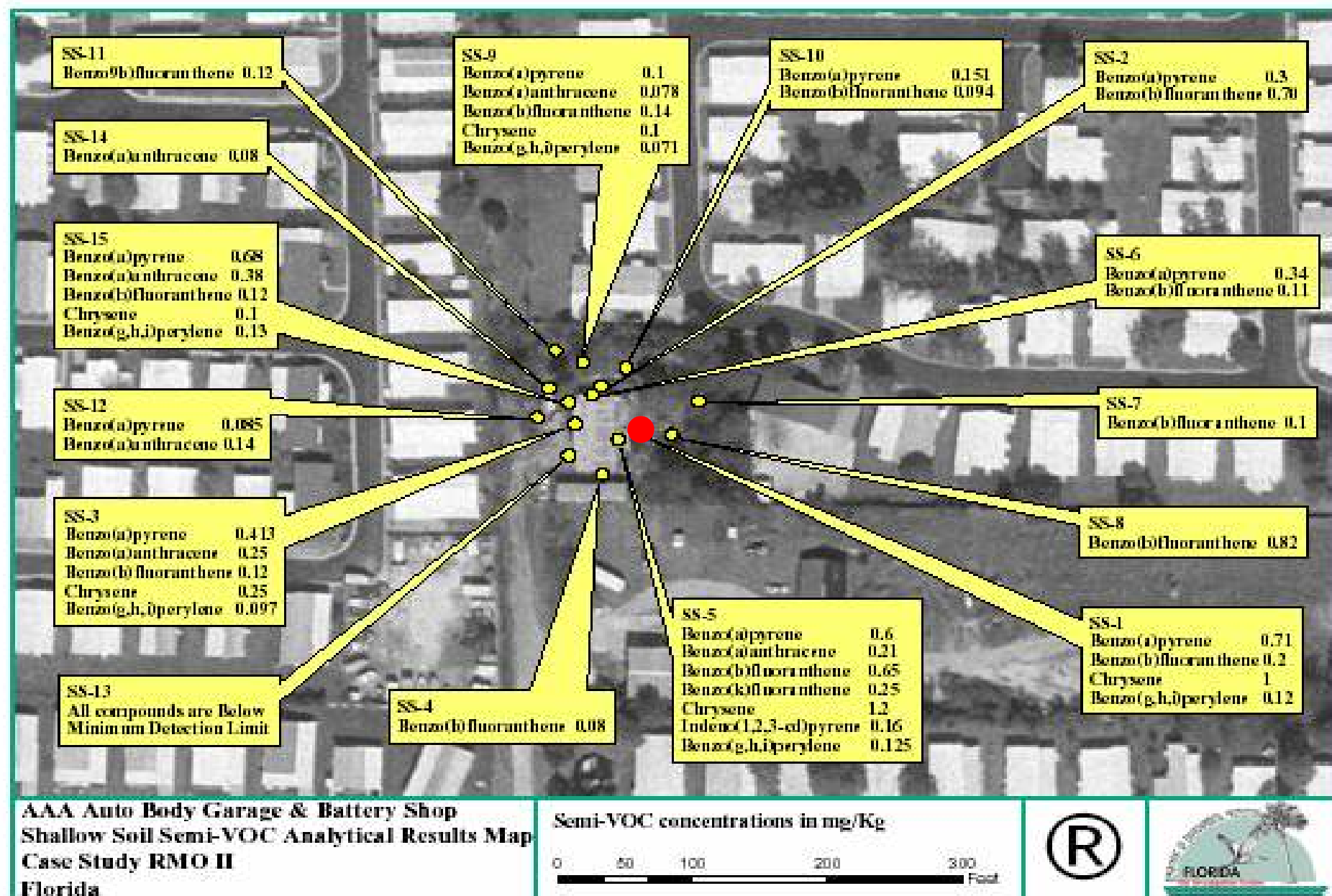


Figure 4 - Lead in Shallow Soil

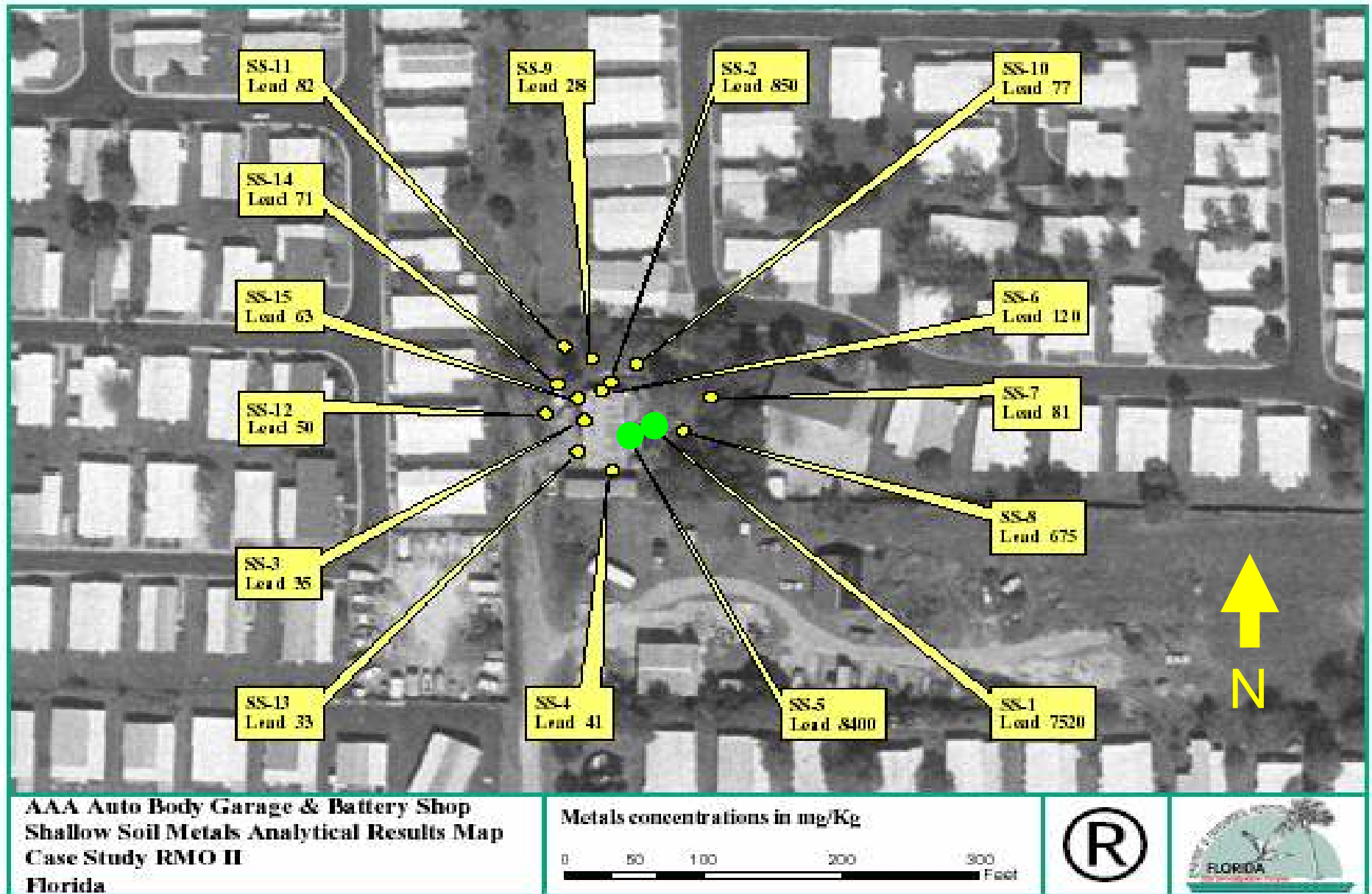


Figure 5 - Shallow Soil PCB Sampling Results

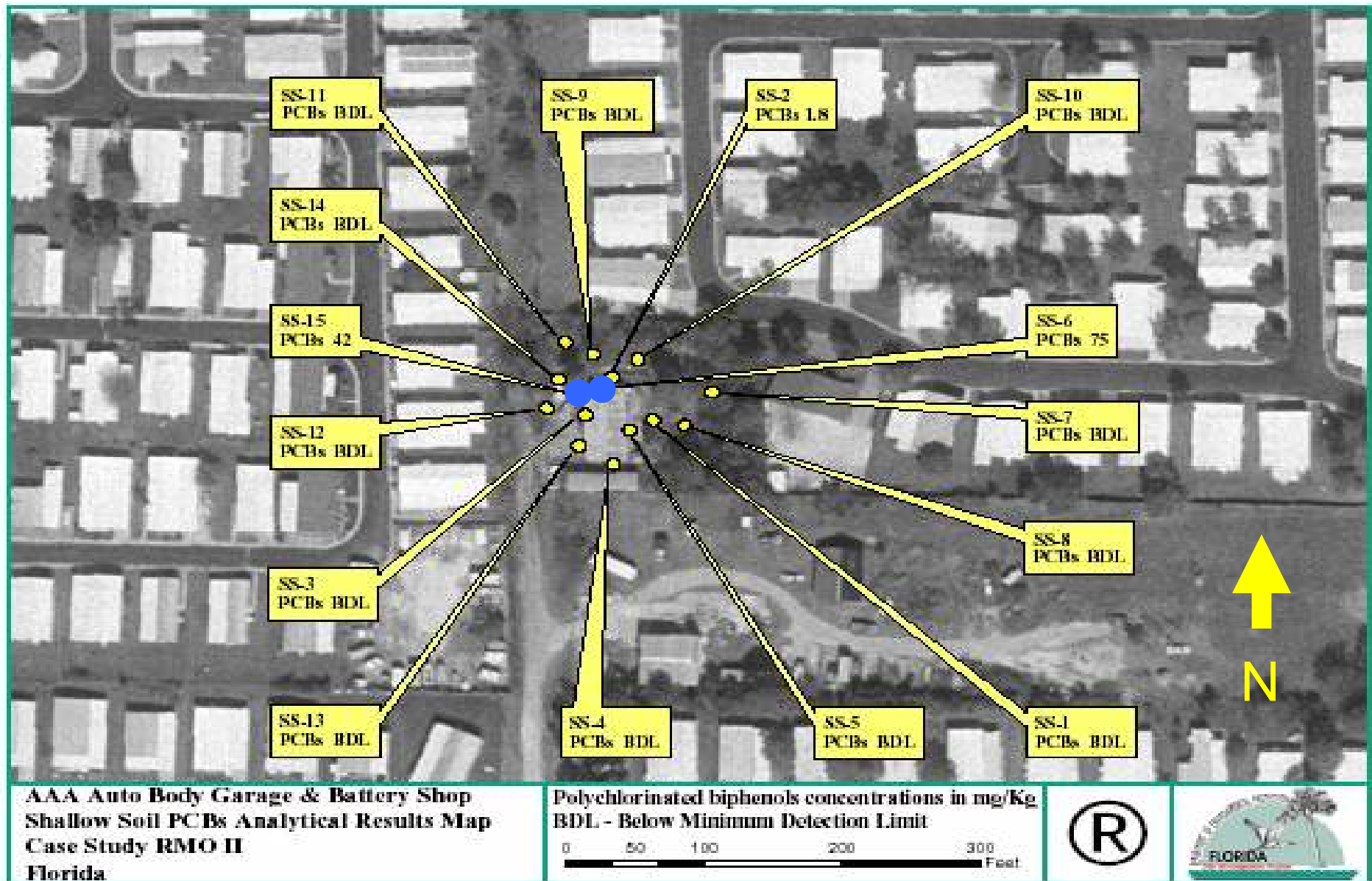


Table 2

Contaminants Detected in Deeper Soil Samples

Sample ID	Bap	Baa	Bbf	Bkf	Chrysene	Ip	Bp	Lead	PCB
SS-1	< 0.07	< 0.07	< 0.07	< 0.07	0.21	< 0.07	< 0.07	2800	< 0.1
SS-2	< 0.07	< 0.07	< 0.07	< 0.07	< 0.07	< 0.07	< 0.07	375	< 0.1
SS-3	< 0.07	< 0.07	< 0.07	< 0.07	< 0.07	< 0.07	< 0.07	25	< 0.1
SS-4	< 0.07	< 0.07	< 0.07	< 0.07	< 0.07	< 0.07	< 0.07	33	< 0.1
SS-5	0.4	0.04	< 0.07	0.15	0.14	< 0.07	< 0.07	2200	< 0.1
SS-6	0.13	< 0.07	< 0.07	< 0.07	< 0.07	< 0.07	< 0.07	40	3.5
SS-7	< 0.07	< 0.07	< 0.07	< 0.07	< 0.07	< 0.07	< 0.07	37	< 0.1
SS-8	< 0.07	< 0.07	0.11	< 0.07	< 0.07	< 0.07	< 0.07	180	< 0.1
SS-9	< 0.07	< 0.07	< 0.07	0.094	< 0.07	< 0.07	< 0.07	13	< 0.1
SS-10	< 0.07	< 0.07	< 0.07	< 0.07	< 0.07	< 0.07	< 0.07	51	< 0.1
