

Global RBCA Training

Risk Based Corrective Action RMOs I, II & III

Presented by

Florida Department of Environmental Protection
Division of Waste Management

Basics

 Please keep in mind:

- We are not certified instructors or “seasoned” teachers.
- We are not trying to make you experts.
- Technical Report: Development of Cleanup Target Levels for Chapter 62-777, F.A.C.

Global RBCA Training

RMOs I, II & III

- Key Concepts:

- 95% UCL, Additivity & Apportionment
- Progression through Risk Management Option Levels
- Conditional Site Rehabilitation Completion Order



Definitions of Key Concepts

• **UCL** [62-780.200(51)]

- 95% Upper Confidence Limit of the mean.

• **Additive effect** [62-780.200(2)]

- A scientific principle that the toxicity that occurs as a result of exposure is the sum of the toxicities of the individual chemicals to which an individual is exposed.

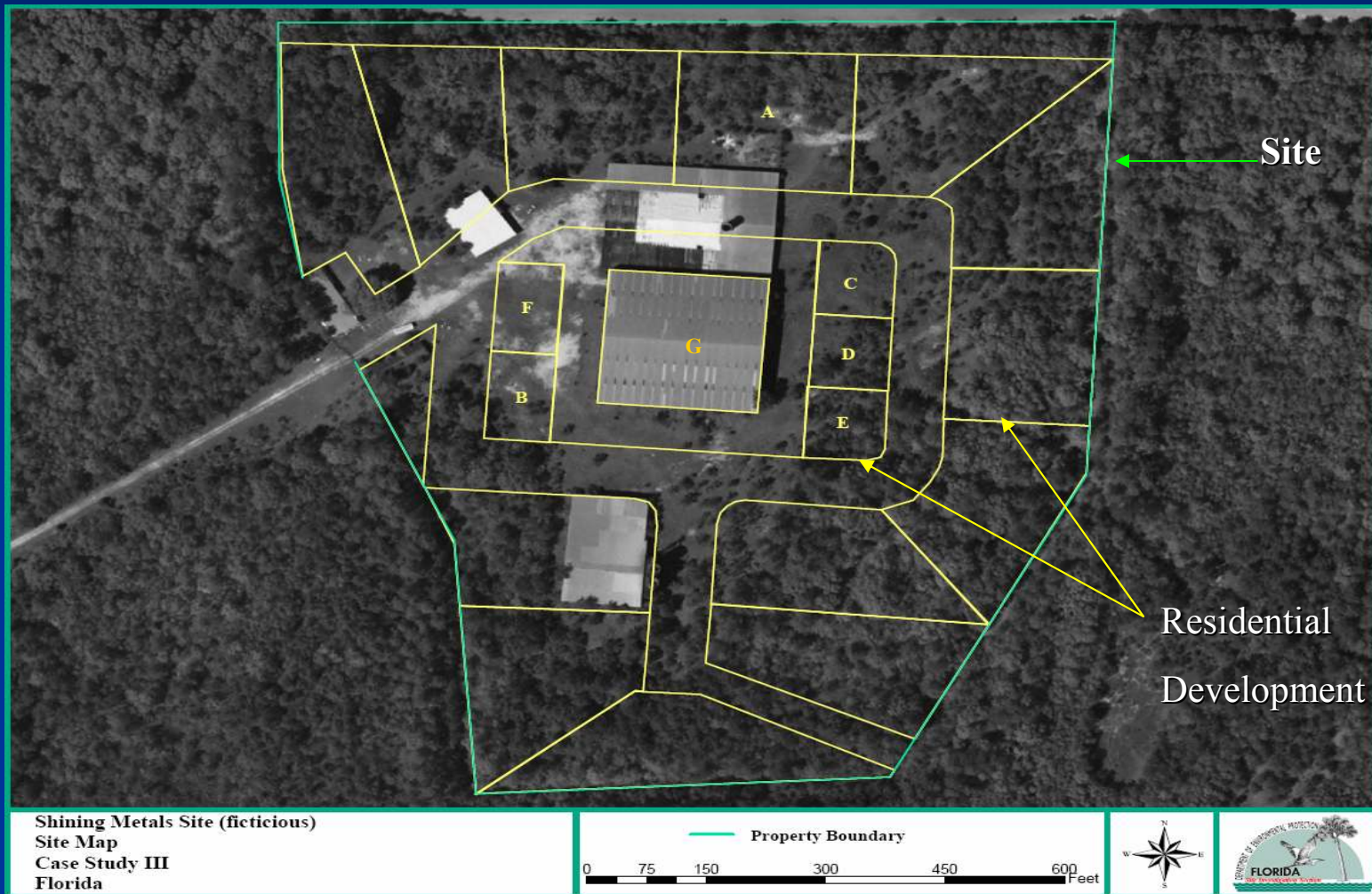
Definitions of Concepts

● **Apportionment** [62-780.200(4)]

- Cleanup Target Levels are adjusted such that:

Chemical Class	Risk
• Non-carcinogens (with the same target organs, systems or effects)	• Hazard Index is 1 or less (Hazard Index = sum of the hazard quotients)
• Carcinogens	• Cumulative lifetime excess cancer risk level is 1.0E-6

Study Area: Shining Metals Site



Definitions

● **Exposure Unit** [62-780.200(20)]

- An area over which receptors are expected to have equal and random exposure.

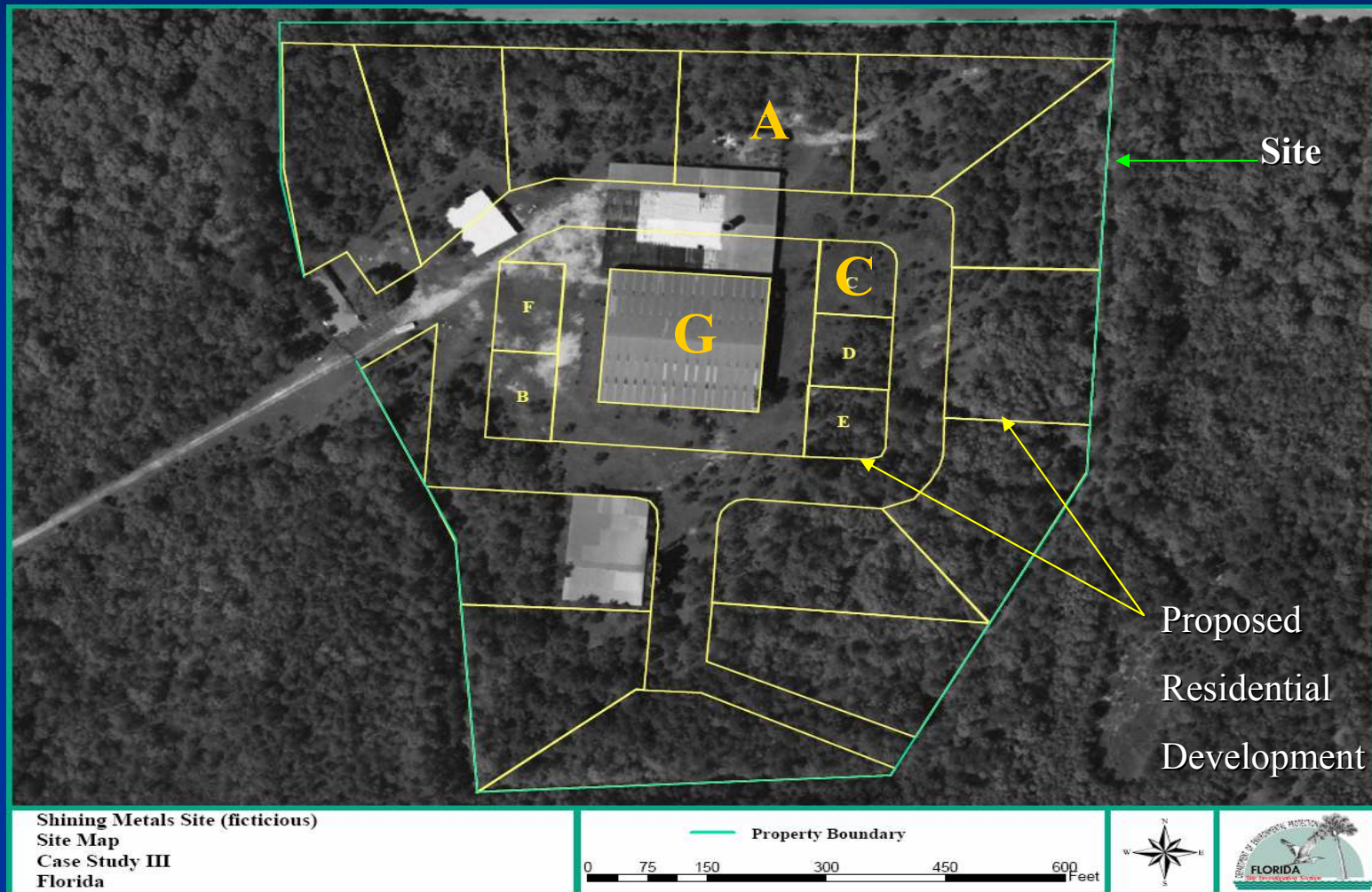
RISK ASSESSMENT



Risk Assessment Principle

- Risk = Toxicity x Exposure
 - Toxicity: Relatively fixed
 - Exposure: Can be managed
- Evaluating routes of exposure is at the heart of Risk Based Corrective Action.

Shining Metals Site



Risk Based Corrective Action

RMOs I, II & III

Specific Strategies

- 95% UCL without conditions
- 95% UCL with conditions
 - Residential SCTLs but increased lot size
- Engineering Controls (with Institutional Controls) to prevent direct exposure to soil

Site Cleanup Strategy

- Groundwater:

- RMO 2

- Poor quality aquifer

Poor Quality Aquifer

- **Poor Quality** [subsection 62-780.200(35), F.A.C.]

- Groundwater within the affected monitoring zone with background concentrations, as defined in subsection 62-780.200(5), F.A.C. that exceeds any of Florida's Primary or Secondary Drinking Water Standards referenced in Chapter 62-550, F.A.C.

Poor Quality Aquifer

• Risk Management Option Level 2 [62-780.680(2)(c)1.]

- For contamination of groundwater of low yield or **poor quality**, the CTLs specified in Chapter 62-777, Table 1 shall apply to groundwater within the property boundaries.
 - Requires a minimum of one (1) year of groundwater monitoring data.
 - Data must show that contaminant concentrations at the property boundaries do not, and will not, exceed the appropriate groundwater CTLs, as specified in 62-777, F.A.C., Table I.
 - Data must show that the plume has not affected, and will not affect, a freshwater or marine surface water body as specified in 62-777, F.A.C., Table I.

Groundwater

RMO Level II Criteria provided for each medium:

Groundwater

Options IIA

COCs $\leq$ GW of low yield/poor quality CTLs (Table I), provided the following criteria are met:

1. Aquifer is of low yield, or poor quality,
2. No actual impact or potential impact to surface water (the more stringent of GW or FSW Level I CTLs, and
3. Demonstration (minimum 1 year of GW monitoring) that contaminant concentrations in GW at the property boundaries will not exceed the applicable Level I CTLs

Options IIB

COCs $>$ Applicable CTLs provided engineering controls such as a permanent containment (e.g., slurry wall) are used to prevent off-site contaminant migration (minimum 1 year of GW monitoring) and no impact or potential impact to surface water (the more stringent of GW, FSW, or MSW Level I CTLs)

Options IIC

COCs $>$ GW or FSW CTLs (Table I), and COCs $\leq$ MSW CTLs (Table I) provided: contamination is affecting or may potentially affect only a MSW body, and there are no other properties or FSW bodies located between the source property and the MSW body

Options IID

COCs $>$ Applicable groundwater CTLs, provided the following are met:

1. Demonstration (historical data or modeling results) that contaminant concentrations in GW at the property boundaries will not exceed the applicable Level I CTLs,
2. Contamination is limited to the source area (contamination $<$ 1/4 acre) and is not migrating from the localized source area (minimum 1 year of GW monitoring), and
3. No impact or potential impact to on-site FSW or MSW (the more stringent of GW, FSW, or MSW Level I CTLs)

Site Cleanup Strategy

• Soil:

• RMO 1

- using 95%UCL and comparing to apportioned residential SCTLs
- 1/4 acre residential parcel (exposure unit C)

• RMO 2

- engineering controls (leaving existing building on site as a cap to eliminate direct exposure to contaminated soil)
- institutional controls (restrictive covenant for existing building to ensure that the “cover” maintains integrity)

• RMO 3

- using 95%UCL and comparing to apportioned residential SCTLs
- institutional controls (restrictive covenant for residential exposure unit A, which is larger than 1/4 acre, to ensure the exposure unit is not subdivided in the future).

Site Cleanup Strategy

• Soil:

• RMO 1 (Exposure Unit C)

- using 95%UCL and comparing to apportioned residential SCTLs
- 1/4 acre residential parcel (default residential parcel size)

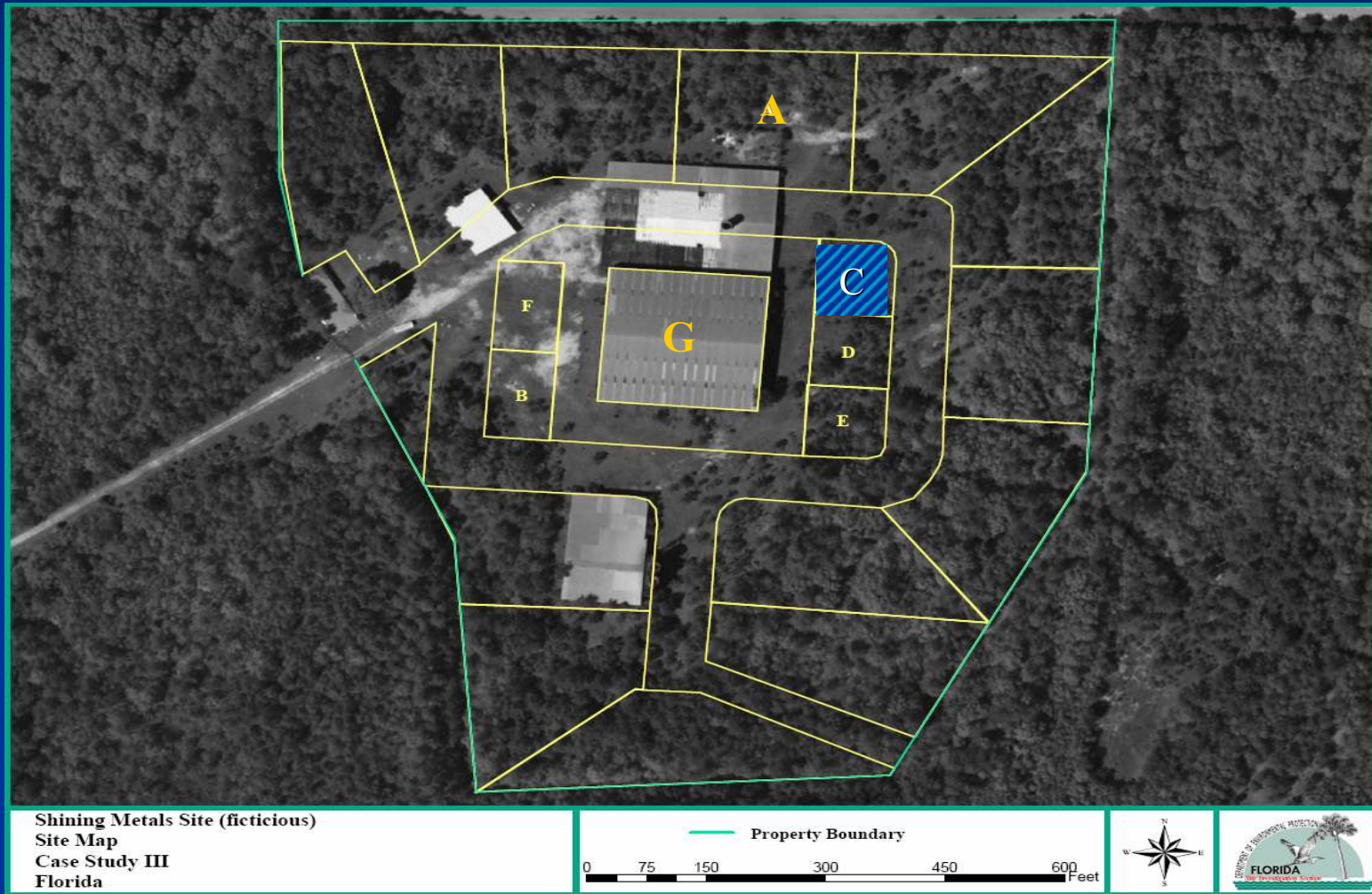
• RMO 2

- engineering controls (leaving existing building on site as a cap to eliminate direct exposure to contaminated soil)
- institutional controls (restrictive covenant for existing building to ensure that the “cover” maintains integrity)

