Date: May 24, 2010

To: Rick Carlson, U.S. Bureau of Reclamation
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From: Mike Deas, Watercourse Engineering, Inc.
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Re: 2010 Klamath River Baseline Sampling Program QA Comparison.

# Summary

In general the sampling and quality assurance procedures followed by PacifiCorp, USBR, Yurok Tribal Environmental Program and the Karuk Tribe are quite similar. The level of detail differs among the programs, so some of the discrepancies identified herein may be due to interpretation of the various documents. Overall, this is a unique opportunity to further refine individual sampling and quality assurance processes to ensure concurrence among the various programs. Although certain differences may persist (e.g., laboratory used by specific programs), documenting such differences is an important element of cooperative and complimentary basin-scale water quality monitoring programs.

Presented below are nine tables representing various elements of sampling, laboratory analyses, and quality assurance. The information is arranged in tabular format to provide comparison among the four principal sampling entities in the KHPA baseline monitoring program.

**Table 1 - Laboratories conducting analyses.**

| | Pacificorp | USBR | Karuk | YTEP |
|---|---|---|---|---|
| **Basic Laboratory (Redding, CA)** | | • Ammonia as N<br>• Nitrate + nitrite as N<br>• Total Nitrogen<br>• Orthophospate<br>• Total Phosphorous<br>• Total suspended solids<br>• Volatile suspended solids<br>• Alkalinity<br>• CBOD<br>• Dissolved organic carbon<br>• Total Kjehdahl Nitrogen<br>• Bicarbonate<br>• Dissolved Ammonia as N<br>• Dissolved Nitrate+Nitrite as N<br>• Chlorophyll a<br>• Pheophytin | | |
| **CH2M Hill Applied Sciences Laboratory (Corvallis, OR)** | • Ammonia<br>• Nitrate + nitrite<br>• Total Nitrogen<br>• Orthophospate (See Note A)<br>• Total Phosphorous<br>• Total suspended solids<br>• Volatile suspended solids<br>• Alkalinity<br>• CBOD<br>• Dissolved organic carbon | • Ammonia as N<br>• Nitrate + nitrite as N<br>• Total Nitrogen<br>• Orthophospate<br>• Total Phosphorous<br>• Total suspended solids<br>• Volatile suspended solids<br>• Alkalinity<br>• CBOD<br>• Dissolved organic carbon<br>• Total Kjehdahl Nitrogen<br>• Dissolved Ammonia as N<br>• Dissolved Nitrate+Nitrite as N | | |

| | Pacificorp | USBR | Karuk | YTEP |
|---|---|---|---|---|
| **Chesapeake Bay Laboratories (Solomons, MD)** | • Chlorophyll-a<br>• Pheophytin<br>• Particulate carbon<br>• Particulate nitrogen | • Particulate carbon<br>• Particulate Inorganic Carbon<br>• Particulate Organinc Carbon | | |
| **Aquatic Analyists (Friday Harbor, WA)** | • Periphyton species composition<br>• Phytoplankton (species composition and cell counts) | • Periphyton species composition<br>• Phytoplankton (species composition and cell counts) | • Periphyton species composition<br>• Phytoplankton (species composition and cell counts) | •Periphyton species composition<br>•Phytoplankton (species composition and cell counts) |
| **Aquatic Research (Seattle, WA)** | • | • Ammonia as N<br>• Nitrate + nitrite as N<br>• Total Nitrogen<br>• Orthophospate<br>• Total Phosphorous<br>• Total suspended solids<br>• Volatile suspended solids<br>• Alkalinity<br>• CBOD<br>• Dissolved organic carbon<br>• Total Kjehdahl Nitrogen<br>• Dissolved Ammonia as N<br>• Dissolved Nitrate+Nitrite as N | • Total phosphorus<br>• Ortho-phosphorus<br>• Total nitrogen<br>• Nitrate and nitrite<br>• Ammonia<br>• Chlorophyll-a/Phaeophytin-a<br>• Total organic carbon<br>• Dissolved organic carbon<br>• Total suspended solids<br>• Volatile suspended solids<br>• Total dissolved solids<br>• Alkalinity<br>• Calcium<br>• Magnesium<br>• CBOD | •Total phosphorus<br>•Ortho-phosphorus<br>•Total nitrogen<br>•Nitrate and nitrite<br>•Ammonia<br>•Chlorophyll-a/Phaeophytin-a<br>•Total organic carbon<br>•Dissolved organic carbon<br>•Total suspended solids<br>•Volatile suspended Solids<br>•Total dissolved solids<br>•Alkalinity<br>•Calcium<br>•Magnesium |
| **US EPA Lab (Richmond, CA)** | • Microcystin | • Microcystin | • Microcystin | •Microcystin |
| **California Department of Fish and Game Water Pollution Control Laboratory (Rancho Cordova, CA)** | • Microcystin confirmation<br>• Anatoxin-a | • Mycrocystin Confirmation<br>• Anatoxin –a | • Mycrocystin Confirmation<br>• Anatoxin –a | • Mycrocystin Confirmation<br>• Anatoxin –a |
| Note A - For PacifiCorp, PO4 was analyzed by E&S personnel using a Hach DR2400 field spectrophotometer and Hach method 8048. This procedure is equivalent to USEPA method 365.2 and Standard Method 4500-P-E. In 2010 PO4 will be analyzed by CH2M lab. | | | | |