SS-11	< 0.07	< 0.07	< 0.07	< 0.07	< 0.07	< 0.07	< 0.07	32	< 0.1
SS-12	< 0.07	< 0.07	< 0.07	< 0.07	< 0.07	< 0.07	< 0.07	27	< 0.1
SS-13	< 0.07	< 0.07	< 0.07	< 0.07	< 0.07	< 0.07	< 0.07	36	< 0.1
SS-14	< 0.07	0.08	< 0.07	< 0.07	< 0.07	< 0.07	< 0.07	22	< 0.1
SS-15	0.086	0.2	< 0.07	< 0.07	0.088	< 0.07	< 0.07	15	0.15
SCTL	0.7	#	#	#	#	#	52000	1400	2.6

Bold and Shaded values are above direct exposure criteria for industrial/commercial scenario

Table 2
Contaminants Detected in Deeper Soil Samples

Sample ID	Bap	Baa	Bbf	Bkf	Chrysene	Ip	Bp	Lead	PCB
SS-1	< 0.07	< 0.07	< 0.07	< 0.07	0.21	< 0.07	< 0.07	2800	< 0.1
SS-5	0.4	0.04	< 0.07	0.15	0.14	< 0.07	< 0.07	2200	< 0.1
SS-6	0.13	< 0.07	< 0.07	< 0.07	< 0.07	< 0.07	< 0.07	40	3.5
SS-15	0.086	0.2	< 0.07	< 0.07	0.088	< 0.07	< 0.07	15	0.15
SCTL	0.7	#	#	#	#	#	52000	1400	2.6

Bold and Shaded values are above direct exposure criteria for industrial/commercial scenario

