Appendix B

Data Summary for Tanks WM-182 and WM-183

Appendix B
Data Summary for Tanks WM-182 and WM-183

B-1. HISTORY OF TANKS WM-182 AND WM-183

Tank WM-182 was built between 1954 and 1955. It was put into service in 1955, and was used primarily to store first-cycle raffinate wastes resulting from the processing of aluminum and zirconium nuclear fuels. Approximately 1,604,100 gal of waste from Tank WM-182 were calcined during five calcination campaigns.

Tank WM-183 was built between 1954 and 1955, and was put into service in 1958. Tank WM-183 has been filled and emptied to heel-level three times and has contained aluminum- and stainless steel-clad fuel reprocessing raffinates.

Wastes other than high-level waste and sodium-bearing waste have been introduced to the TFF (including Tanks WM-182 and WM-183). Mixed low-level waste and low-level waste were sent to the process equipment waste evaporator, and the bottoms were subsequently discharged to the TFF. Of the two tanks, WM-183 has contained the greatest variety of waste, and its heel will likely have the most precipitated solids. Tanks WM-182 and WM-183 now contain 10,800 gal and 12,100 gal of sodium-bearing waste, respectively.[a]

B-2. SAMPLING ACTIVITIES

The light-duty utility arm (LDUA), a remote sampling device, was used to collect samples directly from Tanks WM-182, WM-183, and WM-188. The liquid level in the tanks was reduced to approximately 6 to 10 inches, which allowed samples to be collected of the solids and liquids in the tank bottoms. The LDUA uses a canister-sampling device that is lowered into the waste. Drawing a vacuum on the canister collects liquid and solid samples.

The tank solids had not previously been sampled, measured, or viewed. The LDUA sampling included video of each sampling event. At the time of each sampling event for Tanks WM-182 and WM-183, the liquid levels were different and the undissolved solids were found to vary significantly. Table B-1 shows the estimated solid level and measured liquid amount in WM-182 and WM-183 at the time of sampling. These values are reported in the *Conceptual Design Report, INTEC Tank Farm Facility Closure* (INEEL 2000).

Table B-1. Liquid and solids in tanks at sampling.

Tank	Solid level (in.)	Liquid amount (gal)
WM-182	4	6,400
WM-183	8	12,800

a. Keith Quigley, INEEL, e-mail to Nick Stanisich, Portage Environmental, “Tank Volumes as of August 2001,” October 3, 2001.

The collection of characterization samples from Tanks WM-182 and WM-183 provided initial information about tank heel constituents. The chemical/radiochemical composition of both solid and liquid residuals is better understood because of this effort. In addition, this effort provided users of the LDUA the opportunity to determine its relative effectiveness in remote sampling.

The objective of tank heel characterization is to produce data suitable for meeting the closure requirements as defined by RCRA (42 U.S. Code [USC] 6901, 1976) and DOE (DOE 2001). Quality assurance (QA) objectives are those specifications that data must meet to comply with project requirements. The specific QA parameters of interest are defined as quantitative QA parameters (precision, accuracy, method detection limit, and completeness), and qualitative QA parameters (representativeness and comparability).

Sampling efforts during the initial characterization effort used the LDUA sampling device to obtain both liquid and solid samples from the heels of Tanks WM-182 and WM-183. Although there were some QA/QC problems, many of these problems were associated with performing analysis on samples with high radiation fields. Following data collection, the data were evaluated using Environmental Protection Agency functional guidelines for inorganic and organic data review.

The data collected were generally usable for decision-making. However, some data were rejected (flagged "R") because some QA/quality control (QC) parameters were not within control limits. The characterization effort for Tanks WM-182 and WM-183 is the first characterization of the tank heels. These efforts were the first to acquire data of known quality using standard Environmental Protection Agency or equivalent protocols. A significant amount of operations data has been gathered over the years. However, strict QA/QC controls on sample collection and analysis were not in place. The operations data were collected during the life of the TFF. Because of the time difference, direct comparison of operations data with the data from initial characterization efforts is not advised.

B-3. INITIAL CHARACTERIZATION DATA

B-3.1 Summary of Organic Compound Detections

Several organic compounds were detected in the heels of both tanks. Table B-2 summarizes all organic compounds detected in the tank heel residuals. Most of the organic compounds detected are generally consistent with the waste materials that were expected to contribute contaminants of concern to the tank heels.

Several liquid samples and one solid sample were taken from Tank WM-182, and several liquid and several solid samples were taken from Tank WM-183. Due to the natural breakdown of hexanone, all the detected ketones must be considered when evaluating potential contaminants of concern for closure purposes. Detections of the ketones 2-hexanone, 2-butanone, 4-methyl-2-pentanone, and acetone correlate to the extensive usage of hexanone as a process solvent/extractant and its degradation within both tanks.

In the samples taken from Tank WM-182, all four ketones were detected. 2-hexanone was detected in the solid sample. From the liquid samples, acetone was detected five times, 2-butanone was detected three times, 4-methyl-2-pentanone was detected two times, and 2-hexanone was detected once. Of the four ketones of concern, acetone was detected most often and was found with concentrations above 100 μg/L (see Table B-2). In Tank WM-183, however, the only ketone detected was acetone, with one detection in the liquid samples and two in the solid samples.

Table B-2. Organic results for samples.

