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INTERLABORATORY COMPARISON FOR THE COMMUNITY ENVIRONMENTAL MONITORING PROGRAM OF THE STIBNITE PROJECT, 2025

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Introduction

In conjunction with the Stibnite Advisory Council (SAC), the University of Idaho (U of I) was contracted to independently verify results of laboratory analyses of surface and groundwater samples from the Stibnite Project site. This report summarizes analyses of the pre-mining surface and groundwater sample collections that occurred within the locality of the Stibnite Project in July and August 2025. The primary objective of this study is to quantify differences in analyte concentrations measured by Anatek Labs in Moscow, Idaho and SVL Analytical in Kellogg, Idaho. Secondary objectives are to assess whether there are any persistent differences in reported concentrations by analyte, site, or water type.

Methods

Sampling design

Split Sampling

All sampling protocols met the applicable regulatory standards for water sampling and followed the Project approved Quality Assurance Project Plan (QAPP) and Water Quality Sampling Plan (Serrin 2019; Serrin 2022) for both surface and groundwater sampling. Two forms of data collection occurred: 1) collection of water quality parameters on-site by Perpetua Resources personnel and 2) analysis of water quality parameters using two EPA-certified laboratories. The on-site water quality parameters included water temperature, pH, conductivity, dissolved oxygen, turbidity, and oxidation-reduction potential, and were measured with a calibrated In-Situ Aqua TROLL 600 (In-Situ, Inc., Fort Collins, CO). Only results from the laboratory analyses are compared for this study.

Collection of ground and surface water for laboratory analysis occurred via split sampling, that is the separation of a water sample into two parts such that each part was representative of the original sample. Water was taken from a single source (e.g., a groundwater well) then divided in two, with each sample analyzed by a different EPA-certified laboratory, in this case, submitted by Perpetua Resources to SVL Analytical and by the U of I to Anatek Labs. The parameters, methods, and method detection limits (MDLs) for the analyses are presented in Table A1. In addition, the U of I verified that the analytical methods employed by each laboratory are comparable to permit direct comparisons of the resulting data.

Sample collection

Acquisition of the samples took place at the same time and at the same location as the prescribed Stibnite Project monitoring of groundwater, surface water, and facilities in conjunction with the mine's scheduled monitoring. Water samples were collected by Perpetua Resources and the U of I personnel and divided into two aliquots (approximately 125-250 ml each) for independent laboratory analysis. Dissolved metal samples for SVL were filtered in the field by Perpetua personnel and in the lab by Anatek personnel. After collection, samples were transported to the Perpetua Resources field house and placed in a refrigerator (~ 4 °C) and stored overnight. The samples were placed in coolers with ice packs and transported to Anatek and SVL laboratories the following day.

Surface water

Surface samples were collected at 11 sites on 6 August 2025 (Table A2). Surface water sites also included one duplicate and one field blank sample (deionized water) at randomly selected sites for quality control. The site selection for both duplicate and blanks was random and was done to aid in report validation

between the two laboratories. A total of 25 water quality parameters were quantified for each of the 11 samples resulting in a total of 275 sample-analyte combinations.

Groundwater

Groundwater samples were collected at 10 sites on 16 July 2025 (Table A3). These sites also included one site where a collection was duplicated and another site where a field blank sample of deionized water was collected. Sampling at MWH-B10 (bedrock well north of the office area, southwest of Scout Creek) was not completed because pH, turbidity, conductivity and dissolved oxygen parameters did not stabilize within the two-hour minimum required by the EPA during purging of a low flow well. Like surface water collections, 25 parameters were quantified for the 10 samples resulting in 250 sample-analyte combinations.

Data analysis

Interlaboratory comparison

Comparison of analytical results between the two laboratories was based on procedures described in the Quality Assurance Project Plan (QAPP) and Water Quality Sampling Plan (Serrin 2019; Serrin 2022; Pearson et al., 2023). Acceptability criteria were based on the practical quantification limit (PQL; also referred to as reporting limits or lower limits of quantification) because it represents the lowest concentration of an analyte that can be accurately quantified with acceptable accuracy and precision under typical laboratory conditions. In cases where one laboratory reported detectable concentration and the second reported a non-detection (value less than their minimum detection limit, or MDL), the non-detection result was set to the MDL for quantitative comparison. If both laboratories returned values of non-detections (<MDL) or one laboratory returned a value of non-detect and the other an estimated value (between MDL and Practical Quantitation Limit or PQL) the results were considered acceptable due to the high uncertainty associated with very low concentration analyses. For cases where either lab returned a quantifiable value (>PQL) or both returned estimated values, the relative percent difference (RPD) was used to evaluate differences in analyte concentrations between the two laboratories (Boyer et al., 1985). The RPD was calculated using Equation 1:

$$RPD = \frac{\text{abs}(Anatek\ result - SVL\ result)}{\text{mean}(Anatek\ result, SVL\ result)} \qquad \textbf{(Eqn. 1)}$$