Figure 6 - Lead in Deeper Soil

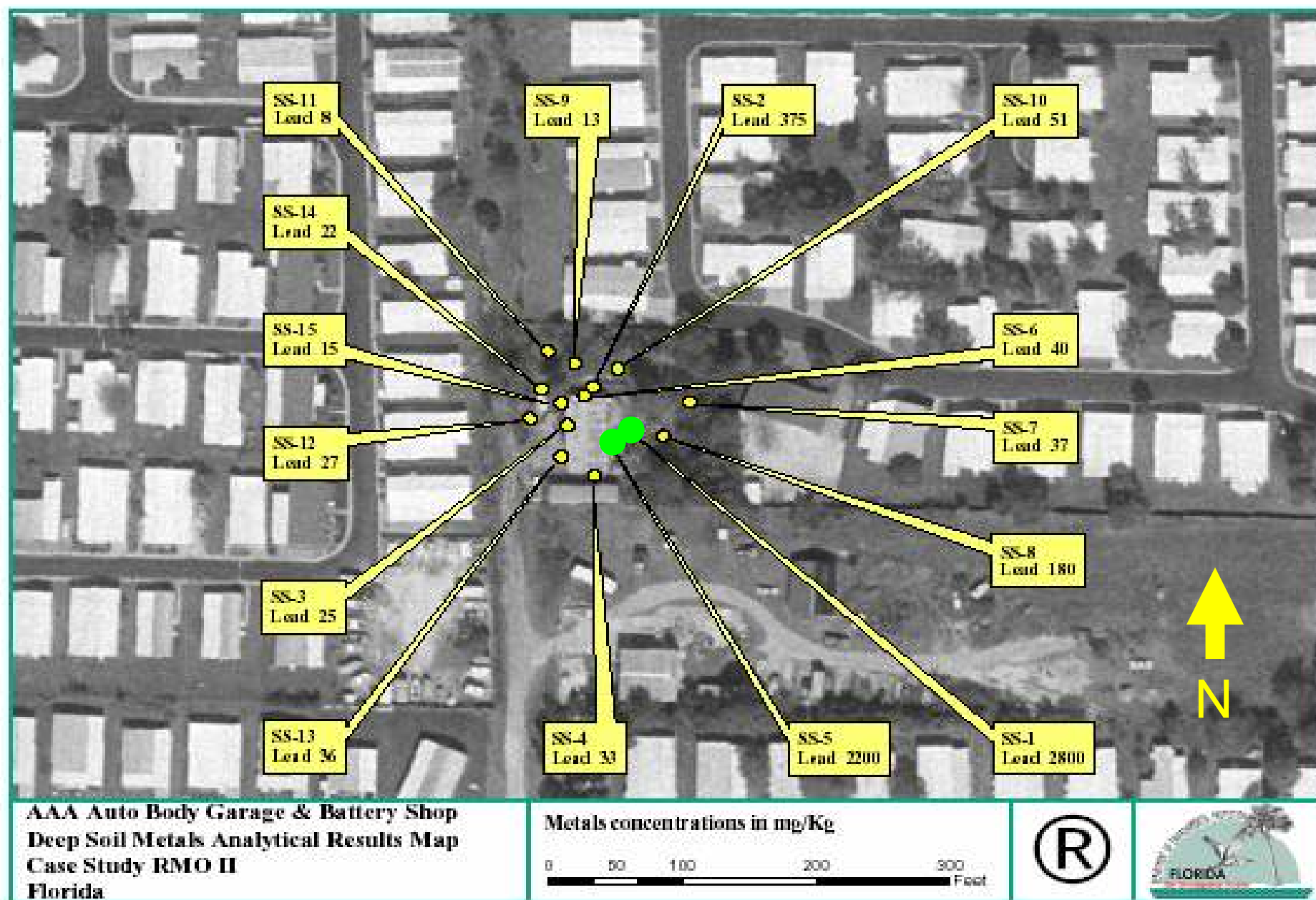


Table 3

Results for SPLP Analyses

Sample ID	Analysis Performed by EPA Method 1312	Result (ug/L)
SS-1	SPLP For Lead	155
SS-2	SPLP For Lead	42
SS-3	SPLP For Lead	3.2
SS-4	SPLP For Lead	BDL
SS-5	SPLP For Lead	130
SS-6	SPLP For Lead	4.9
SS-7	SPLP For Lead	BDL
SS-8	SPLP For Lead	16
SS-9	SPLP For Lead	BDL
SS-10	SPLP For Lead	3.7
SS-11	SPLP For Lead	BDL
SS-12	SPLP For Lead	BDL
SS-13	SPLP For Lead	3.8
SS-14	SPLP For Lead	BDL
SS-15	SPLP For Lead	BDL

