APPENDIX L

T117 Multiple Increment Sampling UCL95 Calculations for PCBs

Appendix L T117 Multiple Increment Sampling UCL95 Calculations for PCBs: Methods and Results

INTRODUCTION

As part of the characterization of yards and streets in areas adjacent to the T117 Uplands site (former Malarkey Asphalt operations), multiple increment sampling (MIS) was used to collect additional information on PCB concentrations in near-surface soils. This MIS sampling was performed in two phases. The first phase sampled residential properties between Dallas Avenue South and South Cloverdale Street; the second phase sampled residential properties between South Cloverdale Street and South Donovan Street, as well as additional sampling at one phase one property. Both phases included sampling of soils adjacent to 16th Avenue South and South Donovan Street. This sampling program and the PCB analysis results are described in the Draft PCB Boundary Refinement Data Report (Integral Consulting, Inc., 2009b).

An MIS sample provides a single analytical result for a defined area, or Decision Unit (DU); that result represents an estimate of the average concentration within the DU, but provides no information on the variability (numerical or spatial) of concentrations across the DU. An MIS sample is a composite of small amounts of soil (soil increments) collected at many locations (30 or more for this study) from a DU; the laboratory analysis is performed on an subsample from this composite sample.

By collecting soil increments from numerous locations within a DU, an MIS sample provides a more thorough physical representation of the DU than a small number of discrete samples, each of which is analyzed individually. The MIS result is, however, only an estimate of the true mean concentration for the DU. Statistical theory supports the idea that MIS values are drawn from a distribution (for the mean) whose variance is reduced compared to the original variance of the DU, but not eliminated. Empirically this can be demonstrated by collecting multiple MIS samples in a DU and observing the variability in resulting concentrations. Variability is reduced if the number of soil increments included in an MIS sample is increased; how many soil increments are "enough" depends on the heterogeneity of the DU being sampled and how much variability in the MIS estimate of the mean value is acceptable. Other factors can also contribute to the variability of MIS results, including sample handling (e.g., the collection of a subsample for laboratory analysis) and instrument/analytical variability. Depending on the number of soil increments used to form MIS samples and the heterogeneity present within a DU, sample handling and analytical errors can be primary sources of variability observed in replicate MIS samples from a DU.

EPA and Ecology have determined that it is appropriate to consider the variability in MIS estimates of the mean when making cleanup decisions at T117. The agencies consider this to be particularly important given that potential exposures and cleanup decisions are for a residential neighborhood. Cleanup decisions will be made at the spatial scale of DUs. Consistent with agency policy, a confidence level of 95 percent is to be applied when making cleanup decisions. Thus, estimates of the one-sided upper 95 percent confidence limit (UCL95) on DU mean concentrations, as measured by MIS samples, are needed. This memorandum describes the methods used to develop such UCL95 PCB values[1] and summarizes the results for all yard and street DUs near T117 where MIS samples were collected.

MIS Data Sets: Yards and Streets

PCB results are available for a total of 25 residential property DUs and 12 street DUs (see EE/CA Map 2-9 for MIS sampling DU locations). In all cases, samples were collected and analyzed separately for two depth intervals: 0 to 2 inches and 2 to 6 inches (with sample codes of DUii-1 and DUii-2, respectively). Calculations of UCLs on the mean are performed separately for each depth in each DU, producing a total of 74 such UCL values.

The 25 residential yard DUs are located on 21 properties. In the first phase of sampling, the DUs covered all accessible soils on a property. In the second phase of sampling, only portions of yards closest to streets (front yards) were sampled. This approach for the second phase of sampling was based on the Conceptual Site Model of the primary transport pathway for PCBs from T117 to nearby areas (trackout) and the comparative results for front versus back yards from the first phase of sampling. Of the 8 residential properties included in phase one sampling, 3 had only a single DU because of the small parcel size. Two properties along South Cloverdale St., one in each phase of sampling, had a narrow DU defined adjacent to the street (DU12 and DU32) based on parcel characteristics, in addition to a larger adjacent yard DU. In phase two sampling, a single DU (DU22) was used to characterize soils at four adjacent recently built residences on South Donovan St., reflecting an assumption of common recent soil disturbance or placement as a result of development activities.

