



Chemical Questions and Observations on Data Presented in Soil Smarts Workshops Submitted to DTSC's STREAM Platform

DTSC should be commended for finally recognizing that the single-sample, single-analyte, “cleanup-to-background” mandate of the 2010 AOC is proving difficult if not impossible to implement. DTSC further acknowledges that the not-to-exceed-background mandate of the AOC, instead of the standard EPA and DTSC risk-based approach will, quote, “*require large scale removal of soil without any measurable protection of human health*” (3 min 48 sec).¹

DTSC's first Soil Smarts workshop on November 20, 2024, and subsequent online supporting materials (cited below) presented evidence that meeting chemical look-up table values (LUTV) generated in DTSC's 2011-2013 Chemical Background Study is proving difficult to implement.

DTSC's Assessment of Background Soil Data ²

DTSC collected 295 soil samples in background locations not affected by SSFL operations and analyzed 111 chemical constituents commonly found in background soils.

“63 of the 295 (21%) background samples had at least one detection greater than a look-up table value” (1 min 28 sec). Typically, cleanup goals should be designed such that false positives occur less than 5% of the time for non-contaminated soil.

“95 of 295 (32%) background samples had at least one non-detected chemical with a detection limit greater than its look-up table value” (2 min 50 sec), Confirmation/closure sampling needs to ensure that detection limits for all analytes will be less than relevant LUTVs, otherwise “cleanup-to-background” and “not-to-exceed” objectives cannot be proven.

DTSC recognized that when 54% of background samples failed its own background test, there was a major problem.

¹ DTSC YouTube Channel, “3 - SSFL Soil Smarts - Digging into Soil Cleanup.”
<https://www.youtube.com/watch?v=iTQGcKT2KhE&list=PL12aGMtOGEbmW9hFjRgOWSEm7aAilzRAz&index=4>

² DTSC YouTube Channel, “4 - SSFL Soil Smarts - When the Test is Wrong”
<https://www.youtube.com/watch?v=GR06antAzlg&list=PL12aGMtOGEbmW9hFjRgOWSEm7aAilzRAz&index=5>



Scatter Plot for Unidentified Chemical

The scatter plot (Figure 1) initially shown in the video, “2 - SSFL Soil Smarts - Cookies and Cleanup”³ shows the widely scattered background sample results for an unidentified single chemical analyte and a very low LUTV = 2.5 ppb that illustrates the problem. The video states, “The orange dots are the non-detected values found at the detection limit for the sample. As you can see, the detection limit varies for each sample. The look-up table value (LUTV) as shown by the blue line is based on the lowest method reporting limit (MRL) achievable for the chemical in the study.” [3 min 31 sec]. This is the point at which DTSC (for chemicals) has deviated from EPA (for radionuclides) in its choice of LUTV. For radionuclides with a large number of non-detects, EPA based the LUTV on an upper estimate of the minimum detectable concentration (MDC), using the 2-sigma upper confidence limit (UCL) of the MDC. In contrast, DTSC has chosen the lowest achievable MRL.⁴ One does not have to be a statistician to recognize that it makes sense to select an LUTV that encompasses the majority of detection limits (orange dots) that would limit the number of potential false positives. By basing the LUTV on the lowest achievable MRL, DTSC has set itself up for failure. This differing approach is discussed in more detail in later sections.

Detect Data: Ignoring for the moment, the non-detect data, there are 13 detect data. 9 detect samples exceed the LUTV while 4 detect samples meet the LUTV. This looks unusual and is equivalent to $9/13 = 69\%$ false positives. Given that a cleanup goal should include a false positive DQO of $\leq 5\%$, the cleanup goal should have been computed to be somewhere between 25 and 30 ppb, ensuring that 0, or at most 1 sample, exceeds the cleanup goal.