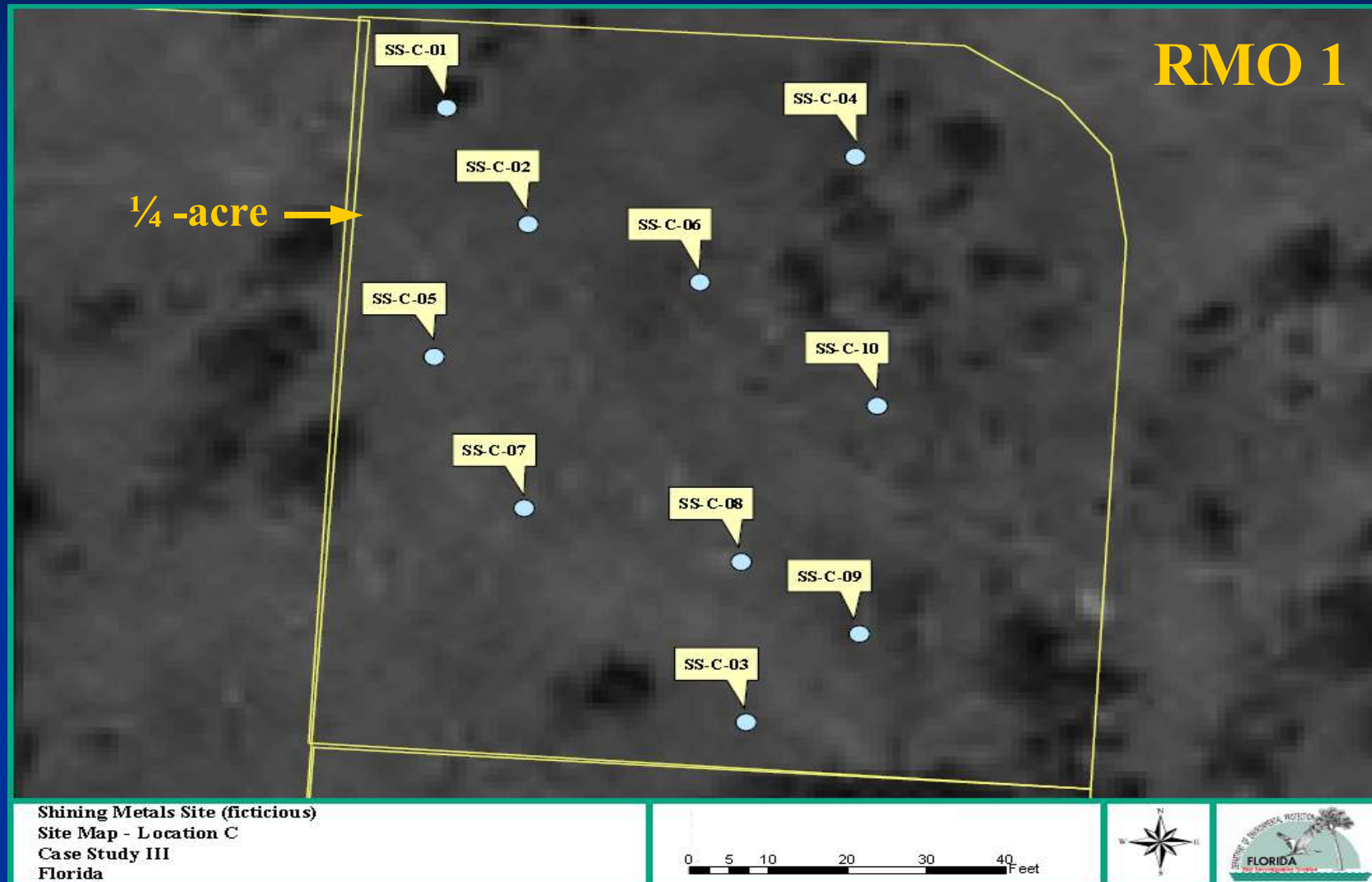
• RMO 3

- using 95%UCL and comparing to apportioned residential SCTLs
- institutional controls (restrictive covenant for residential exposure unit A, which is larger than 1/4 acre, to ensure the exposure unit is not subdivided in the future).

Shining Metals Site - RMO 1



Soil Sample Locations – Exposure Unit C



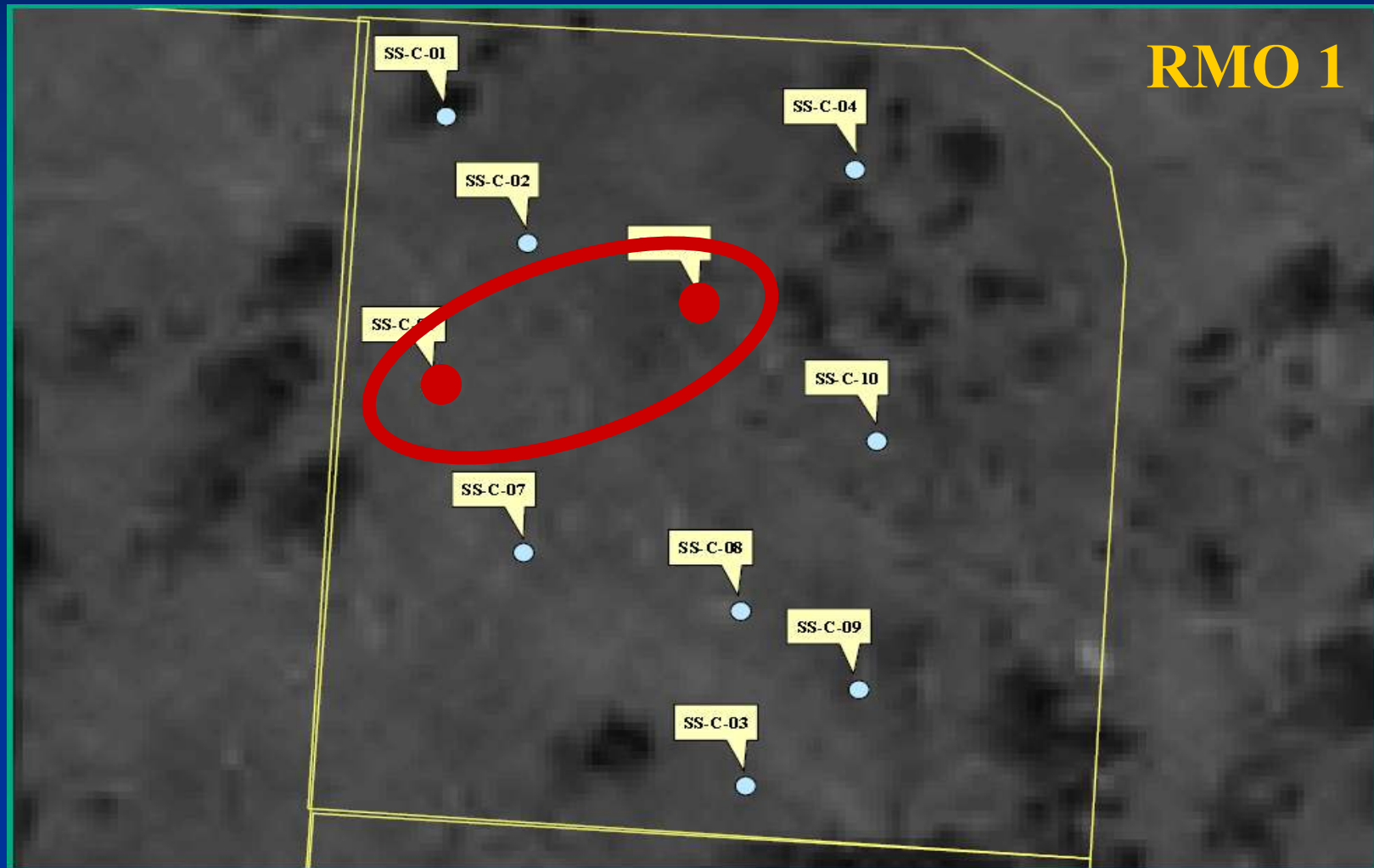
Arsenic Analytical Data

Exposure Unit C

Sample #	Sampling Depth					
	0" - 6"		6" - 1'		1' - 2'	
SS-1	1.04		0.91	U	0.91	U
SS-2	1.42		1.13		0.91	U
SS-3	0.91	U	0.91	U	0.91	U
SS-4	0.91	U	0.91	U	0.91	U
SS-5	2.20		1.52		0.91	U
SS-6	2.32		1.67		0.91	U
SS-7	0.91	U	0.91	U	0.91	U
SS-8	0.70	J	0.70	J	0.70	J
SS-9	0.91	U	0.91	U	0.91	U
SS-10	0.70	J	0.70	J	0.70	J

All concentrations are in mg/kg

Soil Sample Locations – Exposure Unit C



95% UCL

Primary Concept

Upper Confidence Limit (UCL)

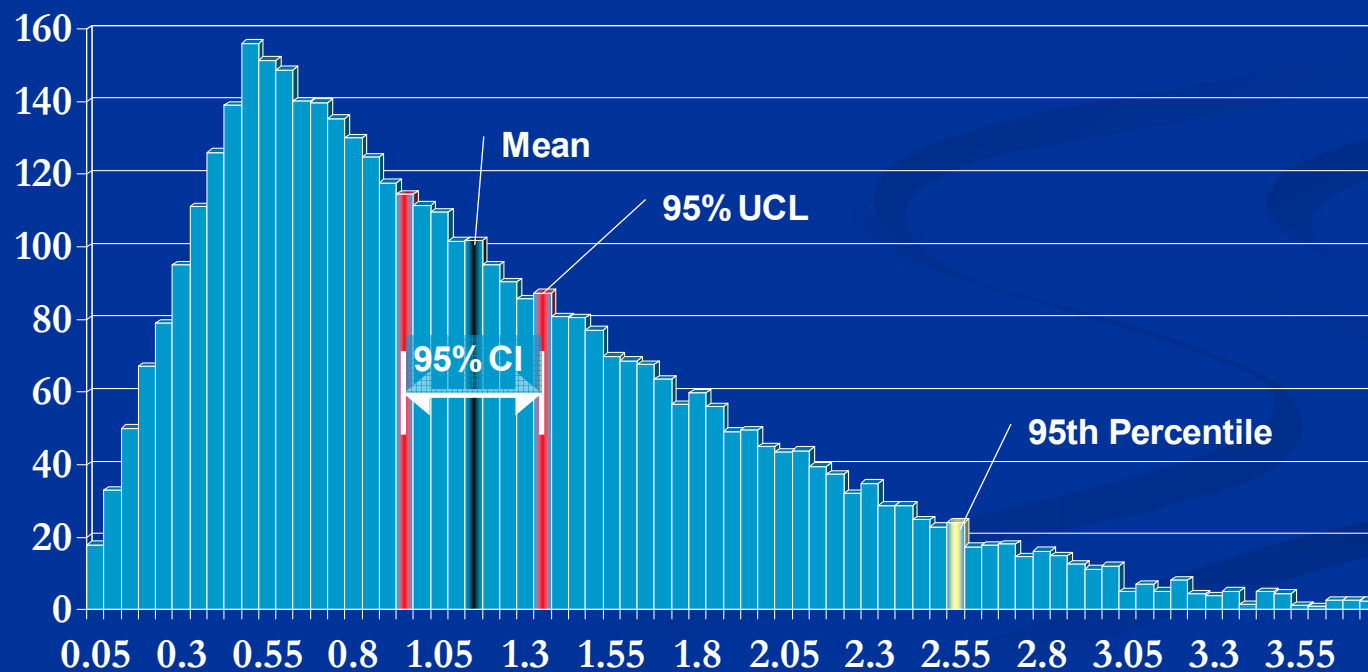
A conservative expression of the mean concentration.

CONCEPT

An individual is exposed to an area of contamination rather than soils in one specific sampling location. The 95% UCL determines the mean concentration from a set of randomly located samples. This is the best representation of the contaminant concentration within an exposure unit that a person could be exposed to.

What is the 95% UCL?

- Estimate of the long term exposure at a site
 - 95% Upper confidence limit of the mean
 - A value that exceeds the true mean 95% of the time
 - A conservative estimate of the average concentration



Exposure Point Concentration (EPC)

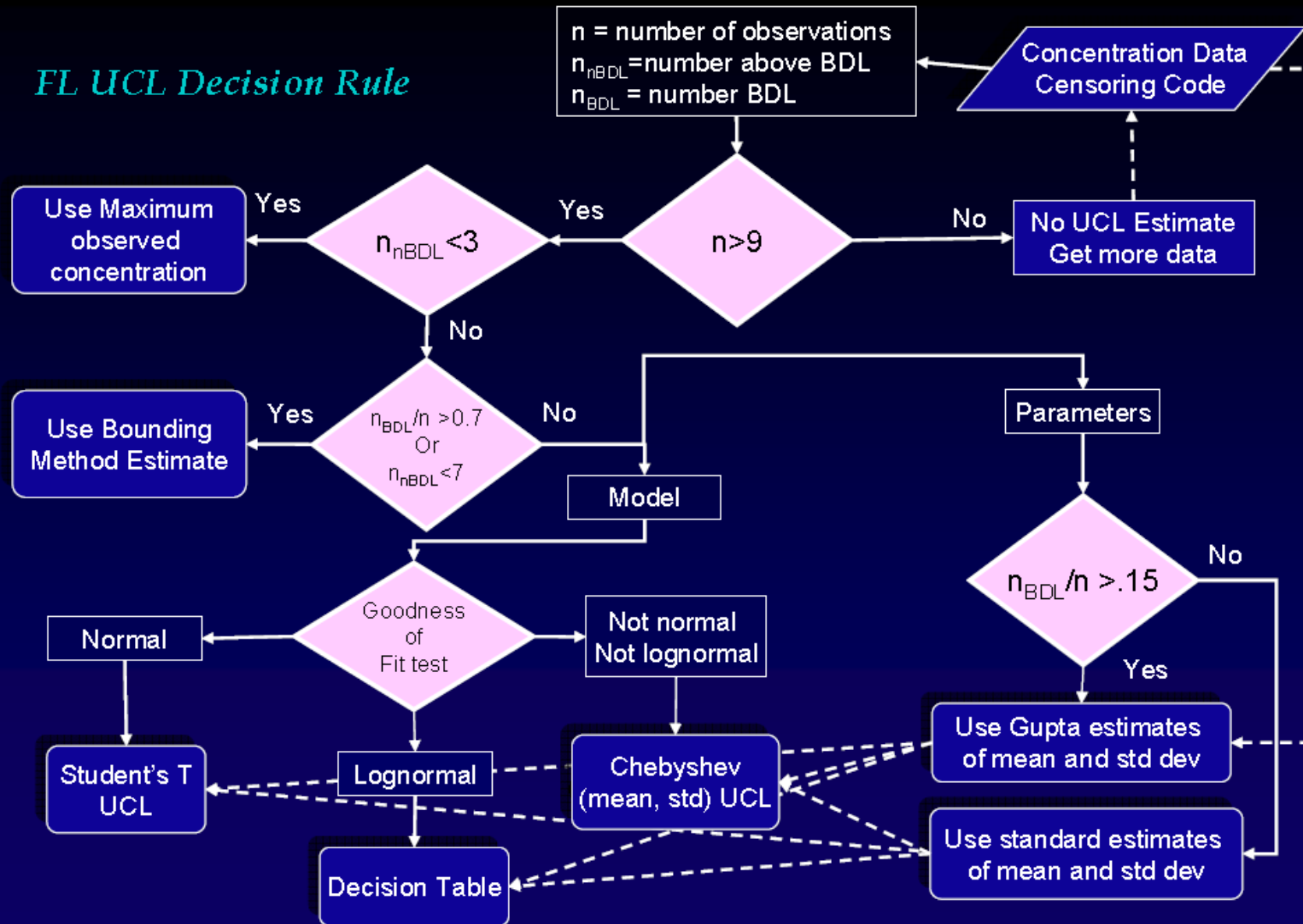
- For this Case Study the EPC will be represented by the 95% UCL result.
- There are situations where the EPC will become the maximum contamination detected within the Exposure Unit

So how do we calculate the 95% UCL?

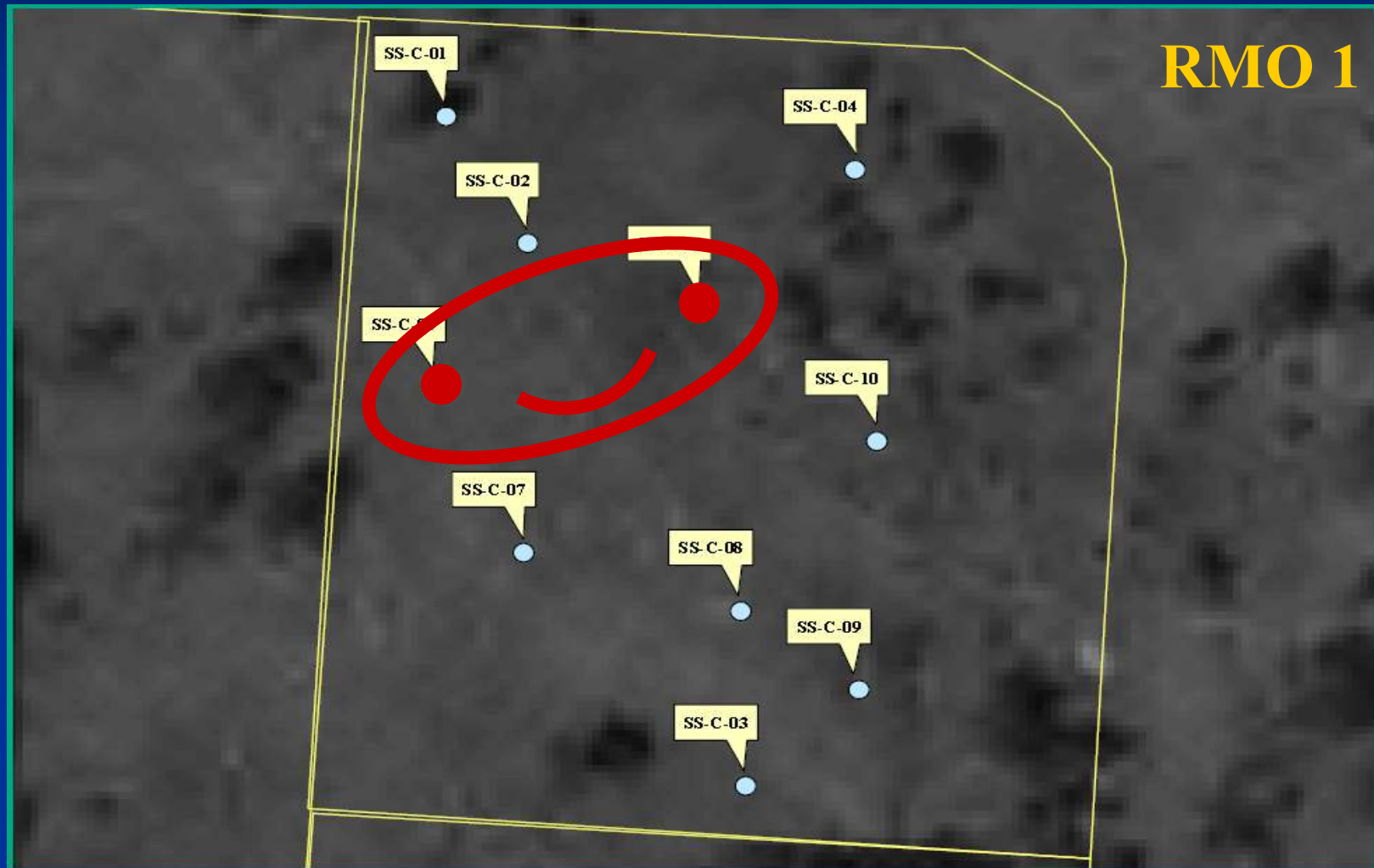
Calculating 95% UCLs with the Florida UCL Calculator (FLUCL)

<http://www.dep.state.fl.us/waste/categories/wc/default.htm>

FL UCL Decision Rule



Soil Sample Locations – Exposure Unit C



Satisfying the SCTL

• The SCTL has been satisfied when:

- The EPC (95% UCL) does not exceed the default SCTL.

and

95% UCL = 2.10

SCTL = 2.10

- The maximum concentration for a chemical remaining on site does not exceed 3 times the default SCTL.

