Technical Memorandum

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To: Demian Ebert, PacifiCorp

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Re: Quality Assurance Review of KHSA 2009-2015 datasets

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1.   Introduction

A quality assurance (QA) review of the Klamath Hydroelectric Settlement Agreement (KHSA) 2009 – 2015 dataset was conducted by Watercourse Engineering, Inc. (Watercourse) by comparing the dataset values of randomly selected Sample ID with the values of those Sample ID results in the original lab reports. Sample IDs were selected from both the Baseline Monitoring Program (Baseline) as well as the Public Health Monitoring Program (Public Health). The review was accomplished with the cooperation of field crews and stakeholders involved in the KHSA sampling programs, including PacifiCorp, the Karuk Tribe, Yurok Tribe, U.S. Bureau of Reclamation - Klamath Falls office, and E&S Chemistry, Inc.

A previous QA review of the KHSA 2009 – 2015 dataset had been carried out in February 2017 by Randy Turner from San Francisco Estuary Institute (SFEI). Methods of that review were similar to the methods discussed below. However, the previous review did not clearly separate out true errors in the dataset from other issues when calculating accuracy and also did not trace possible sources of error. Following that review, the identified errors were addressed and the datasets were reviewed for similar types of errors as those identified.

2.   Review Methods

The QA review method for each monitoring program was accomplished using the same method. For each program, one percent of the Sample ID values included in the 2009 – 2015 KHSA dataset were compared with values in the original lab reports provided to stakeholders during the course of the sampling programs. To select samples for review, the number of Sample IDs in each year was counted and assigned an integer as a reference number. One percent of the total number of Sample IDs in each year was then

calculated and rounded to the nearest integer. Using the Random function in MS Excel (RANDBETWEEN), a random value was generated between 1 and the total number of Sample IDs for that year. A random value was generated again for each year until the total number of random integers equaled one percent of the total number of Sample IDs. Random values were then used to choose random Sample IDs, selecting those Sample IDs with integer reference numbers matching the randomly generated values.

Once both programs had a sufficient number of randomly selected Sample IDs to total one percent of the total number of Sample IDs for each year, this list of Sample IDs was compared to the list of Sample IDs used in the previous QA review. All of the Sample IDs selected by Watercourse were unique, that is none of the Sample IDs in the previous review were selected in new QA review.

The appropriate stakeholders and field crews were then contacted and all original lab reports associated with the randomly selected Sample IDs were requested. Original lab reports included pdf versions of paper lab reports, MS Excel files of paper lab reports, or MS Excel files of digital lab data. Sample IDs and their associated lab reports were documented by Watercourse.

When the original lab reports were obtained, a comparison of each possible result for each Sample ID was carried out. In the Baseline dataset, there were a total of 19 constituents possible for each Sample ID, and in the Public Health dataset, there were a total of 26 possible results (counting each toxic algae species being tracked in the dataset). Each possible result was examined to determine if the KHSA dataset value matched the original lab report value. If a Sample ID did not have a value for a specific constituent within the dataset, Watercourse confirmed that constituent had not been analyzed by any lab associated with that Sample ID using lab reports obtained from the appropriate stakeholders or field crew.

If the result in the KHSA dataset did not match the result in the original lab reports, that result was flagged. If the values did not match, the error was labeled a "true" error. If the value was rounded from the original lab report result, the error was labeled as a "significant figure issue." Error rates were calculated as the percentage of results that did not match the original lab report values. Error rates were calculated for: (a) all non-matches; (b) only true errors; and, (c) only significant figure issues. The accuracy of the datasets for both the Baseline and Public Health programs were calculated as the percentage of results that matched the original lab report values, ignoring significant figure issues (i.e., only true errors).

3.   Types of Errors and Issues

There were several types of true errors that occurred within the KHSA 2009 – 2015 dataset, but the most common two were transcription errors and omission errors. Transcription errors occurred when there was a value entered into a dataset that clearly did not match the value in the original lab report. Omission errors occurred when a

value was not included in the dataset that should have been. Other errors in the dataset included a result added to the dataset that should have been omitted, or a value assigned to a wrong Sample ID.