**Table 2 - Analytical methods for parameters of interest. "NA" indicates a parameter not analyzed by that agency.**

| Constituent Group | Parameter Name | Parameter ID | PacifiCorp | USBR | Karuk | YTEP |
|---|---|---|---|---|---|---|
| **Nutrients** | **Ammonia nitrogen (as N)** | NH3 | EPA350.1 | EPA350.1 | EPA350.1 | EPA350.1 |
| | **Nitrate+nitrite nitrogen (as N)** | NO3 | EPA353.2 | EPA353.2 | EPA353.2 | EPA353.2 |
| | **Total nitrogen** | NT | SM4500-N C[1] | EPA351.1 | EPA351.1 | EPA351.1 |
| | **Total Kjeldahl Nitrogen** | TKN | NA | EPA 351.2 | NA | NA |
| | **Total phosphorus (as P)** | PT | EPA365.4 | SM-4500P-BE | EPA365.1 | EPA365.1 |
| | **Orthophosphate (as P)** | PO4 | EPA365.2 | SM-4500P-E | EPA365.1 | EPA365.1 |
| **Solids** | **Total suspended solids** | TSS | EPA160.2 | SM 2540D | EPA160.2 | EPA160.2 |
| | **Volatile suspended solids** | VSS | EPA160.4 | SM 2540D | SM20 2540E | SM20 2540E |
| | **Total Dissolved Solids** | TDS | NA | NA | EPA160.1 | EPA160.1 |
| **Carbon** | **Dissolved organic carbon** | DOC | EPA415.1 | SM 5310C | SM205310B | SM205310B |
| | **Particulate carbon** | PC | EPA440.0 | EPA 440 | NA | NA |
| | **Particulate Inorganic carbon** | PIC | EPA440.0 | EPA 440 | NA | NA |
| | **Particulate Organic carbon** | | NA | EPA 440 | NA | NA |
| | **Total Organic Carbon** | TOC | NA | NA | EPA415.2 | EPA415.2 |
| **Other Water Quality** | **Alkalinity** | ALKT | EPA310.1 | SM 2320B | EPA310.1 | EPA310.1 |
| | **Carbonaceous Biological Oxygen Demand** | CBOD | SM5210B | SM5210 | | NA |
| | **Calcium** | Ca | NA | NA | EPA200.7 | EPA200.7 |
| | **Magnesium** | Mg | NA | NA | EPA200.7 | EPA200.7 |

