KLEINFELDER

PACIFICORP
A MIDAMERICAN ENERGY HOLDINGS COMPANY

NOVEMBER 2007

Supplemental Evaluation of Mercury In Sediments Report Northwestern Lake Condit Hydroelectric Project FERC Project No. 2342

KLEINFELDER PROJECT NO. 53886 / 5



SUPPLEMENTAL EVALUATION FOR MERCURY IN SEDIMENTS REPORT NORTHWESTERN LAKE CONDIT HYDROELECTRIC PROJECT FERC PROJECT No. 2342 WHITE SALMON, WASHINGTON KLEINFELDER PROJECT NO. 53886 / 5

December 10, 2007

This document was prepared for use only by the client, only for the purposes stated, and within a reasonable time from issuance. Non-commercial, educational and scientific use of this report by regulatory agencies is regarded as a "fair use" and not a violation of copyright. Regulatory agencies may make additional copies of this document for internal use. Copies may also be made available to the public as required by law. The reprint must acknowledge the copyright and indicate that permission to reprint has been received.

Copyright 2007 Kleinfelder

KLEINFELDER 15050 S.W. Koll Parkway, Suite L, Beaverton, OR 97006-6028 (503) 644-9447 (503) 643-1905 fax

December 10, 2007
Kleinfelder Project Number 53886 / 5

Mr. Tim Hemstreet, P.E.
PacifiCorp Hydro Resources
825 N.E. Multnomah, 1500 LCT
Portland, Oregon 97232

Subject: Supplemental Evaluation For Mercury In Sediments Report Northwestern Lake – Condit Hydroelectric Project FERC Project No. 2342 White Salmon, Washington

Dear Mr. Hemstreet:

We are pleased to present our Supplemental Evaluation for Mercury In Sediments Report for Northwestern Lake of the Condit Hydroelectric Project. We trust the information contained in this report will meet your needs at this time.

We appreciate this opportunity to provide our services to you. Should you require additional information or have any questions regarding this report, please contact us at (503) 644-9447.

Sincerely,

KLEINFELDER WEST, INC.

David Earl King, L.G.
Senior Professional Geologist

Lon R. Yandell, L.G.
Principal Geologist
Environmental Department Manager

Copyright 2007 Kleinfelder

KLEINFELDER 15050 S.W. Koll Parkway, Suite L, Beaverton, OR 97006-6028 (503) 644-9447 (503) 643-1905 fax

December 10, 2007
Kleinfelder Project Number 53886 / 5

Mr. Tim Hemstreet, P.E.
PacifiCorp Hydro Resources
825 N.E. Multnomah, 1500 LCT
Portland, Oregon 97232

Subject: **Supplemental Evaluation For Mercury In Sediments Report**
Northwestern Lake – Condit Hydroelectric Project
FERC Project No. 2342
White Salmon, Washington

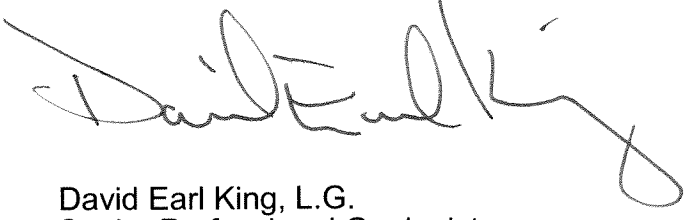
Dear Mr. Hemstreet:

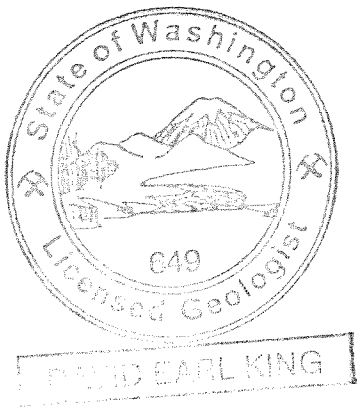
We are pleased to present our Supplemental Evaluation for Mercury In Sediments Report for Northwestern Lake of the Condit Hydroelectric Project. We trust the information contained in this report will meet your needs at this time.

We appreciate this opportunity to provide our services to you. Should you require additional information or have any questions regarding this report, please contact us at (503) 644-9447.

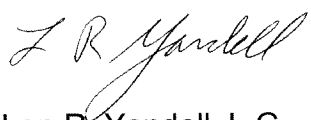
Sincerely,

KLEINFELDER WEST, INC.





David Earl King, L.G.
Senior Professional Geologist



Lon R. Yandell, L.G.
Principal Geologist
Environmental Department Manager

Copyright 2007 Kleinfelder

KLEINFELDER 15050 S.W. Koll Parkway, Suite L, Beaverton, OR 97006-6028 (503) 644-9447 (503) 643-1905 fax

TABLE OF CONTENTS

1.0 INTRODUCTION 1
2.1 PROJECT DESCRIPTION 4
2.2 1994 AND 1997 INVESTIGATIONS 5
2.3 2006 SITE RANKING 6
2.4 MARCH 2007 SEDIMENT REPORT 7
3.0 SITE EXPLORATION METHODOLOGY 9
3.1 SUPPLEMENTAL SAMPLING AND ANALYSIS PLAN 9
3.2 FIELD DOCUMENTATION 9
3.3 SAMPLE TRANSPORT AND CHAIN-OF-CUSTODY PROCEDURES 10
4.1 SAMPLING LOCATIONS 11
4.2 DISCUSSSION OF CHEMICAL ANALYSES 12
4.3 DISCUSSION OF PHYSICAL PARAMETER ANALYSES 13
4.4 COMPARISON OF FINDINGS TO NWRSEF SCREENING LEVELS 14
4.5 ELUTRIATION TESTING OF SEDIMENTS 14
4.6 QUALITY ASSURANCE AND QUALITY CONTROL 15
5.0 BACKGROUND MERCURY EVALUATION 17
5.1 LITERATURE REVIEW 17
5.2 SAMPLING LOCATIONS 19
5.3 DISCUSSION OF PHYSICAL PARAMETER ANALYSES 21
5.4 DISCUSSION OF CHEMICAL LABORATORY ANALYSES 21
5.5 DISCUSSION OF RELATIONSHIP BETWEEN SAMPLE LOCATION AND MERCURY 22
5.6 COMPARISON OF FINDINGS TO NWRSEF SCREENING LEVELS 23
5.7 QUALITY ASSURANCE AND QUALITY CONTROL 23
6.0 FRESHWATER BIOASSAY EVALUATION 24
6.1 FRESHWATER BIOLOGICAL ASSAY (BIO-ASSAY) METHODOLOGY 24
6.2 DISCUSSION OF BIOASSAY RESULTS 25
7.0 MERCURY BIOACCUMULATION EVALUATION 27
7.1 DEVLOPMENT OF SCOPE OF WORK FOR MERCURY BIOACCUMULATION EVALUATION 27
7.2 FIRST PHASE OF SPECIMEN COLLECTION FOR BIOACCUMULATION EVALUATION 27
7.3 SECOND PHASE OF SPECIMEN COLLECTION FOR BIOACCUMULATION EVALUATION .. 29
7.4 FIRST PHASE OF LABORATORY ACTIVITY FOR BIOACCUMULATION EVALUATION 29
7.5 SECOND PHASE OF LABORATORY ACTIVITY FOR BIOACCUMULATION EVALUATION ... 30
7.6 DISCUSSION OF BIOACCUMULATION EVALUATION TEST RESULTS 30
8.0 SUMMARY AND CONCLUSIONS 34
10.0 LIMITATIONS 39

Copyright 2007 Kleinfelder

KLEINFELDER 15050 S.W. Koll Parkway, Suite L, Beaverton, OR 97006-6028 (503) 644-9447 (503) 643-1905 fax

TABLES

1. Probe B-1 Analytical Results
2. Probe B-2 Analytical Results
3. Probe B-3 Analytical Results
4. Probe B-4 Analytical Results
5. Sample Point Locations With Coordinates
6. Analytical Data for Mercury Distribution Analysis
7. Soil Classification of Sediment Samples
8. Elutriation Test Result and Comparison to Water Quality Criteria
9. Analytical Data for Mercury Background Evaluation
10. Comparison of Bioaccumulation Analytical Results To Oregon Guidelines