The 12 street DUs are located along 16th Avenue South and South Donovan St. and represent accessible soils along the street margins. On the west side of 16th Avenue South the wider soil margin was split into two DUs based on perpendicular distance from the street. South Donovan St. is split into upper and lower paved lanes, with a steep vegetated slope in between. Five DUs were designated to sample the complete perimeter of this steep slope, but the central portion (steepest slope) was not sampled. On the south side of upper South Donovan St. one planned street DU was not sampled because it was found to be mostly rocks, and one DU represented a gravel-covered

[1] The statistical distributions of different contaminants are very likely to show significant differences within a DU, based on sources, transport and fate processes, and other factors. As a result, information on the variability of one contaminant (e.g., PCBs), used to develop UCL estimates for that contaminant, should not be applied to other contaminants (e.g., for T117 dioxins/furans). Field replicate measurements of a specific contaminant are required to develop UCLs for that contaminant.

expanse (along the 16th Avenue South extended right-of-way) where vehicle access and hence trackout could have occurred.

In the phase one sampling, one residential DU had three replicate field MIS samples collected and analyzed, as an initial investigation of the possible variability in MIS results. Based on the decision to develop UCL values for all MIS sampling results, a total of 4 residential yard DUs and 4 street DUs had 3 field replicate samples collected and analyzed to provide additional information on MIS variability. The selected DUs provided spatial coverage of the total street and yard areas being sampled by MIS techniques (see EE/CA Map 2-9). During phase two sampling, one yard DU and one street DU sampled during phase one were resampled twice more to provide this spatial coverage for field replicate sampling. Triplicate MIS samples were collected at an additional 2 yard DUs and 3 street DUs during phase two sampling. Only a single MIS sample is available for 21 of the 25 yard DUs and 8 of the 12 street DUs. Where triplicate MIS samples were collected, they were collected for both depth intervals. Thus, of the total of 74 results (DU x depth), 16 have 3 values and 58 have only a single result.

Comparison of the PCB results for the two sampled depth intervals in each DU shows whether the depth profile for PCBs is “normal” (equal or decreasing with depth) or “inverted” (increasing with depth). Depth profiles are inverted for 40% of the yard DUs (10 of 25) and 50% of the street DUs (6 of 12). (The magnitude of the difference between the two depth intervals varies among inverted profiles). Since UCL values are calculated separately for each sampled depth interval, exceedances of the designated 1 ppm PCB cleanup level can occur for both intervals, only 0 to 2 inches, or only 2 to 6 inches. Inverted PCB depth profiles are noted to make the latter case more likely.

A brief data summary is provided in Table 1, which also summarizes the UCL results. The PCB data for individual DUs are included in Table 3 along with the results of UCL calculations.

Table 1. Summary of MIS PCB Results and UCLs

	Yards	Streets
Number of DUs		
total	25	12
1 MIS	21	8
3 MIS	4	4
Number of Inverted Profile DUs		
total	10	6
max > 0.1 ppm	7	6
max > 0.5 ppm	2	5
PCB concentration ranges		
0-2 inch	0.044 - 2.1 ppm	0.061 - 5.7 ppm
2-6 inch	0.048 - 1.7 ppm	0.055 - 8.1 ppm
Number of PCB results > 1 ppm (replicates averaged)		

	Yards	Streets
0 - 2 inch	1	3
2 - 6 inch	2	4
Number of UCL95 results > 1 ppm		
0 - 2 inch		
1 MIS	3	4
3 MIS	2	4
2 - 6 inch		
1 MIS	4	4
3 MIS	0	3
Number of DUs with UCL95 > 1 ppm (either depth)	6	9
Number of DUs with UCL95 > 1 ppm and max PCB result < 1 ppm (including individual replicates)	2	2

UCL95 METHODS

An MIS sample is an aggregate (summation) of many small "increment" samples collected across a DU. As a result, the statistical distribution of an MIS sample (as an estimate of the DU mean) should be approximately Normal, the closeness of the approximation being a function of the number of increments collected and the shape of the contaminant distribution within the DU sampled depth interval (Central Limit Theorem).