Tank ID (WM-###)	Sample ID #	Matrix Type	Analyte	Concentration	Concentration Units	Validation Flag [a]
182	9910262-SV-LIQ RE	Water	2,4-dinitrophenol	260	μg/L	J
182	9910272-SV-LIQ	Water	2,4-dinitrophenol	66	μg/L	J
182	9911081-SV-LIQ	Water	2,4-dinitrophenol	52	μg/L	J
182	9910262-SV-LIQ	Water	2,4-dinitrophenol	260	μg/L	R
182	9910262-VOA-LIQ	Water	2-butanone	10	μg/L	J
182	9911014-VOA-LIQRE	Water	2-butanone	9	μg/L	J
182	WM182- SOLID COMP DL	Water	2-butanone	180	μg/L	R
182	WM:182 SOL COMP	Soil	2-hexanone	34	μg/kg	R
182	WM182- SOLID COMP DL	Water	2-hexanone	140	μg/L	R
182	WM182- SOLID COMP	Water	4-methyl-2-pentanone	14	μg/L	R
182	WM182- SOLID COMP DL	Water	4-methyl-2-pentanone	59	μg/L	R
182	9910262-VOA-LIQ	Water	Acetone	110	μg/L	J
182	9910272-VOA-LIQRE	Water	Acetone	230	μg/L	EJ
182	9910272-VOA-LIQDL	Water	Acetone	120	μg/L	J
182	9911014-VOA-LIQDL5	Water	Acetone	110	μg/L	J
182	9911014-VOA-LIQRE	Water	Acetone	97	μg/L	J
183	WM183-SOLID-TOTAL	Solid	Acetone	78	μg/kg	J
183	WM183-SOLID-TOTALDL10	Solid	Acetone	170	μg/kg	J
183	WM183-011700-PROTO	Water	Acetone	49	μg/L	
183	WM: 183 SOL-TOT	Soil	Aroclor-1260	1600	μg/kg	R
183	WM: 183 SOL-TOT B	Soil	Aroclor-1260	1400	μg/kg	R
183	0001175-PCB-LIQ	Water	Aroclor-1260	2.8	μg/L	J
183	0001175-PCB-LIQB	Water	Aroclor-1260	2.5	μg/L	J
182	9910262-VOA-LIQ-TB	Water	Benzene	5	μg/L	J
182	9910272-VOA-LIQRE	Water	Benzene	11	μg/L	
182	9910272-VOA-LIQDL	Water	Benzene	84	μg/L	J
182	9911014-VOA-LIQDL5	Water	Bromomethane	98	μg/L	J
182	9911014-VOA-LIQRE	Water	Chloroethane	8	μg/L	J
182	9910272-VOA-LIQDL	Water	Chloromethane	34	μg/L	J
182	9911014-VOA-LIQDL5	Water	Chloromethane	220	μg/L	J
182	9911014-VOA-LIQRE	Water	Chloromethane	530	μg/L	EJ
182	WM182- SOLID COMP DL	Water	Chloromethane	27	μg/L	R
183	WM183-011700-PROTO	Water	Chloromethane	42	μg/L	J
182	9910262-VOA-LIQ	Water	Ethylbenzene	4	μg/L	J
182	9910272-VOA-LIQRE	Water	Methylene chloride	3	μg/L	J
183	WM183-SOLID-TOTAL	Solid	Methylene chloride	80	μg/kg	J
183	WM183-SOLID-TOTALDL10	Solid	Methylene chloride	130	μg/kg	J
182	9910262-VOA-LIQ	Water	m-xylene and p-xylene	14	μg/L	J
182	9910262-SV-LIQ RE	Water	N-nitrosodimethylamine	31	μg/L	J
182	9910272-SV-LIQ	Water	N-nitrosodimethylamine	16	μg/L	J

Table B-2. (continued).

Tank ID (WM-###)	Sample ID #	Matrix Type	Analyte	Concentration	Concentration Units	Validation Flag [a]
182	WM182- SOLID COMP	Water	Toluene	8	μg/L	R
182	WM182- SOLID COMP DL	Water	Toluene	22	μg/L	R
182	9910262-SV-LIQ RE	Water	Tri-n-butylphosphate	50	μg/L	J
183	WM: 183 SOLID-TOTAL	Soil	Tri-n-butylphosphate	8,600	μg/kg	R

a. E = exceeds instrument calibration range
J = estimated concentration
R = concentration is rejected quantitatively.

Chlorinated organic compounds were also detected in the samples taken from both tanks. Detections of chlorinated compounds such as chloromethane, chloroethane, and methylene chloride are consistent with process information, which indicates that chlorinated solvents such as carbon tetrachloride, 1,1,1-trichloroethane, and trichloroethylene were likely present in the process stream. The detection of lower-order chlorinated materials may have resulted from the degradation of process solvents, and they must be considered as possible contaminants of concern because carbon tetrachloride, 1,1,1-trichloroethane, and trichloroethylene are constituents for which the TFF wastes have been assigned RCRA-listed hazardous waste numbers (Gilbert and Venneman 1999).

Because detections of other, similar chlorinated organic compounds were made within the tank heel materials, methylene chloride also must be considered as a possible contaminant of concern. Based on process information, the semivolatile organic compound N-nitosodimethylamine also is consistent when considered as a possible degradation product of pyridine. From Tank WM-182 liquid samples, there was one detection each of methylene chloride and chloroethane, two detections of N-nitosodimethylamine, and four detections of chloromethane. From Tank WM-183, there were two detections of methylene chloride in the solid samples and one detection of chloromethane in the liquid samples. Most concentrations detected were below 100 μg/L. Two detections of chloromethane from Tank WM-182 samples and for methylene chloride from the Tank WM-183 samples were above 100 μg/L.

Additional volatile organic compounds such as benzene, ethylbenzene, and toluene were also identified by the TFF process evaluation as likely contaminants of concern in the tank heels. Benzene, ethyl benzene, xylene, and toluene were all detected in tank WM-182 residuals. Benzene and toluene are associated with RCRA-listed hazardous wastes that are included in the RCRA-listed hazardous waste numbers (Gilbert and Venneman 1999). Therefore, their presence along with other aromatics, must be considered as potential contaminants of concern.

Related to the detections of these aromatics were the detections of 2,4-dinitrophenol in WM-182 liquids. Because of the excessive concentration of nitrate ions available in the residual liquids, the mechanism exists for the formation of 2,4-Dinitrophenol from the existing benzene, ethylbenzene, and toluene in Tank WM-182. Therefore, its presence also must be considered significant, and it should be evaluated as a contaminant of concern.

Aroclor-1260 was detected in WM-183 solids samples and in liquids in that tank. The reported concentrations in solid materials far exceed the levels in the liquid residuals.

Two detections of tri-n-butylphosphate were noted, one for WM-182 liquids and one for WM-183 solids. This compound was historically used as a chelating agent in decontamination solvents; therefore, its presence is consistent with past practices at INTEC, and the compound must be considered a viable contaminant of concern in the tank heel system.

Finally, a single detection in WM-182 liquids for bromomethane is consistent with historical data collected from TFF. Bromomethane is likely a degradation product, which falls between two compounds during normal degradation. Although bromide was not analyzed as part of the initial characterization sampling and analysis effort, historical data indicate the presence of bromide within the system and parent compounds from which bromomethane would have been formed.