FIGURES

1. Site Location Map
2. Northwestern Lake Site Map
3. December 2006 Sediment Sampling Locations
4. Mercury Distribution in Sediment Sample Locations
5. Mercury Emission Associated With Volcanics
6. Mercury Background Sample Locations
7. Spring and Little Buck Creeks Sample Locations
8. Mill Creek Sample Location
9. Salt Creek Lahar Sample Location
10. Trout Lake Sample Location
11. Gilmer Creek Sample Location
12. Rattlesnake Creek Sample Location
13. White Salmon River (In-Lieu Fishing Site) Sample Location
14. Little White Salmon River Sample Location
15. Wind River Sample Location

APPENDICES

A. Supplemental Sampling and Analysis Plan with Addendum Letter
B. Correspondence and Approval Letters
C. Columbia Analytical Services Chemical Laboratory Results
D. Northwest Testing's Physical Parameter Laboratory Results
E. Northwestern Aquatic Sciences Report
F. Brooks Rand Bioaccummulation Testing Analytical Report

Copyright 2007 Kleinfelder

KLEINFELDER 15050 S.W. Koll Parkway, Suite L, Beaverton, OR 97006-6028 (503) 644-9447 (503) 643-1905 fax

1.0 INTRODUCTION

This document presents the results of the supplemental mercury evaluation of sediments collected from Northwestern Lake at the Condit Hydroelectric Project in June 2007. The evaluation of the supplemental samples collected in June 2007 is intented to provide a further understanding of mercury analytical results obtained from the sampling and analysis performed on Northwestern Lake sediment samples collected in December 2006. The results of the evaluation of sediment samples collected in December 2006, were reported by Kleinfelder in the *Sediment Sampling and Analysis Report Northwestern Lake Condit Hydrelectric Project; FERC Project No. 2342; White Salmon, Washington; Kleinfelder Project No. 53886 / 4; March 2007* (hereafter referred to as the *March 2007 Sediment Report*). The purpose of the Northwestern Lake sediment evaluation is to determine whether the sediment impounded behind Condit Dam meets established criteria for "open-water" release following the proposed removal of the dam. The Condit Hydroelectric Project is regulated by the Federal Energy Regulatory Commission (FERC) as FERC Project No. 2342.

The data presented in the *March 2007 Sediment Report* indicated that the average concentration of mercury in the fine silts impounded behind Condit Dam was 0.724 milligrams per kilogram (mg/Kg). According to the laboratory data provided in the *March 2007 Sediment Report*, the maximum detected concentration of mercury in the sediments was 2.030 mg/Kg, which was detected in a surface sediment sample collected from a location (boring B-1) near the dam.

The applicable current regulatory screening levels for mercury in freshwater sediments are presented in the *Northwest Regional Sediment Evaluation Framework* (*NWRSEF*) guidance document. The lower screening level (SL1) value is 0.28 mg/Kg and the upper screening level (SL2) is 0.75 mg/Kg. The *NWRSEF* states, "The lower screening level (SL1) corresponds to a concentration below which adverse effects to benthic organisms would not be expected, and the upper screening level (SL2) corresponds to a concentration at which minor adverse effects may be observed in the more sensitive groups of benthic organisms."

The Interim Final *NWRSEF* was presented in September 2006, by the Regional Sediment Evaluation Team (RSET) as a new framework for evaluating sediments and the suitability of disposing those sediments in the Pacific Northwest. The RSET is composed of the U.S. Army Corps of Engineer's (USACOE's) Seattle District,

Copyright 2007 Kleinfelder

USACOE's Portland District, USACOE's Walla Walla District, USACOE's Northwestern Division; the U.S. Environmental Protection Agency (EPA) Region 10; Washington Department of Ecology (WDOE); Washington Department of Natural Resources (WDNR); Oregon Department of Environmental Quality (ODEQ); Idaho Department of Environmental Quality (IDEQ); National Marine Fisheries Service (NMFS); and the U.S. Fish and Wildlife Service (US F&WS).

Laboratory bioassays conducted on sediment collected in December 2006 and composited from the complete lower basin Dredged Material Management Unit (DMMU) indicated that the sediment did not have an adverse effect on the life cycles of the test species. However, because mercury concentrations were found in excess of the upper screening level (SL2) listed in the *NWRSEF*, the RSET requested that PacifiCorp:

1. Collect additional samples from Northwestern Lake to confirm the sediment mercury concentration found near sample location B1-72,
2. Conduct bio-assays on collected sediments found to have the highest mercury concentrations,
3. Establish the bio-availability of mercury found in the sediments through fish and invertebrate tissue analysis (bioaccumulation testing), and
4. Characterize background mercury concentrations in sediments in the local area to determine whether to establish whether Northwestern Lake sediment concentrations are consistent with background levels.

On June 22, 2007, WDOE requested that the bioaccumulation testing initially proposed for the work documented in this report be expanded to include the evaluation of the non-native species *Lumbriculus variegates* and *Corbicula fluminea*. The requested scope expansion by WDOE also included the evaluation of a reference sample with similar characteristics to the project test sediments (location B-1).

The data presented in this report is also intended to support the hypothesis presented in the *March 2007 Sediment Report*, which suggested that the elevated concentrations of mercury encountered in the fine-grained sediments impounded in Northwestern Lake behind Condit Dam are due to naturally occurring background concentrations of the native element. This hypothesis was developed based on the understanding that hydrothermal alteration associated with recent volcanic activity, such as that which has occurred with Mount St. Helens, is a known source of mercury.

Copyright 2007 Kleinfelder

The information presented in this document is intended to satisfy the RSET and *NWRSEF* criteria. Included in this report are the data provided in the *March 2007 Sediment Report*, which have been reconfigured to conform with the format requested by the RSET (refer, Tables 1 through 4).

Copyright 2007 Kleinfelder

2.0 PROJECT DESCRIPTION

The following sections describe the project location, background information, the site ranking, and proposed dredging and sampling parameters.

2.1 PROJECT DESCRIPTION

The Condit Hydroelectric Project is located on the White Salmon River on the border of Klickitat and Skamania Counties approximately 3.3 miles upstream of the confluence of the White Salmon and Columbia Rivers (refer, Figure 1). The U.S. Geological Survey (USGS) topographic coordinates for the Condit Hydroelectric Project are Sections 2 and 3, Township 3 North, Range 10 East, Willamette Meridian (Sec. 2 and 3/T3N/R10E W.M.). The Condit Hydroelectric Project includes a 125-foot high concrete dam across the White Salmon River that diverts water into a 1-mile long woodstave flowline. The woodstave flowline conveys water to a surge tank, where the water is diverted into two pipes (penstocks) for delivery to two turbine generators in the powerhouse downstream of the dam.

The Condit Hydroelectric Project is owned and operated by PacifiCorp and has been in operation since construction was completed in 1913. The name of the reservoir behind the dam is Northwestern Lake. Northwestern Lake is approximately 10,380 feet long with a surface area of approximately 92 acres (refer, Figure 2). The pool elevation listed on the USGS Northwestern Lake topographic map (1983 Edition) is 294 feet above mean sea level. At the time of its construction, the depth of water in the reservoir ranged from approximately 15 to 110 feet. Since the construction of the dam, the reservoir has been collecting sediments brought in by the White Salmon River. As of 1990, the depth of water in the reservoir reportedly ranged from approximately 3 to 85 feet.

Following the construction of the dam, a sawmill was established on a bay on the east shore of the reservoir, immediately upstream of the dam. This sawmill remained in operation for several decades. The exact start up and shut down dates of the sawmill operation are unknown, except that it closed sometime prior to 1960. As part of the development of the *Work Plan for Sediment Characterization* in 1994, a site reconnaissance was conducted of the upland areas around Northwestern Lake and upstream along the White Salmon River. No industrial activity was observed. Land use consisted primarily of residential usage, with some orchards located on the eastern bank of the reservoir. The reconnaissance findings were presented in a report prepared by

Copyright 2007 Kleinfelder

Squier Associates in 1994, entitled the *Condit Hydroelectric Project (FERC Project No. 2342) Northwestern Lake Sediment Characterization Study; White Salmon, Washington* (the *1994 Condit Study*). Reconnaissance of the upstream area of the White Salmon River was also conducted on March 2, 2005, to confirm that no new sources of possible environmental contaminants had been developed since 1994. This reconnaissance identified a new rock quarry just east of Highway 141 (about 0.5 miles east of the northern end of the Lower Basin of Northwestern Lake). This new activity could be considered a new source for fine sediment, but not environmental contaminants. No new potential contaminant sources were discovered during the March 2, 2005, reconnaissance.