| Constituent Group | Parameter Name | Parameter ID | PacifiCorp | USBR | Karuk | YTEP |
|---|---|---|---|---|---|---|
| **Algae** | **Chlorophyll *a*** | CHLA | EPA445 | EPA445 | SM1810200H | SM1810200H |
| | **Pheophytin** | PHEO | EPA445 | EPA445 | SM1810200H | SM1810200H |
| | **Phytoplankton abundance** | PPLK | SM10200F | NA | APHA Standards | APHA Standards |
| | **Phytoplankton Speciation** | PPLK | Millipore filtration and microscopic identification and enumeration | Millipore filtration and microscopic identification and enumeration | NA | NA |
| | **Periphyton Chlorophyll-a** | PERI | NA | NA | APHA Standards (10200.H.3) | APHA Standards (10200.H.3) |
| | **Periphyton speciation and enumeration** | PERI | NA | NA | APHA Standards | APHA Standards |
| **Toxicity** | **Microcystin** | MYCN | ELISA (Envirologix) | ELISA | ELISA | ELISA |
| | **Microcystin confirmation with LCMS** | MYCN-LCMS | LC-MS/MS | LC-MS/MS | LC-MS/MS | LC-MS/MS |

[1]These are the same method. The "20" in the Karuk method listing indicates the edition of Standard Methods used

**Table 3 - Preservation method and hold time for parameters of interest. Fields left blank where no information was identified.**

| | | PacifiCorp | | USBR | | Karuk | | YTEP | |
|---|---|---|---|---|---|---|---|---|---|
| **Constituent Group** | **Parameters** | **Sample Preservation/ Handling** | **Hold Time** | **Sample Preservation/ Handling** | **Hold Time** | **Sample Preservation/ Handling** | **Hold Time** | **Sample Preservation/ Handling** | **Hold Time** |
| **Nutrients** | **Ammonia, Nitrate+Nitrite, Total phosphorus,** | **2 ml $H_2SO_4$ / 4°C** | **28 days** | **2 ml $H_2SO_4$ / 4°C** | **28 days** | **2 ml $H_2SO_4$ / 4°C** | **28 days** | **$H_2SO_4$ pH<2 / 4°C** | **28 days** |
| | **Dissolved Ammonia, Nitrate+Nitrite** | | | **1 ml $H_2SO_4$, Filtered, 4°C** | **28 days** | | | | |
| | **Orthophosphate** | **None / 4°C** | **48 hrs** | **None / Filtered in the lab, 4°C** | **48 hrs** | **None / Filtered in the lab, 4°C** | **48 hrs** | **None / Filtered in the lab, 4°C** | **48 hrs** |
| | **Total nitrogen** | **2 ml $H_2SO_4$ / 4°C** | **28 days** | **2 ml $H_2SO_4$ / 4°C** | **28 days** | **2 ml $H_2SO_4$ / 4°C** | **28 days** | **2 ml $H_2SO_4$ / 4°C** | **28 days** |
| **Solids** | **Total suspended solids, Volatile suspended solids** | **None / 4°C** | **7 days** | **None / 4°C** | **48 hrs** | **None / 4°C** | **7 days** | **None / 4°C** | **7 days** |
| | **Total Dissolved Solids (TDS)** | | | **N/A** | | | | | |
| **Carbon** | **Dissolved organic carbon** | **$H_2SO_4$ pH<2 / Filtered in the field, 4°C** | **28 days** | **None/ Filtered, 4°C** | **28 days** | | | | |
| | **Particulate carbon, particulate inorganic carbon** | **None / Filtered in the field and shipped frozen to the lab, 4°C** | **Freeze** | **None / Filtered, 4°C** | **Freeze** | | | | |
| **Constituent Group** | **Parameters** | **Sample Preservation/ Handling** | **Hold Time** | **Sample Preservation/ Handling** | **Hold Time** | **Sample Preservation/ Handling** | **Hold Time** | **Sample Preservation/ Handling** | **Hold Time** |
| | | **PacifiCorp** | **USBR** | **Karuk** | **YTEP** | | | **PacifiCorp** | **USBR** |
| | | | | | | | | | |
| **Other Water** | **Alkalinity** | **None / 4°C** | **14 days** | **None / 4°C** | **14 days** | **None / 4°C** | **14 days** | **None / 4°C** | **14 days** |