³ DTSC YouTube Channel, “2 - SSFL Soil Smarts - Cookies and Cleanup.”

https://www.youtube.com/watch?v=lp_PnO-TgIA&list=PL12aGMtOGEbmW9hFjRgOWSEm7aAilzRAz&index=3

⁴ Laboratory analysis for chemicals typically reports a result, a method reporting limit (MRL) and a method detection limit (MDL). The MRL and the sample MDL are different quantities and should not be confused. MDLs are variable for each sample (as illustrated in Figure 1). If the result is non-detect, i.e. $<MDL$, then the result is reported to be equal to the MDL. This is called left censored data, and typically biases any parametric value to the right. Typically the MRL (an a priori measure of the lab’s detection capability) is significantly greater than the (a posteriori) sample-specific MDL, which makes the position of the LUTV relative to the range of MDLs in Figure 1, even more surprising.

Laboratory analysis for radionuclides typically reports result, $\pm 2\sigma$ error and MDC. If the result is non-detect, i.e. $<MDC$ the result is not left censored but stays as is. However, the Kaplan-Meier modeling in ProUCL will left-censor the radionuclide data and replace the result with the MDC and treat NDs in the same way as chemicals.



Non-detect Data: The presence of so many non-detect data complicates the calculation of a cleanup goal. However, the presence of such a wide range of detection limits from maybe 0.5 ppb to 27 ppb shows that the laboratory used to analyze background samples was not providing its customer with reliable results. A typical range for detection limits for a single analyte for identical soil samples should differ by no more than a factor of 2 or at most 3. A factor of 50 for detection limits indicates an out-of-control laboratory analysis protocol.

EPA's Radiological Background Study

In its Area IV Radiological Background Study, EPA contracted with Dr. Anita Singh, the author of ProUCL, to calculate parametric background threshold values (BTV) based on the 95% upper simultaneous level (USL95). EPA used a “boutique” laboratory for the relatively small number of background samples (149) to ensure that all 57 radionuclides had an acceptably low and narrow range of detection levels for each sample. For the radionuclides where there are non-detects in the background data, Dr. Singh used the Kaplan-Meier method to account for non-detect data.

DTSC had the benefit of reviewing the radionuclide data, and methodology used by EPA in the Area IV Radiological Background Study.

LUTV Equation

The LUTV equation was proposed by **EPA for radionuclides**.⁵

$$\text{LUTV} = \text{Cleanup Level} + 1.645 * U_M$$

Where ...

Cleanup level = the greater of the BTV or the **laboratory's method MDC**

BTV = background threshold value = USL95 = 95% upper simultaneous level

MDC = minimum detectable concentration

U_M = the laboratory's method uncertainty for results at the Cleanup Level

1.645 = the normal distribution quantile consistent with 5% Type I and Type II decision errors (see MARLAP for additional information)

⁵ EPA/HGL, “Final Technical Memorandum - Look-Up Table Recommendations - SSFL Area IV Radiological Study.” Page 10. November 27, 2012.

https://www.dtsc-ssfl.com/files/lib_doe_area_iv/epaareaivsurvey/miscplansandreports/65848_8-Final_Tech_Memo_Lookup_Table_Recommendations_112712.pdf.



A reasonable upper level of commercially available MDCs was provided in the cited LUTV report (Table 2 of Footnote 5 for Lab B) based on the 2-sigma upper confidence level (UCL) of MDCs for the Area IV characterization samples.

An equivalent equation is utilized by **DTSC for chemicals**.⁶

$$\text{LUTV} = \text{Cleanup Level} + 1.645 * U_M$$

Where ...

Cleanup level = the greater of the BTV or the **DTSC background study method reporting limit (BG-MRL)**

BTV = background threshold value = USL95 = 95% upper simultaneous level

U_M = the analytical measurement uncertainty of the BTV or MRL

1.645 = the normal distribution quantile consistent with 5% Type I decision error (See MARLAP for more information)

The major difference in these equations is that radionuclide LUTVs incorporate the 2-sigma upper confidence level of MDCs for the Area IV characterization samples, while chemical LUTVs incorporate the lowest achievable MRL from the background study samples (BG-MRL).