A bathymetric survey of the reservoir was conducted in 1990 by PacifiCorp. Based upon a comparison of preconstruction topography to current bathymetry, a channel profile, showing the existing water depths and sediment thicknesses, was developed by others. Based upon this document, the existing water depth within the reservoir appears to vary from approximately 3 to 85 feet, with an accumulated sediment thickness that varies from approximately 13 to 65 feet, with an average thickness of approximately 31 feet. Additional bathymetry work was conducted in 1997 and 2006. On the basis of the bathymetry work, the current volume of accumulated sediments has been estimated by others to be 2.3 million cubic yards.

2.2 1994 AND 1997 INVESTIGATIONS

In 1994, exploratory borings were drilled from a barge at 10 locations in Northwestern Lake. Eight of those locations were chosen using a random number selection process. The remaining two borings were located at the extreme upstream and downstream limits of barge access within the reservoir. As part of the *1994 Condit Study*, 45 geotechnical and 39 environmental samples were collected at various depths from the 10 sample points.

The *1994 Condit Study* sediment characterization testing program consisted of both geotechnical and environmental testing. The geotechnical testing included the following:

- soil classification,
- moisture content,
- grain-size analysis, and
- unit weight determination.

Copyright 2007 Kleinfelder

The environmental testing included an analytical testing program for inorganic metals and organic compounds considered to be of concern by WDOE at that time. In 1994, the mercury concentrations ranged from less than 0.025 mg/Kg to 1.1 mg/Kg. The average mercury concentration in samples collected from the fine-grained sediments was 0.724 mg/Kg. The average mercury concentration in the coarse-grained sediments was 0.30 mg/Kg.

Additional investigation of the sediments was also conducted by Squier Associates in 1997. The results of that additional investigation were presented in a report entitled, *"Additional Geotechnical Exploration and Laboratory Testing at the Condit Hydroelectric Project (Contract No. P018780)"* and dated November 20, 1997. Analytical data from the 1994 and 1997 reports were provided in the *March 2007 Sediment Report*.

The 1994 and 1997 geotechnical testing results indicated that the reservoir sediments consist mainly of fine-grained materials in the downstream deep pool area (Lower Basin), and granular materials in the upstream area (Upper Reservoir). A transition area where the upstream granular sediments have overridden the deep pool fine-grained sediments is located in the middle of the reservoir.

Our review of the environmental testing results and pertinent geological literature indicated that the detected metal concentrations (particularly mercury) were within expected background levels. However, residual pesticides and herbicides were detected in the intermediate-aged sediments in the reservoir.

2.3 2006 SITE RANKING

The data presented in the *March 2007 Sediment Report* was generated based on the protocols and criteria presented in the *Dredged Material Evaluation Framework, Lower Columbia River Management Area, November 1998 (DMEF)* and a *Sampling and Analysis Plan* (SAP) approved by the USACOE on October 16, 2006. The *Sampling and Analysis Plan* submitted to the USACOE for the work described in the *March 2007 Sediment Report* was based on the Low Management Area Ranking for the lower basin DMMU of Northwestern Lake. The initial site ranking was based on *DMEF* criteria. Details on the site ranking process are included in the *March 2007 Sediment Report*.

The *DMEF* allowed for the creation of Dredged Material Management Units (DMMUs), which are subdivisions of a sediment-generating project site that represent sediments similar in nature. The Northwestern Lake sediments were segregated into two DMMUs:

Copyright 2007 Kleinfelder

the lower basin sediments and the upper reservoir gravels. The segregation into two DMMUs provides for one Low Management Area Ranking of homogenous sediments (lower basin) and one area of Exclusionary Ranking (upper reservoir). The homogeneity of the sediments is supported by the 1994, 1997, and 2007 mechanical sieve data. PacifiCorp previously estimated that the sediment volume in Northwestern Lake was approximately 2.2 million cubic yards, based on measured accretion rates and the 1990 bathymetric survey. Using this information and the information presented in the *1994 Condit Study*, the lower basin was determined to include about 51percent of the sediments or 1.122 million cubic yards. The *DMEF* sampling requirement for a homogeneous Low Management Area Ranking DMMU is one sample per 100,000 cubic yards. Accordingly, 12 samples were proposed in the *August 2006 SAP* for the 1.122 million cubic yards of sediments.

2.4 MARCH 2007 SEDIMENT REPORT

The *March 2007 Sediment Report* presented the findings of the field work conducted between December 13 and 18, 2006, which consisted of advancing push probes at four locations using a direct-push drill rig mounted on a barge. The four sample locations (B-1 through B-4) were selected to represent the thickest sediment column in an area representing approximately one quarter of the area of the Lower Basin. Surface casing was used between the barge and the mudline for probes B-1 and B-4. Direct sampling (no surface casing) was used in probes B-2 and B-3. Water depth to the mudline (top of submerged sediments) at each probe location was measured directly with a steel tape. All probes were extended until refusal, which was assumed to indicate gravels or bedrock.

Three samples were obtained from each sample location. The sample depths were typically spaced at a minimum of 10-foot intervals. Multiple holes were required for sample locations B-2, B-3, and B-4 due to either poor recovery or the inability of the barge to properly anchor as a result of the strength of the current at that time. Three duplicate samples were also collected during the field activities for quality assurance and quality control (QA/QC) purposes.

Each sediment sample was analyzed for the physical and chemical parameters required by the *DMEF,* except the sediments were not tested for the presence of butyl tins (also referred to as organotins). The sediment testing methods conformed with the methods listed in the *DMEF.* The physical parameter testing indicated that the

Copyright 2007 Kleinfelder

sediments in the Lower Basin are predominantly fine grained (less than 0.43 millimeters).

The mercury concentration in one sample (sample B1-72) was identified as exceeding the *DMEF* bioaccumulation screening level of 1.5 milligrams per kilogram (mg/Kg). Based on this finding, Tier III Biological Testing (bioassay) was conducted. Sample B1-72 was the sample collected nearest the dam, at the sediment surface, and in 72 feet of water. To satisfy the *DMEF* requirements, the freshwater bioassays were conducted with the amphipod *Hyallella azteca* and the midge *Chironomus tentans*. The freshwater bioassays were also conducted on a reference sample obtained at the mouth of the White Salmon River near the Columbia River, at the Underwood In-Lieu Fishing Access Site managed by the U.S. Department of Interior's Bureau of Indian Affairs (BIA). The bioassay testing indicated that the sediments would not adversely impact the biota of the Columbia River system.

Mercury was detected above the *DMEF* Screening Level of 0.41 mg/Kg in 11 of the 15 sediment samples. For reference purposes, the *NWRSEF* SL1 for mercury is 0.28 mg/Kg and the *NWRSEF* SL2 is 0.75 mg/Kg (these values were not included in the *March 2007 Sediment Report*). The range of mercury concentrations documented in the *March 2007 Sediment Report* is from 0.020 mg/Kg to 2.03 mg/Kg. In 1994, the mercury concentrations ranged from less than 0.025 mg/Kg to 1.1 mg/Kg. Mercury was not detected above the *DMEF* Maximum Level of 2.3 mg/Kg.

The chemical analysis of sediments presented in the *March 2007 Sediment Report* indicated that most contaminants of concern (CoCs) were not present in the sediments. Those CoCs that were detected were typically present at relatively low concentrations as compared to the *DMEF* Screening Levels. However, one sample (B1-72) did contain a mercury concentration (2.030 mg/Kg) above the *DMEF* Bioaccumulation Trigger Level (discussed above), which initiated the bioassay testing. The chemical analysis did not detect analytes above *DMEF* Maximum Levels.

Tables 1 through 4 present the *March 2007 Sediment Report* data and compare the data to the NWRSEF criteria. The data has also been reconfigured to conform to the format requested in the NWRSEF. The locations of the samples collected in December 2006 are presented in Figure 3.