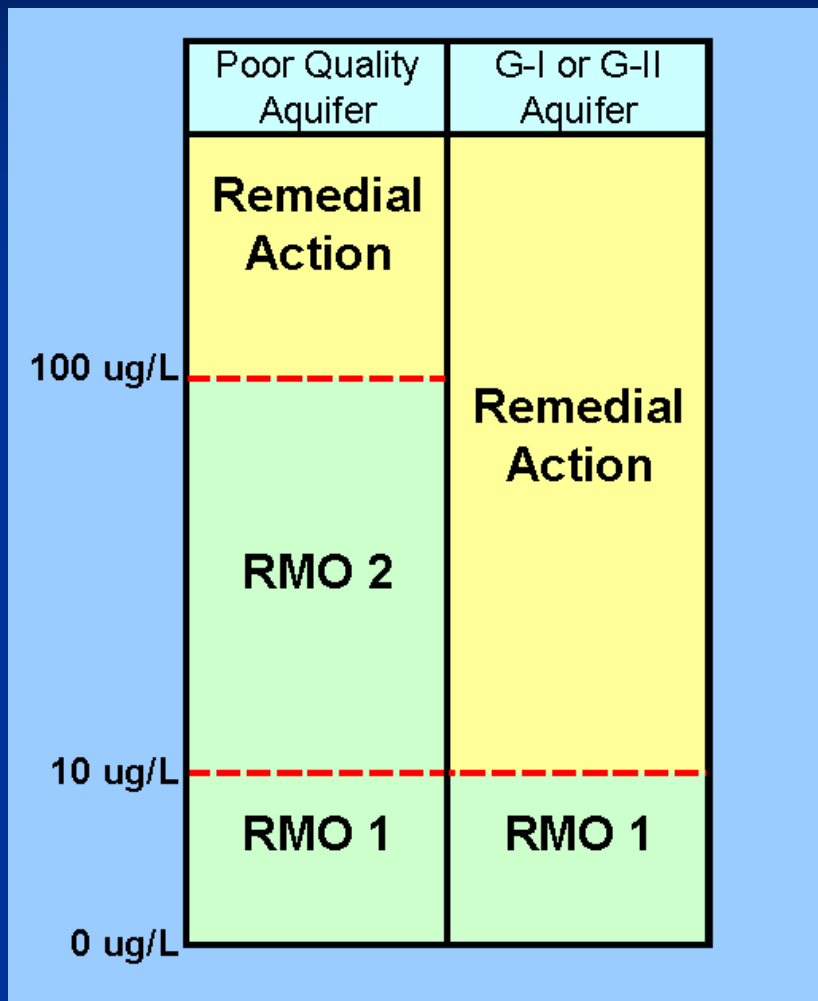
and

Maximum detected = 2.32

3 times SCTL = 6.30

- Soil concentrations remaining on site do not exceed the leachability SCTL.

Arsenic SPLP Results



Poor Quality Aquifer

• Risk Management Option Level 2 [62-780.680(2)(c)1.]

- For contamination of groundwater of low yield or **poor quality**, the CTLs specified in Chapter 62-777, Table 1 shall apply to groundwater within the property boundaries.
 - Requires a minimum of one (1) year of groundwater monitoring data.
 - Data must show that contaminant concentrations at the property boundaries do not, and will not, exceed the appropriate groundwater CTLs, as specified in 62-777, F.A.C., Table I.
 - Data must show that the plume has not affected, and will not affect, a freshwater or marine surface water body as specified in 62-777, F.A.C., Table I.

Site Cleanup Strategy

• Soil:

• RMO 1

- using 95%UCL and comparing to apportioned residential SCTLs
- 1/4 acre residential parcel (exposure unit C)

• RMO 2

- engineering controls (leaving existing building on site as a cap to eliminate direct exposure to contaminated soil)
- institutional controls (restrictive covenant for existing building to ensure that the “cover” maintains integrity)

• RMO 3

- using 95%UCL and comparing to apportioned residential SCTLs
- institutional controls (restrictive covenant for residential exposure unit A, which is larger than 1/4 acre, to ensure the exposure unit is not subdivided in the future).

Exposure Unit C

RMO Level I Criteria provided for each medium:

Soil

Human Health/Direct Exposure

Note: The 95% UCL may be used for comparison to the CTLs provided the CTLs are apportioned.

Options IA

1. COCs $\leq$ Residential CTLs (Table II),
2. 95% UCL of the COCs $<$ Apportioned residential CTLs,
3. COCs $\leq$ Background, or
4. COCs $\leq$ Best achievable detection limits

Option IB

COCs $\leq$ Apportioned alternative residential CTLs calculated using site-specific soil properties (Figs. 4-7 and Table VI)

Option IC

TRPH levels $\leq$ Residential CTLs for the TRPH

Exposure Unit C

Groundwater

Options **IA**

1. COCs $\leq$ Applicable default CTLs: GW and, if applicable, FSW or MSW from Table I (applicability based on the impact or potential impact to FSW or MSW),
2. COCs $\leq$ Background, or
3. COCs $\leq$ Best achievable detection limits

Exposure Unit C

RMO Level II Criteria provided for each medium:

Groundwater

Options IIA

COCs $\leq$ GW of low yield/poor quality CTLs (Table I), provided the following criteria are met:

1. Aquifer is of low yield, or poor quality,
2. No actual impact or potential impact to surface water (the more stringent of GW or FSW Level I CTLs, and
3. Demonstration (minimum 1 year of GW monitoring) that contaminant concentrations in GW at the property boundaries will not exceed the applicable Level I CTLs

Options IIB

COCs > Applicable CTLs provided engineering controls such as a permanent containment (e.g., slurry wall) are used to prevent off-site contaminant migration (minimum 1 year of GW monitoring) and no impact or potential impact to surface water (the more stringent of GW, FSW, or MSW Level I CTLs)

Options IIC

COCs > GW or FSW CTLs (Table I), and COCs $\leq$ MSW CTLs (Table I) provided: contamination is affecting or may potentially affect only a MSWbody, and there are no other properties or FSW bodies located between the source property and the MSWbody

Options IID

COCs > Applicable groundwater CTLs, provided the following are met:

1. Demonstration (historical data or modeling results) that contaminant concentrations in GW at the property boundaries will not exceed the applicable Level I CTLs,
2. Contamination is limited to the source area (contamination < 1/4 acre) and is not migrating from the localized source area (minimum 1 year of GW monitoring), and
3. No impact or potential impact to on-site FSW or MSW (the more stringent of GW, FSW, or MSW Level I CTLs)

Questions



Risk Management

Option Level 2

Site Cleanup Strategy

• Soil:

• RMO 1

- using 95%UCL and comparing to apportioned residential SCTLs
- 1/4 acre residential parcel (exposure unit C)

• RMO 2 (Exposure Unit G)

- engineering controls (leaving existing building on site as a “cap” to eliminate direct exposure to contaminated soil)
- institutional controls (restrictive covenant for existing building to ensure maintaining the integrity of the cap)

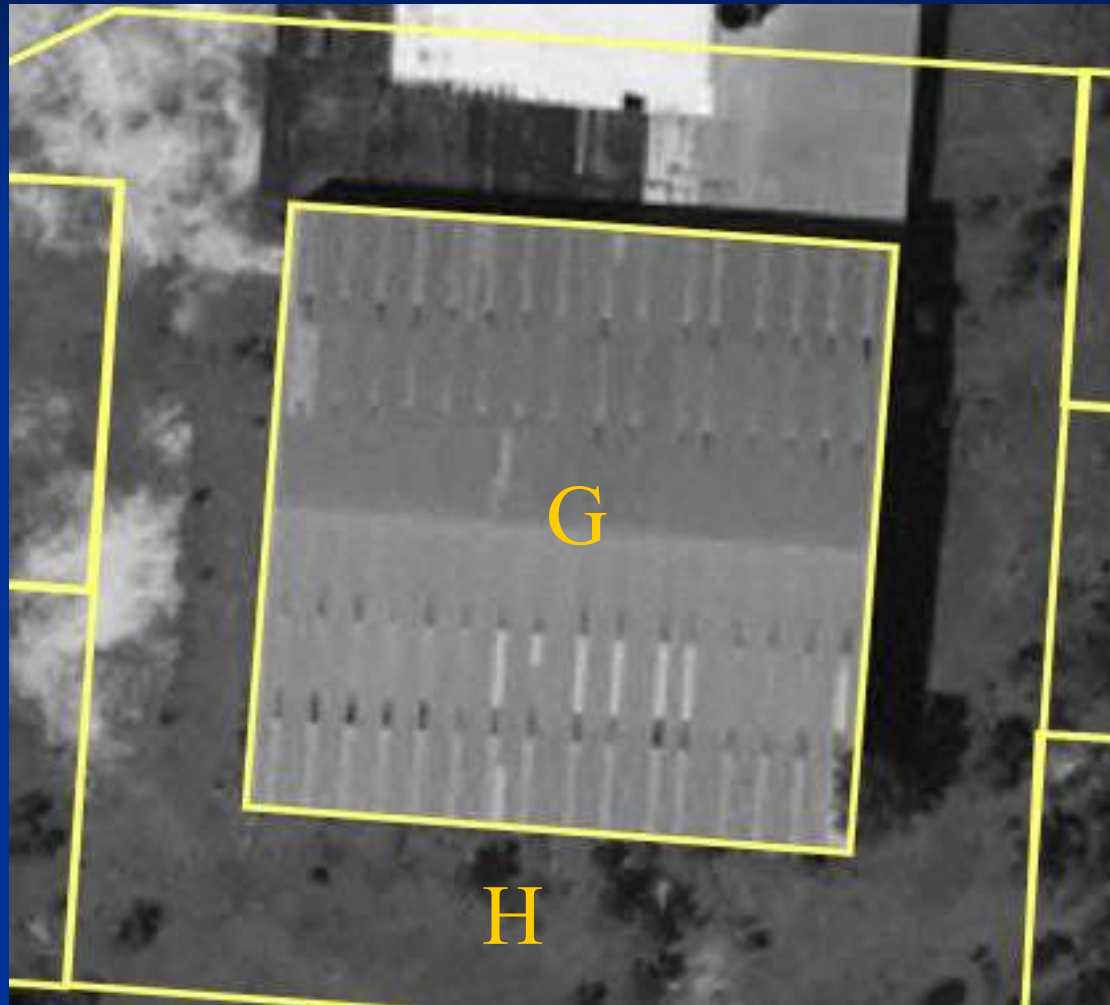
• RMO 3

- using 95%UCL and comparing to apportioned residential SCTLs
- institutional controls (restrictive covenant for residential exposure unit A, which is larger than 1/4 acre, to ensure the exposure unit is not subdivided in the future)

Shining Metals Site – RMO 2



Exposure Unit G – RMO 2



Exposure Unit G

RMO Level II Criteria provided for each medium:

Soil

Human Health/Direct Exposure

Note: The 95% UCL may be used for comparison to the CTLs provided the CTLs are apportioned.

Options IIA

COCs < Commercial/industrial CTLs (Table II)

Option IIB

COCs > Level I residential CTLs (Table II), provided: engineering controls such as cover material (minimum 2 feet of clean soil, concrete pad, etc.) are used to prevent or manage human exposure

Option IIC

COCs $\leq$ Apportioned alternative commercial/industrial CTLs calculated using site-specific soil properties (Figs. 4-7 and Table VI)

Option IID

TRPH levels $\leq$ TRPH commercial/industrial CTLs for the TRPH fractions provided in App. C

Exposure Unit G

RMO Level II Criteria provided for each medium:

Leachability

Options IIA

COCs $\leq$ Alternative leachability-based soil CTLs calculated (Fig. 8) using applicable Level II GW CTLs

Option IIB

Direct leachate results (SPLP/TCLP) $\leq$ applicable Level II GW CTLs

Option IIC

COCs $>$ Level I leachability-based soil CTLs (Table II), provided: engineering control such as impermeable cover is used to prevent infiltration (minimum 1 year of GW monitoring)

Option IID

COCs $\leq$ Alternative leachability-based soil CTLs calculated (Fig. 8) using site-specific soil properties and the applicable Level II GW CTLs

Option IIE

TRPH levels $\leq$ Alternative leachability-based soil CTLs for the TRPH fractions calculated using Fig. 8, the chemical/physical properties provided in App. C and the applicable TRPH Level II GW CTL

Option IIF

Demonstration (minimum 1 year of GW monitoring) that COCs based on site-specific conditions will not leach at levels $>$ applicable Level I or Level II GW CTLs

Exposure Unit G

RMO Level II Criteria provided for each medium:

Groundwater

Options IIA

COCs $\leq$ GW of low yield/poor quality CTLs (Table I), provided the following criteria are met:

1. Aquifer is of low yield, or poor quality,
2. No actual impact or potential impact to surface water (the more stringent of GW or FSW Level I CTLs, and
3. Demonstration (minimum 1 year of GW monitoring) that contaminant concentrations in GW at the property boundaries will not exceed the applicable Level I CTLs

Options IIB

COCs $>$ Applicable CTLs provided engineering controls such as a permanent containment (e.g., slurry wall) are used to prevent off-site contaminant migration (minimum 1 year of GW monitoring) and no impact or potential impact to surface water (the more stringent of GW, FSW, or MSW Level I CTLs)

Options IIC

COCs $>$ GW or FSW CTLs (Table I), and COCs $\leq$ MSW CTLs (Table I) provided: contamination is affecting or may potentially affect only a MSWbody, and there are no other properties or FSW bodies located between the source property and the MSWbody

Options IID

COCs $>$ Applicable groundwater CTLs, provided the following are met:

1. Demonstration (historical data or modeling results) that contaminant concentrations in GW at the property boundaries will not exceed the applicable Level I CTLs,
2. Contamination is limited to the source area (contamination $<$ 1/4 acre) and is not migrating from the localized source area (minimum 1 year of GW monitoring), and
3. No impact or potential impact to on-site FSW or MSW (the more stringent of GW, FSW, or MSW Level I CTLs)

Risk Management

Option Level 3

Site Cleanup Strategy

• Soil:

• RMO 1

- using 95%UCL and comparing to apportioned residential SCTLs
- 1/4 acre residential parcel (exposure unit C)

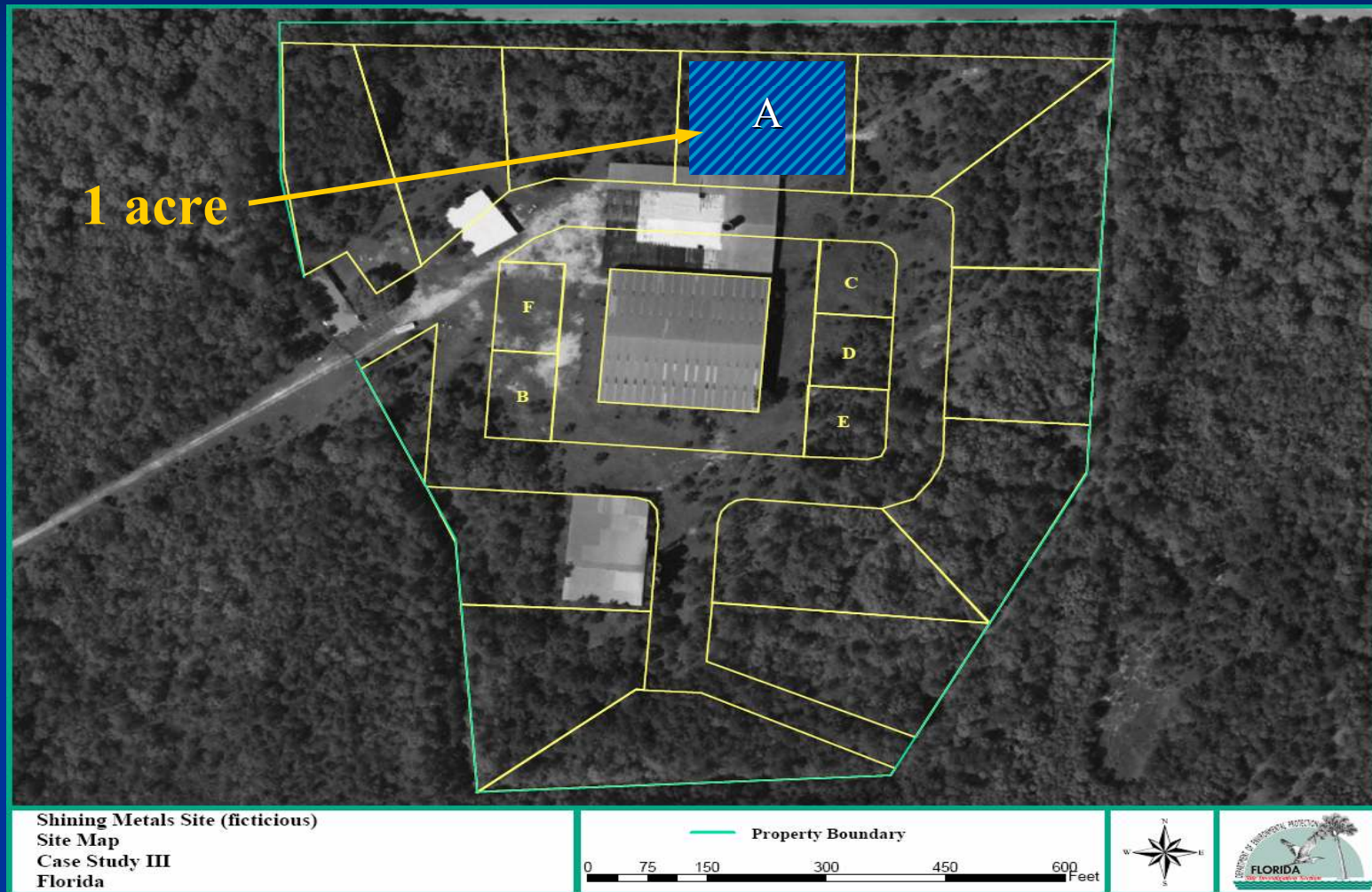
• RMO 2

- engineering controls (leaving existing building on site as a cap to eliminate direct exposure to contaminated soil)
- institutional controls (restrictive covenant for existing building to ensure that the “cover” maintains integrity)

• RMO 3 (Exposure Unit A)

- using 95%UCL and comparing to apportioned residential SCTLs
- institutional controls (restrictive covenant for residential exposure unit A, which is larger than 1/4 acre, to ensure the exposure unit is not subdivided in the future).