B-3.2 Inorganic Detections and Physical Parameters

A significant number of detections were made for target metals measured in tank heel residuals for both WM-182 and WM-183. Table B-3 summarizes the positive metals detections found in tank heel residual solids and liquids. Table B-4 summarizes detectable concentrations for anion analyses performed in support of the initial characterization effort.

The metals detected in Tanks WM-182 and WM-183 are consistent with process knowledge. Chromium (24 mg/L), lead (6 mg/L), cadmium (5 mg/L), and mercury (17 mg/L) in Tank WM-183 solids were detected in concentrations that exceed maximum concentrations of contaminants for the toxicity characteristic (40 CFR 261.24, 2001). The mercury toxicity characteristic leaching procedure (TCLP) concentration was rejected during data validation and is, therefore, considered questionable.

In Tank WM-182 solids, only mercury (3 mg/L) and cadmium (2 mg/L) exceeded the concentrations of the toxicity characteristic standards. The RCRA toxicity characteristic regulatory concentration levels are 0.2 mg/L for mercury, 1.0 mg/L for cadmium, 5.0 mg/L for chromium, and 5.0 mg/L for lead.

The concentrations of metals in solution are generally greater in WM-183. The metals concentrations in the liquid phase and the possible inability to remove all liquids may account for the higher TCLP values and the more frequent detections above the toxicity characteristic limits. Concentrations of metals in solids were generally 2 to 3 orders of magnitude greater than the concentrations in solution.

The detectable anions in the WM-182 and WM-183 tank heels are chloride, fluoride, nitrate, sulfate, and phosphate (see Table B-4). Five samples were taken from WM-183; only one sample was taken from WM-182. In the WM-183 tank heel, phosphate was detected in the solid sample and B-acid was detected in the liquid samples.

B-3.3 Statistical Analysis of Initial Characterization Data

Statistical analysis was performed on the data to investigate the properties of the contents of WM-182 and WM-183 using various methods. The primary goal of the analysis was to determine the sample size required to meet the data quality objective requirements for each analyte. The secondary goal of the analysis was to examine how the concentrations of the tested constituents varied between tanks. Ratios also were calculated to analyze the difference in concentrations of analytes between the solid matrix and the liquid matrix for the metals in each tank. This section provides information on the type of statistical analysis that was performed, as well as a summary of results from this analysis. There was insufficient organic data to perform a statistical analysis for those analytes.

Table B-3. Inorganic results for samples.

Tank ID (WM-###)	Sample ID#	Matrix	Analyte	Concentration	Concentration Units	Validation Flags [a]
182	WM182 SOLID COMP TOTALS	Solid	Aluminum	2.19E+04	mg/kg	J
182	9910262 LIQUID	Water	Aluminum	8.05E+06	µg/L	
182	9910272 LIQUID	Water	Aluminum	7.68E+06	µg/L	
182	9911081 LIQUID	Water	Aluminum	7.52E+06	µg/L	
182	9911082 LIQUID	Water	Aluminum	8.03E+06	µg/L	
183	WM183-SOLID-TOTAL	Solid	Aluminum	2.49E+04	mg/kg	
183	0001125-LIQUID	Water	Aluminum	1.19E+07	µg/L	
183	0001175-LIQUID	Water	Aluminum	1.06E+07	µg/L	
183	0001191-LIQUID	Water	Aluminum	1.44E+07	µg/L	
183	0001192-LIQUID	Water	Aluminum	9.47E+06	µg/L	
183	WM183-SOLID-TOTAL	Solid	Antimony	3.20E+01	mg/kg	J
183	0001125-LIQUID	Water	Antimony	4.70E+02	µg/L	
183	0001175-LIQUID	Water	Antimony	6.70E+02	µg/L	
183	0001191-LIQUID	Water	Antimony	3.40E+02	µg/L	
183	0001192-LIQUID	Water	Antimony	4.70E+02	µg/L	
182	WM182 SOLID COMP TOTALS	Solid	Arsenic	2.81E+02	mg/kg	J
183	WM183-SOLID-TOTAL	Solid	Arsenic	5.56E+01	mg/kg	J
183	0001125-LIQUID	Water	Arsenic	7.90E+02	µg/L	
183	0001191-LIQUID	Water	Arsenic	4.80E+02	µg/L	
183	0001192-LIQUID	Water	Arsenic	4.70E+02	µg/L	
182	WM182 SOLID COMP TOTALS	Solid	Barium	1.27E+02	mg/kg	
182	WM182 SOLID COMP	TCLP	Barium	2.44E+02	µg/L	
182	9910262 LIQUID	Water	Barium	3.49E+03	µg/L	
182	9910272 LIQUID	Water	Barium	3.33E+03	µg/L	
182	9911081 LIQUID	Water	Barium	3.47E+03	µg/L	
182	9911082 LIQUID	Water	Barium	3.52E+03	µg/L	
183	WM183-SOLID-TOTAL	Solid	Barium	2.36E+01	mg/kg	
183	WM183-SOLID-TCLP	TCLP	Barium	7.76E+02	µg/L	
183	WM: 183 LIQ	Water	Barium	5.15E+03	µg/L	
183	0001125-LIQUID	Water	Barium	6.92E+03	µg/L	
183	0001175-LIQUID	Water	Barium	6.53E+03	µg/L	
183	0001191-LIQUID	Water	Barium	8.39E+03	µg/L	
183	0001192-LIQUID	Water	Barium	5.85E+03	µg/L	
182	9910262 LIQUID	Water	Beryllium	3.03E+01	µg/L	
182	9910272 LIQUID	Water	Beryllium	3.03E+01	µg/L	
182	9911081 LIQUID	Water	Beryllium	3.03E+01	µg/L	
182	9911082 LIQUID	Water	Beryllium	3.03E+01	µg/L	
183	0001125-LIQUID	Water	Beryllium	6.00E+01	µg/L	
183	0001175-LIQUID	Water	Beryllium	5.00E+01	µg/L	
183	0001191-LIQUID	Water	Beryllium	7.00E+01	µg/L	

Table B-3. (continued).

