APPENDIX C3

TOTALS ANALYSIS VERSUS TOXICITY CHARACTERISTIC LEACHING PROCEDURE

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Data from totals analyses (total organic compound analysis and total metals analysis) are compared to the Regulatory Toxicity Levels (RTL) expressed as total values. RTL values are obtained by calculating the weight/weight concentration (in the solid) of a Toxicity Characteristic (TC) analyte that would give the regulatory weight/volume concentration (in the extract), assuming 100 percent analyte dissolution. Table C3-1 lists the TC levels expressed as RTL values for toxicity characteristic leaching procedure (TCLP) and totals analysis.

To demonstrate the appropriateness and conservatism of using totals analysis rather than the TCLP, consider the following example. Assume that a solid sample contains 100 milligrams per kilogram (mg/kg) of lead (Pb). The current TCLP regulatory level for Pb is 5 milligrams per liter (mg/L). This is comparable to a concentration of 5 mg/kg as demonstrated by the following calculation:

$$\frac{5 \text{ mg Pb}}{1 \text{ L solution}} \times \frac{1 \text{ L solution}}{1000 \text{ milliliters (ml) solution}} \times \frac{1 \text{ ml solution}}{1 \text{ gram (g) solution}} \times \frac{1000 \text{ g solution}}{1 \text{ kg solution}} = 5 \text{ mg Pb/kg}$$

When one compares the predicted results of totals analysis and TCLP analysis on the same sample, the following is observed:

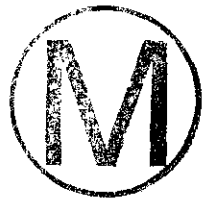
Totals Analysis

Analyzing a sample by totals analysis yields a result equal to the actual contaminant concentration in the sample (assuming that the instrument and the methodology are 100 percent accurate).

Predicted result = 100 mg Pb/kg sample

TCLP Analysis

Assuming that 5 grams [g] (0.2 ounces (oz)) of sample is extracted and analyzed, 100 g of extraction fluid must be used (TCLP requires that the weight of extraction fluid must be 20 times the weight of the solid sample). Assuming that 100 percent of the lead in the sample is leachable, and as a result, is extracted into the solution where it will be detected in the analysis, the predicted concentration of the TCLP solution will be 5 mg/kg, as demonstrated in the following calculation:



$$\frac{5\text{ g sample} \times \frac{100\text{ mg Pb}}{1\text{ kg sample}} \times \frac{1\text{ kg sample}}{1000\text{ g sample}}}{100\text{ g solution} \times \frac{1\text{ kg solution}}{1000\text{ g solution}}} = 5\text{ mg Pb/kg solution}$$

These calculations demonstrate that, by conservatively assuming a 100 percent leaching efficiency, a concentration of 100 mg/kg obtained by totals analysis is comparable to a concentration of 5 mg/kg (or 5 mg/L) using TCLP (See Figure C3-1). As such, by using a regulatory level of 100 mg/kg for totals analysis for lead (i.e., 20 times the TCLP level), the U.S. Department of Energy (DOE) is taking a conservative approach to the regulation, because a leaching efficiency of 100 percent is improbable. A comparison of the regulatory levels used for TCLP versus totals analysis for all TC analytes is presented in Table C3-1.

This approach was also addressed by the U.S. Environmental Protection Agency (EPA) in the preamble to a proposed rule issued in the Federal Register (FR) on October 24, 1991. In this preamble, the EPA stated the following:

> One could compare the numerical value of a potential TCLP standard to a theoretical maximum leaching level derived from a total constituent standard. One would have to assume that the entire amount of the toxicity characteristic constituent (as represented by the total constituent concentration at the level of the standard) would be extracted into an aqueous leaching medium. One would then have to account for the 20-fold dilution inherent in the TCLP analytical procedure. A theoretical maximum leaching value could, thus be calculated by dividing the numerical value of the total constituent treatment standard by a factor of 20 (56 FR 55167).

TABLE C3-1
RTLS FOR TCLP ANALYSIS VS. RTLS FOR TOTALS ANALYSIS

Analyte	TCLP RTL Value (mg/kg)	Totals RTL Value (mg/kg)[a]
Metals and Semi-VOCs[b]		
Arsenic	5.0	100
Barium	100.0	2000
Cadmium	1.0	20
Chromium	5.0	100
Cresols	200.0	4000
1,4-Dichlorobenzene	7.5	150
2,4-Dinitrotoluene	0.13	2.6
Hexachlorobenzene	0.13	2.6
Hexachloroethane	3.0	60
Lead	5.0	100
Mercury	0.2	4
Nitrobenzene	2.0	40
Pentachlorophenol	100.0	2000
Pyridine	5.0	100
Selenium	1.0	20
Silver	5.0	100
VOCs[c]		
Benzene	0.5	10
Carbon tetrachloride	0.5	10
Chlorobenzene	100.0	2000
Chloroform	6.0	120
1,2-Dichloroethane	0.5	10
1,1-Dichloroethylene	0.7	14
Methyl ethyl ketone	200.0	4000
Pyridine	5.0	100
Tetrachloroethylene	0.7	14
Trichloroethylene	0.5	10
Vinyl chloride	0.2	4