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| **Quality** | **Carbonaceous Biochemical Oxygen Demand (CBOD)** | **None / 4°C** | **48 hours** | **None / 4°C** | **48 hours** | | | | |
| | **Biochemical Oxygen Demand (BOD)** | **None / 4°C** | **48 hours** | **N/A** | | | | | |
| **Algae** | **Chlorophyll *a*** | **4°C, keep in dark. Filter and freeze prior to shipping to the laboratory.** | | **None / 4°C** | **14 hours** | | | | |
| | **Pheophytin** | **4°C, keep in dark. Filter and freeze prior to shipping to the laboratory.** | | **None / 4°C** | **14 hours** | | | | |
| | **Phytoplankton abundance** | **5 ml Lugols, 4°C** | **6 mo** | **Lugols** | **6 mo** | **Lugol's iodine** | **6 mo** | **Lugol's iodine** | **6 mo** |
| | **Periphyton speciation and enumeration** | **5 ml Lugols, 4°C** | **6 mo** | **Lugols** | **6 mo** | **Lugol's iodine** | **6 mo** | **Lugol's iodine** | **6 mo** |
| | **Periphyton Chlorophyll-a** | **$MgCO_3$, 4°C** | | **NA** | | **$MgCO_3$** | | **$MgCO_3$** | |
| **Toxicity** | **Microcystin** | **None / 4°C** | **7 days** | **None / Frozen** | **28 days** | | | | |
| | **Microcystin confirmation with LCMS** | **None / 4°C** | **7 days** | **None / Frozen** | | | | | |

**Table 4 - Sample identification, labeling and tracking.**

| | PacifiCorp | USBR | Karuk | YTEP |
|---|---|---|---|---|
| **ID** | A unique sample identification (ID) number is used for samples collected at different sites. The same number is used for all sample bottles collected at a given site on a given day. Sample ID numbers are consecutive within a year. | Field IDs should be consecutive and each number unique. A unique sample identification (ID) number is used for samples collected at different sites. The same number is used for all sample bottles collected at a given site on a given day. | Every sample, including samples collected from a single location but going to separate laboratories, will be assigned a unique sample number | Every sample, including samples collected from a single location but going to separate laboratories, will be assigned a unique sample number |
| **Labeling** | Sample ID, constituent analysis required, date sampled, time sampled, type of preservative, if used. | Sample ID, constituent to be tested, date, time sampler, and preservation. | Sample ID, station location, date of collection, analytical parameter(s), and method of preservation | Sample ID, station location, date of collection, analytical parameter(s), and method of preservation |
| **COC** | Yes | Yes | Yes | Yes |
| **Field data sheet/ log book** | Bound field notebook with numbered pages. | Field data sheet | Field notebook | Data sheet |