Where abs is the absolute value of the difference between lab results for each parameter and the mean is the average of the lab results for each parameter. Results are also more variable at low concentrations and because differences in very small values can produce large RPDs, hence the closer the result for a particular analyte was to the PQL, the greater the RPD that was considered to be acceptable (Table 1).

Table 1. Acceptability criteria based on the relative percent difference (RPD) between results obtained by Anatek and SVL Analytical relative to the analytical practical quantitation limit (PQL).

	PQL-to-RPD relationship		
Acceptability criteria	<3x, PQL	3x to 4x, PQL	>4x, PQL
Acceptable	<50% RPD	<30% RPD	<20% RPD
Acceptable (Caution)	50-100% RPD	30-50% RPD	20-30% RPD
Flagged	> 100% RPD	> 50% RPD	> 30% RPD

Each result was classified as acceptable, acceptable but viewed with caution, or flagged. Cautionary values are those that are just outside of the most restrictive acceptance criteria and for all intents and purposes can be considered comparable, especially for those that correspond to very low analyte concentrations. Overall, these approaches were implemented to provide a rigorous assessment of interlaboratory consistency for reliably quantifiable analyte concentrations above the PQL. Discussions with SVL analytical chemists in March 2024 confirmed that this approach and the acceptability thresholds employed are very appropriate for comparing values between different laboratories. The specific workflow is summarized in Appendix B.

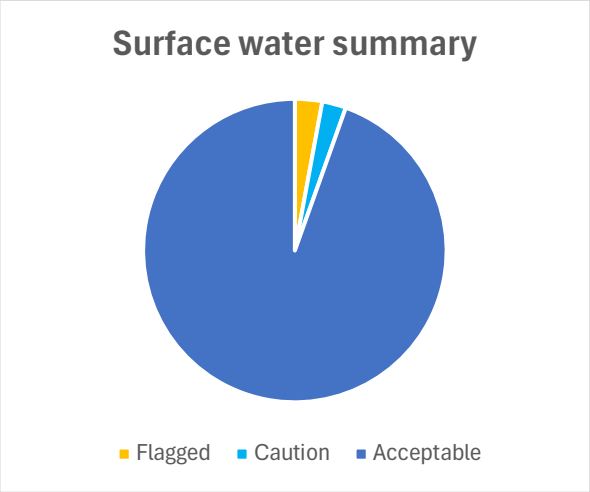

Figure 1. The proportion of surface water data that fell within the acceptable (94.5%), caution (2.5%) and flagged (2.9%) categories in 2025.

Results

Surface water

Results of the 275 sample-parameter comparisons from surface water samples collected on 6 August indicated that 94.5% (n=260) were acceptable, 2.5% (n=7) should be viewed with caution, and 2.9% (n=8) were flagged (Figure 1). Overall, the SVL values exceeded the Anatek values for all eight of the flagged site-analyte combinations (Figure 2; Table A4). Relative percent differences for the flagged values ranged from 31% to 148% and the majority of flagged values were for analytes at concentrations well above the MDL. Of the eight flagged samples, six were total mercury and one each total arsenic and cyanide. (Figure 2; Table A4). The arsenic and cyanide discrepancies were slightly outside of the 30% RPD acceptability criteria. Of the six flagged total mercury samples, two came from Meadow Creek sites and two from Sugar Creek sites. The field blank and duplicate samples were also flagged. (Figure 2; Table A4). The majority of flagged mercury results were for very low (< 25 ng/L) concentrations.