Comparison of Plots of Unidentified Chemical, Dioxin, and Radionuclide Europium-152

The scatter plot and LUTV for an unidentified chemical shown in Soil Smarts Video #2 (Figure 1) is repeated in Soil Smarts Video #4.⁷ The position of LUTV appears strange for the reasons previously discussed.

Europium-152: Figure 2 shows a similar scatter plot for the radionuclide europium-152 generated by EPA. Europium-152 has approximately the same number of background sample datapoints (150), approximately the same percentage of non-detect samples (~90%). The Europium-152 USL95 of 0.0169 pCi/g, is identified by the brown line, significantly above the majority of the datapoints. The BTV is also 0.0169 pCi/g. The

⁶ DTSC, "Chemical Look-Up Table Technical Memorandum." June 11, 2013.

https://www.dtsc-ssfl.com/files/lib_look-uptables/chemical/66073_06112013LUTand_cover.pdf.

⁷ DTSC YouTube Channel, "4 - SSFL Soil Smarts - When the Test is Wrong"

<https://www.youtube.com/watch?v=GR06antAzIq&list=PL12aGMtOGEbmW9hFjRgOWSEm7aAitzRAz&index=5>



maximum non-detect detection limit is identified by the red line as 0.0306 pCi/g. The 2-sigma UCL MDC is calculated to be 0.0459 pCi/g (see Table 2 of Footnote 5 for Lab B). Since the 2-sigma UCL MDC exceeds the BTV, the Cleanup Level is assigned to be 0.0459 pCi/g. Finally, the U_M for Lab B was included to give the Europium-152 LUTV of 0.0739 pCi/g.⁸ The radionuclide reference concentration (RRC) for Lab B was chosen by DTSC to be the draft provisional LUTV for 16 radionuclides including europium-152.

$$\begin{aligned} \text{LUTV} &= \text{Cleanup level} + 1.645 * U_M \\ \text{LUTV} &= \max(\text{BTV} : 2\sigma \text{ UCL MDC}) + 1.645 * U_M \\ \text{LUTV} &= \max(0.0169 : 0.0459) + 1.645 * 0.017 \\ \text{LUTV} &= 0.0459 + 0.0280 \\ \text{LUTV} &= 0.0739 \end{aligned}$$

Note that the measurement uncertainty, U_M , has been assigned by EPA to be 100% of the BTV.

Clearly, using the prescribed protocol for calculating LUTV, including the addition of the laboratory measurement uncertainty ensures that the LUTV is well above all background sample data points in Figure 2.

Unidentified Chemical: Visual inspection of the data points in Figure 1 for the unidentified chemical and comparing to the similar Europium-152 data point spread, it would appear that the USL95 and BTV and 2σ UCL MDL should be in the 25 to 30 ppb range. When the laboratory measurement uncertainty is added, the LUTV should be even higher.

It is not obvious why the “*lowest achievable MRL*” should be so much lower than the large spread of detection limits.

Dioxin: A second comparison may be made to DTSC background dioxin data (Figure 3).⁹ Background dioxin also has a similar 150 sample dataset and a similar large percentage of non-detect data (~90%). Using the same Kaplan-Meier statistical methodology for non-detects, DTSC calculated the USL95 to be 0.0358 ppt, indicated by the blue line that

⁸ EPA/HGL, “Development and Use of Radionuclide Reference Concentrations.” Attachment B. November 28, 2012.
https://www.dtsc-ssfl.com/files/lib_doe_area_iv/epaareaivsurvey/techdocs/67106_EPA_Final_Radiological_Characterization_of_Soils_Report_-_Appendix_K_-_RRCs.pdf.