Tank ID (WM-###)	Sample ID#	Matrix	Analyte	Concentration	Concentration Units	Validation Flags [a]
183	0001192-LIQUID	Water	Beryllium	5.00E+01	µg/L	
182	WM182 SOLID COMP TOTALS	Solid	Cadmium	3.25E+02	mg/kg	J
182	WM182 SOLID COMP	TCLP	Cadmium	2.19E+03	µg/L	
182	9910262 LIQUID	Water	Cadmium	6.09E+04	µg/L	
182	9910272 LIQUID	Water	Cadmium	5.97E+04	µg/L	
182	9911081 LIQUID	Water	Cadmium	6.02E+04	µg/L	
182	9911082 LIQUID	Water	Cadmium	6.08E+04	µg/L	
183	WM183-SOLID-TOTAL	Solid	Cadmium	1.42E+02	mg/kg	
183	WM183-SOLID-TCLP	TCLP	Cadmium	5.85E+03	µg/L	
183	WM: 183 LIQ	Water	Cadmium	7.29E+04	µg/L	
183	0001125-LIQUID	Water	Cadmium	8.31E+04	µg/L	
183	0001175-LIQUID	Water	Cadmium	7.50E+04	µg/L	
183	0001191-LIQUID	Water	Cadmium	9.29E+04	µg/L	
183	0001192-LIQUID	Water	Cadmium	7.00E+04	µg/L	
182	WM182 SOLID COMP TOTALS	Solid	Calcium	1.76E+03	mg/kg	J
182	9910262 LIQUID	Water	Calcium	5.24E+05	µg/L	
182	9910272 LIQUID	Water	Calcium	5.02E+05	µg/L	
182	9911081 LIQUID	Water	Calcium	5.02E+05	µg/L	
182	9911082 LIQUID	Water	Calcium	5.13E+05	µg/L	
183	WM183-SOLID-TOTAL	Solid	Calcium	1.87E+03	mg/kg	
183	0001125-LIQUID	Water	Calcium	1.09E+06	µg/L	
183	0001175-LIQUID	Water	Calcium	9.46E+05	µg/L	
183	0001191-LIQUID	Water	Calcium	1.29E+06	µg/L	
183	0001192-LIQUID	Water	Calcium	8.36E+05	µg/L	
182	WM182 SOLID COMP TOTALS	Solid	Chromium	5.52E+02	mg/kg	
182	WM182 SOLID COMP	TCLP	Chromium	1.87E+03	µg/L	
182	9910262 LIQUID	Water	Chromium	1.01E+05	µg/L	
182	9910272 LIQUID	Water	Chromium	9.66E+04	µg/L	
182	9911081 LIQUID	Water	Chromium	9.82E+04	µg/L	
182	9911082 LIQUID	Water	Chromium	1.00E+05	µg/L	
183	WM183-SOLID-TOTAL	Solid	Chromium	9.49E+02	mg/kg	
183	WM183-SOLID-TCLP	TCLP	Chromium	2.46E+04	µg/L	
183	WM: 183 LIQ	Water	Chromium	2.61E+05	µg/L	J
183	0001125-LIQUID	Water	Chromium	4.48E+05	µg/L	
183	0001175-LIQUID	Water	Chromium	3.88E+05	µg/L	
183	0001191-LIQUID	Water	Chromium	5.99E+05	µg/L	
183	0001192-LIQUID	Water	Chromium	3.33E+05	µg/L	
182	9910262 LIQUID	Water	Cobalt	8.68E+02	µg/L	
182	9910272 LIQUID	Water	Cobalt	8.78E+02	µg/L	
182	9911081 LIQUID	Water	Cobalt	8.37E+02	µg/L	
182	9911082 LIQUID	Water	Cobalt	8.78E+02	µg/L	

Table B-3. (continued).

Tank ID (WM-###)	Sample ID#	Matrix	Analyte	Concentration	Concentration Units	Validation Flags [a]
183	WM183-SOLID-TOTAL	Solid	Cobalt	9.30E+00	mg/kg	
183	0001125-LIQUID	Water	Cobalt	5.35E+03	µg/L	
183	0001175-LIQUID	Water	Cobalt	4.75E+03	µg/L	
183	0001191-LIQUID	Water	Cobalt	6.49E+03	µg/L	
183	0001192-LIQUID	Water	Cobalt	4.38E+03	µg/L	
182	9910262 LIQUID	Water	Copper	1.29E+04	µg/L	J
182	9910272 LIQUID	Water	Copper	1.68E+04	µg/L	J
182	9911081 LIQUID	Water	Copper	1.33E+04	µg/L	J
182	9911082 LIQUID	Water	Copper	1.24E+04	µg/L	J
183	WM183-SOLID-TOTAL	Solid	Copper	1.66E+02	mg/kg	
183	0001125-LIQUID	Water	Copper	1.10E+05	µg/L	
183	0001175-LIQUID	Water	Copper	7.86E+04	µg/L	
183	0001191-LIQUID	Water	Copper	6.82E+04	µg/L	
183	0001192-LIQUID	Water	Copper	3.80E+04	µg/L	
182	WM182 SOLID COMP TOTALS	Solid	Iron	4.48E+03	mg/kg	
182	9910262 LIQUID	Water	Iron	6.25E+05	µg/L	
182	9910272 LIQUID	Water	Iron	5.95E+05	µg/L	
182	9911081 LIQUID	Water	Iron	6.32E+05	µg/L	
182	9911082 LIQUID	Water	Iron	6.48E+05	µg/L	
183	WM183-SOLID-TOTAL	Solid	Iron	1.80E+04	mg/kg	
183	0001125-LIQUID	Water	Iron	1.95E+06	µg/L	
183	0001175-LIQUID	Water	Iron	1.68E+06	µg/L	
183	0001191-LIQUID	Water	Iron	2.48E+06	µg/L	
183	0001192-LIQUID	Water	Iron	1.52E+06	µg/L	
182	WM182 SOLID COMP TOTALS	Solid	Lead	3.69E+02	mg/kg	
182	9910262 LIQUID	Water	Lead	7.28E+04	µg/L	
182	9910272 LIQUID	Water	Lead	7.07E+04	µg/L	
182	9911081 LIQUID	Water	Lead	7.32E+04	µg/L	
182	9911082 LIQUID	Water	Lead	7.40E+04	µg/L	
183	WM183-SOLID-TOTAL	Solid	Lead	2.74E+02	mg/kg	
183	WM183-SOLID-TCLP	TCLP	Lead	6.75E+03	µg/L	
183	WM: 183 LIQ	Water	Lead	1.22E+05	µg/L	
183	0001125-LIQUID	Water	Lead	1.58E+05	µg/L	
183	0001175-LIQUID	Water	Lead	1.35E+05	µg/L	
183	0001191-LIQUID	Water	Lead	1.80E+05	µg/L	
183	0001192-LIQUID	Water	Lead	1.17E+05	µg/L	
182	WM182 SOLID COMP TOTALS	Solid	Magnesium	4.10E+02	mg/kg	
182	9910262 LIQUID	Water	Magnesium	1.01E+05	µg/L	
182	9910272 LIQUID	Water	Magnesium	9.59E+04	µg/L	
182	9911081 LIQUID	Water	Magnesium	9.44E+04	µg/L	
182	9911082 LIQUID	Water	Magnesium	9.39E+04	µg/L	