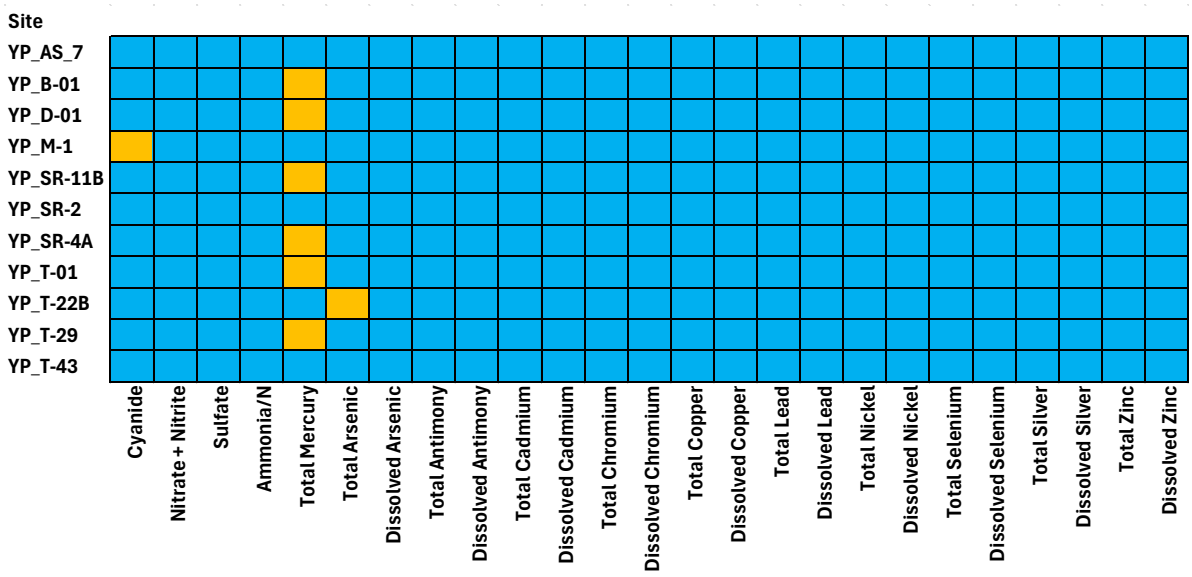

Figure 2. Flagged data from the interlaboratory comparison of surface water results. Dark gold cells represent cases where the SVL value exceeded the Anatek value. Blue cells are considered acceptable.

Groundwater

Results of the 250 sample-parameter comparisons from groundwater samples collected on 16 July 2025 indicated that 96.0% (n=240) were acceptable, 2.8% (n=7) should be viewed with caution and 1.2% (n=3) were flagged (Figure 3). Of the three flagged samples, two were dissolved arsenic and one was total mercury. The SVL value exceeded the Anatek value for both flagged dissolved arsenic comparisons, while the Anatek value exceeded the SVL value for the one flagged total mercury comparison (Figure 4; Table A5). Relative percent differences for flagged values ranged from 32% to 64% and most flagged values were for analytes at very low concentrations near the MDL or slightly above the acceptability thresholds (Table A5).

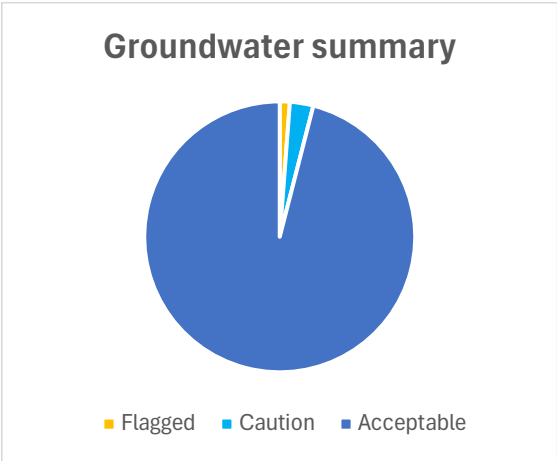

Figure 3. The proportion of groundwater data that fell within the acceptable (96.0%), caution (2.8%) and flagged (1.2%) categories.