Copyright 2007 Kleinfelder

3.0 SITE EXPLORATION METHODOLOGY

The following sections discuss the methodologies and protocols used to complete the field portion of this project.

3.1 SUPPLEMENTAL SAMPLING AND ANALYSIS PLAN

Kleinfelder submitted a *Mercury Distribution and Background Evaluation Supplemental Sampling and Analysis Plan* (*SSAP*) to PacifiCorp on June 12, 2007 *(June 2007 SSAP).* A copy of the SSAP is included in Appendix A. After PacifiCorp's review and approval, the *June 2007 SSAP* was submitted to RSET for review and approval. At WDOE's request, an addendum letter was submitted on July 2, 2007 that included a description of additional bioaccumulation testing to be conducted. The objective of the *June 2007 SSAP* was to provide a systematic approach to collecting additional sediment characterization data that would supplement the existing data presented in the *1994 Condit Study* and *March 2007 Sediment Report*. The data collected during implementation of the *June 2007 SSAP* (and July 2007 Addendum Letter) are intended to satisfy the requirements of the RSET in accordance with the *NWRSEF*.

The USACOE, acting on behalf of the RSET, approved the *June 2007 SSAP* on July 10, 2007, in a transmittal to PacifiCorp (refer, Appendix B). The Washington Department of Fish and Wildlife provided a *Hydraulic Project Approval* on July 11, 2007, that authorized the sampling program to proceed in Northwestern Lake. A copy of the *Hydraulic Project Approval* is also included in Appendix B. A Wilderness Use Permit was also obtained from the U.S. Department of Agriculture's (USDA) Forest Service on July 17, 2007, to access the sampling locations within the Gifford Pinchot National Forest.

3.2 FIELD DOCUMENTATION

A team consisting of a Kleinfelder geologist and a Kleinfelder biologist conducted the field work to collect the sediment samples. The fish species collection effort was conducted by a PacifiCorp fish biologist and two representatives from the Washington Department of Fish and Wildlife.

Each sediment sampling location was documented by a member of the Kleinfelder field team in the field notes, which were maintained during sampling operations. Included in the field notes was the following information:

Copyright 2007 Kleinfelder

- Names of the individuals onsite during sample collection
- Weather conditions
- Depth to top of sediments (mudline) at each sampling station
- Date and time of collection of each sample
- The sample identification number
- Physical sediment descriptions, including general soil classification and observations for the presence of vegetation, debris, evidence of biological activity, and other distinguishing characteristics or features
- Any deviation from the approved sampling plan

The sediment samples for chemical analysis and bioassay testing were immediately placed in properly labeled, laboratory-supplied, glass jars with teflon-lined lids, and placed on ice. Containers were filled as tightly as possible, eliminating obvious air pockets. With the cap liner's Teflon side down, the cap was carefully placed on the opening of the container, displacing any excess material. Bulk samples for use in the exposure process of the bioaccumulation testing were placed into clean 5-gallon plastic buckets with clean lids.

The sampling containers were labeled with: the project name, sample identification, date, and time; and referenced by entry into the field logs. New, disposable nitrile gloves were worn and replaced between each sample collected.

3.3 SAMPLE TRANSPORT AND CHAIN-OF-CUSTODY PROCEDURES

Following sample collection, the samples were packed on ice in coolers. A signed and dated chain-of-custody seal was placed on all coolers prior to removal from the site. The chain-of-custody records were maintained throughout all sampling activities and accompanied samples during shipment to the laboratory. Information tracked by the chain-of-custody records included: sample identification number, date and time of sample receipt, and analytical parameters requested.

Copyright 2007 Kleinfelder

4.0 MERCURY DISTRIBUTION EVALUATION

The mercury concentrations presented in the *March 2007 Sediment Report* ranged from 0.020 mg/Kg to 2.03 mg/Kg. The *NWRSEF* SL1 for mercury is 0.28 mg/Kg and the *NWRSEF* SL2 is 0.75 mg/Kg. The *NWRSEF* SL1 and SL2 are the current applicable action levels. The highest mercury concentration detected (2.03 mg/Kg) was in the sediment sample collected nearest the dam (identified as sample B1-72). Sample B1-72 was collected when the sampling barge was anchored adjacent to the safety-buoy line that is intended to limit water craft from approaching the dam. The water depth at the location of sample B1-72 was about 72 feet at the time of sampling on December 18, 2006. The sample consisted of fine-grained material only.

One of the objectives of the *June 2007 SSAP* was to further characterize sediment mercury concentrations in the vicinity of sample B1-72. This was accomplished by collecting a set of seven supplemental sediment samples in the vicinity of sample B1-72.

4.1 SAMPLING LOCATIONS

On July 18, 2007, seven supplemental surface sediment samples were collected in the vicinity of sample B1-72. The seven sample points were identified as NW1-071807, NW2-071807, NW3-071807, NW4-071807, NW5-071807, MW6-071807, and NW7-071807. The locations of the sample points were determined with a Global Positioning System (GPS) unit with a minimum of three satellite points for reference (refer to Table 5 and Figure 4).

The sediment sampling was conducted from a 24-foot aluminum sled with twin outboard motors owned and operated by Mark Marine Services, Inc., of Camas, Washington (Mark Marine sled). The sediment samples were collected using a bottom dredge capable of securely recovering an approximate 235 cubic inch sample.

Adequate sample volume (approximately 360 cubic inches) was collected from each location for the proposed tests. In order to accomplish this, the sediment-filled bottom dredge was emptied into a clean, dedicated, 5-gallon bucket immediately after retrieval. When an adequate volume of sediment was obtained, the sediments were transferred to the appropriate containers. The sampling containers were referenced in the field

Copyright 2007 Kleinfelder

logbook and labeled with the project name, sample identification, type of analysis to be performed, and the date and time.

4.2 DISCUSSSION OF CHEMICAL ANALYSES

The samples for chemical analyses were delivered to Columbia Analytical Services in Kelso, Washington (CAS-Kelso) for chemical analysis. All samples delivered to CAS-Kelso were transported under chain-of-custody protocols. The seven project samples collected in Northwestern Lake on July 18, 2007, were tested for the following:

- mercury concentrations by EPA Method 7471A,
- total solids by EPA Method 160.3M,
- total volatile solids (TVS) by EPA Method 160.4M,
- total organic carbon (TOC) by EPA Method American Society for Testing and Materials (ASTM) D 4129-98M,
- ammonia by EPA Method 350.1M, and
- sulfides by Standard Method 9030M.

The results of the chemical analyses are presented in Table 6. Copies of the analytical reports provided by CAS-Kelso are included in Appendix C. In summary, the following results were reported for the seven samples collected from the vicinity of sample point B1-72:

- Mercury concentrations ranged from 0.094 mg/Kg to 0.881 mg/Kg with an average of 0.6 mg/Kg. The mercury concentration in B1-72 was 2.030 mg/Kg and the average mercury concentration derived from the *March 2007 Sediment Report* is 0.7 mg/Kg.
- Total solids percentages ranged from 43.7 percent to 55.1 percent with an average of 50.4 percent. The total solids percentage in B1-72 was 48.0 percent and the average total solids percentage derived from the *March 2007 Sediment Report* is 61.0 percent.
- Total volatile solids percentages ranged from 3.67 percent to 5.84 percent with an average of 4.99 percent. The TVS percentage in B1-72 was 4.01 percent and the average TVS percentage derived from the *March 2007 Sediment Report* is 4.8 percent.
- TOC ranged from 0.86 percent (8,600 mg/Kg) to 1.64 percent (16,400 mg/Kg) with an average of 1.37 percent (13,700 mg/Kg). The TOC in B1-72 was 1.05

Copyright 2007 Kleinfelder

percent (10,500 mg/Kg) and the average TOC derived from the *March 2007 Sediment Report* is 1.1 percent (11,000 mg/Kg).

- Ammonia concentrations ranged from 11.0 mg/Kg to 26.9 mg/Kg with an average of 18.9 mg/Kg. The ammonia concentration in B1-72 was 2.88 mg/Kg and the average ammonia concentration derived from the *March 2007 Sediment Report* is 78.4 mg/Kg.
- Sulfides ranged from non-detect (less than 0.5 mg/Kg) to 50.2 mg/Kg with an average of 19.5 mg/Kg. The sulfide concentration in B1-72 was also less than 0.5 mg/Kg and the average sulfide concentration derived from the *March 2007 Sediment Report* is 63.1 mg/Kg.