**Table 5 - Grab Sampling**

| | PacifiCorp | USBR | Karuk | YTEP |
|---|---|---|---|---|
| **Grab sampling** | Direct collection, churn splitter, Kemmerer sampler, , other approved method | Direct collection, churn splitter, Van Dorn sampler | Churn splitter | Churn splitter |
| **Cleaning between sampling events (e.g., at the end of the sampling day)** | Remove foreign material with nylon brush, wash with Alconox soap and water, rinse 3 times with DI water. | Remove foreign material with nylon brush, wash with Liquinox soap and water, rinse 3 times with DI water. | Rinse with distilled water and clean with mild soap that does not contain phosphorous or nitrogen. Rinse. Rinse with 5-1 HCl solution. | Rinse with distilled water and clean with mild soap that does not contain phosphorous or nitrogen. Rinse. Rinse with 5-1 HCl solution. |
| **Field use** | Environmental rinse, 3x. Upon completion of sampling at a site rinse 3 times with DI water. | Rinse 3 times with DI water. Rinse 3 times with environmental water. | Rinse 3 times with DI water, rinse 3 times with stream water. | Rinse 3 times with DI water, rinse 3 times with stream water. |
| **Fill Churn** | Fill churn splitter with sufficient water to fill all sample bottles while maintaining minimum for adequate mixing in churn. | Fill churn splitter using Van Dorn sampler or hand dip churn in sample water. | Churn is full submerged into the stream and filled to the lid with flowing water. | Churn is full submerged into the stream and filled to the lid with flowing water. |
| **Churn the sample** | Churn sample at uniform rate of about 9 inches per second (in/s). Churning disc should touch the bottom of tank on every stroke and stroke length should be as long as possible without breaking water surface. At least 10 strokes before sample withdrawal. | Churn the sample at a uniform rate of about 9 inches per second (in/s). The churning disc should touch the bottom of the tank on every stroke and the stroke length should be as long as possible without breaking the water surface. At least 10 strokes before sample withdrawal. | Churn sample at uniform rate of about 9 inches per second (in/s). Avoid breaking water surface while churning. | Churn sample at uniform rate of about 9 inches per second (in/s). Avoid breaking water surface while churning. |

| | PacifiCorp | USBR | Karuk | YTEP |
|---|---|---|---|---|
| **Withdraw samples** | Maintain 9 in/s churning rate as water level in churn decreases. If a break in churning is necessary, stirring rate must be re-established (i.e., 10 strokes). | Maintain 9 in/s churning rate as water level in churn decreases. If a break in churning is necessary, stirring rate must be re-established (i.e., 10 strokes). | If sample bottle filling is stopped, stirring rate must be re-established. Maintain 9 in/s churning rate as water level in churn decreases | If sample bottle filling is stopped, stirring rate must be re-established. Maintain 9 in/s churning rate as water level in churn decreases. |
| **Sampling hierarchy** | Largest unfiltered samples first, followed by the remainder of unfiltered samples. Remainder of water in churn may be filtered for collection of filtered samples. All subsamples at each site are collected from the same churn. | All Nutrient samples are collected together from one churn, followed by the remainder of sample bottles making sure that each bottle of the same constituent are collected together from the same churn. When finished collecting samples, empty churn splitter and rinse 3 times with DI water. | No information given | No information given |
| **Van Dorn Sampler** | [not used: 2008, 2009] | 1. Rinse sampler 3 times with environmental water<br>2. Sampler lowered to 0.5 meters below the surface, trigger mechanism activated, sampler raised and water poured from sampler into churn splitter.<br>3. After use, debris removed, exterior cleaned, interior rinsed 3 times with DI water. | | |

| | PacifiCorp | USBR | Karuk | YTEP |
|---|---|---|---|---|
| **Kemmerer Sampler** | Sampler is lowered, trigger mechanism activated, sampler raised, water dispensed into sample bottles only for reservoir samples. For river samples multiple sample pulls are dispensed into a churn splitter and dispensed from the churn to the sample container | NA | | |
| **Submersible pump** | At desired sampling depth, 5 tube volumes are pumped then sample bottles are filled sequentially as pump continues to operate. For QA samples, pump is used to fill churn splitter for sample dispensing. | NA | | |