Two cases need to be addressed, depending on whether there are 3 or only 1 MIS results. This follows from the decision not to do multiple field replicate MIS sampling for every DU and depth interval. Where 3 field replicate MIS results are available, a DU-specific estimate of the MIS variance can be obtained, and the calculation of a UCL follows from the t-equation for the UCL with two degrees of freedom. Note that both the mean and the variance in this case are estimated based on 3 measurements. Where only a single MIS result is available, the mean is based on only a single value and an estimate of the MIS variability for that DU must be developed based on information from other DUs (namely, those that were selected for field replicate sampling in this study). The difference between these two cases in the information available to estimate the DU mean results in a modified t-equation for the UCL for the case of 1 MIS result (Johnson 2009).

Conceptually, since less information is available to estimate the DU mean, the confidence intervals should be wider and the UCL should be larger than in the case with 3 MIS results.

The calculations of UCL values may be termed "direct" for 3 MIS results and "indirect", or inferred, for 1 MIS result. Absent additional sampling, "indirect" UCL estimates are required for cleanup decisions where only a single MIS result is available. The extrapolation of variability measurements from selected DUs to estimate variability at other DUs involves an assumption of similarity or predictability across DUs. It is recognized, however, that distinct DUs may well differ in the variability of PCB concentrations as a result of location in relation to sources, property-specific histories (e.g., current or past owner's soil-disturbing activities), or other factors. The option to collect additional DU-specific MIS samples and thereby support a "direct" UCL calculation, replacing an "indirect" UCL calculation, should be maintained. "Direct" UCL calculations are considered to have less uncertainty than "indirect" UCL calculations.

Where 3 MIS results are available, the UCL is calculated from Equation 1:

$$UCL_{\text{1-sided, 95\%}} = \text{x-bar} + t_{0.95,\, n-1} \left(s / n^{0.5} \right) \qquad \text{(Equation 1)}$$

with

n = 3

x-bar = the average of 3 MIS results

s = the standard deviation of 3 MIS results

$t_{0.95,\, 2} = 2.92$

Where only 1 MIS result is available, the UCL is estimated from Equation 2 (Johnson 2009):

$$UCL_{\text{1-sided, 95\%}} = \text{x-bar} + t_{0.95,\, n-1} (s) \qquad \text{(Equation 2)}$$

with

n = 3

x-bar = the single MIS result

s = developed from DUs where MIS replicate samples were collected

$t_{0.95,\, 2} = 2.92$

The collection of field replicate MIS samples at 4 yard DUs and 4 street DUs, each at 2 depths (for a total of 16 data sets), was designed to support evaluations of statistical patterns in MIS variability. If one or more statistically significant ($p<0.05$) regression relationships were identified, the intent was to use such regression equations to extrapolate a variability estimate to DUs with only a single MIS result, and thereby calculate "indirect" or inferred UCL values. Various combinations of the replicate MIS variability results were considered: yards and streets combined, versus yards and streets separately; combining both surface (0-2 inch) and subsurface (2-6 inch) results, versus keeping the sampled depth intervals separate; and evaluating both standard deviation (SD) and coefficient of variation (CV, equal to standard deviation divided by mean).[2] Combining all three choices led to evaluations of 18 cases (3x3x2 combinations of factors).