The mercury concentrations reported for the seven supplemental samples were all less than the mercury concentration detected in sample B1-72. The mercury concentrations in the supplemental sediment samples appear to be more consistent with the average mercury concentrations derived from the data presented in the *March 2007 Sediment Report*.

4.3 DISCUSSION OF PHYSICAL PARAMETER ANALYSES

Representative samples from the seven supplemental sediment sample points (NW-1 through NW-7) were also delivered to Northwest Testing, Inc. a division of Northwest Geotech, Inc., of Wilsonville, Oregon (Northwest Testing). The seven samples were analyzed for grain size determination using ASTM D422 and ASTM D2487 methods. The ASTM D422 analysis used the following sieve sizes: 5-inch; 2.5-inch; 1.25-inch; 0.63-inch; 0.31-inch; and numbers 5, 10, 18, 35, 60, 100, and 200. The fine-grained fraction (finer than No. 200 sieve) was classified using hydrometer analysis on the seven samples. Hydrogen peroxide was not used in the preparation for grain size analysis.

The results of the grain size analysis are provided in Appendix D and are summarized in Table 6. On the basis of the grain size analysis, Kleinfelder has classified the sediment in accordance with the Unified Soil Classification System, ASTM D 2487. The sediment classification is presented in Table 7.

Copyright 2007 Kleinfelder

4.4 COMPARISON OF FINDINGS TO NWRSEF SCREENING LEVELS

The applicable current regulatory screening levels for mercury in freshwater sediments are found in the NWRSEF. These screening levels include a lower screening level (SL1) of 0.28 mg/Kg and an upper screening level (SL2) of 0.75 mg/Kg. Five of the seven samples collected to evaluate the distribution of mercury in the vicinity of the sample B1-72 exceeded the SL1 screening level of 0.28 mg/Kg. Four of those five samples also exceeded the SL2 screening level of 0.75 mg/Kg. The average mercury concentration for the seven samples (NW1-071807 through NW7-071807) also exceeded the SL1 screening level.

4.5 ELUTRIATION TESTING OF SEDIMENTS

The mercury that has been identified in the Northwestern Lake sediments has been sorbed onto fine-grained particles deposited by the river. Elutriation testing was also conducted on the sediments in order to evaluate the ability of that mercury to resuspend into the water column and become water-borne mercury. The elutriation process is a method of washing, straining, or decanting that separates the light and heavy particles.

The elutriation testing was conducted by CAS-Kelso. Two liters of sediment were provided by Kleinfelder for each sampling location. The sediment collected from sample location NW1-071807 was selected for the elutriation testing since this location had the highest concentration of mercury of the seven sets of sediment samples collected on July 18, 2007. CAS-Kelso conducted the elutriation preparation in general accordance with the guidance procedures provided by the EPA for water quality evaluations of water column effects. The CAS-Kelso elutriation preparation procedures differed from the EPA guidance for standard elutriate preparation in that they used laboratory grade deionized water instead of natural water from the receiving water body. This deviation in the methodology produces a concentration with a high bias with respect to released contaminants concentrations due to the principle of chemical equilibria, which provides for a greater desorption into a pure media than a media that already has a solute load. Both procedures aggressively mix the sediments with the aqueous media, allow for settling of the sediments over a prescribed time period, and then siphon off the supernate without disturbing the settled material. A supernate, or supernatant liquid, is the liquid that floats above non-soluble solids.

Copyright 2007 Kleinfelder

The supernate was analyzed for mercury using EPA Method 1631. This EPA method is used to detect very low levels of mercury. The reporting limit for the EPA Method 1631 analysis is in nanograms per liter (ng/L or parts per trillion). The elutriate sample analysis resulted in a detected mercury concentration of 0.525 ug/L.

Various regulatory levels have been promulgated for mercury. These include the WDOE's Ambient Water Quality Criteria (AWQC) for chronic and acute exposures as defined in Washington Administrative Code (WAC) Chapter 173-201A (*Water Quality Standards for Surface Waters of the State of Washington*) and the National Recommended Water Quality Criteria (NWRQC) published by EPA's Office of Water and Office of Science and Technology in 2004. The NWRQC include the Criteria Maximum Concentration (CMC), which is "an estimate of the highest concentration of …" mercury… "in surface water to which an aquatic community can be exposed briefly without resulting in an unacceptable effect." The NWRQC also include the Criterion Continuous Concentration (CCC), which is "an estimate of the highest concentration of …" mercury … "in surface water to which an aquatic community can be exposed indefinitely without resulting in an unacceptable effect." Also presented, for reference, are the EPA's Maximum Contaminant Level (MCL) and EPA's Region IX Preliminary Remediation Goal (PRG) for mercury in tap (drinking) water.

These regulatory levels and reported sample concentration (0.525 ug/L) are presented in Table 8 in descending order. This method displays the relationship between of the values and the observed sample concentration. Based on this review, the elutriation test concentration only exceeds the WDOE AWQC concentration for chronic exposures (0.012 ug/L).

4.6 QUALITY ASSURANCE AND QUALITY CONTROL

CAS-Kelso has provided a Case Narrative for their package of laboratory results submitted for this set of analyses (refer, Appendix C). The Case Narrative notes that the Kleinfelder sampler neglected to sign the chain of custody prior to relinquishing the samples to the CAS-Kelso courier. This is also noted in Kleinfelder's Quality Assurance (QA) review of the data package (refer, Appendix C). The sampler did sign the chain of custody in the title block.

Our QA review of the data indicates that the data is valid and, therefore, is acceptable for use in accomplishing the project objectives. The one noted issue is that the sulfide

Copyright 2007 Kleinfelder

detections may be biased high due to high relative percent differences (RPDs) between the project samples and a selected duplicate sample. It is noted in the Case Narrative that the high RPDs may be due to variability within the sediments. It appears that all samples for physical and chemical analysis were analyzed within the recommended holding times. Kleinfelder's QA/QC review included an evaluations of both the laboratory and field QA/QC procedures and results.

Copyright 2007 Kleinfelder

5.0 BACKGROUND MERCURY EVALUATION

As stated earlier, the *March 2007 Sediment Report* documented that the mercury concentration in one sample (Sample B1-72) was reported as 2.030 mg/Kg. The *March 2007 Sediment Report* further presented that the average concentration of mercury in the fine silts impounded behind Condit Dam, based on the samples collected in December 2006, is 0.724 mg/Kg.

Mercury is a native element commonly found in rocks associated with Cascade Range volcanic activity. The White Salmon River receives direct runoff from nearby Mount Adams, a Cascades Range volcano. The objective of the background mercury evaluation was to determine whether mercury concentrations identified in Northwestern Lake are within background concentrations found in the local area.

5.1 LITERATURE REVIEW

According to U.S. Geological Services (USGS) Professional Paper 1270 (*Element Concentrations In Soils and Other Surficial Materials of the Conterminous United States*), background mercury concentrations are considered to be between 0.32 mg/Kg and 2.0 mg/Kg in the White Salmon River area. Mark A. Engle, PhD, a Research Geologist with the USGS, has stated in a personal communication that the USGS generally considers 0.100 mg/Kg as a "cutoff for soils" when considering whether a soil has an elevated mercury concentration. Mr. Engle was contacted based on a published abstract for a Poster Presentation entitled *Mercury Rising Out of Volcanoes and Geothermal Systems*.

Engle's abstract and a paper prepared by James J. Rytuba identify the Mount Saint Helens eruption as being a local source of mercury emissions. Mr. Rytuba's paper (*Geogenic and Mining Sources of Mercury to the Environment*) includes a discussion on the processes involved in the release of mercury from volcanic activity, which are depicted in Figure 5. Both authors indicate that the amount of mercury emitted by Cascade volcanoes is minor compared to the global loading of mercury, but that the process can be significant on a local scale. According to the researchers, mercury will also be concentrated in hydrothermally altered argillic (clayey) rocks. The argillic hydrothermal alteration zones are typically located on or near the volcanic summits. However, due to the argillic rocks inherent weakness and instability of active volcanic

Copyright 2007 Kleinfelder

summits, the rocks are entrained in lahars and associated debris flows that can travel great distances from the volcano.