Table B-3. (continued).

Tank ID (WM-###)	Sample ID#	Matrix	Analyte	Concentration	Concentration Units	Validation Flags [a]
183	WM183-SOLID-TOTAL	Solid	Magnesium	4.34E+02	mg/kg	
183	0001125-LIQUID	Water	Magnesium	2.08E+05	µg/L	
183	0001175-LIQUID	Water	Magnesium	1.81E+05	µg/L	
183	0001191-LIQUID	Water	Magnesium	2.33E+05	µg/L	
183	0001192-LIQUID	Water	Magnesium	1.60E+05	µg/L	
182	WM182 SOLID COMP TOTALS	Solid	Manganese	5.65E+02	mg/kg	
182	9910262 LIQUID	Water	Manganese	2.39E+05	µg/L	
182	9910272 LIQUID	Water	Manganese	2.28E+05	µg/L	
182	9911081 LIQUID	Water	Manganese	2.23E+05	µg/L	
182	9911082 LIQUID	Water	Manganese	2.29E+05	µg/L	
183	WM183-SOLID-TOTAL	Solid	Manganese	7.40E+02	mg/kg	
183	0001125-LIQUID	Water	Manganese	4.67E+05	µg/L	
183	0001175-LIQUID	Water	Manganese	3.96E+05	µg/L	
183	0001191-LIQUID	Water	Manganese	5.72E+05	µg/L	
183	0001192-LIQUID	Water	Manganese	3.65E+05	µg/L	
182	WM182 SOLID COMP TOTALS	Solid	Mercury	3.10E+02	mg/kg	
182	WM182 SOLID COMP	TCLP	Mercury	3.13E+03	µg/L	J
182	WM182-SOLID-COMPR	TCLP	Mercury	3.16E+03	µg/L	J
182	9910262 LIQUID	Water	Mercury	1.78E+05	µg/L	
182	9910272 LIQUID	Water	Mercury	1.59E+05	µg/L	
182	9911081 LIQUID	Water	Mercury	1.72E+05	µg/L	
183	WM183-SOLID-TOTAL	Solid	Mercury	3.24E+02	mg/kg	
183	WM183-SOLID-TCLP	TCLP	Mercury	1.73E+04	µg/L	R
183	WM: 183 LIQ	Water	Mercury	3.30E+05	µg/L	J
183	0001125-LIQUID	Water	Mercury	4.40E+05	µg/L	
183	0001175-LIQUID	Water	Mercury	2.68E+05	µg/L	
183	0001191-LIQUID	Water	Mercury	3.78E+05	µg/L	
183	0001192-LIQUID	Water	Mercury	3.04E+05	µg/L	
182	WM182 SOLID COMP TOTALS	Solid	Nickel	3.09E+02	mg/kg	
182	WM182 SOLID COMP	TCLP	Nickel	2.89E+03	µg/L	
182	9910262 LIQUID	Water	Nickel	5.05E+04	µg/L	
182	9910272 LIQUID	Water	Nickel	5.00E+04	µg/L	
182	9911081 LIQUID	Water	Nickel	4.88E+04	µg/L	
182	9911082 LIQUID	Water	Nickel	5.09E+04	µg/L	
183	WM183-SOLID-TOTAL	Solid	Nickel	4.17E+02	mg/kg	
183	WM183-SOLID-TCLP	TCLP	Nickel	1.70E+04	µg/L	
183	WM: 183 LIQ	Water	Nickel	1.46E+05	µg/L	
183	0001125-LIQUID	Water	Nickel	2.33E+05	µg/L	
183	0001175-LIQUID	Water	Nickel	1.90E+05	µg/L	
183	0001191-LIQUID	Water	Nickel	2.66E+05	µg/L	
183	0001192-LIQUID	Water	Nickel	1.83E+05	µg/L	

Table B-3. (continued).