⁹ DTSC, “Technical Memorandum - Rational and Summary for Using World Health Organization Toxicity Equivalency Approach, Santa Susana Field Laboratory, Ventura County, California.” May 21, 2013.
https://www.dtsc-ssfl.com/files/lib_look-up/tables/chemical/66070_TEQ_White_Paper.pdf.



exceeds all but three of the detect samples. This chart is unusual in that all the non-detect data are identified as having identical detection limits (MDL) of 0.005 ppt. This is unrealistic and illustrates an obvious difference in plotting non-detects between Figure 1 (2024) and Figure 3 (2013). Taking the orange non-detect data points on face value, the 2σ UCL MDL would also be 0.005 ppt since there is no variation. Repeating the LUTV calculation that was done for Europium-152 ...

$$\text{LUTV} = \text{Cleanup level} + 1.645 * U_M$$

$$\text{LUTV} = \max(\text{BTV} : 2\sigma \text{ UCL MDL}) + 1.645 * U_M$$

$$\text{LUTV} = \max(0.0358 : 0.005) + 1.645 * U_M$$

$$\text{LUTV} = 0.0358 + 1.645 * U_M$$

Without knowledge of the dioxin measurement uncertainty, it is not possible to calculate the final LUTV, but it will exceed 0.0358 ppt, perhaps exceeding the highest detection at 0.06 ppt. Clearly, the LUTV will not be in the lower portion of the plot the same as the unidentified chemical in Figure 1.

Has DTSC or DOE performed a similar comparison of radionuclide background samples to radionuclide LUTVs?

Summary

DTSC used the example of the unidentified chemical in the November 20, 2024, Soil Smarts workshop to illustrate the difficulty in implementing the 2010 AOC not-to-exceed protocol. However, the implication that more than half the background samples could not pass the not-to-exceed LUTV test themselves was hard to swallow. DTSC titled video #4 as “When the Test is Wrong.” However, I believe that the preceding has shown that the test is not inherently wrong, but the position/value of the LUTV is incorrect. The LUTV is unrealistically low because DTSC intentionally based it on the “*lowest achievable MRL.*” Can DTSC identify the unidentified chemical? Can DTSC provide the calculational steps it performed for the unidentified chemical LUTV?

Final Thoughts

I will concede that even if LUTVs for all 111 chemicals are calculated correctly, then meeting a $\leq 5\%$ false positive test for all 111 chemicals and all 16 (or 52) radionuclides, for each and every individual confirmatory/closure sample taken following remediation will be an impossible task. DTSC’s announcement that $>50\%$ of its own background samples are incorrectly identified as “contaminated” also questions the credibility of the tens of thousands of characterization samples that the RPs have taken over the past many years.



How many of these samples, that have been identified as contaminated, are in fact false positives?

The single-sample, parametric, not-to-exceed, 2010 AOC should be retired.

For chemical cleanup, DTSC should adopt and enforce the established EPA CERCLA risk assessment guidance that it uses at all other California cleanup sites.

For radiological cleanup, DTSC should adopt DOE's dose-based cleanup goal of 25 mrem/y plus ALARA standard in the recent DOE-STD-1241-2023,¹⁰ that is consistent with the Nuclear Regulatory Commission's License Termination Rule, 10 CFR 20.1402.¹¹ DTSC should adopt the confirmatory sampling protocols of the Multi-Agency Radiation Survey and Site Investigation Manual (MARSSIM).¹² MARSSIM uses non-parametric methods (e.g. Wilcoxon Rank Sum test) to compare a site sample distribution to a background sample distribution. This avoids many of the problems comparing single sample data to a single parametric level (i.e., a single value LUTV) that were identified by Dr. Hanley in the November 20, 2024, Soil Smarts workshop.

DTSC technical staff have openly stated that *"The Human and Ecological Risk Office (HERO) has previously supported and continues to support using a population-based test (such as the Wilcoxon Rank Sum Test) as a primary method to evaluate background-versus-site populations for COPC/COPEC selection on the Boeing portions of the SSFL site, consistent with HERO/DTSC guidance and USEPA guidance."*¹³ DTSC management should listen to, and heed, the advice of its technical staff who are not affected by political and activist pressure.