Shining Metals Site – RMO 3



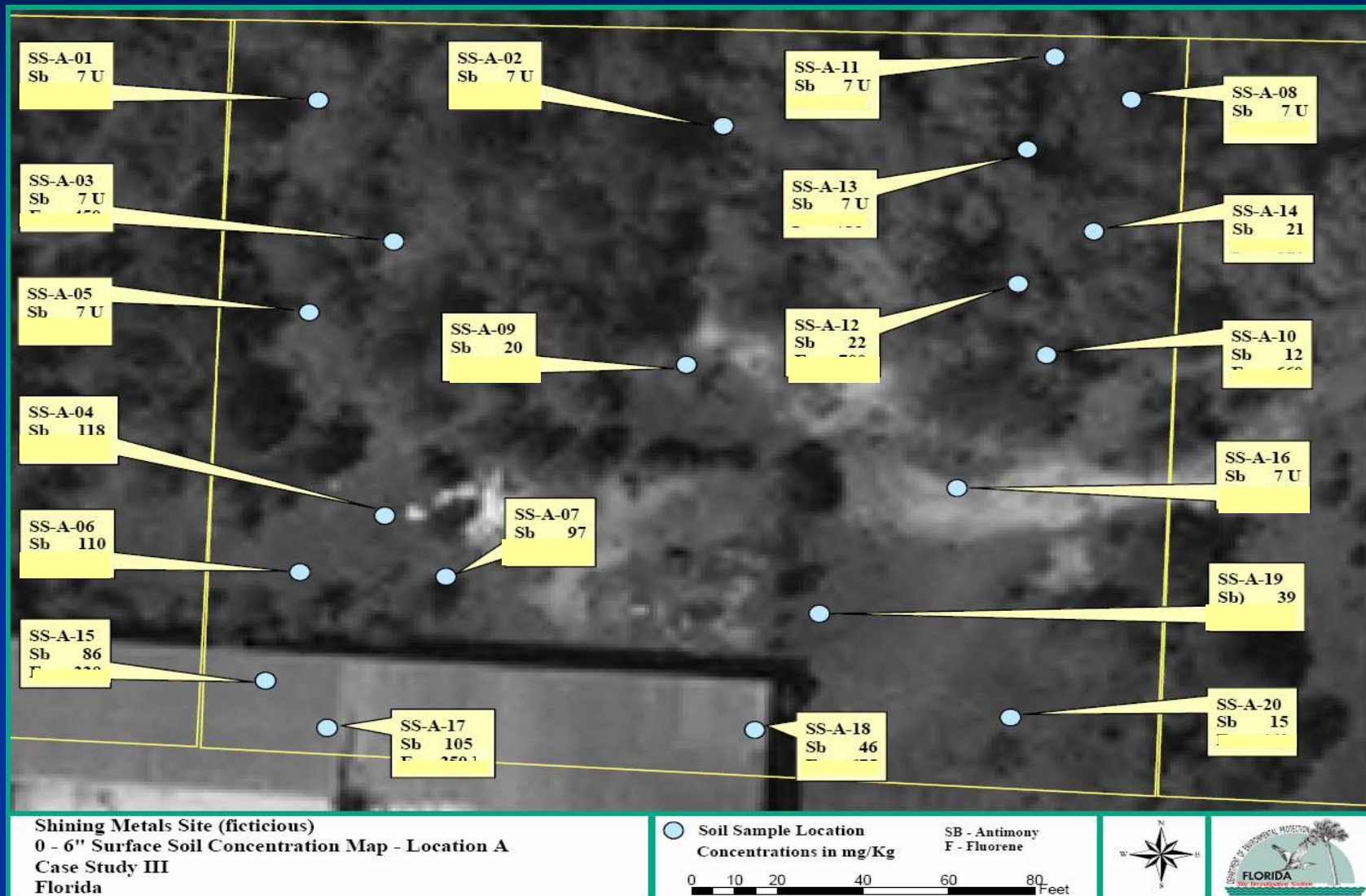
Exposure Unit A

Soil Analytical Data for 0 – 6”

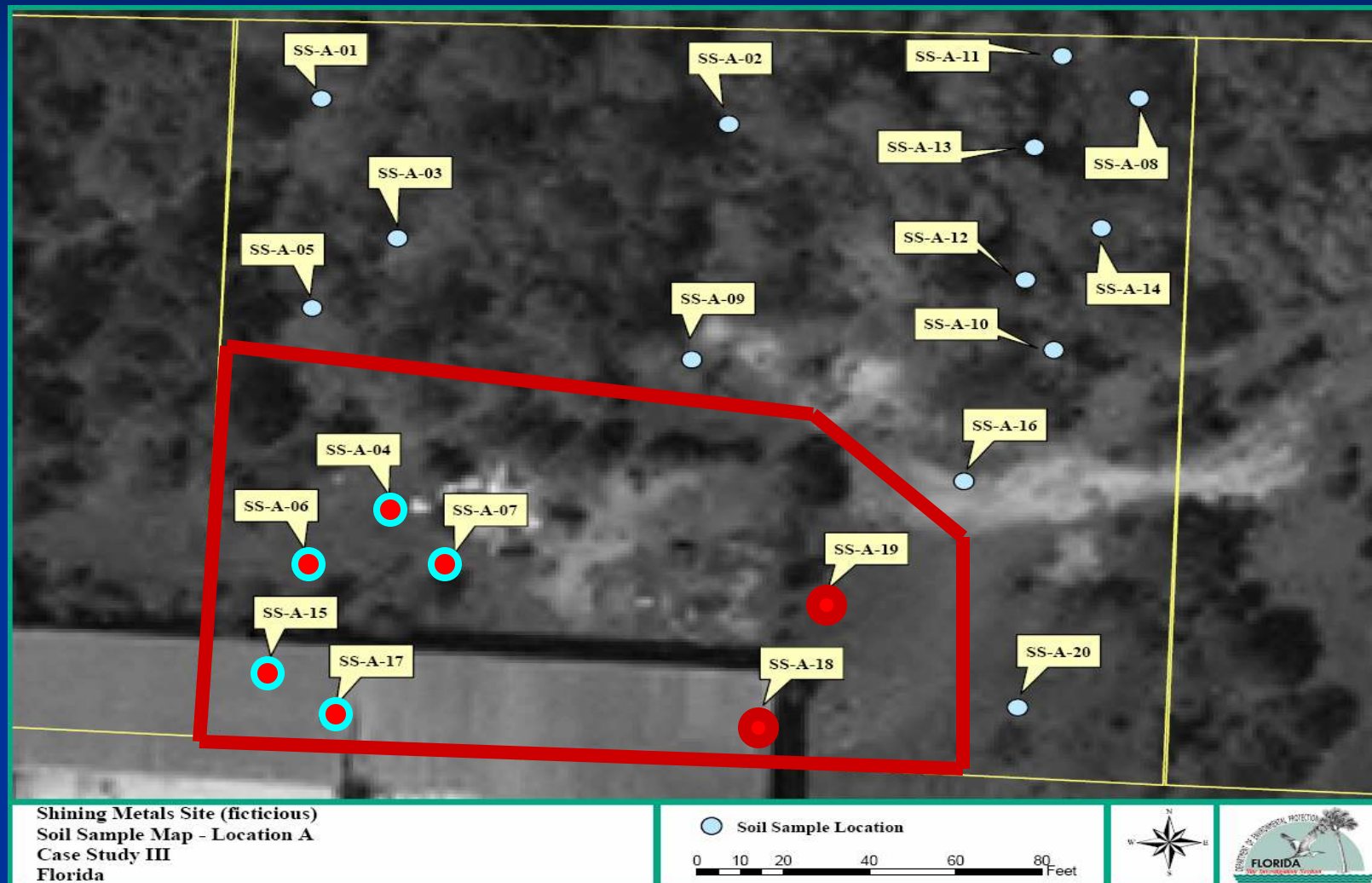
	Acetophenone	Antimony (Sb)	Arsenic (As)	DEHP	Cadmium (Cd)	Fluorene (F)	Iron (Fe)	Lead (Pb)	Manganese (Mn)	PCB-1254
residential SCTL	3900	27	2.10	72	82	2600	53000	400	3500	0.5
SS-A-01	0.340 U	7 U	0.43 U	0.340 U	0.09 U	470 J	560	2.0	77	0.100 U
SS-A-02	0.340 U	7 U	0.43 U	0.340 U	0.09 U	350	550	2.9	101	0.100 U
SS-A-03	0.340 U	7 U	0.43 U	0.340 U	0.09 U	450	930	1.1 J	44	0.100 U
SS-A-04	0.340 U	118	0.43 U	0.340 U	0.06 U	370	1100	1.5 J	56	0.100 U
SS-A-05	0.340 U	7 U	0.43 U	0.340 U	0.07 U	450	200	4.2	83	0.100 U
SS-A-06	0.340 U	110	1.16	0.380	0.11 U	450	500	3.1	21	0.100 U
SS-A-07	0.340 U	97	1.55	0.980	0.13 U	550	480	1.4	51	0.100 U
SS-A-08	0.040 J	7 U	0.67	0.630	0.09 U	730	269	7.9	90	0.100 U
SS-A-09	0.038 J	20	1.34	0.510	1.50	510	277	4.6	100	0.100 U
SS-A-10	0.035 J	12	0.26	0.780	1.10	660	118	4.7	62	0.400 J
SS-A-11	0.045 J	7 U	1.05	0.860	0.09 U	1200	1050	5.1	21	0.100 U
SS-A-12	0.340 U	22	0.95	0.340 U	0.11 U	700	720	8.0	90	0.100 U
SS-A-13	0.340 U	7 U	0.43 U	0.750	0.13 U	735	635	3.3	89	0.100 U
SS-A-14	0.340 U	21	1.20	0.660	1.20	820	205	3.1	32	0.100 U
SS-A-15	0.300 J	86	0.51	0.315	0.13 U	320	117	5.4	24	0.100 U
SS-A-16	0.340 U	7 U	0.43 U	0.340 U	1.35	420	248	4.9	87	0.100 U
SS-A-17	0.050 J	105	0.43 U	0.340 U	0.09 U	455	352	3.0	19	0.100 U
SS-A-18	0.040 J	46	0.67	0.340 U	0.11 U	675	900	2.3	102	0.100 U
SS-A-19	0.039 J	39	0.43 U	0.505	1.25	390	603	2.7	85	0.100 U
SS-A-20	0.035 J	15	0.25	0.860	1.05	460	244	2.0	56	0.100 U

All units are in mg/kg

Surface Soil Analyses – Exposure Unit A



Sample Locations above Default Residential SCTLs RMO 3



Screening for Potential Contaminants of Concern (PCC)

Not all SCTLs should be Apportioned

Do Not Apportion:

- ➔ • SCTLs based on natural background or PQL.
- ➔ • SCTLs based on acute toxicity
- SCTLs (direct exposure) for Lead (Pb)
 - Default SCTLs for Lead are based on a unique toxicological analysis that is not amenable to apportionment
- SCTLs for chemicals present in low concentrations
 - Maximum concentration is $\leq 1/10$ the default SCTL
 - or
 - Maximum concentration is ≤ 2 times the average background concentration
- SCTLs for chemicals detected infrequently

ACUTE TOXICITY

- Barium
- Cadmium
- Copper
- Cyanide
- Fluoride
- Nickel
- Phenol
- Vanadium

- Applicable in unrestricted scenarios where small children may be present (residence, playground, school, etc.)
- Always regarded as “not-to-exceed values”
- Compare maximum concentration to the default SCTLs.

Do Not Apportion:

- SCTLs based on natural background or PQL.
- SCTLs based on acute toxicity
- • SCTLs (direct exposure) for Lead (Pb)
 - Default SCTLs for Lead are based on a unique toxicological analysis that is not amenable to apportionment
- • SCTLs for chemicals present in low concentrations
 - Maximum concentration is $\leq 1/10$ the default SCTL
 - or
 - Maximum concentration is ≤ 2 times the average background concentration
- SCTLs for chemicals detected infrequently

BACKGROUND CONCENTRATION

Concentrations of contaminants that are naturally occurring in the groundwater, surface water, soil or sediment in the vicinity of the site. [62-780.200(5)]

Do Not Apportion:

- SCTLs based on natural background or PQL.
 - SCTLs based on acute toxicity
 - SCTLs (direct exposure) for Lead (Pb)
 - Default SCTLs for Lead are based on a unique toxicological analysis that is not amenable to apportionment
 - SCTLs for chemicals present in low concentrations
 - Maximum concentration is $\leq 1/10$ the default SCTL
 - or
 - Maximum concentration is ≤ 2 times the average background concentration
- • SCTLs for chemicals detected infrequently

Exclusion Based on Frequency

- All three criteria must be met in order to allow for exclusion based on infrequent detection :
 - In only 1 out of 10 or more samples, or 5% or fewer out of 20 or more samples.
 - Detected in low concentrations (no greater than the default SCTL).
 - No reason to believe that the chemical presence is due to historical site activities.