Tank ID (WM-###)	Sample ID#	Matrix	Analyte	Concentration	Concentration Units	Validation Flags [a]
182	WM182 SOLID COMP TOTALS	Solid	Selenium	9.11E+01	mg/kg	J
183	0001192-LIQUID	Water	Selenium	2.80E+02	µg/L	
182	WM182 SOLID COMP TOTALS	Solid	Silver	6.47E+01	mg/kg	J
182	WM182 SOLID COMP	TCLP	Silver	4.60E+01	µg/L	J
182	9911082 LIQUID	Water	Silver	2.32E+02	µg/L	
183	WM183-SOLID-TOTAL	Solid	Silver	2.20E+02	mg/kg	
183	WM183-SOLID-TCLP	TCLP	Silver	6.96E+02	µg/L	
183	WM: 183 LIQ	Water	Silver	2.22E+02	µg/L	J
183	0001125-LIQUID	Water	Silver	6.10E+02	µg/L	
183	0001175-LIQUID	Water	Silver	3.60E+02	µg/L	
183	0001191-LIQUID	Water	Silver	8.10E+02	µg/L	
183	0001192-LIQUID	Water	Silver	4.20E+02	µg/L	
183	0001125-LIQUID	Water	Thallium	1.16E+03	µg/L	
183	0001175-LIQUID	Water	Thallium	3.90E+02	µg/L	
183	0001191-LIQUID	Water	Thallium	1.11E+03	µg/L	
183	0001192-LIQUID	Water	Thallium	7.60E+02	µg/L	
182	WM182 SOLID COMP TOTALS	Solid	Vanadium	1.33E+01	mg/kg	
182	9910262 LIQUID	Water	Vanadium	4.84E+02	µg/L	
182	9910272 LIQUID	Water	Vanadium	5.25E+02	µg/L	
182	9911081 LIQUID	Water	Vanadium	4.94E+02	µg/L	
182	9911082 LIQUID	Water	Vanadium	4.54E+02	µg/L	
183	WM183-SOLID-TOTAL	Solid	Vanadium	1.07E+01	mg/kg	
183	0001125-LIQUID	Water	Vanadium	1.76E+03	µg/L	
183	0001175-LIQUID	Water	Vanadium	1.53E+03	µg/L	
183	0001191-LIQUID	Water	Vanadium	2.04E+03	µg/L	
183	0001192-LIQUID	Water	Vanadium	1.34E+03	µg/L	
182	WM182 SOLID COMP TOTALS	Solid	Zinc	1.79E+02	mg/kg	
182	9910262 LIQUID	Water	Zinc	2.32E+04	µg/L	
182	9910272 LIQUID	Water	Zinc	3.60E+04	µg/L	
182	9911081 LIQUID	Water	Zinc	2.58E+04	µg/L	
182	9911082 LIQUID	Water	Zinc	2.25E+04	µg/L	
183	WM183-SOLID-TOTAL	Solid	Zinc	1.48E+02	mg/kg	
183	0001125-LIQUID	Water	Zinc	9.52E+04	µg/L	
183	0001175-LIQUID	Water	Zinc	7.59E+04	µg/L	
183	0001191-LIQUID	Water	Zinc	7.04E+04	µg/L	
183	0001192-LIQUID	Water	Zinc	4.64E+04	µg/L	

a. J = estimated concentration

R = concentration is rejected quantitatively

Table B-4. Detectable anion results.

Tank ID (WM-###)	Sample ID#	Matrix	Analyte	Concentration	Concentration Units	Validation Flags [a]
183	0001125-LIQUID	Water	B-Acid	2.50E+00	mg/L	
183	0001175-LIQUID	Water	B-Acid	2.40E+00	mg/L	
183	0001191-LIQUID	Water	B-Acid	2.50E+00	mg/L	
183	0001192-LIQUID	Water	B-Acid	2.40E+00	mg/L	
182	WM182 SOLID COMP	Water Extract	Chloride	2.02E+03	mg/kg	J
183	WM183-SOLID-TOTAL	Solid	Chloride	1.31E+03	mg/kg	
183	0001125-LIQUID	Water	Chloride	3.11E+02	mg/L	
183	0001175-LIQUID	Water	Chloride	2.93E+02	mg/L	
183	0001191-LIQUID	Water	Chloride	3.08E+02	mg/L	
183	0001192-LIQUID	Water	Chloride	2.52E+02	mg/L	
182	WM182 SOLID COMP	Water Extract	Fluoride	1.49E+04	mg/kg	J
183	WM183-SOLID-TOTAL	Solid	Fluoride	4.37E+03	mg/kg	
183	0001125-LIQUID	Water	Fluoride	8.27E+02	mg/L	
183	0001175-LIQUID	Water	Fluoride	7.32E+02	mg/L	
183	0001191-LIQUID	Water	Fluoride	6.62E+02	mg/L	
183	0001192-LIQUID	Water	Fluoride	6.03E+02	mg/L	
182	WM182 SOLID COMP	Water Extract	Nitrate	7.07E+04	mg/kg	R
183	WM183-SOLID-TOTAL	Solid	Nitrate	1.75E+05	mg/kg	
183	0001125-LIQUID	Water	Nitrate	1.09E+05	mg/L	
183	0001175-LIQUID	Water	Nitrate	1.91E+05	mg/L	
183	0001191-LIQUID	Water	Nitrate	2.01E+05	mg/L	
183	0001192-LIQUID	Water	Nitrate	1.83E+05	mg/L	
182	WM182 SOLID COMP	Water Extract	Phosphate	6.84E+04	mg/kg	J
183	WM183-SOLID-TOTAL	Solid	Phosphate	1.26E+05	mg/kg	
182	WM182 SOLID COMP	Water Extract	Sulfate	3.32E+04	mg/kg	J
183	WM183-SOLID-TOTAL	Solid	Sulfate	1.36E+04	mg/kg	
183	0001125-LIQUID	Water	Sulfate	1.44E+03	mg/L	
183	0001175-LIQUID	Water	Sulfate	2.36E+03	mg/L	
183	0001191-LIQUID	Water	Sulfate	2.58E+03	mg/L	
183	0001192-LIQUID	Water	Sulfate	2.25E+03	mg/L	

a. J = estimated concentration
R = concentration is rejected quantitatively

B-3.3.1 Tank Comparison

This section provides a description of the statistical methods that were applied to the data to compare WM-182 and WM-183 and the justification for each method. Data were analyzed separately for each tank and in some instances for both tanks combined. Data from the liquid matrix was always analyzed separately from the data for the solid matrix.

B-3.3.1.1 Histograms. A histogram is a graphic representation of the quantitative data that separates the data from various intervals or bins and plots the frequency of the data in each bin. This type of graph displays the overall distribution or shape of the data, which can point out many trends or irregularities, such as outliers. The histogram also is one of the first steps in assessing whether the data follow a normal distribution. The graph points out any obvious departures from normality.

Histograms were constructed for each of the metals, anions, and radionuclides that was analyzed, detected, or had two or more observations in a given tank. Histograms were not generated from measurements taken from the solid matrix since there was no more than one measurement per tank for any analyte. If sufficient data were available for both tanks for a particular analyte, three histograms were made for that analyte. These histograms were made from the data for each tank, as well as a third histogram for the combined data from both tanks. If sufficient data were only available from one tank, only one histogram was made for that analyte.

The histograms consistently show a trend for the metal analyses between the tanks. The data for WM-182 had a different range and spread than the data for WM-183 and in every case the data for WM-182 show lower concentrations and a smaller range of values than the data for WM-183. Examination of the histograms showed that none of the analytes appeared to follow a normal distribution for either tank or for the combined data.