Relatively few of these cases resulted in statistically significant relationships (Integral Consulting, Inc. 2009a; regression results independently confirmed). The 4 statistically significant cases at times also provided only partial coverage of the entire MIS data set; for example, they applied only to one type of DU (yards) or one sampled depth interval (surface). Therefore an alternate approach was also evaluated.

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[2] The more restrictive the selection criteria, the fewer results are included in the regression evaluation.

Where the measured mean PCB concentration is above 1 ppm, the UCL value will definitely be greater than the cleanup level of 1 ppm using either equation 1 or equation 2, and cleanup actions will be indicated. MIS PCB variability may in some manner reflect the general magnitude of PCB concentrations; especially at low (background) concentrations, that variability may not be representative of variability for mixed background-plus-site related distributions. Therefore, the variability results from a window of mean PCB concentrations just below the cleanup level of 1 ppm PCBs are of greatest interest.[3] Average SD and average CV values for yard DUs, street DUs, and yard plus street DUs combined were calculated, using results where the average PCB concentration was within the range of 0.5 to 1 ppm.[4] The average SD result can be used directly in equation 2; the SD in equation 2 can also be expressed as the average CV times the mean. (See Table 2 for details on equations used).

From either the statistically significant regression equations or the average SD or average CV results, a "critical value" can be calculated from equation 2; any single MIS result greater than that critical value will have an "indirect" UCL concentration greater than the cleanup level. If the critical value falls below the range of average PCB values selected for calculating the average SD and average CV, the process is iterated by extending the range downward to include all results equal to or greater than the initial critical value. This process is continued until the calculated critical PCB value falls within the range used to calculate average SD and average CV. (See Table 2 for an example of iteration).

Critical values were calculated for all statistically significant regression models and for all average SD and average CV cases starting with a range of PCB average values between 0.5 and 1 ppm (i.e., for both measures and for yards and streets separately or combined). The comparison of these critical values was used for the final selection of the method for "indirect" UCL calculations for DUs with only 1 MIS result, using equation 2. "Direct" UCL values were calculated using equation 1 and replicate MIS results for DUs with 3 MIS results.

The Data Management Rules (see EE/CA, Appendix D) were used in a stepwise manner for all calculations of these UCLs. In particular, those rules were applied to the number of significant figures retained as calculations proceeded.

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[3] Note that where 3 MIS results are available 1 or 2 individual MIS results could exceed 1 ppm even though the average MIS concentration is less than 1 ppm.

[4] Using a range of average PCB concentrations between 0.5 and 1 ppm, there are initially 4 yard and 4 street results included in the average SD and average CV calculations. Both sampling depth intervals are included. Iteration (see text) increases the number of values used to calculate averages in some cases. If a narrower range of 0.7 to 1 ppm PCBs is used, 3 yard DUs and 3 street DUs are initially included in the average SD and CV values. The differences in calculated critical values are minor (with iteration, often the same result is obtained as starting with the 0.5 to 1 ppm range) and would not change any of the DU/depth cleanup decisions for the current data set based on inferred UCL concentrations.

UCL95 Results

A summary of all of the calculated critical values for "indirect" UCL calculations is provided in Table 2. The variability for street DUs with replicate MIS samples was generally greater than for yard DUs; as a result, the critical values for average PCB concentrations are substantially lower for streets than yards when calculated separately, based on average SD or CV results. The critical values for yards and streets combined are intermediate between the two cases calculated separately.

Table 2. Summary of critical values for "indirect" UCL calculations

	Calculated Critical PCB Values, for UCL=1 (in ppm)					
	Yards + Streets		Yards		Streets	
average SDs	0.34	(b)	0.53	(b)	0.11	(b)
average CVs	0.50	(b)	0.57	(b)	0.45	(b)
regression SDs			0.61	(b)		
regression CVs	0.41	(a)			0.37	(b)
					0.33	(a)

(a) surface 0-2 inch depth only

(b) both surface (0-2 inch) and subsurface (2-6 inch) depths

Average SD and CV values calculated based on results where PCB average is in a range below the1 ppm cleanup level (see below for details)

Note that table entries are the calculated critical values above which the UCL will exceed 1 ppm; the average SD and average CV values used for the calculations are not shown.