Do Not Apportion:

- SCTLs based on natural background or PQL.
- SCTLs based on acute toxicity
- SCTLs (direct exposure) for Lead (Pb)
- SCTLs for chemicals present in low concentrations
 - Maximum concentration $\leq 1/10$ the default SCTL
 - or
 - Maximum concentration ≤ 2 times avg. background
- SCTLs for chemicals detected infrequently
 - Detected in only 1 out of 10 samples, or $\leq 5\%$ out of 20 or more samples
 - and
 - Maximum concentration ≤ 2 times avg. background
 - and
 - No reason to believe chemical presence is due to historical site activities

Exposure Unit A Soil Analyses – RMO 3

Potential Contaminants of Concern Screening

<i>Chemical</i>	<i>Maximum</i>	<i>residential SCTL</i>	<i>1/10 SCTL</i>	<i>2X Average BG</i>	<i>Detection frequency</i>	<i>PCOC ?</i>	<i>Reason</i>
Acetophenone	0.34	3900	390	NA	9/20	NO	BSL
Antimony	118	27	2.7	14	12/20	YES	ASL ABG
Arsenic	1.55	2.1	0.21	1.76	11/20	NO	BBG
Bis(2-ethylhexyl)phthalate	0.980	72	7.2	NA	11/20	NO	BSL
Cadmium	1.5	82	8.2	0.24	6/20	NO	BSL
Fluorene	1200	2600	260	NA	20/20	YES	ASL
Iron	1100	53000	5300	1760	20/20	NO	BSL BBG
Lead	8.0	400	40	5.2	20/20	NO	BSL
Manganese	101	3500	350	106	20/20	NO	BSL BBG
PCB-1254	0.4	0.5	0.05	NA	1/20	NO	LFD

A/BSL = above/below screening level (1/10 SCTL)

A/BBG = above/below background (2 times average BG)

LFD = low frequency of detection

Exposure Unit A Soil Analyses – RMO 3

Potential Contaminants of Concern Screening

<i>Chemical</i>	<i>Maximum</i>	<i>residential SCTL</i>	<i>1/10 SCTL</i>	<i>2X Average BG</i>	<i>Detection frequency</i>	<i>PCOC ?</i>	<i>Reason</i>
Acetophenone	0.34	3900	390	NA	9/20	NO	BSL
Antimony	118	27	2.7	14	12/20	YES	ASL ABG
Arsenic	1.55	2.1	0.21	1.76	11/20	NO	BBG
Bis(2-ethylhexyl)phthalate	0.980	72	7.2	NA	11/20	NO	BSL
Cadmium	1.5	82	8.2	0.24	6/20	NO	BSL
Fluorene	1200	2600	260	NA	20/20	YES	ASL
Iron	1100	53000	5300	1760	20/20	NO	BSL BBG
Lead	8.0	400	40	5.2	20/20	NO	BSL
Manganese	101	3500	350	106	20/20	NO	BSL BBG
PCB-1254	0.4	0.5	0.05	NA	1/20	NO	LFD

A/BSL = above/below screening level (1/10 SCTL)

A/BBG = above/below background (2 times average BG)

LFD = low frequency of detection

Questions



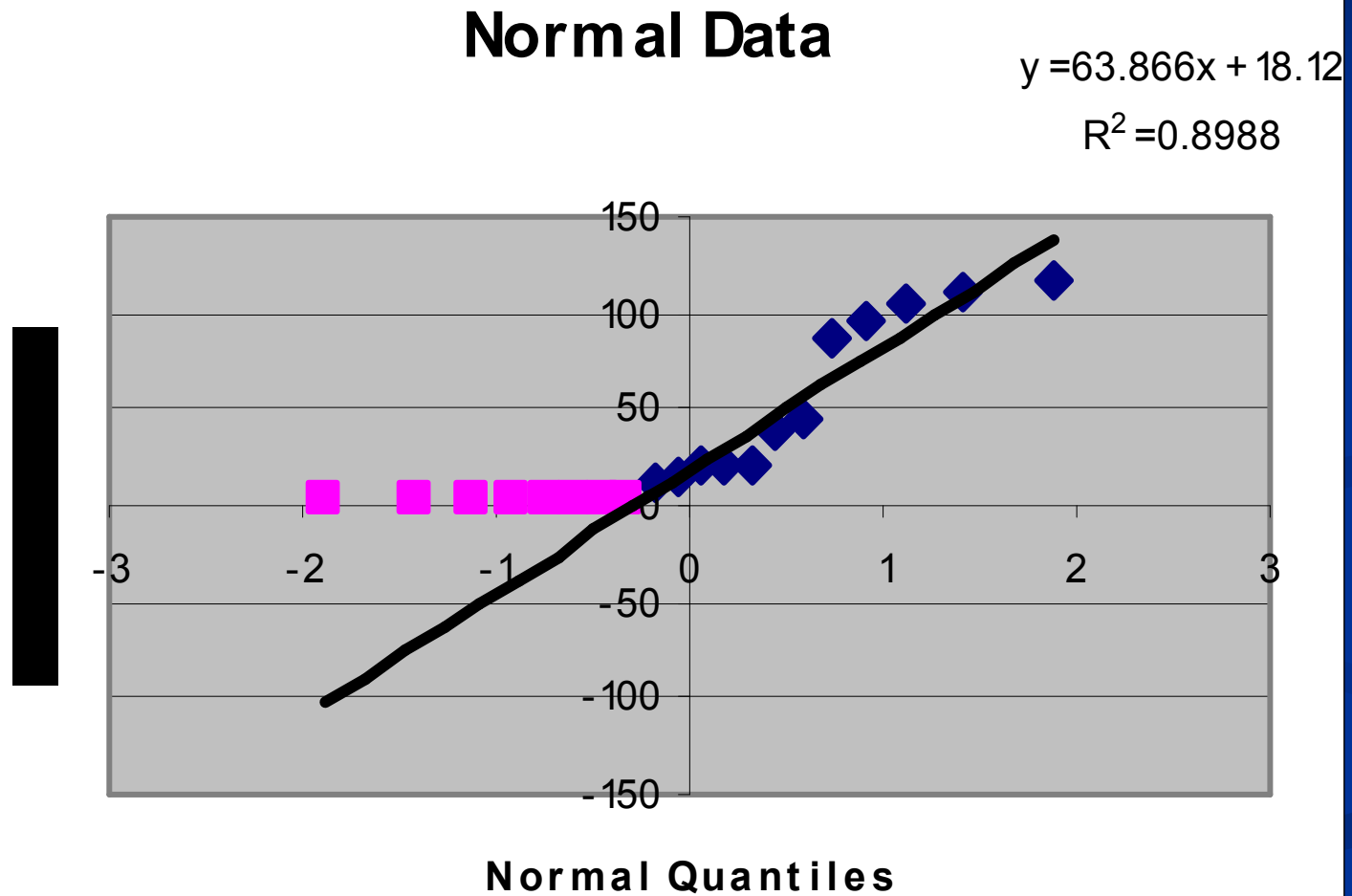
95% UCL

Review the 95% UCL Calculation Spreadsheets



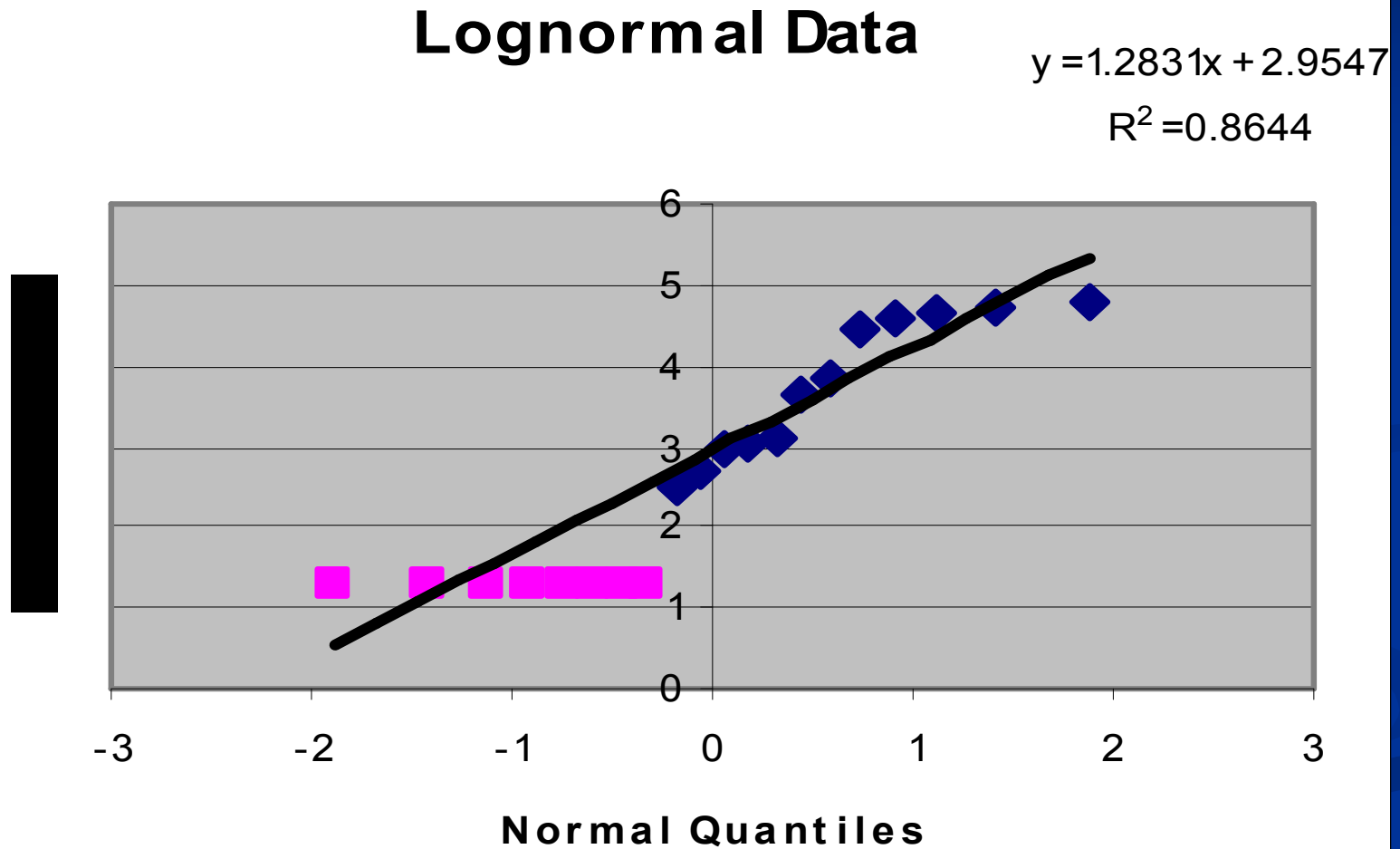
FLUCL Calculator

Goodness-of-fit Test Results – Antimony



FLUCL Calculator

Goodness-of-fit Test Results - Antimony



FLUCL Calculator Version

Goodness-of-fit Test Results

Antimony

Shapiro-Francia Results (Adjust for Censoring)

- SF for Normal Distribution = 0.899
- SF for Log Normal Distribution = 0.8644
- SF critical value for $p < 0.05$ = 0.92641

Test stat > critical value indicates a reasonable fit

Shapiro-Wilk's Test Results for All Data (BDL replaced w/ $\frac{1}{2}$ DL)

- SW for Normal Distribution = 0.899
- SW for Log Normal Distribution = 0.8644
- SW critical value for $p < 0.05$ = 0.92641

Test stat > critical value indicates a reasonable fit

Based on the results of the Shapiro-Francia test, Distribution is best described as: Neither



FDEP UCL Calculator – Version 1.0

Antimony

Summary Statistics for

Number of Samples	20
Number of Censored Data	8
Minimum	3.5
Maximum	118
Mean	35.95
Median	17.5
Standard Deviation	41.94919
Variance	1759.734
Coefficient of Variation	1.166876
Skewness	1.057741

95% UCL (Assuming Normal Data)

Student's-t	52.16946
-------------	----------

95% UCL (Adjusted for Skewness)

Adjusted -CLT	53.75123
Modified-t	52.53923

95% Nonparametric UCL

CLT	51.3808
Jackknife	NA
Standard Bootstrap	52.87234
Bootstrap-t	54.47573
Chebyshev (Mean, Std)	76.83796

Summary Statistics for ln()

Minimum	1.252763
Maximum	4.770685
Mean	2.749637
Standard Deviation	1.414479
Variance	2.00075

Goodness-of-Fit Results

Distribution recommended	Neither
Distribution Used	Neither

Estimates Assuming Lognormal Distribution

MLE Mean	42.52161
MLE Standard Deviation	107.5267
MLE Median	15.63696
MLE Coefficient of Variation	2.528755
MVUE Estimate of Mean	36.99268
MVUE Estimate of Std. Dev.	62.23007
MVUE Estimate of SE	16.516
MVUE Coefficient of Variation	1.682227

UCL Assuming Lognormal Distribution

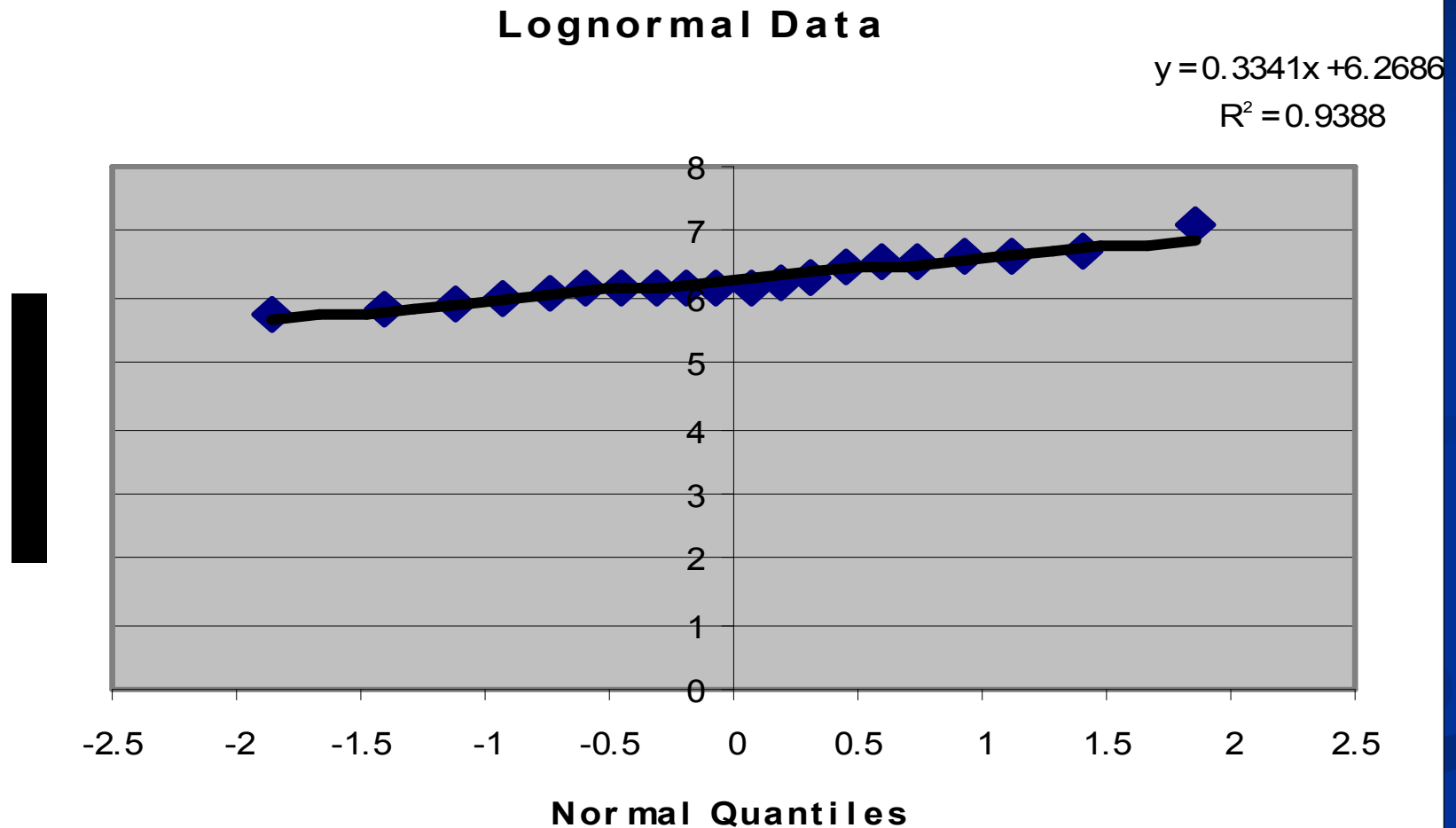
95% H-UCL	123.9708
95% Chebyshev (MVUE0 UCL	108.9843
99% Chebyshev (MVUE0 UCL	201.3252

FDEP Recommended UCL

76.83795929

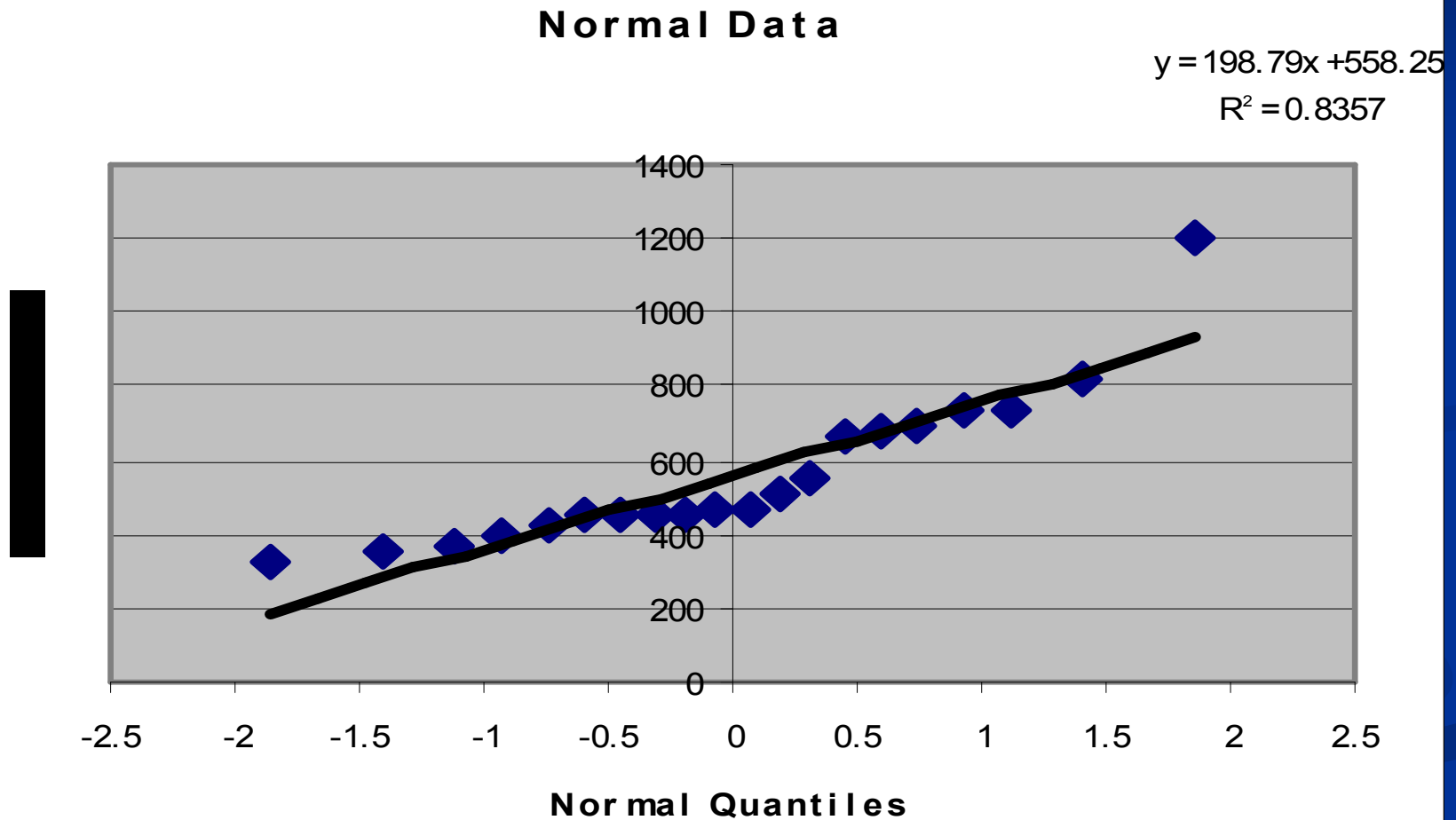
FLUCL Calculator

Goodness-of-fit Test Results – Fluorene



FLUCL Calculator

Goodness-of-fit Test Results – Fluorene



FLUCL Calculator

Goodness-of-fit Test Results

Area A - Fluorene

■ Shapiro-Francia Results (Adjust for Censoring)