Bold and Shaded values are above CTL

Figure 7 - Monitor Well Locations

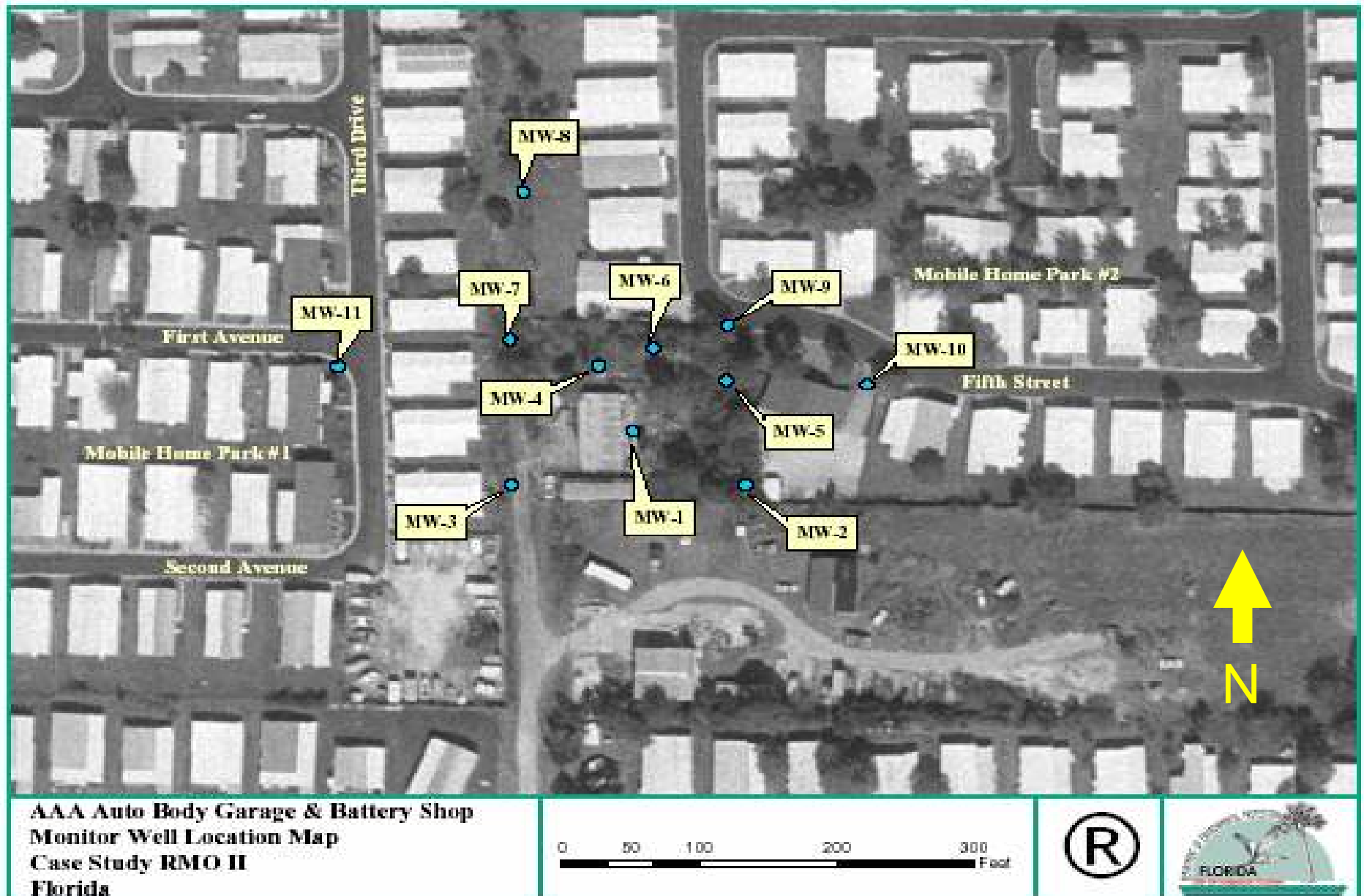