Only enough anion data was available to construct histograms for WM-183 since there was only one measurement per analyte in WM-182. The histograms were constructed primarily to determine if the data followed a normal distribution; none of the data exhibited a normal distribution.

B-3.3.1.2 Normal Probability Plots. A normal probability plot was used to assess the normality of the data. The normal probability plot is a graph of the quantiles of a data set against the quantiles of the normal distribution. If the points on the graph follow a straight line, the data are considered to follow the normal distribution. If the data varies from a straight line, the data are considered non-normal in distribution.

Normal probability plots were made for each data set for which a histogram had previously been constructed. None of the metals or anions demonstrated a normal distribution for either tank or for the combined data from both tanks.

B-3.3.1.3 Summary Statistics. One of the primary goals of this statistical evaluation is the comparison of WM-182 and WM-183 against each other with respect to analyte concentration. To examine the differences and similarities between the tanks more closely, each tank was compared by analyte and by matrix (liquid or solid). This was done by calculating summary statistics for each analyte by tank. If two or more observations were measured and detected for a particular analyte in a certain tank, the mean, median, standard deviation, range, minimum concentration, and maximum concentration were calculated. If only one measurement was recorded, this was the value used for comparison. Tables B-5, B-6, and B-7 contain the summary statistics.

Table B-5. Summary statistics for Tanks WM-182 and WM-183.

Metal	Statistic	WM-182 (mg/L)	WM-183 (mg/L)
Aluminum	Mean	7,820	11,592.5
	Standard Deviation	262	1,059.35
	Median	7,855	11,250
	Range	530	4,930
	Minimum	7,520	9,470
	Maximum	8,050	14,400
Antimony	Mean	Undetected	0.49
	Standard Deviation	Undetected	0.14
	Median	Undetected	0.47
	Range	Undetected	0.33
	Minimum	Undetected	0.34
	Maximum	Undetected	0.67
Arsenic	Mean	Undetected	0.39
	Standard Deviation	Undetected	0.28
	Median	Undetected	0.47
	Range	Undetected	0.68
	Minimum	Undetected	0.11
	Maximum	Undetected	0.79
Barium	Mean	3.45	6.57
	Standard Deviation	0.08	1.07
	Median	3.48	6.53
	Range	0.19	3.24
	Minimum	3.33	5.15
	Maximum	3.52	8.39
Beryllium	Mean	0.0303	0.0575
	Standard Deviation	0.00	0.01
	Median	0.0303	0.055
	Range	0.0303	0.02
	Minimum	0.00	0.05
	Maximum	0.0303	0.07
Cadmium	Mean	60.4	78.78
	Standard Deviation	0.56	10.01
	Median	60.5	75.0
	Range	1.2	22.9
	Minimum	59.7	70.0
	Maximum	60.9	92.9

Table B-5. (continued).

Metal	Statistic	WM-182 (mg/L)	WM-183 (mg/L)
Calcium	Mean	510.25	1,040.5
	Standard Deviation	10.53	196.2
	Median	507.5	1,018
	Range	22	454
	Minimum	502	836
	Maximum	524	1,290
Chromium	Mean	98.95	405.8
	Standard Deviation	1.95	115.0
	Median	99.1	388
	Range	4.4	338
	Minimum	96.6	261
	Maximum	101	599
Cobalt	Mean	0.865	5.243
	Standard Deviation	0.02	0.92
	Median	0.873	5.050
	Range	0.041	2.110
	Minimum	0.837	4.380
	Maximum	0.878	6.490
Copper	Mean	13.85	73.7
	Standard Deviation	2.00	29.7
	Median	13.1	73.4
	Range	4.4	72
	Minimum	12.4	38
	Maximum	16.8	110
Iron	Mean	625	1,907.5
	Standard Deviation	22.2	420.9
	Median	628.5	1815
	Range	53	960
	Minimum	595	1,520
	Maximum	648	2,480
Lead	Mean	72.681	142.4
	Standard Deviation	1.41	27.4
	Median	73	135
	Range	3.3	63
	Minimum	70.7	117
	Maximum	74	180

Table B-5. (continued).

Metal	Statistic	WM-182 (mg/L)	WM-183 (mg/L)
Magnesium	Mean	96.3	195.5
	Standard Deviation	3.25	31.8
	Median	95.15	194.5
	Range	7.1	73
	Minimum	93.9	160
	Maximum	101	233
Manganese	Mean	229.75	450
	Standard Deviation	6.70	91.9
	Median	228.5	431.5
	Range	16	207
	Minimum	223	365
	Maximum	239	572
Mercury	Mean	169.67	344
	Standard Deviation	9.71	76.8
	Median	172	330
	Range	19	172
	Minimum	159	268
	Maximum	178	440
Nickel	Mean	50.05	203.6
	Standard Deviation	0.91	38.9
	Median	50.25	190
	Range	2.1	120
	Minimum	48.8	146
	Maximum	50.9	266
Selenium	Mean	Undetected	0.14
	Standard Deviation	Undetected	0.10
	Median	Undetected	0.09
	Range	Undetected	0.19
	Minimum	Undetected	0.09
	Maximum	Undetected	0.28
Silver	Mean	0.126	0.484
	Standard Deviation	0.07	0.20
	Median	0.091	0.42
	Range	0.141	0.588
	Minimum	0.091	0.222
	Maximum	0.232	0.81

Table B-5. (continued).

Metal	Statistic	WM-182 (mg/L)	WM-183 (mg/L)
Thallium	Mean	Undetected	0.855
	Standard Deviation	Undetected	0.36
	Median	Undetected	0.935
	Range	Undetected	0.77
	Minimum	Undetected	0.39
	Maximum	Undetected	1.16
Vanadium	Mean	0.489	1.668
	Standard Deviation	0.03	0.30
	Median	0.489	1.645
	Range	0.071	0.700
	Minimum	0.454	1.340
	Maximum	0.525	2.040
Zinc	Mean	26.875	71.975
	Standard Deviation	6.25	20.09
	Median	24.5	73.15
	Range	13.5	48.8
	Minimum	22.5	46.4
	Maximum	36	95.2

Table B-6. Comparison of TCLP metal concentrations in the solid matrix.