- SF for Normal Distribution = 0.8357
- SF for Log Normal Distribution = 0.9388
- 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 w/ $\frac{1}{2}$ DL)

- SF for Normal Distribution = 0.846
- SF for Log Normal Distribution = 0.941
- Shapiro-Francia critical value for $p < 0.05$ = 0.905

Test stat > critical value indicates a reasonable fit

Based on the results of the Shapiro-Francia test, Distribution is best described as: Lognormal



FDEP UCL Calculator – Version 1.0

Fluorene

Summary Statistics for

Number of Samples	10
Number of Censored Data	0
Minimum	100
Maximum	1200
Mean	340.1
Median	273.5
Standard Deviation	319.2597
Variance	101926.8
Coefficient of Variation	0.938723
Skewness	2.566683

95% UCL (Assuming Normal Data)

Student's-t	525.1689
-------------	----------

95% UCL (Adjusted for Skewness)

Adjusted -CLT	593.7485
Modified-t	538.8262

95% Nonparametric UCL

CLT	506.1772
Jackknife	NA
Standard Bootstrap	497.392
Bootstrap-t	806.933
Chebyshev (Mean, Std)	780.1794

Summary Statistics for ln()

Minimum	4.60517
Maximum	7.090077
Mean	5.565397
Standard Deviation	0.511926
Variance	

Goodness-of-Fit Results

Distribution recommended	Lognormal
Distribution Used	Lognormal

Estimates Assuming Lognormal Distribution

MLE Mean	337.4307
MLE Standard Deviation	275.89
MLE Median	261.2289
MLE Coefficient of Variation	0.81762
MVUE Estimate of Mean	327.3908
MVUE Estimate of Std. Dev.	243.5066
MVUE Estimate of SE	76.44417
MVUE Coefficient of Variation	0.74378

UCL Assuming Lognormal Distribution

95% H-UCL	644.6135
95% Chebyshev (MVUE0 UCL)	660.6033
99% Chebyshev (MVUE0 UCL)	1088.003

FDEP Recommended UCL

644.6135254

Questions



Additivity & Apportionment

Primary Concept

ADDITIVITY

“CTLs adjusted such that for non-carcinogenic contaminants with the same target organ (s) systems or effects, the hazard index (sum of the hazard quotients) is 1 or less, and for carcinogens, the cumulative lifetime excess cancer risk level is $1.0E-6$ ”.

CONCEPT

Combining the risks posed to receptors by the presence of multiple contaminants at a site.

- For carcinogens, the effects are assumed to be additive.
- For non-carcinogens, additive effects are assumed if the chemical affects the same target organs/systems or produce the same effect.

Additivity

- Current rules require a more direct treatment of the issue of potential additive effects of chemicals in developing risk-based cleanup goals.
- Used whenever SCTLs are compared with 95% UCL values or whenever alternative SCTLs are developed.
- Non-carcinogens with the same target organ/system or effect are potentially in the “additivity pool”.
- The effects of carcinogens are assumed to be additive.
- Target organs/systems and effects for each chemical are listed in Chapter 62-777.

Potential Contaminants of Concern Screening

Exposure Unit A Soil Analyses

<i>Chemical</i>	<i>Maximum</i>	<i>residential SCTL</i>	<i>1/10 SCTL</i>	<i>2X Average BG</i>	<i>Detection frequency</i>	<i>PCC</i>	<i>Reason</i>
Acetophenone	0.34	3900	390	NA	9/20	N	BSL
Antimony	118	27	2.7	14	12/20	Y	ASL ABG
Arsenic	1.55	2.1	0.21	1.76	11/20	N	BBG
Bis(2-ethylhexyl)phthalate	0.980	72	7.2	NA	11/20	N	BSL
Cadmium	1.5	82	8.2	0.24	6/20	N	BSL
Fluorene	1200	2600	260	NA	20/20	Y	ASL
Iron	1100	53000	5300	1760	20/20	N	BSL BBG
Lead	8.0	400	40	5.2	20/20	N	BSL
Manganese	101	3500	350	106	20/20	N	BSL BBG
PCB-1254	0.4	0.5	0.05	NA	1/20	N	LFD

A/BSL = above/below screening level (1/10 SCTL)

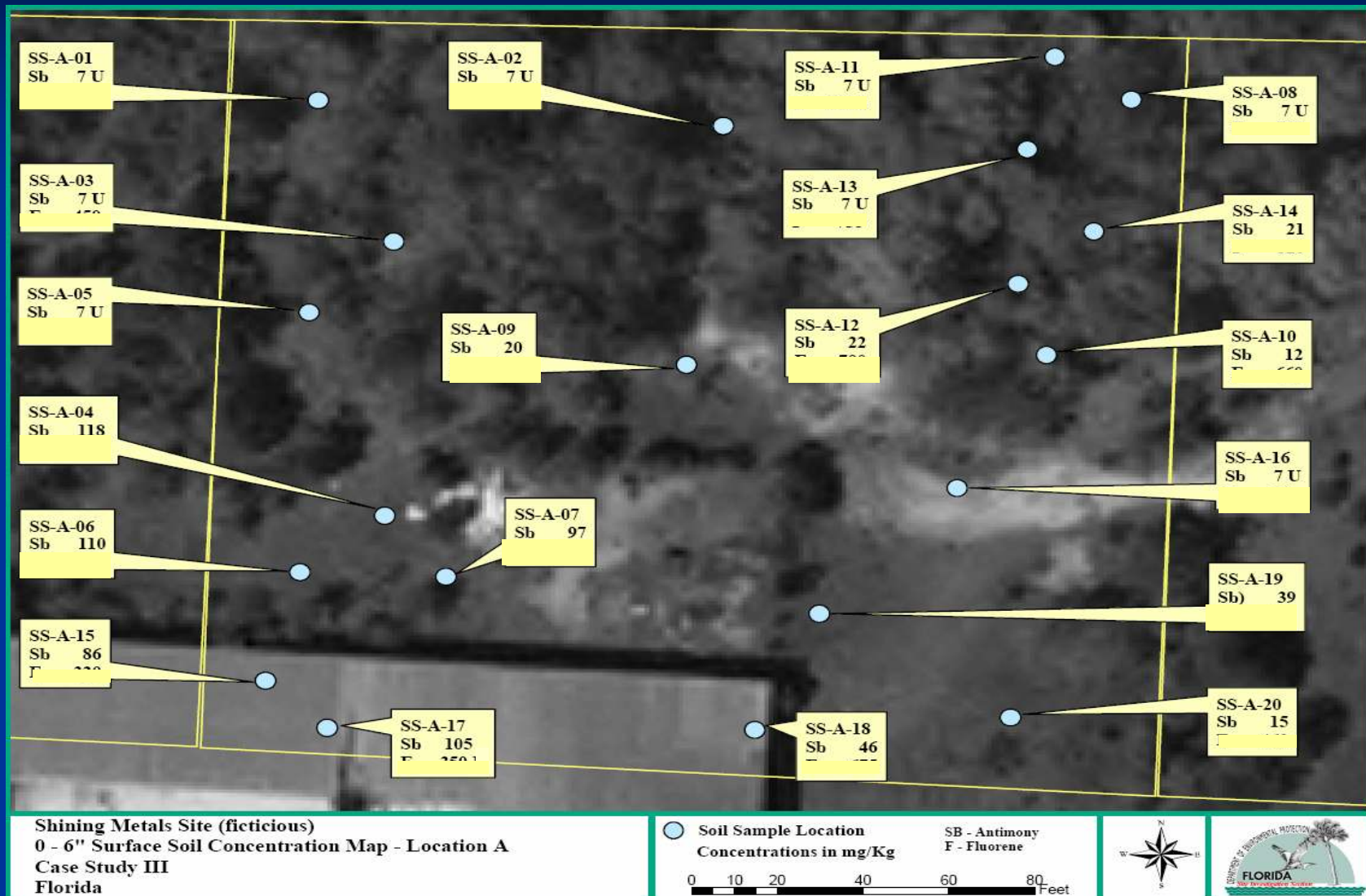
A/BBG = above/below background (2x average BG)

LFD = low frequency of detection

Additivity

<i>Chemical</i>	<i>95% UCL (mg/kg)</i>	<i>Target Organ</i>	<i>Apportion?</i>
Antimony (Sb)	76.8	Blood	YES
Fluorene (F)	645	Blood	YES

Surface Soil Analyses – Exposure Unit A



Primary Concept

APPORTIONMENT

The adjustment of SCTLs such that for non-carcinogenic contaminants that affect the same target organ(s), the hazard index (sum of the hazard quotients) is no greater than 1, and for carcinogens, the cumulative lifetime excess cancer risk level is 1×10^{-6} , as applicable.

CONCEPT

Distribution of the risk among multiple contaminants so that there is an acceptable total risk.

- no greater than 1×10^{-6} for carcinogens
- hazard index no greater than 1 for non-carcinogens

Primary Concept

Apportionment

- Cleanup Target Levels are adjusted such that:

Chemical Class	Risk
• Non-carcinogens (with the same target organs, systems or effects)	• Hazard Index is 1 or less (Hazard Index = sum of the hazard quotients)
• Carcinogens	• Cumulative lifetime excess cancer risk level is 1.0E-6

Different Ways to Apportion

- Simple Apportionment
- Weighted Apportionment
- Selective Apportionment

Different Ways to Apportion

• Simple Apportionment:

Divide the default SCTL for each chemical by the number of chemicals that produce the same type of toxicity (i.e., the same target organs/systems or effects).

- Calculation is simple.
- Often overly conservative.

Apportionment Screening and Simple Apportionment

Apportionment Screening

95% UCL = EPC

<i>Chemical</i>	<i>Maximum</i>	<i>95%UCL</i>	<i>EPC</i>	<i>Target Organ</i>	<i>Apportion</i>
Antimony (Sb)	118	76.8	76.8	Blood	Yes
Fluorene (F)	1200	645	645	Blood	Yes

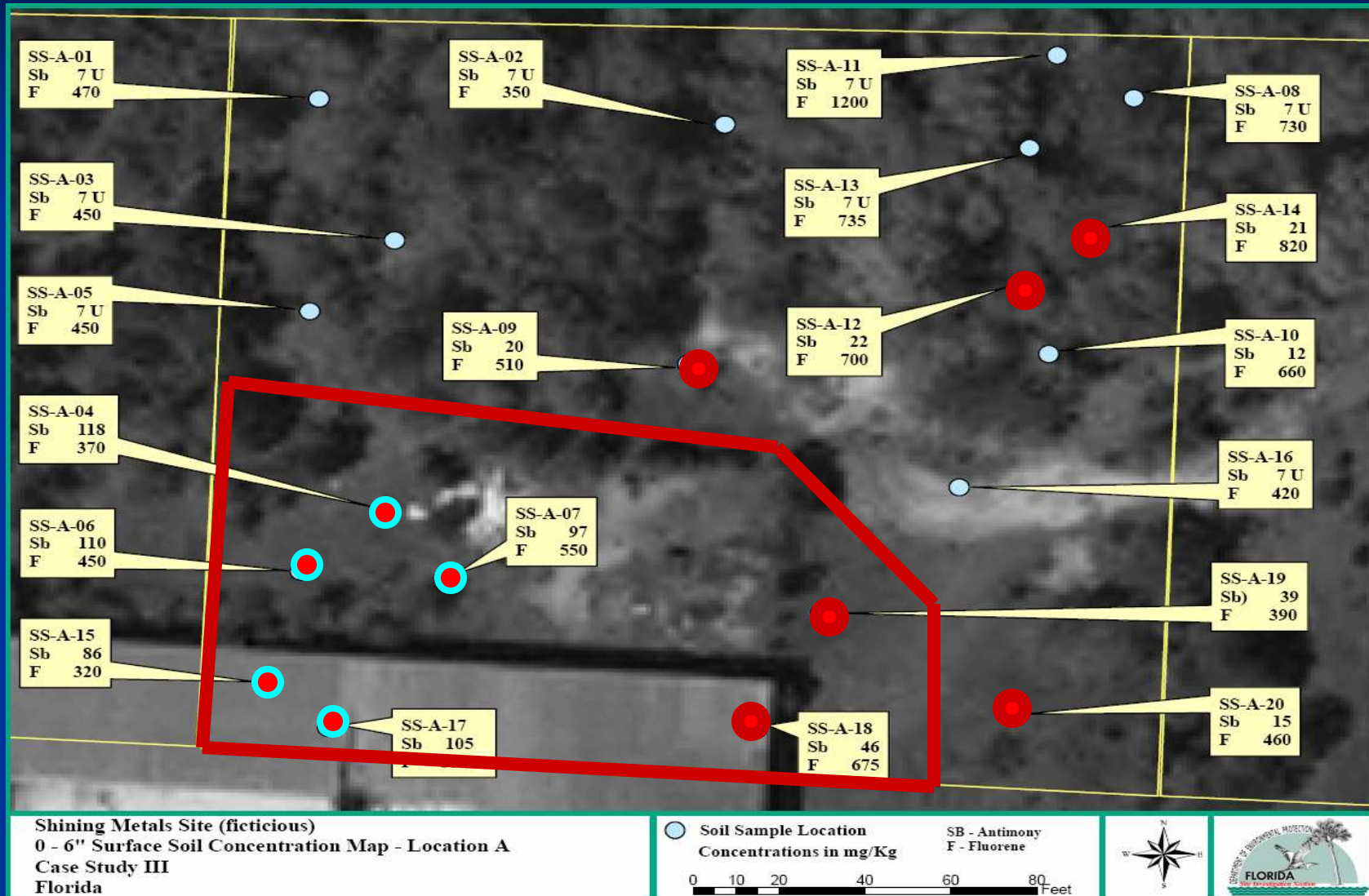
All units are in mg/kg

Simple Apportionment

<i>Chemical</i>	<i>EPC</i>	<i>SCTL</i>	<i>SCTL sa</i>
Antimony (Sb)	76.8	27	13.5
Fluorene (F)	645	2600	1300

SCTLsa = Soil Cleanup Target Level, simple apportionment

Simple Apportionment – RMO 3



Questions



Different Ways to Apportion

• Weighted Apportionment:

Results in SCTLs that more precisely achieve DEP risk goals.

- Involves calculation of the ratios of the 95% UCLs to their SCTLs.
- Distributes risk among chemicals with the same target organ/system or effect.
- Steps to achieve the apportioned SCTLs are expected to produce proportional decreases in the concentrations of each chemical.
- Weighting can be tailored to the site.

This approach makes sense if the contaminants are co-located such that removal of one contaminant results in similar reductions to the other contaminants.

Weighted Apportionment

Apportionment Screening

95% UCL = EPC

<i>Chemical</i>	<i>Maximum</i>	<i>95%UCL</i>	<i>EPC</i>	<i>Target Organ</i>	<i>Apportion?</i>
Antimony (Sb)	118	76.8	76.8	Blood	Y
Fluorene (F)	1200	645	645	Blood	Y

All units are in mg/kg

Weighted Apportionment

<i>Chemical</i>	<i>EPC</i>	<i>SCTL</i>	<i>Exceedance Ratio</i>
Antimony (Sb)	76.8	27	
Fluorene (F)	645	2600	

IMPORTANT TERMS/FORMULAS

SCTL

Default Soil Cleanup Target Level

Exceedance Ratio

$$= \frac{\text{Exposure Point Concentration}}{\text{SCTL}}$$

Weighted Apportionment

<i>Chemical</i>	<i>EPC</i>	<i>SCTL</i>	<i>Exceedance Ratio</i>
Antimony (Sb)	76.8	27	2.84
Fluorene (F)	645	2600	0.25

SUM: 3.09

Exceedance Ratio = EPC/SCTL

Antimony: $76.8 / 27 = 2.84 \text{ mg/kg}$

Fluorene: $645 / 2600 = 0.25 \text{ mg/kg}$

IMPORTANT TERMS/FORMULAS

SCTL_{wa}

**Soil Cleanup Target Levels, weighted
apportioned.**

$$= \frac{\text{Exposure Point Concentration}}{\text{Sum of the Exceedance Ratios}}$$