Supporting Information: The table below provides results for the 16 data sets with 3 field replicate MIS results, ranked by mean PCBs:

Location	Depth	Type	Rep 1	Rep 2	Rep 3		Std Dev	Rep Avg	CV
DU27	2-6"	street	1.55	1.5	1.7		0.1041	1.5833	0.0657
DU27	0-2"	street	1.45	1.3	1.4		0.0764	1.3833	0.0552
DU28	0-2"	street	1.3	0.97	0.84		0.2371	1.0367	0.2287
DU17	0-2"	street	1.3	0.88	0.84		0.2548	1.0067	0.2531
DU01	0-2"	yard	0.74	1.13	1.05		0.2060	0.9733	0.2116
DU21	2-6"	street	0.86	0.65	1.4		0.3869	0.9700	0.3989
DU14	0-2"	yard	0.73	0.91	1.2		0.2371	0.9467	0.2505
DU23	0-2"	yard	0.62	0.78	0.89		0.1358	0.7633	0.1779
DU17	2-6"	street	1.1	0.63	0.44		0.3398	0.7233	0.4697
DU28	2-6"	street	0.87	0.71	0.53		0.1701	0.7033	0.2418
DU21	0-2"	street	0.44	0.29	0.9		0.3179	0.5433	0.5850
DU33	0-2"	yard	0.59	0.68	0.3		0.1986	0.5233	0.3794
DU01	2-6"	yard	0.43	0.47	0.5		0.0351	0.4667	0.0753
DU23	2-6"	yard	0.16	0.25	0.32		0.0802	0.2433	0.3296
DU14	2-6"	yard	0.17	0.18	0.19		0.0100	0.1800	0.0556
DU33	2-6"	yard	0.17	0.14	0.1		0.0351	0.1367	0.2570

The 8 cases with mean PCBs in the range of 0.50 to 1.00 ppm are highlighted.

The average SD for those 8 cases is: 0.2490

The average CV for those 8 cases is: 0.3394

Example of iteration:

Using the average SD of 0.2490 from data sets with mean PCBs between 0.50 and 1.00 ppm, the initial calculated critical value is 0.2729. This is outside the range of 0.50 to 1.00 ppm used to derive the average SD used in the calculation. The range is expanded to include any additional data sets with mean PCBs above the initial critical value; one data set is added for the new range of 0.27 to 1.00 ppm, highlighted in yellow. The process is repeated; the new average SD of 0.2252 results in a critical value of 0.3424. Since this is within the range used to derive the average SD, the iteration process ends.

Equations:

The basic equation for calculating an "indirect" UCL is
UCL = PCB + 2.92(SD)

Using the average SD the equation is:
UCL = PCB + 2.92(average SD)

Using the average CV the equation is:
UCL = PCB + 2.92(average CV)(PCB)
since CV = SD/mean, and thus SD = (CV)(mean)

Using a regression equation for CV of the form CV = mPCB + b:
UCL = PCB + 2.92(mPCB + b)(PCB)
yielding a quadratic equation in PCB

Using a regression equation for SD of the form SD = mPCB + b:
UCL = PCB + 2.92(mPCB + b)
yielding a linear equation in PCB

In all cases, the equations are solved for the "critical value" of PCB by setting UCL = 1 ppm

Table 2 also provides the calculated critical values for the 4 statistically significant ($p<0.05$) regression relationships.[5] Where available, the critical values for streets are also less than the single critical value for yards only.

The three critical values for yards only, developed from two different approaches, are similar, ranging from 0.53 to 0.61 ppm. One of the four calculated critical values for streets only is substantially lower than the other three. Critical values developed from average SD values are less than those from average CV values in all cases (yards and streets combined or separately).