**Table 6 - Filtering samples.**

| | PacifiCorp | USBR | Karuk | YTEP |
|---|---|---|---|---|
| **Water samples** | 25mm GF/F syringe filter cartridge | N/A | No Information Given | No Information Given |
| | Syringe is rinsed with sample. Sample is drawn into syringe, filter cartridge is affixed to syringe, pressure is applied and filter is rinsed with 10ml of sample. | | | |
| | Sample is dispensed directly into sample container from filter cartridge. New cartridge is used for each sample. | | | |
| **Particulate samples and associated filtered water** | Syringe filter cartridge assembly. Filter type and size depend on constituents. Filters are supplies by the laboratory. | Peristaltic pump and filter assembly | N/A | |
| | Sample water collected for the churn splitter using Kemmerer sampler. | Sample water collected in 3 2oz boston round amber glass bottles from the churn splitter | | |
| | Syringe is rinsed with sample. Sample is drawn into syringe, filter cartridge is affixed to syringe, pressure is applied and filter is rinsed with 10ml of sample. | Each bottle is filtered trough a 25mm pre-fired glass fiber filter. | | |
| | Filter containing particulates is folded and put in foil pouch. Repeat process 2 more times, collecting 2 more filters with particulates that are added to the foil pouch along with the first filter. | Filter containing particulates is folded and put in foil pouch. Labeled with the sample ID, date, time, technician, and final volume of filtered material. The filtrate is used to fill a 4oz amber glass bottle for the DOC sample. Repeat process 2 more times, collecting 2 more filters with particulates that are added to the foil pouch along with the first filter. | | |

**Table 7 - Instrument Calibration.**

| | PacifiCorp | USBR | Karuk | YTEP |
|---|---|---|---|---|
| **Calibration** | Calibrated according to manufacturer specifications and procedures before use in the field. | The Hydrolab H2O unit is calibrated as described in the KBAO Hydrolab calibration SOP. The turbidimeter is calibrated according to manufacturer's instructions. | Calibrated according to manufacturer specifications and procedures before use in the field. | Calibrated according to manufacturer specifications and procedures before use in the field. |
| **Record** | Field personnel record instrument calibrations, which are kept on file at office. | Field personnel verify that the instruments have been recently calibrated by consulting the calibration logbook. | Project Manager will check calibration logs to ensure that QA/QC procedures are followed. | Project Manager will check calibration logs to ensure that QA/QC procedures are followed. |
| **After sampling** | Instrument calibration will be verified at the conclusion of each sampling event. | Post-calibration of equipment after sampling has taken place. | | |
| **Field Calibration** | When instruments are calibrated in the field, all appropriate calibration information is recorded in the field notebook. | When instruments are calibrated in the field, all appropriate calibration information is recorded in the field notebook. | When instruments are calibrated in the field, all appropriate calibration information is recorded on field datasheets. | When instruments are calibrated in the field, all appropriate calibration information is recorded on the field datasheets. |

**Table 8 - QA sample types and incorporation.**

| | PacifiCorp | USBR | Karuk | YTEP |
|---|---|---|---|---|
| **Regular/ Duplicate Sample Set** | Duplicates make up approximately 10 percent of samples, with a minimum of at least one duplicate per sample batch (one days samples = one batch).. | One Regular/Duplicate sample set for every sampling event. | One duplicate for every 10 field samples | One duplicate collected every sampling event. |
| **Reference and Spike Samples** | Spikes make up approximately 10 percent of samples, with a minimum of at least one duplicate per sample batch. | One Spike or Reference sample for every sampling event. | One spike samples for every 20 samples. Reference samples are not discussed. | One spike sample collected every sampling event. Reference samples are not discussed. |
| | The reference solution is used to fill the entire sample bottle. | The reference solution is used to fill the entire sample bottle.<br>Parameters at least 5 times the RL. If action level is greater than 5 times RL, select reference close to action level. If historical results exceed action level, select reference close to historical results. | | |