Weighted Apportionment

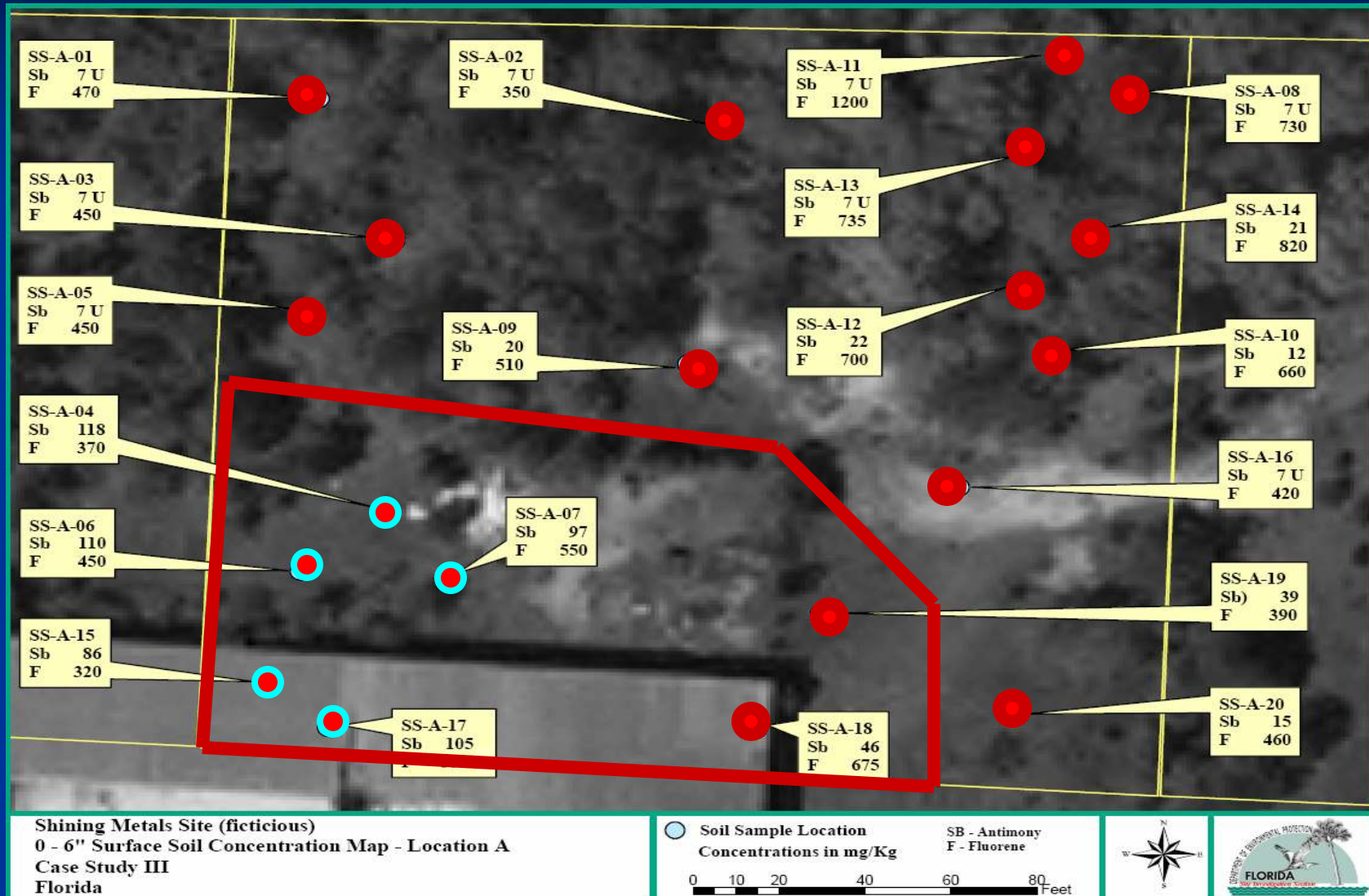
<i>Chemical</i>	<i>EPC</i>	<i>SCTL</i>	<i>Exceedance Ratio</i>	<i>SCTL wa</i>
Antimony (Sb)	76.8	27	2.84	24.8
Fluorene (F)	645	2600	0.25	209
SUM:			3.09	

$SCTL_{wa} = EPC / \text{Sum of the Exceedance Ratio}$

Antimony: $76.8 / 3.09 = 24.8 \text{ mg/kg}$

Fluorene: $645 / 3.09 = 209 \text{ mg/kg}$

Weighted Apportionment – RMO 3

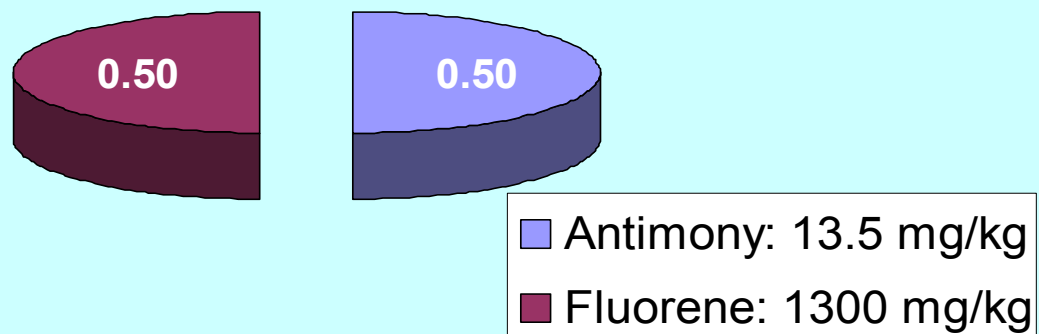


Apportionment

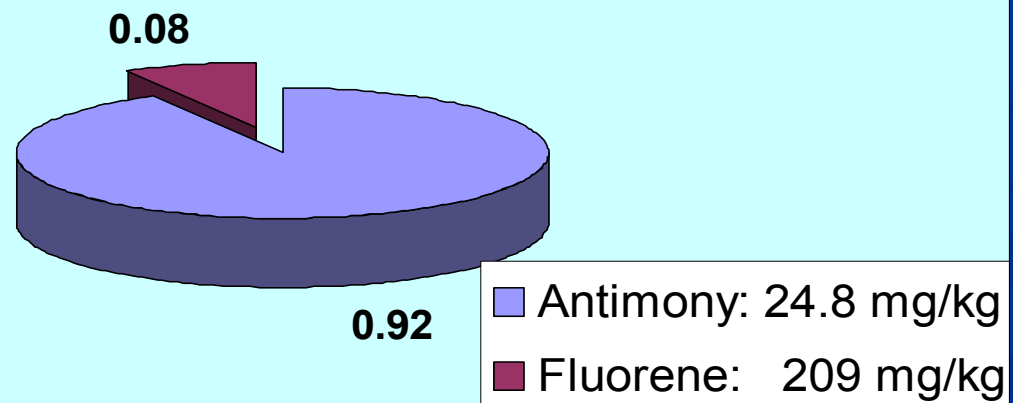
Simple vs. Weighted

<i>Chemical</i>	<i>EPC</i>	<i>SCTL</i>	<i>SCTL sa</i>	<i>SCTL wa</i>
Antimony (Sb)	76.8	27	13.5	24.8
Fluorene (F)	645	2600	1300	209

Simple Apportionment



Weighted Apportionment



Questions



Different Ways to Apportion

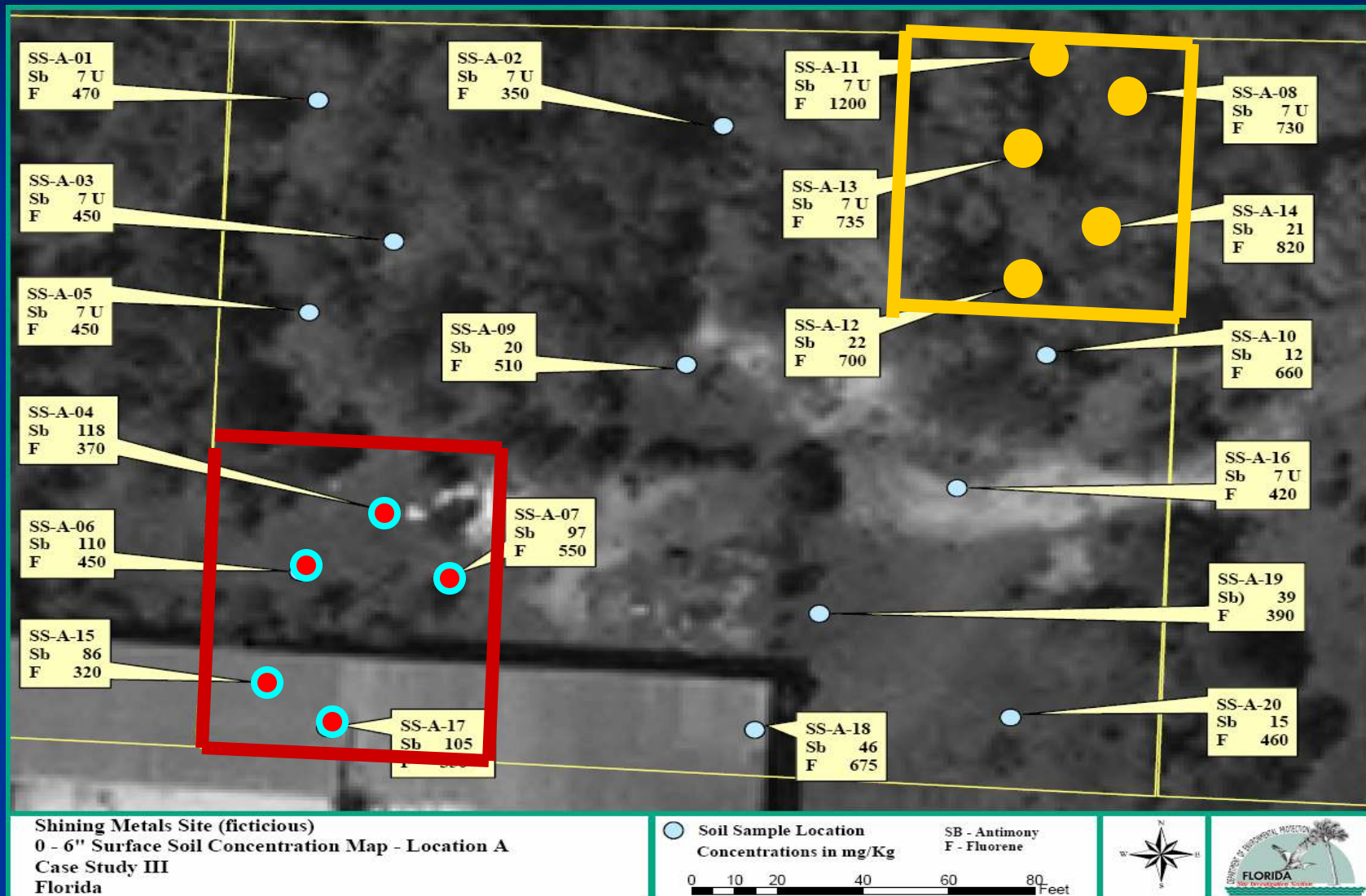
• Selective Apportionment:

Another method of weighted apportionment.

- The objective is to achieve a situation in which the sum of the risks posed by the apportioned SCTLs does not exceed the risk goals for any health effect.
- Distributes risk among chemicals with the same target organ/system or effect, but the risk reduction may be taken unevenly between the contaminants. (non-proportional reduction)

This approach makes sense if the contaminants are not co-located.

Selective Apportionment – RMO 3



Selective Apportionment

<i>Chemical</i>	<i>EPC</i>	<i>SCTL</i>	<i>Exceedance Ratio</i>	<i>SCTL wa</i>	<i>Co-located</i>	<i>Adjusted Exceedance Ratio</i>	<i>SCTL sla</i>
Antimony (Sb)	76.8	27	2.84	24.8	No		
Fluorene (F)	645	2600	0.25	209	No		
SUM			3.09		SUM:	1.00	

IMPORTANT TERMS/FORMULAS

SCTLsla

Soil Cleanup Target Level, selective
apportionment

= Adjusted Exceedance Ratio x SCTL

Selective Apportionment

<i>Chemical</i>	<i>EPC</i>	<i>SCTL</i>	<i>Exceedance Ratio</i>	<i>SCTL_{wa}</i>	<i>Adjusted Exceedance Ratio</i>	<i>SCTL_{sla}</i>
Antimony (Sb)	76.8	27	2.84	24.8		
Fluorene (F)	645	2600	0.25	209	0.25	650
SUM:			3.09	SUM:	1.00	

$$SCTL_{sla} = SCTL \times \text{Adjusted Exceedance Ratio}$$

$$\text{Fluorene: } 2600 \times 0.25 = 650 \text{ mg/kg}$$

Selective Apportionment

<i>Chemical</i>	<i>EPC</i>	<i>SCTL</i>	<i>Exceedance Ratio</i>	<i>SCTL_{wa}</i>	<i>Adjusted Exceedance Ratio</i>	<i>SCTL_{sla}</i>
Antimony (Sb)	76.8	27	2.84	24.8	0.75	20
Fluorene (F)	645	2600	0.25	209	0.25	650
SUM:			3.09	SUM:	1.00	

$$\text{SCTL}_{sla} = \text{SCTL} \times \text{Adjusted Exceedance Ratio}$$

Antimony: $27 \times 0.75 = 20 \text{ mg/kg}$

Fluorene: $2600 \times 0.25 = 650 \text{ mg/kg}$

Satisfying the SCTL

- The SCTL has been satisfied when:
 - The EPC (95% UCL) is below the apportioned SCTL.
and
 - The maximum concentration for a chemical remaining on site does not exceed 3 times the apportioned SCTL.
and
 - The maximum concentration for a chemical remaining on site does not exceed the leachability SCTL.

Satisfying the SCTLs

<i>Chemical</i>	<i>EPC</i>	<i>SCTL sla</i>	<i>SCTL</i>
Antimony (Sb)	76.8	20	NA
Fluorene (F)	645	650	NA

<i>Chemical</i>	<i>Maximum</i>	<i>3X SCTL sla</i>	<i>SCTL Leachability</i>
Antimony (Sb)	118	60	54
Fluorene (F)	1200	1950	1600

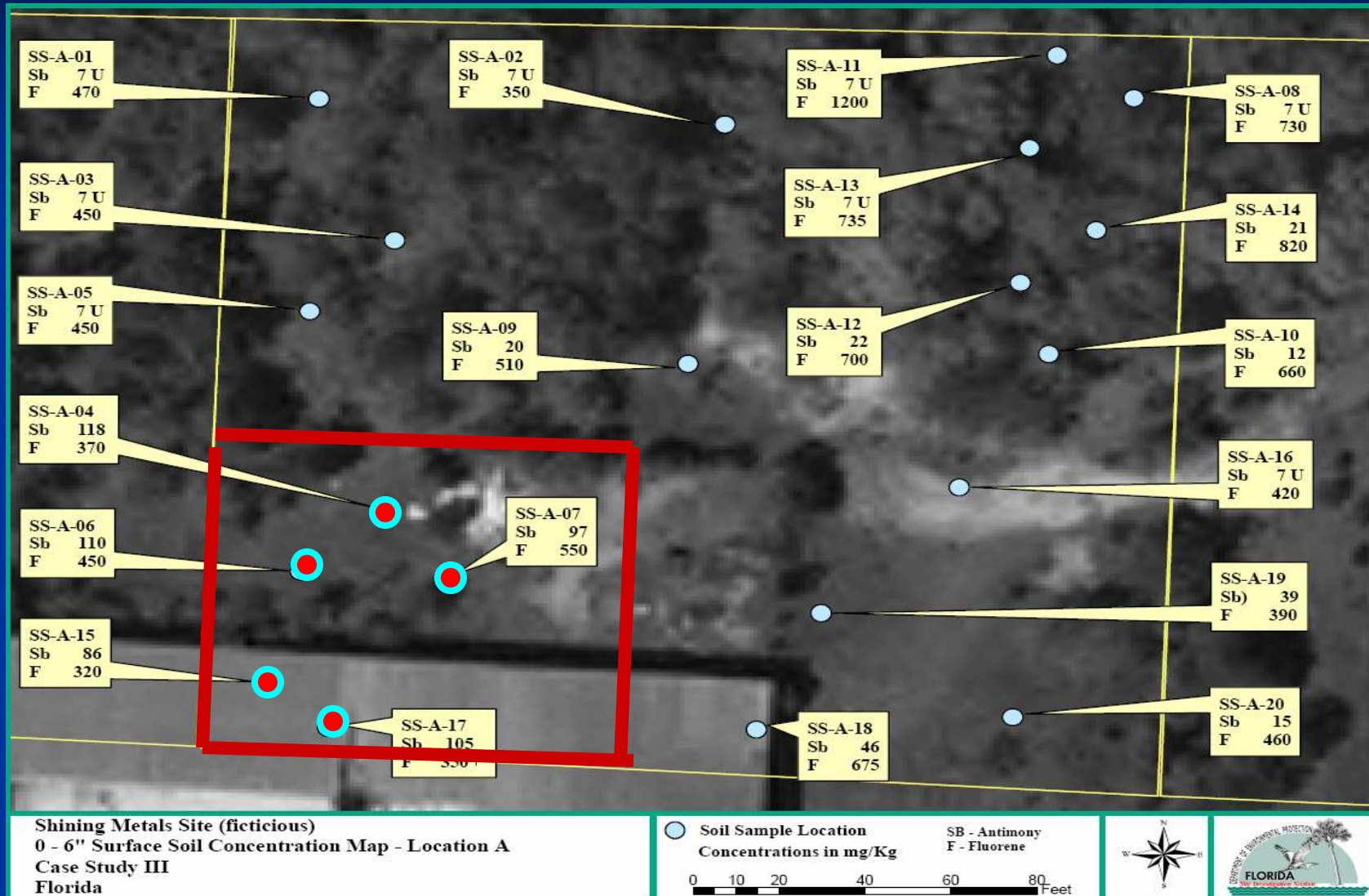
Virtual Remediation

Virtual Remediation

- Plan remediation by eliminating the highest data points in a step-wise fashion.
- Recalculate the 95% UCL until the cleanup target levels are achieved.