Analyte	WM-182 (mg/L) [a]	WM-183 (mg/L) [a]
Arsenic	ND	ND
Barium	0.24	0.78
Cadmium	2.2	5.8
Chromium	1.9	24
Lead	ND	6.7
Mercury	3.1	17 (R)
Nickel	2.9	17
Selenium	ND	ND
Silver	0.046	0.70

a. ND = not detected
R = rejected during data validation

Table B-7. Comparison of metal concentrations in the solid matrix.

Analyte	WM-182 (mg/kg) [a]	WM-183 (mg/kg) [a]
Aluminum	21,900	24,900
Antimony	ND	32
Beryllium	ND	ND
Calcium	1,760	1,870
Cobalt	ND	9.3
Copper	ND	166
Iron	4,480	18,000
Magnesium	410	434
Manganese	565	740
Thallium	ND	ND
Vanadium	13.3	10.7
Zinc	179	148

a. ND = not detected

The metals in the liquid matrix demonstrated a trend that the average concentration in WM-182 was consistently less than the average concentration in WM-183. The difference was so extreme for each of the metals, with the exception of silver, that the maximum measured concentration in WM-182 was less than the minimum measured concentration in WM-183. (The maximum measured concentration for silver in WM-182 was 0.232 mg/L and the minimum measured concentration in WM-183 was 0.222 mg/L.) By examining the full set of summary statistics for silver, on average the concentration of silver is higher in WM-183 than in WM-182. Hypothesis tests were not performed on the difference between the means, because the data did not exhibit sufficient normality to justify doing so.

A trend is also shown in the spread of the data between the two tanks. The standard deviation and the range both demonstrate that there is much larger variation in the concentration measurements in WM-183 than in WM-182. The range and standard deviation were larger in WM-183 than in WM-182 for every metal measured. The summary statistics for metals in the liquid matrix can be found in Table B-5.

The metals in the solid matrix did not exhibit any trend. Since only one measurement was taken in the solid matrix per tank there is no way to analyze the difference in variation in the concentrations of the metals between tanks. However, higher concentrations of arsenic, barium, cadmium, lead, selenium, vanadium, and zinc were found in WM-182. Higher concentrations of aluminum, antimony, calcium, chromium, cobalt, iron, magnesium, manganese, mercury, nickel, silver, and thallium were measured in WM-183. Beryllium was not detected in either measurement, and the copper measurement in WM-182 was rejected so no comparisons can be made for either analyte. The summary statistics for the metals in the solid matrix can be found in Tables B-6 and B-7.

A comparison of anions measured in the liquid matrix for each tank could only be performed on chloride, fluoride, nitrate, and sulfate since these were the only anions detected in both tanks. One measurement was taken in WM-182 and four measurements were taken in WM-183 for each of these analytes. There appears to be a much higher concentration of nitrate in WM-183 than in WM-182, and notably higher concentrations of chloride and sulfate in WM-183 as opposed to WM-182. There was not much difference between the concentration of fluoride in the two tanks, but WM-182 had a slightly higher mean concentration than WM-183. There was no comparison of anions for b-acid phosphate because of lack of data. There was also no analysis done on anion concentrations in the solid matrix because no measurements were taken in WM-182 and only one measurement was taken in WM-183. The summary statistics for anion analyses in the liquids can be found in Table B-8.

B-3.3.1.4 Detection Levels. This section provides a summary of the measured concentration of the constituents of interest before WM-182 and WM-183 were decontaminated and how those measurements relate to the TCLP regulatory limit of each constituent. Of particular interest is identifying the analytes that were not detected in a particular tank or whose measured concentration was far below the TCLP regulatory limit. The anions had high concentrations in both tanks so only the metals will be analyzed in this section. The results for this section are based on the information in Tables B-3, B-5, B-6, and B-7. TCLP maximum concentration limits are reported in parentheses after discussed analytes where pertinent.

This information is based on four measurements per analyte per tank at most and sometimes as few as one measurement per analyte per tank.

Table B-5 shows that if an analyte had a low concentration in one of the tanks, that same analyte had a low concentration in the other tank. However, with the exception of selenium, if one analyte was not detected in one tank it was not necessarily detected in the other tank. This was evident for metals in both the liquid matrix and the solid matrix.

In Tank WM-182 for the metals in the liquid matrix, antimony, arsenic, selenium, and thallium were not detected. Beryllium, cobalt, silver, and vanadium all had concentration measures less than 1 mg/L. All of the measurements for barium were below the TCLP maximum concentration limit (100 mg/L). Where direct TCLP measurements on samples of tank solids were not available, total constituent analysis data were compared to the TCLP regulatory limits by dividing the total analysis result (mg/kg) by 20 to obtain the maximum possible TCLP results in mg/L. Antimony, beryllium, cobalt, and thallium were not detected in the WM-182 solids. Vanadium had a concentration measurement less than 1 mg/L, and selenium was measured below the TCLP maximum concentration limit (5 mg/L).

In Tank WM-183 for the metals in the liquid matrix, all metals analyzed were detected. Antimony, arsenic, barium, beryllium, selenium, silver, thallium, and vanadium were all measured at relatively small concentrations. All of the measurements for arsenic, barium, and silver were below their TCLP maximum concentration limits (5 mg/L, 100 mg/L, and 1 mg/L respectively). As with the Tank WM-182 solids, total constituent analysis data were used to calculate maximum TCLP concentrations when an analyte was not measured in the TCLP extract produced from the solid sample. Beryllium, selenium, and vanadium were not detected. The measured concentrations for antimony, arsenic, barium, cobalt, and thallium were relatively small. All of the measurements for arsenic and barium were below their TCLP maximum detection limits (5 mg/L and 100 mg/L, respectively).

Table B-8. Summary statistics for anions in liquids.

Anion	WM-182	WM-183 Minimum (mg/L)	WM-183 Mean (mg/L)
Chloride	101	252	291
Fluoride	745	603	706
Nitrate	3,535	10,900	171,000
Sulfate	1,660	1,440	2,157.2
	Median of anions:	5.76E+05	7.73E+05
	Range of anions:	1.78E+05	3.46E+05

B-4. REFERENCES

40 CFR 261.24, 2001, "Toxicity Characteristic," *Code of Federal Regulations*, Office of the Federal Register, July 1.

42 USC 6901 et seq., 1976, "Resource Conservation and Recovery Act of 1976."

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