[a]The calculations assume 1) the maximum amount of material suggested by the TCLP is used, 2) wastes are 100 percent solid (no liquid fraction), 3) the maximum amount of extraction fluid is used, and 4) all analytes are 100 percent soluble in the extraction fluid.

[b]For metals and semi-VOCs, RTL value (mg/kg) = (TC level, mg/L) (volume of extraction fluid, 2L)/(weight of sample, 0.100 kg)

[c]For VOCs, RTL value (mg/kg) = (TC level, mg/L) (volume of extraction fluid, 0.5 L)/(weight of sample, 0.025 kg)

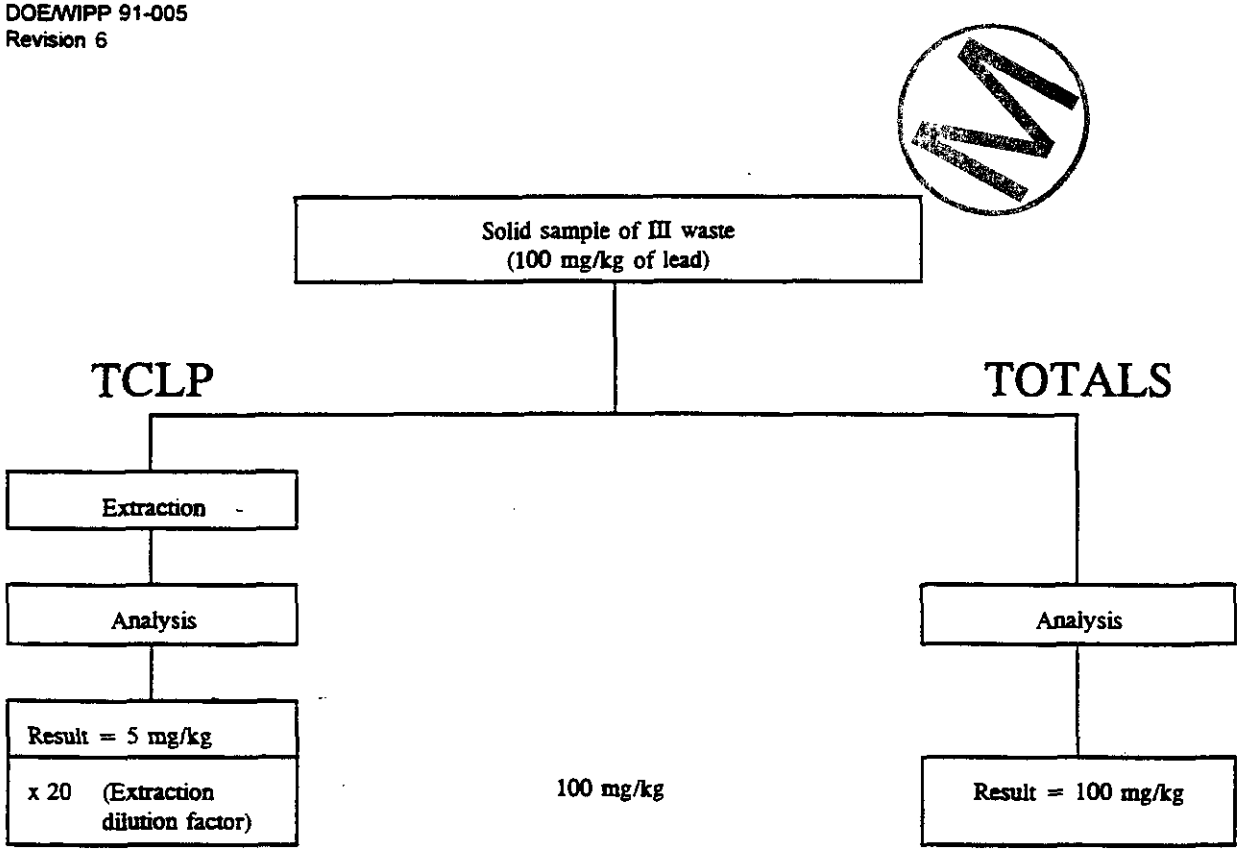


FIGURE C3-1
Comparison of TCLP and Totals Analyses for 100 mg/kg Lead Sample