Exposure Unit A

RMO 3



ANTIMONY DATA

SAMPLE NUMBER	CONCENTRATION	QUALIFIER
1	7	U
2	7	U
3	7	U
4	118 	
5	7	U
6	110 	
7	97 	
8	7	U
9	20	
10	12	
11	7	U
12	22	
13	7	U
14	21	
15	86 	
16	7	U
17	105 	
18	46	
19	39	
20	15	

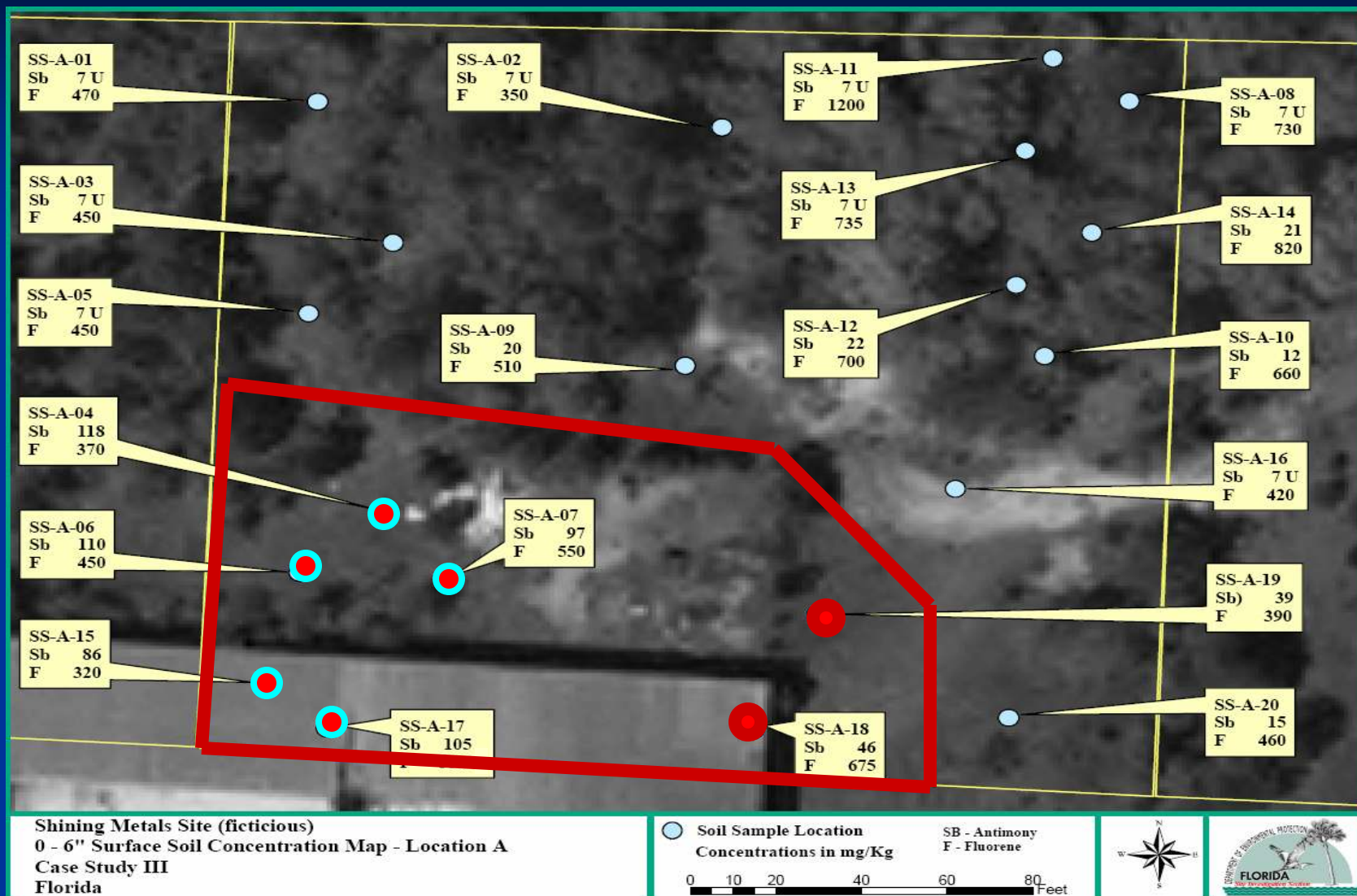
Re-Calculating 95% UCLs
with the
Florida UCL Calculator (FLUCL)

ANTIMONY DATA

SAMPLE NUMBER	CONCENTRATION	QUALIFIER
1	7	U
2	7	U
3	7	U
4	118 	
5	7	U
6	110 	
7	97 	
8	7	U
9	20	
10	12	
11	7	U
12	22	
13	7	U
14	21	
15	86 	
16	7	U
17	105 	
18	46 	
19	39	
20	15	

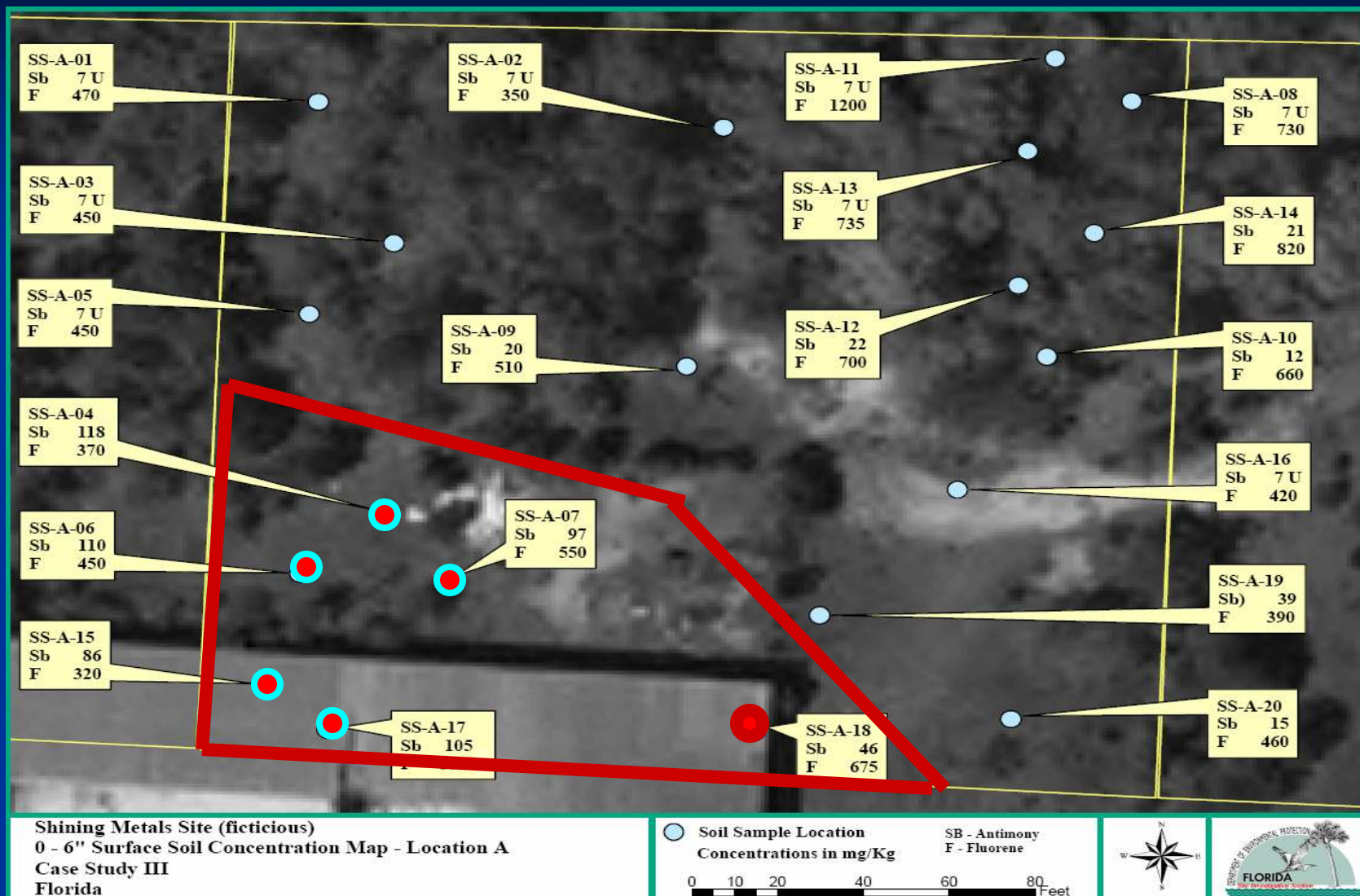
Exposure Unit A

RMO 3



Exposure Unit A

RMO 3



Satisfying the SCTLs

<i>Chemical</i>	<i>EPC</i>	<i>SCTL sla</i>
Antimony (Sb)	19.5	20
Fluorene (F)	645	650

<i>Chemical</i>	<i>Maximum</i>	<i>3X SCTL</i>	<i>Leach</i>
Antimony (Sb)	39	60	54
Fluorene (F)	1200	1950	1600

<i>Chemical</i>	<i>EPC Virtual remediation</i>	<i>Remedial Action Level</i>
Antimony (Sb)	19.5	39
Fluorene (F)	645	1200

ANTIMONY DATA

SAMPLE NUMBER	CONCENTRATION	QUALIFIER
1	7	U
2	7	U
3	7	U
4	118	
5	7	U
6	110	
7	97	
8	7	U
9	20	
10	12	
11	7	U
12	22	
13	7	U
14	21	
15	86	
16	7	U
17	105	
18	46	
19	39	
20	15	

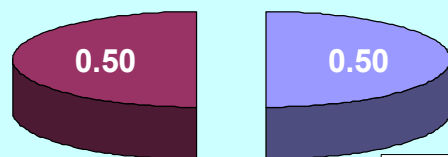
Comparison of SCTL Options

<i>Chemical</i>	<i>SCTL default</i>	<i>SCTL simple apportionment</i>	<i>SCTL weighted apportioned</i>	<i>SCTL selectively apportioned</i>
Antimony (Sb)	27	13.5	24.8	20
Fluorene (F)	2600	1300	209	650

Requires removal of the Antimony “hot spots”

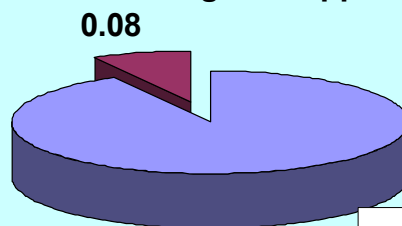


Simple Apportionment



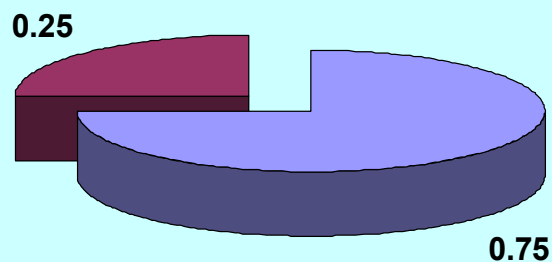
Antimony: 13.5 mg/kg
Fluorene: 1300 mg/kg

Weighted Apportionment



Antimony: 24.8 mg/kg
Fluorene: 209 mg/kg

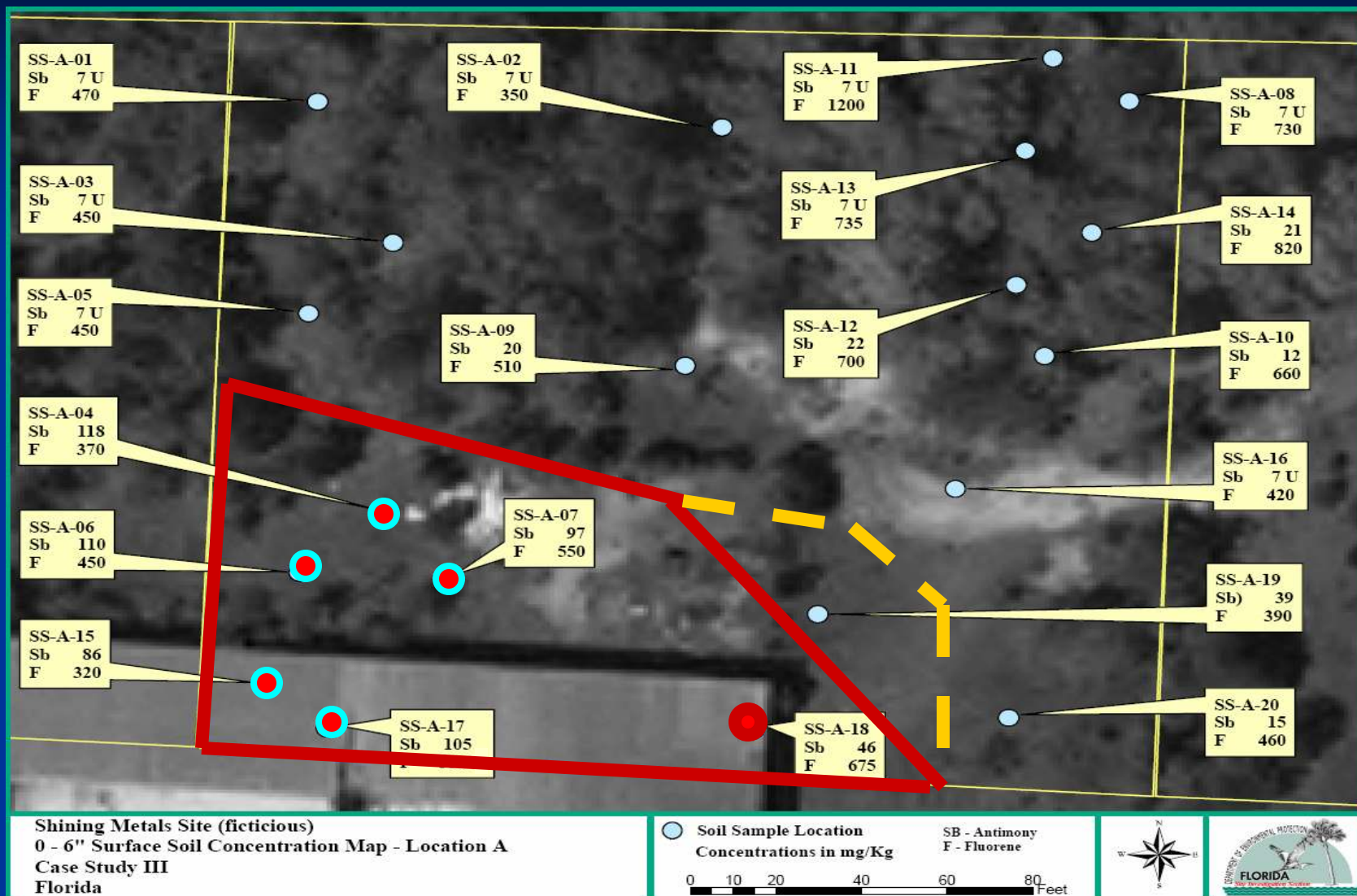
Selective Apportionment



Antimony:
20 mg/kg
Fluorene:
650 mg/kg

Exposure Unit A

RMO 3



Exposure Unit A

RMO Level III Criteria provided for each medium:

Soil

Human Health/Direct Exposure

Note: The 95% UCL may be used for comparison to the CTLs.

Options IIIA

COCs $\leq$ Apportioned alternative CTLs based on a site-specific risk assessment

Exposure Unit A

RMO Level II Criteria provided for each medium:

Leachability

Options IIA

COCs $\leq$ Alternative leachability-based soil
CTLs calculated (Fig. 8) using applicable Level II
GW CTLs

Option IIB

Direct leachate results (SPLP/TCLP) $\leq$
applicable Level II GW CTLs

Option IIC

COCs $>$ Level I leachability-based soil CTLs
(Table II), provided: engineering control such as
impermeable cover is used to prevent infiltration
(minimum 1 year of GW monitoring)

Option IID

COCs $\leq$ Alternative leachability-based soil
CTLs calculated (Fig. 8) using site-specific soil
properties and the applicable Level II GW CTLs

Option IIE

TRPH levels $\leq$ Alternative leachability-based soil
CTLs for the TRPH fractions calculated using
Fig. 8, the chemical/physical properties provided
in App. C and the applicable TRPH Level II GW
CTL

Option IIF

Demonstration (minimum 1 year of GW
monitoring) that COCs based on site-specific
conditions will not leach at levels $>$ applicable
Level I or Level II GW CTLs

Exposure Unit A

RMO Level II Criteria provided for each medium:

Groundwater

Options IIA

COCs $\leq$ GW of low yield/poor quality CTLs (Table I), provided the following criteria are met:

1. Aquifer is of low yield, or poor quality,
2. No actual impact or potential impact to surface water (the more stringent of GW or FSW Level I CTLs, and
3. Demonstration (minimum 1 year of GW monitoring) that contaminant concentrations in GW at the property boundaries will not exceed the applicable Level I CTLs

Options IIB

COCs $>$ Applicable CTLs provided engineering controls such as a permanent containment (e.g., slurry wall) are used to prevent off-site contaminant migration (minimum 1 year of GW monitoring) and no impact or potential impact to surface water (the more stringent of GW, FSW, or MSW Level I CTLs)

Options IIC

COCs $>$ GW or FSW CTLs (Table I), and COCs $\leq$ MSW CTLs (Table I) provided: contamination is affecting or may potentially affect only a MSWbody, and there are no other properties or FSW bodies located between the source property and the MSWbody

Options IID

COCs $>$ Applicable groundwater CTLs, provided the following are met:

1. Demonstration (historical data or modeling results) that contaminant concentrations in GW at the property boundaries will not exceed the applicable Level I CTLs,
2. Contamination is limited to the source area (contamination $<$ 1/4 acre) and is not migrating from the localized source area (minimum 1 year of GW monitoring), and
3. No impact or potential impact to on-site FSW or MSW (the more stringent of GW, FSW, or MSW Level I CTLs)

Shining Metals Site



Summary

- Calculation of the 95% UCL
- Simple Apportionment
- Weighted Apportionment
- Selective Apportionment
- Institutional Controls
- Engineering Controls

Site Cleanup Strategy

• Soil:

- Exposure Unit C

Risk Management Option 1

- used 95%UCL and compared to apportioned residential SCTLs

- Exposure Unit G

Risk Management Option 2

- engineering controls
- institutional controls

- Exposure Unit A

Risk Management Option 3

- used 95%UCL and compared to apportioned residential SCTLs
- institutional controls

• Groundwater:

- Poor Quality Aquifer

Risk Management Option 2

Questions