The physical processes and human activities affecting yard soils and soils adjacent to streets may differ in several respects, and the relationships of PCB magnitudes to SD and CV measures are seen to vary in the field replicate DU results for this site. However, a well-supported rationale for developing UCL estimates separately by DU type is not evident. Moreover, combining the results from yard and street DUs provides a larger data set for evaluation. Considering all of the results in Table 2, the critical value of 0.50 ppm PCBs developed from the average CV for yards and streets combined is a single mid-range value chosen for development of all "indirect" UCLs. The average CV value on which "indirect" UCL calculations are based is 0.34, an average derived from 4 yard and 4 street DUs with average PCB concentrations between 0.5 and 1 ppm. This selected approach is less conservative than any of the

[5] The critical values developed from regression relationships are calculated using substitution for the SD term in Equation 2 and mathematically solving for the PCB concentration yielding a UCL equal to 1 ppm. See Table 2 for details.

other options reflected in Table 2 for street DUs. It is somewhat more conservative than the three options shown in Table 2 for yards based on yard results only, but for the current T117 data set of MIS results those three alternatives would result in identifying the same yard DUs for cleanup based on UCLs.

Table 3 lists all of the individual MIS sample results for all 37 yard and street DUs, as well as the calculated UCL values. "Direct" UCLs, based on 3 MIS samples in a DU, that exceed 1 ppm are highlighted in yellow. "Indirect" UCLs, based on extrapolating an average CV of 0.34 to the single available MIS result, that exceed 1 ppm are highlighted in blue.

Six of 25 yard DUs have UCLs greater than 1 ppm[6]; 4 of the 6 have single MIS concentrations above 1 ppm. The range of average MIS PCB concentrations (based on either 1 or 3 results) for units with UCLs above 1 ppm is 0.80 to 2.1 ppm PCBs.

Nine of 12 street DUs have UCLs greater than 1 ppm; 7 of the 9 have single MIS concentrations above 1 ppm. The range of average MIS PCB concentrations for units with UCLs above 1 ppm is 0.53 to 8.1 ppm PCBs.

Table 3. UCL calculation results

Location	PCBs				CV (a)	SD	UCL
	Repl 1	Repl 2	Repl 3	Average			
Yards							
DU01-1	0.74	1.1	1.1	0.97		0.21	1.3
DU01-2	0.43	0.47	0.50	0.47		0.035	0.53
DU02-1	0.48				0.34	0.16	0.95
DU02-2	0.34				0.34	0.12	0.69
DU03-1	0.21				0.34	0.071	0.42
DU03-2	0.94				0.34	0.32	1.9
DU04-1	0.13				0.34	0.044	0.26
DU04-2	0.11				0.34	0.037	0.22
DU05-1	0.20				0.34	0.068	0.40
DU05-2	0.16				0.34	0.054	0.32
DU06-1	0.054				0.34	0.018	0.11
DU06-2	0.078				0.34	0.027	0.16
DU07-1	0.16				0.34	0.054	0.32
DU07-2	0.18				0.34	0.061	0.36
DU08-1	0.053				0.34	0.018	0.11
DU08-2	0.048				0.34	0.016	0.095
DU09-1	0.14				0.34	0.048	0.28
DU09-2	0.16				0.34	0.054	0.32
DU10-1	0.38				0.34	0.13	0.76

[6] Note that the UCL for DU23-1, equal to 1.0 (with significant figures per the data management rules), does not exceed 1 and that DU is therefore not identified for cleanup actions.