Figure 8 - Groundwater Flow Map

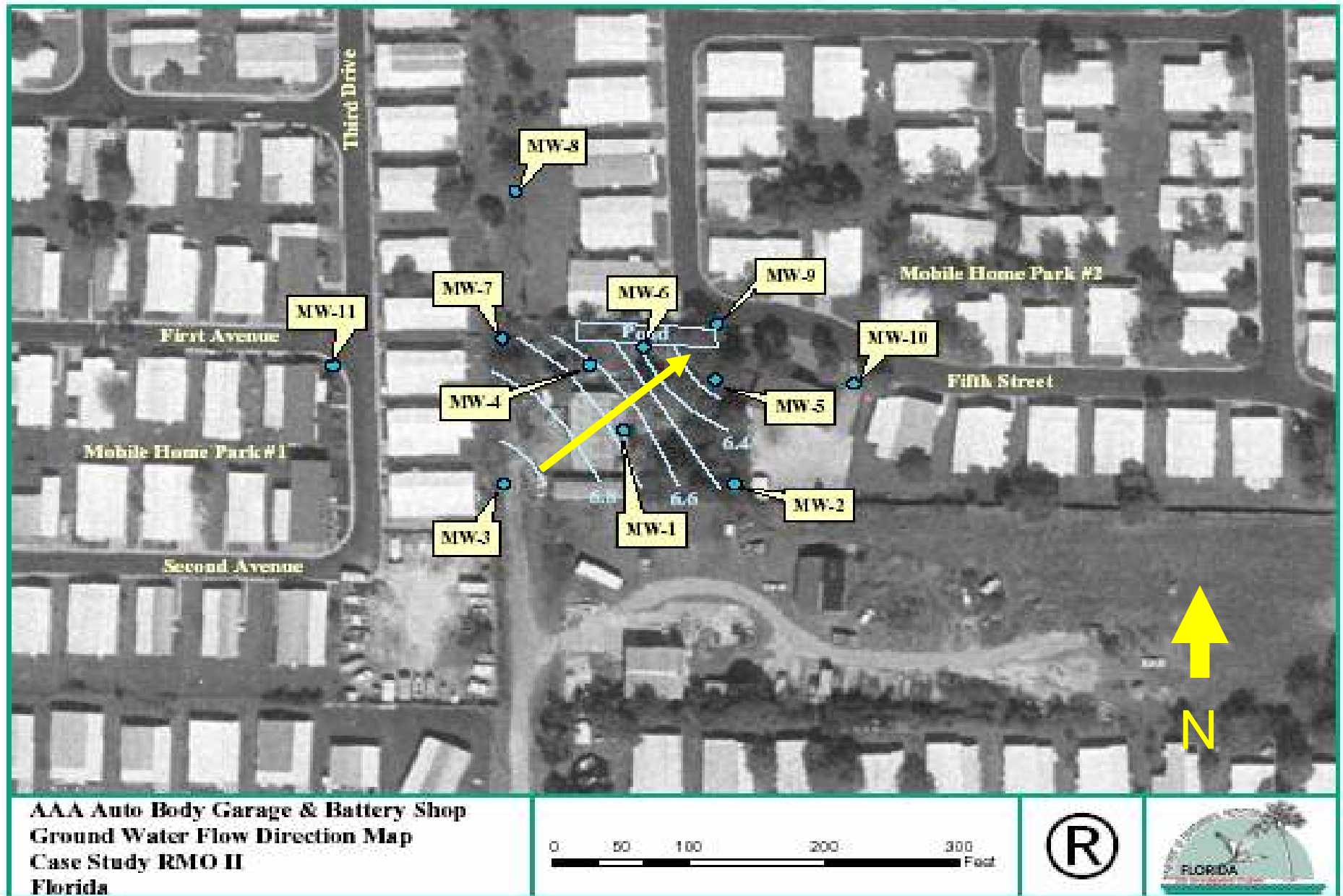
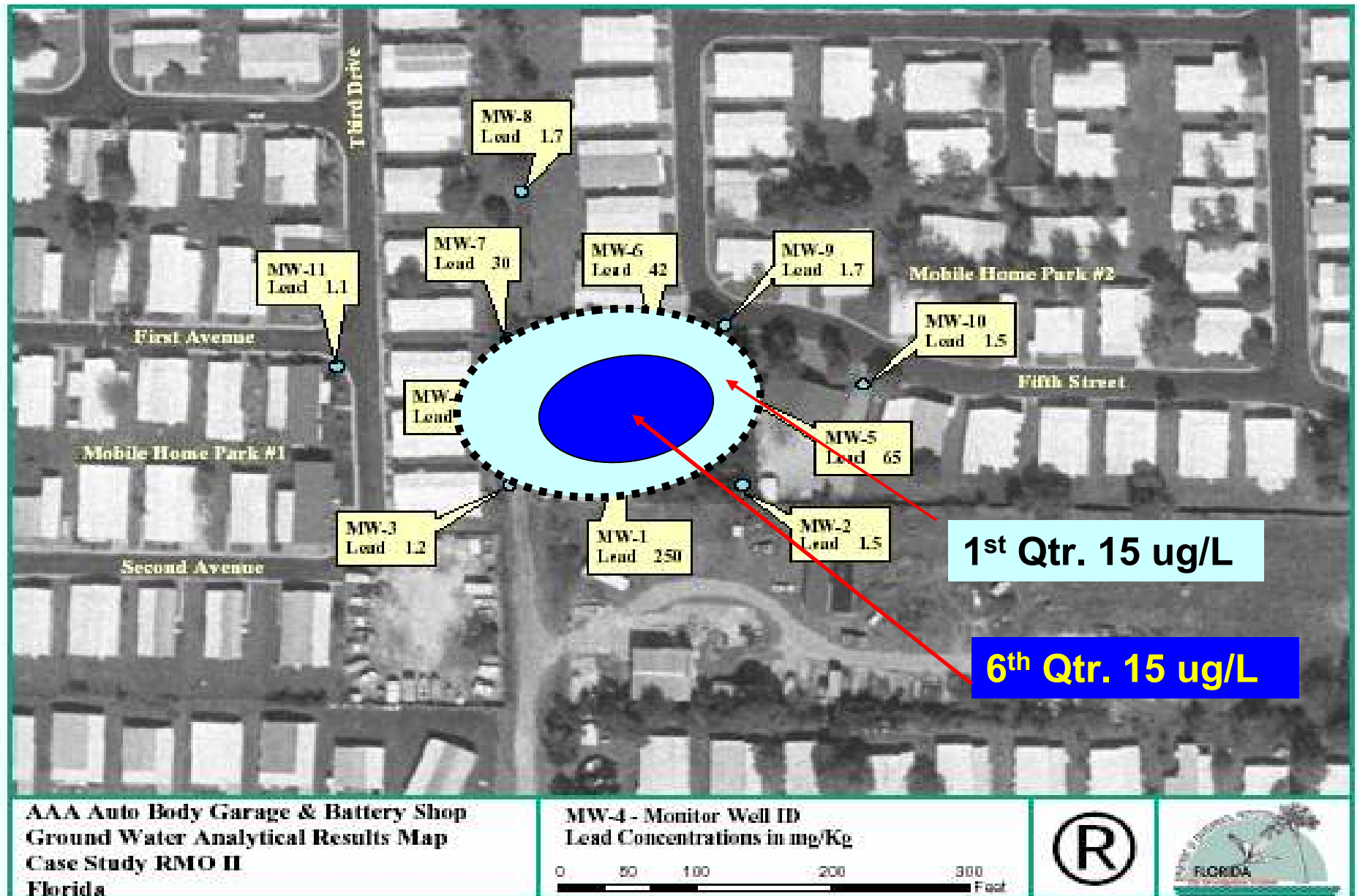