The issue of significant figures was also included in the QA review of the KHSA dataset. At this time, there has been no decision on the number of significant figures that should be included in the KHSA dataset for each constituent. For this review, if the dataset value was rounded from the original lab-reported value, that value was flagged.

4.   Possible Sources of Errors

As a further investigation into the dataset accuracy, Watercourse investigated the possible source of error or significant figure issue for each flagged value. This was done by using the compilation spreadsheets and other files provided to Watercourse by stakeholders and field crews in the past. These files had been used to create the annual KHSA datasets and reports. Because of this, they could be compared to original lab reports and newly revised KHSA dataset files to determine when an error or significant figure issue most likely had been introduced into the dataset. The number and percentages of each of those possible sources of each error was calculated and documented.

5.   Review Results

For the Baseline dataset, there were a total of 475 possible results reviewed; consisting of 19 possible constituents for each of the 25 randomly selected Sample IDs from all years. A total of 364 possible results were reviewed for the Public Health dataset, consisting of 26 for each of the 14 randomly selected Sample IDs from all years (Table 1).

The QA review results found that the Baseline dataset had an estimated accuracy of 95%, while the Public Health dataset had an estimated accuracy of 100%. If significant figure issues were included, the accuracy of the Baseline dataset dropped to 84% and the Public Health accuracy dropped to 95% (Table 2).

Accuracy estimates calculated for this QA review are comparable to the previous QA review,. In the previous review of the Baseline dataset, if only the "red cells" (which is equivalent to the true errors in this review) were considered, the estimated accuracy was 92%, and the overall estimated accuracy was 84%. The previous "red cells" accuracy estimate of the Public Health dataset was 97%, as was the overall accuracy estimate.

The most common errors in the Baseline Program were omission errors introduced by the sampling entity (46% of true errors), followed by other errors introduced by Watercourse (25% of true errors), and transcription errors introduced by Watercourse (13%) (Table 3). The most common introduction of significant figure issues was by sampling entity (74% of significant figure issues for Baseline; 65% for Public Health) (Table 4).

Table 1. KHSA 2009 - 2015 Possible Results Reviewed by Program.

	Baseline							Public Health						
Number of Constituents per Sample	19							26						
Year	2009	2010	2011	2012	2013	2014	2015	2009	2010	2011	2012	2013	2014	2015
Number of Sample IDs	337	403	389	402	345	321	380	164	171	179	162	210	187	215
1% of Sample IDs	3	4	4	4	3	3	4	2	2	2	2	2	2	2
Number of possible results examined	57	76	76	76	57	57	76	52	52	52	52	52	52	52
Total number of possible results reviewed	475							364						

Table 2. KHSA 2009 - 2015 Accuracy Estimates.

	Baseline		Public Health	
Number of possible results	475		364	
Number of results that were not exact matches	77	(16%)	17	(5%)
Number of non-matches that were significant figure issues	53	(11%)	17	(5%)
Number of results that were true errors	24	(5%)	0	(0%)
Estimated Accuracy of dataset	**95%**		**100%**	

Table 3. KHSA 2009 - 2015 Sources of True Errors.

	Baseline		Public Health	
Number of true errors	24		0	
Transcription error, introduced by sampling entity	1	(4%)	0	(0%)
Transcription error, introduced by Watercourse	3	(13%)	0	(0%)
Omission, unknown source	1	(4%)	0	(0%)
Omission, introduced by sampling entity	11	(46%)	0	(0%)
Omission, introduced by Watercourse	1	(4%)	0	(0%)
Other error, introduced by sampling entity	1	(4%)	0	(0%)
Other error, introduced by Watercourse	6	(25%)	0	(0%)

Table 4. KHSA 2009 - 2015 Sources of Significant Figure Issues.

	Baseline		Public Health	
Number of significant figure issues	53		17	
Significant figure issue, unknown source	4	(8%)	0	(0%)
Significant figure issue, introduced by sampling entity	39	(74%)	11	(65%)
Significant figure issues, introduced by Watercourse	10	(19%)	6	(35%)

Watercourse Engineering, Inc.