Location	PCBs				CV (a)	SD	UCL
	Repl 1	Repl 2	Repl 3	Average			
DU10-2	0.22				0.34	0.075	0.44
DU11-1	0.14				0.34	0.048	0.28
DU11-2	0.15				0.34	0.051	0.30
DU12-1	0.37				0.34	0.13	0.75
DU12-2	0.36				0.34	0.12	0.71
DU13-1	0.39				0.34	0.13	0.77
DU13-2	0.30				0.34	0.1	0.59
DU14-1	0.73	0.91	1.2	0.93		0.24	1.3
DU14-2	0.17	0.18	0.19	0.18		0.010	0.20
DU22-1	0.044				0.34	0.015	0.088
DU22-2	0.074				0.34	0.025	0.15
DU23-1	0.62	0.78	0.89	0.77		0.14	1.0
DU23-2	0.16	0.25	0.32	0.24		0.080	0.37
DU24-1	0.060				0.34	0.020	0.12
DU24-2	0.079				0.34	0.027	0.16
DU25-1	0.81				0.34	0.28	1.6
DU25-2	0.80				0.34	0.27	1.6
DU26-1	0.13				0.34	0.044	0.26
DU26-2	0.14				0.34	0.048	0.28
DU32-1	2.1				0.34	0.71	4.2
DU32-2	1.4				0.34	0.48	2.8
DU33-1	0.59	0.68	0.30	0.53		0.20	0.87
DU33-2	0.17	0.14	0.10	0.14		0.035	0.20
DU34-1	0.25				0.34	0.085	0.50
DU34-2	0.36				0.34	0.12	0.71
DU35-1	0.84				0.34	0.29	1.7
DU35-2	1.7				0.34	0.58	3.4
DU36-1	0.18				0.34	0.061	0.36
DU36-2	0.17				0.34	0.058	0.34
DU37-1	0.18				0.34	0.061	0.36
DU37-2	0.14				0.34	0.048	0.28
Streets							
DU15-1	0.46				0.34	0.16	0.93
DU15-2	0.37				0.34	0.13	0.75
DU16-1	0.45				0.34	0.15	0.89
DU16-2	1.4				0.34	0.48	2.8
DU17-1	1.3	0.88	0.84	1.0		0.25	1.4
DU17-2	1.1	0.63	0.44	0.73		0.34	1.3
DU18-1	1.2				0.34	0.41	2.4
DU18-2	1.4				0.34	0.48	2.8
DU19-1	5.7				0.34	1.9	11

Location	PCBs				CV (a)	SD	UCL
	Repl 1	Repl 2	Repl 3	Average			
DU19-2	8.1				0.34	2.8	16
DU20-1	0.65				0.34	0.22	1.3
DU20-2	0.14				0.34	0.048	0.28
DU21-1	0.44	0.29	0.90	0.53		0.32	1.1
DU21-2	0.86	0.65	1.4	0.97		0.39	1.6
DU27-1	1.5	1.3	1.4	1.4		0.10	1.6
DU27-2	1.6	1.5	1.7	1.6		0.10	1.8
DU28-1	1.3	0.97	0.84	1.0		0.24	1.4
DU28-2	0.87	0.71	0.53	0.70		0.17	0.99
DU29-1	0.80				0.34	0.27	1.6
DU29-2	0.68				0.34	0.23	1.4
DU30-1	0.061				0.34	0.021	0.12
DU30-2	0.055				0.34	0.019	0.11
DU38-1	0.21				0.34	0.071	0.42
DU38-2	0.23				0.34	0.078	0.46

UCL>1 based on 3 replicate MIS results ("direct" UCL)

UCL>1 based on 1 MIS result ("indirect" UCL)

(a) An average CV of 0.34 is used to derive an SD value for "indirect" UCL calculations (see text for details).

REFERENCES

Integral Consulting, Inc., 2009a. Evaluation and Use of MIS Results From T117. October 16.

Integral Consulting, Inc., 2009b. Draft PCB Boundary Refinement Data Report. Lower Duwamish Waterway Superfund Site, Terminal 117 Early Action Area. October 22.

Johnson, Robert L, 2009. Argonne National Laboratory. Personal communication with Gregory L. Glass. October 22.