¹⁰ DOE Technical Standard. "Implementing Release and Clearance of Property Requirements." Section 4.7 Release of Real Property and Section 4.8 Release of Soils. March 2023.
<https://www.standards.doe.gov/standards-documents/1200/1241-AStd-2023/@@images/file>.

¹¹ NRC, 10 CFR 20.1402, "Radiological Criteria for Unrestricted Use."
<https://www.nrc.gov/reading-rm/doc-collections/cfr/part020/part020-1402.html>

¹² EPA, NRC, DOE, DOD, "Multi-Agency Radiation Survey and Site Investigation Manual (MARSSIM)." August 2000.
https://www.epa.gov/sites/default/files/2017-09/documents/marssim_manual_rev1.pdf.

¹³ DTSC/HERO, Faulkner, Brian, "Statistical Methods for Application in the Chemical Soil Background Study for the Modified Site Evaluation Approach of the AOCs (DOE and NASA) and for Risk Assessment-Based Approach (Boeing) at the Santa Susana Field Laboratory, Ventura County, CA." May 9, 2013.
https://www.dtsc-ssfl.com/files/lib_look-upables/chemical/66069_Statistical_Methods_for_Application_in_the_Chemical_Soil_background_Study.pdf.

BACKGROUND SOIL TESTING RESULTS

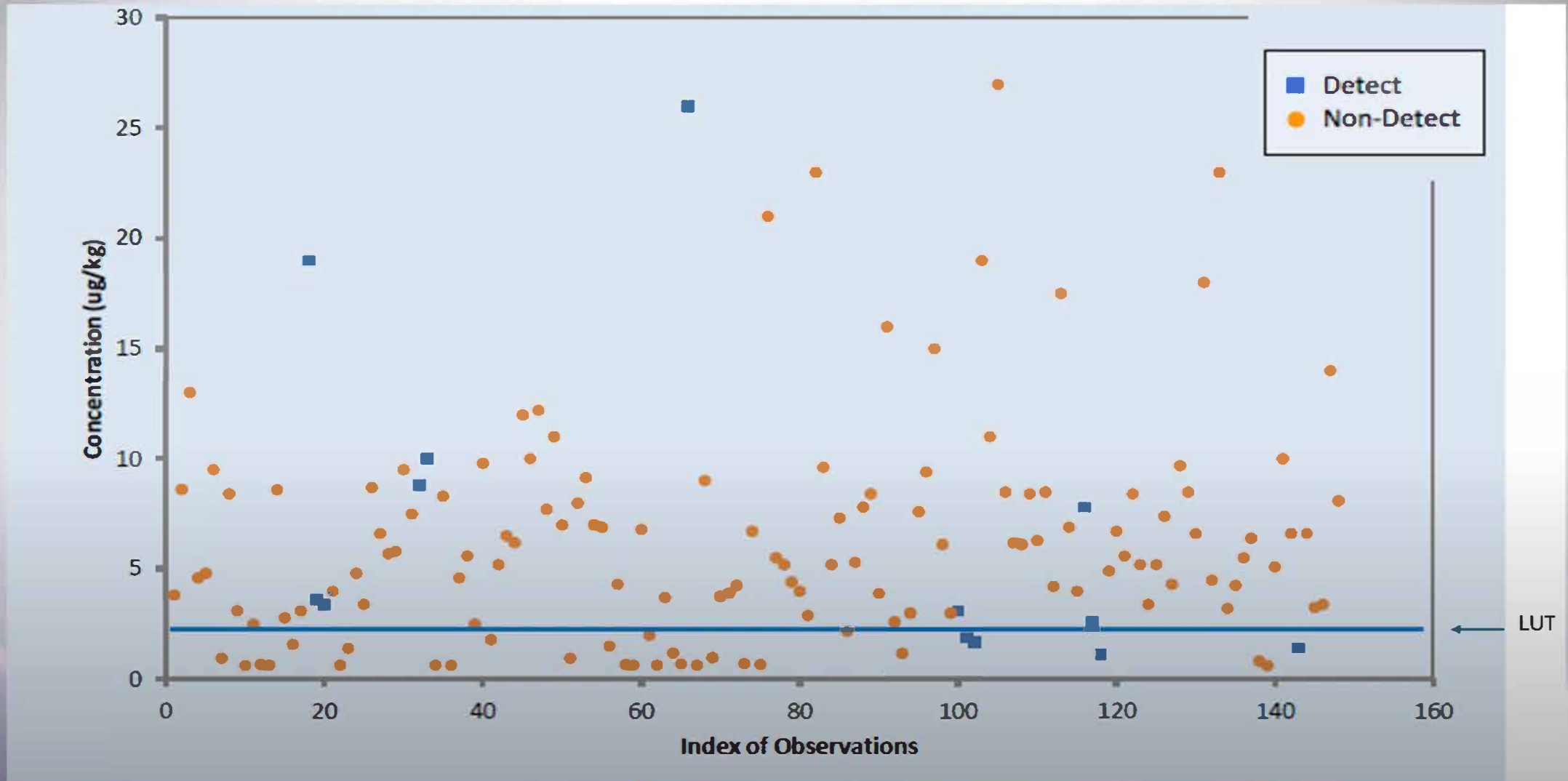