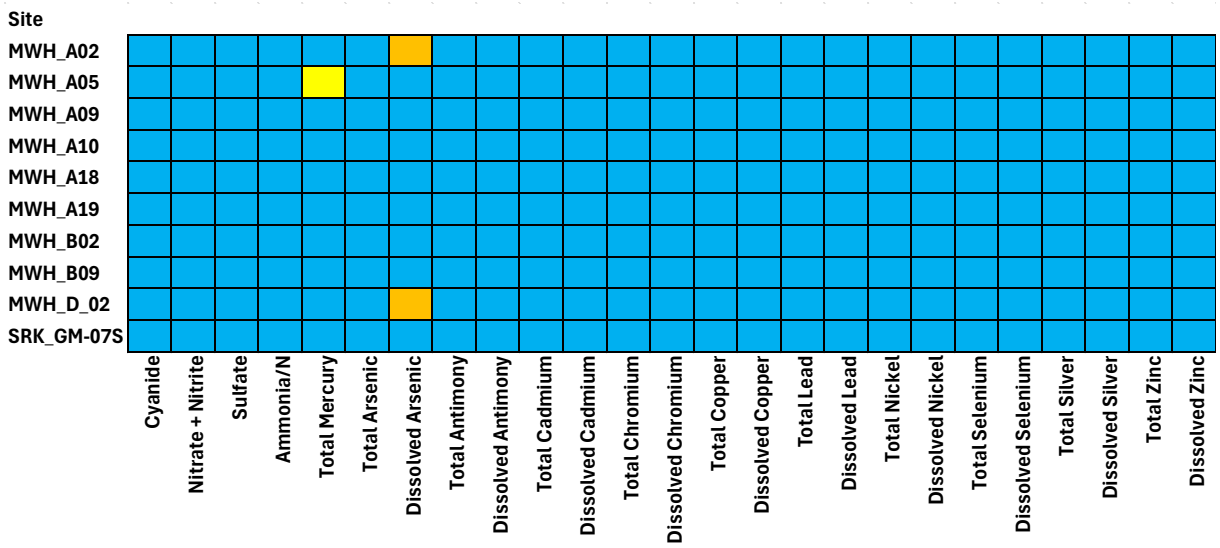

Figure 4. Flagged data from the interlaboratory comparison of groundwater results. Yellow cells represent cases where the Anatek value exceeded the SVL value. Dark gold cells represent cases where the SVL value exceeded the Anatek value. Blue cells are considered acceptable.

Discussion

Surface water

The surface water results revealed that 94.5% of the comparisons between the two laboratories were considered acceptable compared to 2.5% cautionary and 2.9% flagged. The percentage of acceptable results in 2025 is consistent with previous years and in the middle of the five-year range (92.0-96.9%; Table 2; Joseph et al. 2021; Libunao et al. 2022; Link and Naughton 2023 and 2024). However, flagged total mercury comparisons increased in 2025 compared to 2024. Total mercury was flagged at 6 of 11 (55%) surface water sites in 2025, compared to only 2 of 9 (22%) in 2024. Moreover, SVL results exceeded those of Anatek for all flagged comparisons in 2025. The 2025 flagged total mercury results were similar to both 2022 and 2023 where total mercury was flagged at 7 of the 11 surface water sample sites. Similar to other years with higher percentages of flagged mercury results, most of the flagged values are for extremely low concentrations (<25 ng/L). There are however some occasional discrepancies at higher concentrations, therefore we recommend that differences between laboratories be closely monitored in upcoming years and consider having samples analyzed for mercury in triplicate if discrepancies persist.

Groundwater

The number of flagged groundwater comparisons in 2025 was the lowest (1.2%) of the five study years. (Table 2). Dissolved arsenic comprised two of the three flagged groundwater comparisons indicating there was no site or laboratory-specific bias. The primary difference between 2024 and 2025 comparisons was a major reduction in flagged dissolved chromium results in 2025. In 2024, dissolved chromium accounted for 44% (7/16) of the flagged values. Anatek results exceeded those of SVLs at all 11 site comparisons, including the seven flagged values. The improvement in the accuracy of the analyses may be due to the Anatek chemists running samples with reaction gas to eliminate almost all polyatomic interferences and analyzing total and dissolved fractions on the same day (E. Linskey, pers. comm.). These improvements were a result of discussions with the Anatek analytical chemists that occurred following the analyses of the 2024 results.

Table 2. Multi-year summary of analytical test comparisons between Anatek and SVL laboratories, 2021-2025. The results are based on the comparison of 25 analytes at 7-11 sites.