The role of lahars in distributing the weakened, hydrothermally altered argillic rocks is also discussed by James W. Vallance in *Postglacial Lahars and Potential Hazards in the White Salmon River System on the Southwest Flank of Mount Adams, Washington* (USGS Bulletin 2161). The Salt Creek Lahar was identified by Vallance and Rytuba (personal communication) as being a flow with abundant blocks of hydrothermally altered rocks.

According to the EPA, the most prevalent source of anthropogenic (man-made) mercury in the environment is from the burning of fossil fuels, particularly coal. Coal-burning power plants reportedly account for over 40 percent of the mercury emissions in the United States. The EPA further estimates that less than half of the mercury that is deposited in the U.S. comes from U.S. sources.

WDOE's publication, *Chemicals of Special Concern in Washington State* (1992), describes the following other anthropogenic sources of mercury:

> "Mercury is used as a cleaning agent in heavy metal soaps, and as a base for pesticides. It is used in chemical production, laboratories, auto repair shops, dentistry, preservation of some latex paints, and the plating and metal printing industries. Mercury is used in thermometers, switches, and batteries, in fluorescent light bulbs, and in pharmaceuticals. It is found at illegal drug laboratory hazardous waste sites, where amphetamines and barbiturates have been processed."

Rytuba (2005) also identified forest fires as a mechanism to redistribute mercury into upper soil layers. Rytuba cites a 2003 article by Hans Friedli for this assertion. Hans Friedli and Christine Wiedinmyer reasserted this action in a 2007 article, *Mercury Emissions Estimates From Fires: An Initial Inventory for the United States,* which was published in the October issue of the journal, *Environmental Science and Technology*. The mercury released by the forest fires is not generated by the forest fires. Instead, it is atmospheric mercury, typically anthropogenic mercury that has been accumulated by the forests, which is then released by the combustion.

In 2001 and 2002, WDOE staff collected 60 sediment samples from 20 waterbodies in the State of Washington. The results of the study were published in 2003 under

Copyright 2007 Kleinfelder

the title "*Mercury in Edible Fish Tissue and Sediments from Selected Lakes and Rivers of Washington State*, June 2003, Publication No. 03-03-026." Mercury was detected in all the waterbodies, although two waterbodies (the Okanogan River and Banks Lake) produced sediment samples with no detectable mercury among the set of three samples collected from those water bodies. The waterbodies with the highest levels of mercury were located in the southwestern portion of Washington. Northwestern Lake is in the southwestern portion of Washington. The maximum mercury concentration for Washington lake sediments, as reported in the 2003 document, is 0.327 mg/Kg.

5.2 SAMPLING LOCATIONS

Ten sample locations were selected from the region around Northwestern Lake and the White Salmon River for the background mercury evaluation. The selection of 10 samples for the data set was based on WAC 173-340-709 *Methods For Defining Background Concentrations* under the *Model Toxics Cleanup Act* (MTCA). Ten samples is the minimum required sample set for determining natural background concentrations. Natural background is further defined as the concentration "consistently present in the environment that has not been influenced by localized human activities."

Each sample location, illustrated on Figures 6 through 15, was selected to represent sediment that was within the White Salmon River drainage basin or within the same physiographical region. Efforts were made to match fine-grained sediments in Northwestern Lake by focusing the sampling efforts in areas where fine-grained sediments might accumulate in the selected locations. The sampling activities were conducted between July 17 and July 19, 2007. The ten sample locations in the Northwestern Lake region are described as follows:

- Little Buck Creek - Sample LBC-071807 (LBC) was collected from the Mark Marine sled with a dredge sampler at the confluence of Little Buck Creek and Northwestern Lake (refer, Figures 6 and 7).

- Buck Creek - No sample was collected from this location (refer, Figures 2 and 6) at the confluence of Buck Creek and Northwestern Lake due to the predominant prevalency of gravel and lack of fine grained material.

Copyright 2007 Kleinfelder

- Mill Creek - Sample MC-071807 (MC) was collected from the Mark Marine sled with a dredge sampler at the confluence of Mill Creek and Northwestern Lake (refer, Figures 6 and 8).

- Spring Creek - Sample BC-071807 (BC) was collected from the Mark Marine sled with a dredge sampler at the confluence of Spring Creek and Northwestern Lake (refer, Figures 6 and 7).

- Salt Creek - Sample SP1-01707 (SP1) was collected in the southeast corner of Salt Creek Meadows on the Salt Creek Lahar (refer, Figures 6 and 9).

- Trout Lake – Sample SP2-071707 (SP2) was collected in a marshy area near the main flow channel and the southwest end of Trout Lake (refer, Figures 6 and 10).

- Gilmer Creek - Sample SP3-071707 (SP3) was collected near the confluence of Gilmer Creek and the White Salmon River approximately 300 feet upstream on Gilmer Creek (refer, Figures 6 and 11).

- Rattlesnake Creek - Sample SP4-071707 (SP4) was collected at the confluence of Rattlesnake Creek and The White Salmon River (refer, Figures 6 and 12).

- White Salmon – Sample SP5-071707 (SP5) was collected in a bay just north of the confluence of the White Salmon and Columbia Rivers in the tribal Underwood In-Lieu Fishing Access Site (refer, Figures 6 and 13). The letter granting permission for sampling access from the Northwest Regional Office of the BIA is included in Appendix B.

- Little White Salmon – Sample LWS-071907 (LWS) was collected along a river bend just below the Little White Salmon Fish Hatchery, at the confluence of the Little White Salmon and Drano Lake (refer, Figures 6 and 14).

- Wind River - Sample WR-071907 (WR) was collected in the bay at the confluence of the Wind River and the Columbia River (refer, Figures 6 and 15).

Sample collection tools were decontaminated between each location. The locations of the sample points were determined with a GPS unit with a minimum of three satellite points for reference (refer to Table 6).

Copyright 2007 Kleinfelder

5.3 DISCUSSION OF PHYSICAL PARAMETER ANALYSES

The ten samples collected for the mercury background evaluation were also evaluated for the physical parameters of the sediments. Specifically, particle size was evaluated by ASTM Methods C-136/C117 and D 422 by Northwest Testing. The particle size analysis was conducted using the following sieve sizes: 5-inch; 2.5-inch; 1.25-inch; 0.63-inch; 0.31-inch; and numbers 5, 10, 18, 35, 60, 120, and 230. The fine-grained fraction (finer than No. 230 sieve) was further classified using hydrometer analysis (ASTM D-422). Hydrogen peroxide was not used in the preparation for grain size analysis.

The report provided by Northwest Testing is provided in Appendix D. In addition, the percentages of sediment that passed each of the sieves are included in Table 9. Sediment classification designations were also made in accordance with USCS and ASTM D 2487. The sediment classification designations are included in Table 7.

A special request was made to Northwest Testing to retain the portion of each sediment sample that passed the Number 200 sieve. This portion was collected into clean 8-ounce or 4-ounce jars (depending on the available volume) provided by CAS-Kelso and returned to Kleinfelder for delivery to CAS-Kelso.

5.4 DISCUSSION OF CHEMICAL LABORATORY ANALYSES

Both sets of samples (unsieved and sieved) for mercury analysis were delivered to CAS-Kelso for chemical analysis using EPA Method 7471A. CAS-Kelso also provided a total solids value for each sample. The analytical report from CAS-Kelso is included in Appendix C and the data are summarized in Table 9.

The highest mercury concentration (0.72 mg/Kg) encountered in the unsieved samples was associated with the mouth of the White Salmon River (collected at the Underwood In-Lieu Fishing Access Site). This concentration is comparable to the average mercury concentration (0.724 mg/Kg) of the sediment samples collected from Northwestern Lake in the 2006 samples - also on the White Salmon River. The mercury concentrations of the other unsieved samples ranged from 0.007 mg/Kg (collected at Trout Lake) to 0.443 mg/Kg (collected at the mouth of Mill Creek).