Table 4
Lead Detections In Monitor Well Samples

Sample ID	Analyte	Result (ug/L) 1 st Qtr. / 6 th Qtr.	GCTL (ug/L)
MW-1	Lead	250 200	15
MW-2	Lead	1.5	15
MW-3	Lead	1.2 < 1	15
MW-4	Lead	150 95	15
MW-5	Lead	65 22	15
MW-6	Lead	42 12	15
MW-7	Lead	30 8	15
MW-8	Lead	1.7	15
MW-9	Lead	1.7 < 1	15
ME-10	Lead	1.5	15
MW-11	Lead	1.1	15

Figure 9 - Lead in Groundwater



Where Are We in the Process?

- Extent of soil and groundwater contamination defined
- Soil Removal Action for PCBs completed
- Ready to perform data analysis



End of Part II



QUESTIONS ?

Part III-Data Analysis

- Can be the most challenging part of the RBCA process
- Point at which
 - ◆ All data is evaluated
 - ◆ Determine risks to human health / environment
 - ◆ Whether RMO strategy is viable
 - ◆ Where Technical Document is most needed
 - ◆ www.dep.state.fl.us/waste/quick_topics/rules

Carcinogenic PAHs TE-BaP

- PAHs
 - ◆ Chemically related compounds
 - ◆ Typically found as a mixture of related congeners
 - ◆ Some being carcinogenic
- To account for sum of additive toxic effects
 - ◆ Relative toxic potency of each congener is expressed as an equivalent (TE) to Benzo(a)pyrene
 - ◆ Total result for each sample is TE-BaP value
 - ◆ TE-BaP compared to applicable criteria
- TE-BaP calculator spreadsheet is available

TE-BaP Calculator Spreadsheet

Benzo(a)pyrene Conversion Table

Site Name: _____
 Location: _____
 Facility ID No.: _____

Soil Sample No. _____
 Sample Date _____
 Location: _____
 Depth (ft): _____

INSTRUCTIONS: Calculate Total Benzo(a)pyrene Equivalents only if at least one of the carcinogenic PAHs is detected in the sample at a concentration equal to or higher than the Method Detection Limit (MDL), whether quantified with certainty (the concentration reported has no qualifier) or estimated (the concentration reported has a "J" or "M" qualifier). Enter the contaminant concentrations (in mg/kg) for all seven carcinogenic PAHs in the yellow boxes using the following criteria: if quantified with certainty enter the reported value; if not detected at the MDL (the concentration reported is the MDL followed by the "U" qualifier) enter 1/2 of the reported value; if detected at a concentration lower than the MDL and the concentration is estimated (has the "T" qualifier) enter the estimated value; if detected at a concentration equal to or higher than the MDL but lower than the Practical Quantitation Limit (PQL) and the concentration is estimated (has the "I" qualifier) enter the estimated value; if detected at a concentration equal to or higher than the MDL but lower than the PQL and it is not estimated (the concentration reported is the PQL followed by the "M" qualifier) enter 1/2 of the reported value.

Contaminant	Concentration (mg/kg)	Toxic Equivalency Factor	Benzo(a)pyrene Equivalents
Benzo(a)pyrene		1.0	0.000
Benzo(a)anthracene		0.1	0.000
Benzo(b)fluoranthene		0.1	0.000
Benzo(k)fluoranthene		0.01	0.000
Chrysene		0.001	0.000
Dibenz(a,h)anthracene		1.0	0.000
Indeno(1,2,3-cd)pyrene		0.1	0.000

DE Residential SCTL = 0.1 mg/kg; Total Benzo(a)pyrene Equivalents = 0.0

The concentration shown does not exceed the Direct Exposure Residential SCTL.

Benzo(a)pyrene Conversion Table

Site Name: RMO II Case Study

Location: AAA Auto Body Site

Facility ID No.:

Soil Sample No. SS-1

Sample Date

Location:

Depth (ft): 0' - 0.5'

Contaminant	Concentration (mg/kg)	Toxic Equivalency Factor	Benzo(a)pyrene Equivalents
Benzo(a)pyrene	0.710	1.0	0.710
Benzo(a)anthracene	0.035	0.1	0.004
Benzo(b)fluoranthene	0.200	0.1	0.020
Benzo(k)fluoranthene	0.035	0.01	0.000
Chrysene	1.000	0.001	0.001
Dibenz(a,h)anthracene	0.035	1.0	0.035
Indeno(1,2,3-cd)pyrene	0.035	0.1	0.004

DE Comm./Ind. SCTL = 0.7 mg/kg; Total Benzo(a)pyrene Equivalents = 0.8

The concentration shown EXCEEDS the Direct Exposure Commercial/Industrial SCTL!