Collection	Year	% Acceptable	% Caution	% Flagged
Surface water	2021	94.2	2.9	2.9
	2022[1]	96.7	0.0	3.3
	2023	92.0	3.3	4.7
	2024	96. 9	1.8	1.3
	2025	94.5	2.5	2.9
Groundwater	2021	96.0	2.2	1.8
	2022[1]	94.9	0.0	5.1
	2023	95.6	1.8	2.5
	2024	91.6	2.5	5.5
	2025	96.0	2.8	1.2

[1]Results based on the first of two sample collections.

Conclusions

Based on the results of surface and groundwater analyte comparisons in 2025, four primary conclusions can be drawn: 1) there was strong interlaboratory agreement for both the surface water and groundwater results between Anatek and SVL laboratories; 2) there was no consistent site-specific bias between laboratories relative to any specific analyte other than mercury; 3) the 2025 flagged groundwater comparisons were the lowest in the five year study period and; 4) flagged total mercury results increased in 2025 with all flagged comparisons indicating SVL values exceeding Anatek values. Flagged mercury values were generally for very low concentrations, consistent with previous evaluations.

Acknowledgments

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Appendix A.

Table A1. The 25 water quality parameters measured in surface and groundwater samples collected at the Stibnite Mine site in 2025, including method minimum detection limit (MDL) for each laboratory, and the concentration units. Note that the unit for total mercury is ng/L.

Parameter	Method	Anatek MDL	SVL MDL	Units
Ammonia	SM 4500-NH3 G	0.0053	0.013	mg/L
Cyanide	EPA 335.4	0.005	0.0038	mg/L
Dissolved Antimony	EPA 200.8	0.0003	0.00072	mg/L
Dissolved Arsenic	EPA 200.8	0.00033	0.00021	mg/L
Dissolved Cadmium	EPA 200.8	0.00012	0.000063	mg/L
Dissolved Chromium	EPA 200.8	0.00051	0.00017	mg/L
Dissolved Copper	EPA 200.8	0.0002	0.00036	mg/L
Dissolved Lead	EPA 200.8	0.0004	0.00014	mg/L
Dissolved Nickel	EPA 200.8	0.00019	0.00012	mg/L
Dissolved Selenium	EPA 200.8	0.00032	0.00024	mg/L
Dissolved Silver	EPA 200.8	0.0002	0.000061	mg/L
Dissolved Zinc	EPA 200.8	0.00086	0.002	mg/L
Nitrate + Nitrite	EPA 300.0	0.356	0.04	mg/L
Sulfate	EPA 300.0	0.2	0.18	mg/L
Total Antimony	EPA 200.8	0.0003	0.00072	mg/L
Total Arsenic	EPA 200.8	0.00033	0.00021	mg/L
Total Cadmium	EPA 200.8	0.00012	0.000063	mg/L
Total Chromium	EPA 200.8	0.00051	0.00017	mg/L
Total Copper	EPA 200.8	0.0002	0.00036	mg/L
Total Lead	EPA 200.8	0.0004	0.00014	mg/L
Total Mercury	EPA 1631 E	0.2	0.12	ng/L
Total Nickel	EPA 200.8	0.00019	0.00012	mg/L
Total Selenium	EPA 200.8	0.00032	0.00024	mg/L
Total Silver	EPA 200.8	0.0002	0.000061	mg/L
Total Zinc	EPA 200.8	0.00086	0.002	mg/L

Table A2. The 11 surface water sites sampled in the locality of the Stibnite mine on 6-August-2025

Site	Description
YP-AS-7	Meadow Creek Mine adit seep
YP-SR-2	East Fork South Fork of Salmon River (EFSFSR) downstream of Sugar Creek
YP-SR-4A	EFSFSR between the Yellow Pine and Sugar Creek confluences
YP-SR-11B	EFSFSR upstream of Meadow Creek
YP-T-1	Sugar Creek upstream of the EFSFSR
YP-T-22B	Meadow Creek along the Stibnite airstrip, upstream from confluence with the EFSFSR
YP-T-29	Blowout Creek
YP-T-43	Meadow Creek upstream from the Keyway Dam
YP-M-1	Frac tank
YP-B-01	Field blank sample
YP-D-01	Duplicate sample

Table A3. The 10 groundwater sites sampled in the locality of the Stibnite mine on 16-July-2025