The average mercury concentration for the ten sieved samples collected to assist in the understanding of background concentrations in the White Salmon River drainage is

Copyright 2007 Kleinfelder

0.142 mg/Kg. This average is less than the average derived from samples collected in Northwestern Lake.

The portions of the seven samples collected from tributaries of the White Salmon River that passed the number 230 sieve during the grain size analysis were also submitted for analysis of mercury content. The results of the mercury analysis on the sieved samples are also included in Appendix C and summarized in Table 9.

The laboratory reports show that the mercury concentrations in the sieved samples were about an order of magnitude higher than concentrations found in the unsieved samples. The mercury concentrations in the sieved samples ranged from 0.08 mg/Kg to 1.2 mg/Kg. The highest mercury concentration (1.2 mg/Kg) was found in the sample collected in Mill Creek, where the highest mercury concentration (0.443 mg/Kg) was detected in the seven unsieved samples. The lowest mercury concentration in the sieved samples (0.08 mg/Kg) was reported for the sample from Gilmer Creek, which contained a mercury concentration of 0.021 mg/Kg in the unsieved sample. The lowest unsieved mercury concentration (0.007 mg/Kg) was found in the Trout Lake sample, which increased to 0.11 mg/Kg in the sieved sample.

5.5 DISCUSSION OF RELATIONSHIP BETWEEN SAMPLE LOCATION AND MERCURY

The samples collected from sample points in proximity to Northwestern Lake (Mill Creek, Spring Creek, and Little Buck Creek) tended to produce greater mercury concentrations than the samples collected from points upstream of the lake (Salt Creek, Trout Lake, Gilmer Creek, and Rattlesnake Creek). Specifically, the average mercury concentrations for the two separate sample point types were an order of magnitude apart (0.19 mg/Kg compared to 0.019 mg/Kg).

The two sample point types could also be differentiated according to direction of origin. The three samples collected from the confluences of creeks with Northwestern Lake (Mill Creek, Spring Creek, and Little Buck Creek) originated west of Northwestern Lake and the White Salmon River. The three samples collected at the confluences of creeks with the White Salmon River (Salt Creek, Gilmer Creek, and Rattlesnake Creek) originated east of the white Salmon River. The Big Lava Bed Geologic Area and the Indian Heaven Volcanic Field, which together include over 20 volcanic vents of Quaternary age, and Mount St. Helens are located west of the White Salmon River and Mount Adams is located northeast of the White Salmon River. Samples collected from

Copyright 2007 Kleinfelder

points west of the White Salmon produced higher mercury concentrations than those samples collected from sample points east of the White Salmon River. More recent volcanism has occurred west of the White Salmon River.

5.6 COMPARISON OF FINDINGS TO NWRSEF SCREENING LEVELS

As stated earlier, the applicable regulatory screening levels for mercury in freshwater sediments include a lower screening level (SL1) of 0.28 mg/Kg and an upper screening level (SL2) of 0.75 mg/Kg. The sample collected from the White Salmon River (SP5-071707) at its confluence with the Columbia River exceeded the SL1 criteria but not the SL2 criteria, although it closely approached that criteria (0.72 mg/Kg compared to 0.75 mg/Kg). Mercury concentrations in two of the three sieved samples collected from tributaries that empty into the lower portion of Northwestern Lake (Little Buck Creek and Mill Creek) exceeded both (SL1 and SL2) screening levels. The mercury concentration in the third sieved sample (the Spring Creek's sample concentration of 0.73 mg/Kg) almost matched the upper screening level. The only unsieved sample where the mercury concentration exceeded the lower screening level was collected from Mill Creek (MC-071807). No unseived samples exceeded the SL2 criteria.

5.7 QUALITY ASSURANCE AND QUALITY CONTROL

The initial set of samples for mercury analysis used in the mercury background evaluation were included in the CAS-Kelso data package discussed in Section 4.6. As stated earlier, the Case Narrative notes that the Kleinfelder sampler neglected to sign the chain of custody prior to relinquishing the samples to the CAS-Kelso courier. This is also noted in Kleinfelder's QA review of the data package (refer, Appendix C). The sampler did sign the chain of custody in the title block.

The second set of samples for mercury analysis (the sieved samples) were reported in a separate CAS-Kelso document. No issues or discrepancies were noted in the second CAS-Kelso Case Narrative (refer, Appendix C). It appears that all samples for physical and chemical analysis were analyzed within the recommended holding times. Our QA review of the data indicates that the data is valid and, therefore, are acceptable for use in accomplishing the project objectives.

Copyright 2007 Kleinfelder

6.0 FRESHWATER BIOASSAY EVALUATION

The work presented in the *March 2007 Sediment Report* was based on guidance provided by the *Dredged Material Evaluation Framework, Lower Columbia River Management Area (DMEF, 1998).* In the *March 2007 Sediment Report*, one sample (Sample B1-72) was identified as exceeding the *DMEF, 1998* bioaccumulation screening level of 1.5 mg/Kg. Based on this finding, DMEF Tier III Biological Testing (bioassay) was conducted with the amphipod *Hyallella azteca* and the midge *Chironomus tentans* on a composite sample represenative of the complete sediment unit. The freshwater bioassays were also conducted on a reference sample obtained at the mouth of the White Salmon River near the Columbia River, at the Underwood In-Lieu Fishing Access Site managed by the U.S. Department of Interior's Bureau of Indian Affairs.

The laboratory bioassays conducted on the composited sediment collected in December 2006 indicated that the sediment had no adverse effect on the life cycles of test species. However, because mercury concentrations were found in excess of the *NWRSEF* SL2, the RSET requested that PacifiCorp collect additional information to confirm the concentrations of mercury in sediments of Northwestern Lake, and conduct bioassays on the worst-case sediments (the sample with the highest mercury concentrations).

6.1 FRESHWATER BIOLOGICAL ASSAY (BIO-ASSAY) METHODOLOGY

The freshwater biological assay testing was conducted by Northwestern Aquatic Sciences of Newport, Oregon (NW Aquatic). NW Aquatic also conducted the initial bioassays reported in the *March 2007 Sediment Report*. The freshwater bioassays were conducted with the amphipod *Hyallella azteca* and the midge *Chironomus tentans*. The amphipods are small (about 0.25-inch) aquatic crustaceans. Midges are tiny (about 0.05-inch) 2-winged flying insects. The testing protocol for the *Hyallella azteca* and *Chironomous tentans* testing was based on EPA Methods 100.1 and 100.2, respectively, and ASTM Method E 1706-00 (for both).

Bioassays were conducted on the one sample selected based on the mercury concentration, as reported by CAS-Kelso and a reference sample, also selected based on mercury concentrations reported by CAS-Kelso. Specifically, sample NW1-071807, with a mercury concentration of 0.881 mg/Kg was selected as the worst-case sample

Copyright 2007 Kleinfelder

and sample NW7-071807, with a mercury concentration of 0.094 mg/Kg was selected as the reference sample. The sediment samples for freshwater bioassay testing were developed by obtaining three discrete 32-ounce jars at each of the seven sampling locations accessed for the mercury distribution task (samples NW1-071807 through NW7-071807).

As stated earlier, physical parameter information and chemical reference information were obtained on the samples from Northwestern Lake and identified as NW1-071807 through NW7-071807. Samples NW1-071807 through NW7-01807 were collected from the same medium at the same relative time, and accordingly are considered seven replicates. The physical parameter analyses (grain size) were completed by Northwest Testing and the chemical reference analyses were completed by CAS-Kelso. The chemical reference analyses for the seven replicate samples included the following:

- total solids,
- TVS,
- total organic carbon,
- ammonia, and
- sulfides.

The analytical reports from CAS-Kelso were provided to NW Aquatic prior to initiating the bioassay testing. NW Aquatic personnel collected their own negative control sample from Beaver Creek, a location about 8 miles south of Newport, Oregon prior to initiating the bioassays.

The *Hyella* and *Chironomus* tests are both 10-day growth and survival tests. A known quantity of each species is introduced into each of the test sediments (project, reference, and control). After the 10-day period the population of each specie is evaluated for mortality rate. The *Chironomus* population is also burned and weighed for an “ash-free weight”. The “ash-free weights” are used to evaluate changes in biomass between the sediments. The results are then compared to “One Hit Criteria” and “Two Hit Criteria”. A more complete description of the bioassay method is included in Appendix E.