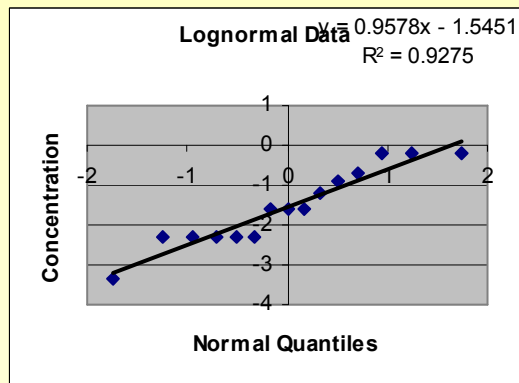
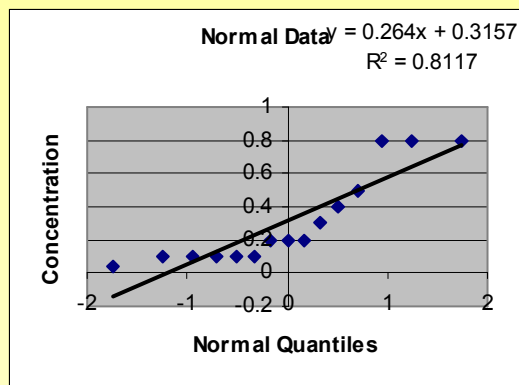
Benzo(a)pyrene Conversion Table

Site Name:	Case Study		
Location:	AAA Auto Body Site		
Facility ID No.:			
Soil Sample No.	SS-4		
Sample Date			
Location:			
Depth (ft):	0' - 0.5'		
Contaminant	Concentration (mg/kg)	Toxic Equivalency Factor	Benzo(a)pyrene Equivalents
Benzo(a)pyrene	0.035	1.0	0.035
Benzo(a)anthracene	0.035	0.1	0.004
Benzo(b)fluoranthene	0.080	0.1	0.008
Benzo(k)fluoranthene	0.035	0.01	0.000
Chrysene	0.035	0.001	0.000
Dibenz(a,h)anthracene	0.035	1.0	0.035
Indeno(1,2,3-cd)pyrene	0.035	0.1	0.004
DE Comm./Ind. SCTL = 0.7 mg/kg; Total Benzo(a)pyrene Equivalents =			0.1
The concentration shown does not exceed the Direct Exposure Commercial/Industrial SCTL.			

Table 5
TE-BaP Data for 95% UCL Calculation

Sample Location	TE-BaP Value (mg/kg)
SS-1	0.8
SS-2	0.4
SS-3	0.5
SS-4	0.1
SS-5	0.8
SS-6	0.3
SS-7	0.1
SS-8	0.1
SS-9	0.2
SS-10	0.2
SS-11	0.1
SS-12	0.2
SS-13	0.035
SS-14	0.1
SS-15	0.8

FL-UCL Data Distribution Best Fit



Shapiro-Francia Results (Adjust for Censoring)

SF for Normal Distribution	0.8117
SF for LogNormal Distribution	0.9275
Shapiro-Francia critical value for $p < 0.05$	NA

Test stat > critical value indicates a reasonable fit

Shapiro-Wilk's Test Results for All Data (BDL replaced with 1/2 DL)

SW test statistic for Normal Distribution	0.794
SW test statistic for LogNormal Distribution	0.918
Shapiro-Wilk's critical value for $p < 0.05$	0.881

Test stat > critical value indicates a reasonable fit

**Based on the results of the Shapiro-Wilk's test
Distribution is best described as: Lognormal**

Lognormal

Recommended 95% UCL

FDEP UCL Calculator Version 1.0

5/5/06

Summary Statistics for

Number of Samples	15
Number of Censored Data	0
Minimum	0.035
Maximum	0.8
Mean	0.315667
Median	0.2
Standard Deviation	0.279865
Variance	0.078325
Coefficient of Variation	0.886585
Skewness	1.018156

95% UCL (Assuming Normal Data)

Student's-t	0.44294
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95% UCL (Adjusted for Skewness)

Adjusted-CLT	0.454837
Modified-t	0.446106

95% Non-parametric UCL

CLT	0.434536
Jackknife	NA
Standard Bootstrap	0.433823
Bootstrap-t	0.557993
Chebyshev (Mean, Std)	0.630652

Summary Statistics for ln()

Minimum	-3.35241
Maximum	-0.22314
Mean	-1.5451
Standard Deviation	0.949737
Variance	0.902

Goodness-of-Fit Results

Distribution Recommended	Lognormal
Distribution Used	Lognormal

Estimates Assuming Lognormal Distribution

MLE Mean	0.334841
MLE Standard Deviation	0.405217
MLE Median	0.213291
MLE Coefficient of Variation	1.210176

MVUE Estimate of Mean	0.32155
MVUE Estimate of Std. Dev.	0.34087
MVUE Estimate of SE	0.085656
MVUE Coefficient of Variation	1.060083

UCL Assuming Lognormal Distribution

95% H-UCL	0.675709
95% Chebyshev (MVUE) UCL	0.694916
99% Chebyshev (MVUE) UCL	1.173817

FDEP Recommended UCL to Use:

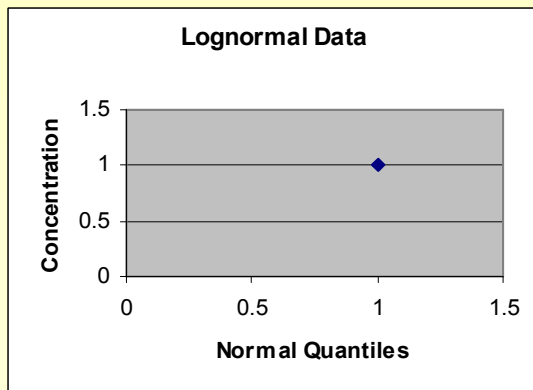
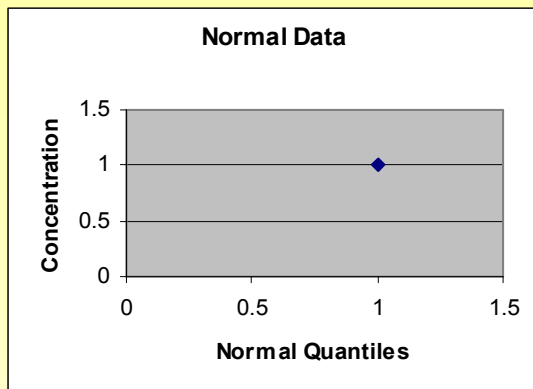
0.675709