Site	Description
MWH-A02	Alluvial well within the SODA spent ore and tailings
MWH-A05	Alluvial well east of HECLA heap leach pad and Hangar Flats deposit
MWH-A09	Alluvial well west of the office area, near Garnet Creek.
MWH-A10	Alluvial well north of the office area, southwest of Scout Creek.
MWH-A18	Alluvial well north of the EFSFSR, across the river from the Bradley Dumps
MWH-A19	Alluvial well at the toe edge of the Bradley Dumps
MWH-B09	Bedrock well west of the office area, near Garnet Creek.
MHW-B-02	Field blank sample
MWH-D-02	Duplicate sample
SRK-GM-07S	Above the Yellow Pine pit and EFSFSR diversion

Table A4. Flagged analytical result comparison for surface water samples collected at the Stibnite mine locality on 6-August-2025. Differences are in mg/L except total mercury (ng/L). RPD = relative percent difference (see Methods for explanation). Flagged samples represent 1.3% (3/225) of sample-analyte comparisons. SVL results exceeded Anatek's in all comparisons.

Site/Sample	Analyte	Laboratory Result Comparison	Difference (mg/L, Hg: ng/L)	RPD
YP_B-01	Total mercury	SVL>Anatek	-0.0034	147.7
YP_D-01	Total mercury	SVL>Anatek	-1.130	44.9
YP_M-1	Cyanide	SVL>Anatek	-7.0	30.9
YP_SR-11B	Total mercury	SVL>Anatek	-1.1	51.0
YP_SR-4A	Total mercury	SVL>Anatek	-1.37	33.8
YP_T-01	Total mercury	SVL>Anatek	-40.6	95.5
YP_T-22B	Total arsenic	SVL>Anatek	-0.0043	34.5
YP-T-29	Total mercury	SVL>Anatek	-1.89	59.0

Table A5. Flagged analytical result comparison for groundwater samples collected at the Stibnite mine locality on 18-July-2025. Differences are in mg/L except total mercury (ng/L). RPD = relative percent difference (see methods). Flagged sites represent 5.5% (16/275) of site-analyte comparisons. Comparisons where Anatek's estimates exceeded those of SVL's are in bold.

Site/Sample	Analyte	Laboratory Result Comparison	Difference (mg/L)	RPD
MWH-A02	Dissolved arsenic	SVL>Anatek	-0.0019	44.8
MWH-A05	Total mercury	**Anatek>SVL**	96.0	31.5
MWH-D-02	Dissolved arsenic	SVL>Anatek	-0.0025	64.1

Appendix B: Laboratory Comparison Workflow

1. Combine and align all site and analyte data.
2. Convert values from text to numeric for detectable concentrations.
3. Convert results, detection, and reporting limits to consistent units (e.g. mg/L) if needed.
4. Compute corrected lab results. If result is below Method Detection Limit (MDL), set result to MDL as an estimate of concentration for quantitative comparisons.
5. Code each analysis for whether specific analytes were detected (>MDL) or not (<MDL).
6. Code each pair of analyses into detection classes.
    a. 0 = Both labs were below detection limit
    b. 1 = Anatek below MDL, SVL above MDL
    c. 2 = Anatek above MDL, SVL below detection limit
    d. 3 = Both labs found detectable concentrations
7. Correct detection classes for cases where one laboratory reported a detectable concentration that was below the MDL of the other laboratory. If so, code both as non-detects.
8. Compute relative percent differences (RPDs) using corrected data.
9. Determine concentration classes for each result based on the Practical Quantitation Limit (PQL) or Reporting Limit which is synonymous.
    a. 1 = Result < 3x PQL
    b. 2 = Result between 3x and 4x PQL
    c. 3 =Result > 4x PQL
10. Set the result to PQL ratio class to the minimum concentration class for each laboratory for each specific analyte.
11. Determine Acceptance class
    a. 2 = “flagged”
    b. 1 = “acceptable with caution”
    c. 0 = “acceptable”
12. Manually check every flagged and cautionary value against MDLs and RPDs to ensure that classifications are correct and to determine the general concentration ranges where the various discrepancies occur. Manually check high RPD values that are not flagged to verify that values are close to detection limits.
13. If consistent differences between labs are noted for flagged samples, check for likely dilution errors (discrepancies of consistent factors), contamination (discrepancies of relatively constant amounts), or analytical variations (dissolved fractions consistently exceeding totals). Contact the project managers at one or both labs to discuss error concerns and whether corrected data should be used prior to finalization of the analysis and/or if protocols should be modified for future analyses.
14. Repeat comparison analysis if either lab identifies errors and submits corrected data.