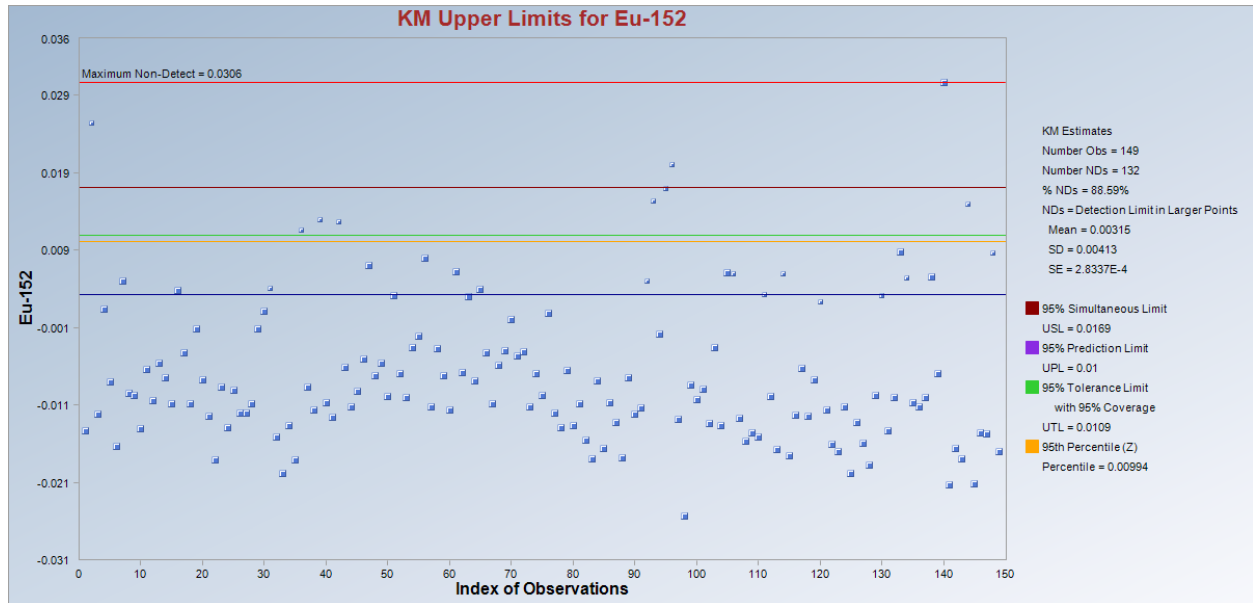
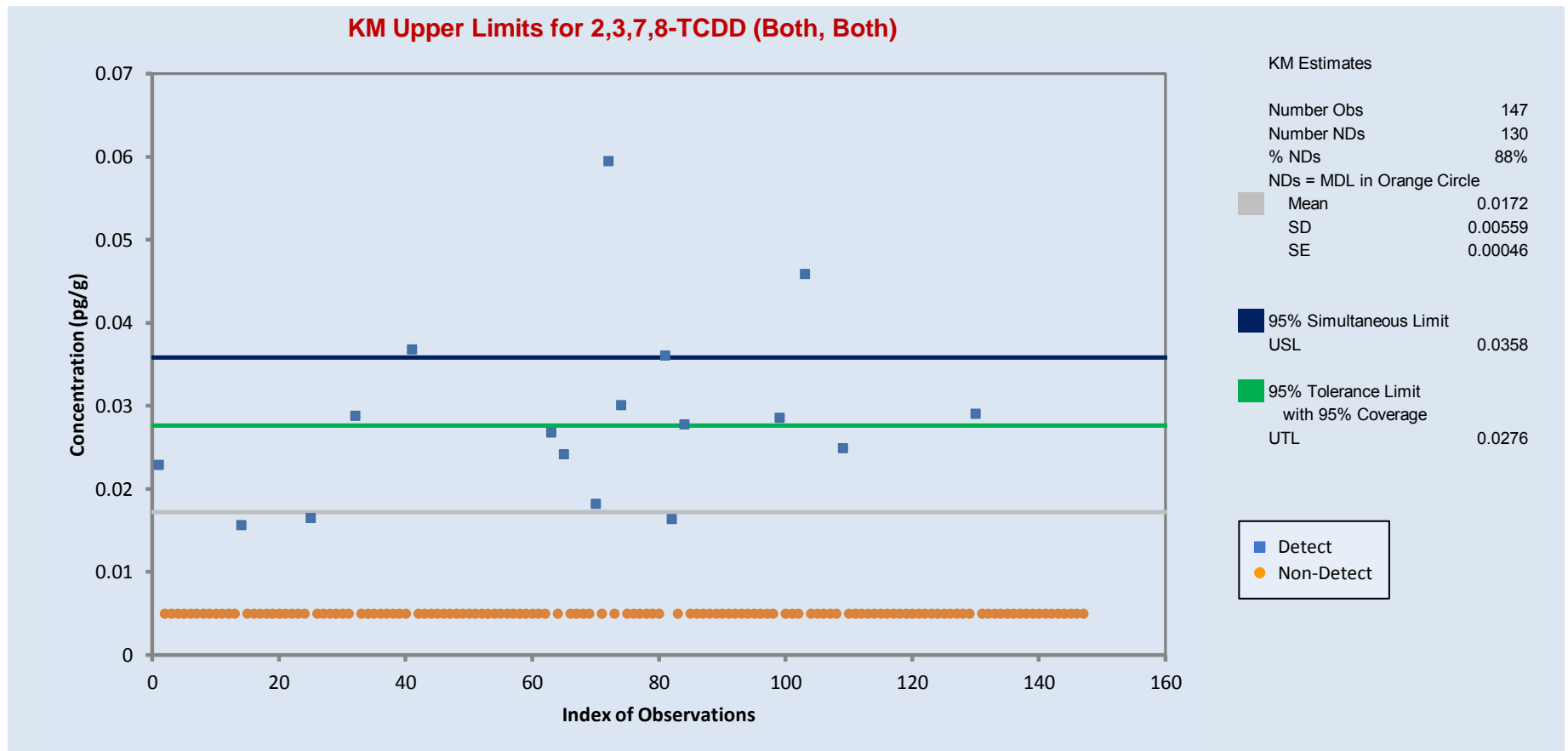


FIGURE 2



KM Method Based BTV Estimates of Eu-152 Activity in 2 Formations (using the combined data from 2 formations)

FIGURE 3



Variability within the background dataset is expected to also occur in on-site samples.

These plots illustrate that background is variable and a range of background values exists. The USL95 BTV statistically approximates the maximum. For 2,3,7,8-TCDD, the USL95 BTV < MAX. 1 outlier was identified, ranging up to 0.14 on this scale (~4X higher).