Lead in Shallow Soil

Sample # Lead (mg/Kg)	
SS-1	7520
SS-2	850
SS-3	35
SS-4	41
SS-5	8400
SS-6	120
SS-7	81
SS-8	675
SS-9	28
SS-10	77
SS-11	82
SS-12	50
SS-13	33
SS-14	71
SS-15	63

FDEP UCL Calculator Version 1.0

Goodness-of-fit test results



Shapiro-Francia Results (Adjust for Censoring)

SF for Normal Distribution	0.4655
SF for LogNormal Distribution	0.7845
Shapiro-Francia critical value for $p < 0.05$	NA

Test stat > critical value indicates a reasonable fit

Shapiro-Wilk's Test Results for All Data (BDL replaced with 1/2 DL)

SW test statistic for Normal Distribution	0.476
SW test statistic for LogNormal Distribution	0.778
Shapiro-Wilk's critical value for $p < 0.05$	0.881

Test stat > critical value indicates a reasonable fit

**Based on the results of the Shapiro-Wilk's test
Distribution is best described as: Neither**

Neither

95% UCL for Lead

FDEP UCL Calculator Version 1.0

5/5/06

Summary Statistics for

Number of Samples	15
Number of Censored Data	0
Minimum	28
Maximum	8400
Mean	1208.4
Median	77
Standard Deviation	2757.263
Variance	7602498
Coefficient of Variation	2.281747
Skewness	2.384889

95% UCL (Assuming Normal Data)

Student's-t	2462.315
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95% UCL (Adjusted for Skewness)

Adjusted-CLT	2848.002
Modified-t	2535.379

95% Non-parametric UCL

CLT	2379.512
Jackknife	NA
Standard Bootstrap	2457.656
Bootstrap-t	12775.74
Chebyshev (Mean, Std)	4311.669

Summary Statistics for ln()

Minimum	3.332205
Maximum	9.035987
Mean	5.037946
Standard Deviation	1.879511
Variance	3.532562

Goodness-of-Fit Results

Distribution Recommended	Neither
Distribution Used	Neither

Estimates Assuming Lognormal Distribut

MLE Mean	901.6508
MLE Standard Deviation	5196.162
MLE Median	154.1531
MLE Coefficient of Variation	5.762943

MVUE Estimate of Mean	698.105
MVUE Estimate of Std. Dev.	1892.452
MVUE Estimate of SE	390.2051
MVUE Coefficient of Variation	2.710842

UCL Assuming Lognormal Distribution

95% H-UCL	8616.09
95% Chebyshev (MVUE) UCL	2398.97
99% Chebyshev (MVUE) UCL	4580.606

FDEP Recommended UCL to Use:

4311.669

Apportionment Exceptions

NOT FOR:

- SCTL based on natural background concentration or PQL
- SCTL based on acute toxicity
- Lead SCTLs
- Chemical detected $\leq 1/10^{\text{th}}$ SCTL
- Contaminants detected infrequently

Table 6
Apportionment Table

Contaminants	Target Organs/Effects	Max Conc./ 95% UCL	SCTL(mg/kg) Commercial / Industrial	Apport. SCTL Y/N?	Apportionment Rational*
Benzo(a)pyrene- (TE-BaP)	Carcinogen	0.8 / 0.68	0.7	No	Only Carcinogen
Benzo(g,h,i) perylene	Neurological	0.13	52,000	No	Level < 1/10 SCTL and Infrequent
Lead	Neurological	8400	1400	No	Not Applicable to Lead
PCBs (Removed)	Immunological / Carcinogen	75	2.6	No	Removal to < 1/10 SCTL

End of Part III



Questions ?

Strategy for NFA w/Controls

- **Groundwater Contamination**
 - ◆ Deed restriction for onsite well construction, and AGCTL = 200 ug/L
 - ◆ Plume
 - < ¼ acre
 - Entirely on-site;
 - Stable or shrinking (1 yr. monitoring)
 - ◆ SPLP lead results < alternative CTL

Strategy for NFA w/Controls

- Soil Contamination
 - ◆ Deed restriction
 - Commercial / industrial land use
 - EC features are maintained
 - ◆ Lead
 - > commercial/industrial SCTL and leachability
 - Capped- engineering control
 - ◆ PAHs
 - > SCTL
 - 95% UCL is < SCTL
 - No action
 - ◆ PCBs in soil > 1/10th SCTL removed

SRCO for RMO II Case Study



SRCO

May 22, 2006

- **CERTIFIED MAIL**
- **RETURN RECEIPT REQUESTED**
- Mr. John Doe
- 123 Memory Lane
- Gatorville, FL 43675
- Subject: **Conditional Site Rehabilitation Completion Order (SRCO)**
- AAA Auto Body Garage and Battery Shop
- 45 Old Oak Street, Gatorville, Florida 43675
- Voluntary Cleanup Agreement OGC # XX-XXXX-XX-XX
- Dear Mr. Doe:
- The North District has reviewed the Conditional No Further Action (NFA) Proposal, dated July 4, 2005, prepared by R2D2 Consulting, Inc. for the AAA Auto Body Garage and Battery Shop, located at 45 Old Oak Street, Gatorville, Florida. Maps showing the location of the AAA Auto Body Garage and Battery Shop and the location of the “contaminated site” (i.e., contaminant plume) for which this Order is being issued are attached as Exhibits 1 and 2.