| | PacifiCorp | USBR | Karuk | YTEP |
|---|---|---|---|---|
| **Reference and Spike Samples (cont'd)** | • For spike samples, a volumetric flask or graduated cylinder is used to measure the volume of environmental water used for the "spiked" samples.<br>• For those samples with spikes, rinse the volumetric flask or graduated cylinder three times with sample water.<br>• Quantitatively transfer the spike solution to the volumetric flask. Dilute to the mark with environmental water.<br>• Dispense into the appropriate sample containers.<br>• Rinse the volumetric flask or graduated cylinder 3 times with environmental water and then 3 times with distilled/deionized water. | • For spike samples, a graduated cylinder is used to measure the volume of environmental water used for the "spiked" samples.<br>• Rinse the graduated cylinder three times with sample water.<br>• Using the graduated cylinder, measure out the appropriate volume of sample water. Pour approximately half of the sample water from the graduated cylinder into the sample bottle.<br>• Add the "spike" solution to the sample bottle. Rinse the inside of the "spike" container with sample water from the graduated cylinder and add to the sample bottle. Pour the remaining half of the sample water from the graduated cylinder into the sample bottle.<br>• Spike sample to greater than or equal to 2 times the average historical background level or to greater than or equal to 5 times the RL, whichever is greater.<br>• $(V_i)(C_i)=(V_f)(C_f)$ | • SAP does not contain information regarding the production of spiked samples.<br>• Concentration between 5 and 50 times the minimum detection limit or between1 and 10 times the ambient level, whichever is greater. | • A pre-mixed spike sample is brought to the field (kept cool with ice) and poured directly into an empty sample bottle.<br>• Concentration between 5 and 50 times the minimum detection limit or between1 and 10 times the ambient level, whichever is greater. |

| | PacifiCorp | USBR | Karuk | YTEP |
|---|---|---|---|---|
| **Blank Sample** | Blanks make up approximately 10 percent of samples, with a minimum of at least one duplicate per sample batch. | One Blank sample for every sampling event. | One for every 20 field samples. | One blank collected every sampling event. |
| | Sample bottle is filled with DI water. | Sample bottle is rinsed 3 times with DI water and filled with DI water in laboratory. | Collected as “field blanks”, ie., DI water poured into sample bottle at sampling site. | Collected as “field blanks”, ie., DI water poured into sample bottle at sampling site. |
| | DI water | DI water | DI water | DI water |

**Table 9 - QA evaluation.**

| | PacifiCorp | USBR | Karuk | YTEP |
|---|---|---|---|---|
| **Blank** | Result should be less than or equal to 2x RL *or* less than or equal to 10% of the lowest of the quality sample or duplicate | Less than 2xRL *or* less than 10% of the lowest production sample result | Less than or equal to 2xRL | Less than or equal to 2xRL |
| **Duplicate** | RPD= ((Q-D)/((Q+D)/2))x100** | RPD= ((R-D)/((R+D)/2))x100 | RPD= ((R-D)/((R+D)/2))x100 | RPD= ((R-D)/((R+D)/2))x100 |
| **Duplicate RPD** | 20% or less for values greater than or equal to 5 times the RL | 20% or less for values greater than or equal to 5 times the RL | Less than 20% | Less than 20% |
| **Spike** | (PR)=((S-Q)/A)x100** | (PR)=((S-R)/A)x100 | %Recovery=(B-A[1])x100T | (PR)=((S-R)/A)x100 |
| **Spike recovery** | 80-120%* | 80-120%* | | 80-120% |
| **Reference sample** | PR=(F/MPV)x100 | PR=(F/MPV)x100 | | |
| **Reference sample recovery** | 80-120%* | 80-120%* | | |
| **Completeness** | %=V/nx100, >90% is expected | >90% is expected | >90% is expected | >90% is expected |

| | PacifiCorp | USBR | Karuk | YTEP |
|---|---|---|---|---|
| **Data review and Validation** | After each sampling event, accuracy, precision and completeness are determined. Corrective actions (e.g., flagging, re-sample, re-analysis) are implemented if needed. Check lab QC sample results for acceptability. Explain any anomalous results or submit sample for reanalysis. | Check QA samples to verify they meet QA acceptance criteria. If samples do not meet criteria, laboratory re-analysis is required. | "Where inconsistencies are encountered, data will be re-entered and re-inspected until the entered data is found to be satisfactory or results will be discarded." | Data will be reviewed for inconsistencies or anomalous results. "Where inconsistencies are encountered, data will be re-entered and re-inspected until the entered data is found to be satisfactory or results will be discarded." |

* for values greater than or equal to 5 times the RL

** Q represents R in the PacifiCorp RPD and spike calculations