6.2 DISCUSSION OF BIOASSAY RESULTS

NW Aquatic’s report for the freshwater biological assay is included in Appendix E. In summary, the following statistical results were reported for the *Hyella* tests:

Copyright 2007 Kleinfelder

- Project Sample (NW1-071807) = 6.3 percent mean mortality with a Standard Deviation (SD) of plus or minus (+/-) 7.4.
- Reference Sample (NW7-071807) = 0.0 percent mean mortality with an SD of +/- 0.0.
- Control Sample = 1.3 percent mean mortality with an SD of +/- 3.5.

The statistical results of the *Chironomous* tests are as follows:

- Project Sample (NW1-071807) = 3.8 percent mean mortality with an SD of +/- 5.2.
- Reference Sample (NW7-071807) = 5.0 percent mean mortality with an SD of +/- 5.3.
- Control Sample = 1.3 percent mean mortality with an SD of +/- 3.5.

The statistical results of the average individual ash-free weights of the *Chironomous* are as follows:

- Project Sample (NW1-071807) = 0.62 milligrams (mg) with an SD of +/- 0.05.
- Reference Sample (NW7-071807) = 0.76 mg with an SD of +/- 0.05.
- Control Sample = 0.74 mg with an SD of +/- 0.05.

Although the results of the project sample are considered "statistically significantly different from the reference" sample, the results did not fail under the one-hit rule, nor did the results fail under the two-hit rule. The one-hit and two-hit rules are levels of observed response for biological test interpretation. The one-hit rule is for when a single observed response indicates a test failure, such as a test species' mortality rate being greater than 15 percent of the mean reference mortality rate. The two-hit response is similar, but there are two observed indications of test failures. Accordingly, the project sediments, which are the sediments with the highest detected concentration of mercury of the seven samples collected in July 2007 in the vicinity of the highest reported mercury concentration for Northwestern Lake, passed the freshwater biological assay tests (refer, Appendix E).

Copyright 2007 Kleinfelder

7.0 MERCURY BIOACCUMULATION EVALUATION

The State of Washington recognizes certain toxic substances in the environment as being bioaccumulative. Bioaccumulation is the process wherein a member of the biosphere takes in a substance quicker than it will excrete the same substance. This is a problem when the substance is toxic. The bioaccumulated toxic substance can also be passed along from one species (prey) to another species (predator). The larger the organism and the more active a carnivore an organism is, the greater the potential bioaccumulation. Mercury is a recognized bioaccumulative toxic substance.

To establish the possible bio-availability of mercury found in the sediments through fish and invertebrate tissue analysis, bioaccumulation testing was also conducted as part of this supplemental mercury evaluation.

7.1 DEVLOPMENT OF SCOPE OF WORK FOR MERCURY BIOACCUMULATION EVALUATION

On June 8, 2007, Kleinfelder submitted a *Supplemental Sediment Sampling and Analysis Plan* (*SSAP*) to further evaluate mercury distribution in the sediments and aquatic fauna of Northwestern Lake. One of the three tasks specified in the *SSAP* was a bioaccumulation study that was to focus on fish tissue, molluscan tissue, and crayfish (*Astacidae*) tissue. Based on the initial field findings, on June 22, 2007, WDOE requested that the bioaccumulation testing initially proposed for the work documented in this report be expanded to include the evaluation of the non-native species *Lumbriculus variegates* and *Corbicula fluminea*. The requested scope expansion by WDOE also included the evaluation of a reference sample with similar characteristics to the project test sediments (location B-1).

7.2 FIRST PHASE OF SPECIMEN COLLECTION FOR BIOACCUMULATION EVALUATION

On June 5, 2007, a PacifiCorp fish biologist, accompanied by two representatives of the Washington Department of Fish and Wildlife (WDFW) initiated the proposed field work for the bioaccumulation task of the *SSAP*. The bioaccumulation field team used two 250-foot long, monofilament gill nets with 3-inch stretch mesh and a 50-foot long, monofilament gill net with variable mesh that stretched from ¾-inch to 2-inch openings.

One of the 250-foot long nets was deployed near the boat barrier at the dam and the other 250-foot long net was deployed just upstream of Little Buck Creek on the west

Copyright 2007 Kleinfelder

shoreline. At these sites, the nets spanned nearly half the width of the lake. The 50-foot long net was fished from the east shoreline across from the southern boat ramp. The three nets were set at the bottom of the lake and allowed to remain in place for four half-hour sets. The 50-foot net was also used just offshore of Northwestern Lake Park in an effort to increase the fish catch.

All captured fish were examined for evidence of hatchery origins. Two fish were returned to Northwestern Lake based on the determination that they were hatchery fish. Hatchery fish were excluded from the study based on the presumption that hatchery fish would not have as much exposure time to lake conditions to exhibit the strength of evidence of mercury bioaccumulation that would be provided by native fish.

A total of seven rainbow trout (*Oncorhynchus mykiss*) were collected during the June 5, 2007 field collection event. The collected fish were measured (fork length) and weighed with a spring scale. Each fish was filleted and one fillet from each fish was placed in one of three polyethylene bags. The sample bags contained the following:

- Sample Bag #1 = Fish collected from Little Buck Creek
  - Fish 1: fork length = 305 millimeters (mm) and weight of 0.75 pounds
  - Fish 4: fork length = 255 mm and weight of 0.30 pounds
  - Fish 5: fork length = 315 mm and weight of 0.75 pounds

- Sample Bag #2 = Fish collected near boat barrier
  - Fish 2: fork length = 309 mm and weight of 0.75 pounds
  - Fish 3: fork length = 331 mm and weight of 0.95 pounds

- Sample Bag #3 = Fish collected from near Northwestern Lake Park
  - Fish 6: fork length = 225 mm and weight of 0.25 pounds
  - Fish 7: fork length = 355 mm and weight of 1.00 pounds.

The remnant fish carcasses, along with canned tuna, were used to bait two crayfish traps. The two crayfish traps were set during the fish capture activities. One crayfish trap was set near the mouth of Little Buck Creek and the other crayfish trap was set near the mouth of Mill Creek. The traps were periodically checked and re-baited while being left in place during the day of sampling for the bioaccumulation task. No crayfish were found in the traps. Accordingly, no crayfish were available for further evaluation of the tissues for mercury concentrations.

During the same period that the fish were being collected and efforts were being made to obtain crayfish, a work crew from WDFW and the US Bureau of Land Management

Copyright 2007 Kleinfelder

(BLM) were also actively conducting a survey for molluscs in Northwestern Lake by wading in shallow water and snorkeling into deeper water. Representative samples of molluscs were requested from the mollusc survey team by the Pacificorp representative at the end of the field day. However, the mollusc survey team did not observe molluscs in Northwestern Lake. Accordingly, no molluscan tissues were available for further evaluation of mercury concentrations.

7.3 SECOND PHASE OF SPECIMEN COLLECTION FOR BIOACCUMULATION EVALUATION

As stated above, during the field work conducted for the bioaccumulation task, the biologists were only able to recover representative fish. Based on this field result, the *SSAP* was amended to include the laboratory-controlled exposure of imported populations of the freshwater oligochate (worm) *Lumbriculus variegatus* and an imported population of the freshwater clam *Corbicula fluminea*.

The *Lumbriculus* population was obtained from Aquatic Foods, Inc. of Fresno, California. The *Corbicula* were obtained from Virgina Polytechnic Institute and State University in Blacksburg, Virgina. Their source of the clams was the Upper Clinch River in Virginia.

7.4 FIRST PHASE OF LABORATORY ACTIVITY FOR BIOACCUMULATION EVALUATION

Kleinfelder provided NW Aquatic Sciences of Newport, Oregon with 15 gallons of sediment obtained from the vicinity of sample B1-72. Kleinfelder also collected 15 gallons of sediment from the sampling location below the Little White Salmon Fish Hatchery, the location of sample LWS-071907, as a reference sample. The samples were collected on July 19, 2007, and placed into clean 5-gallon buckets dedicated to the bioaccumulation tests.

The vicinity of sample B1-72 was selected for the bioacumulation tests because the highest concentration of mercury was detected at this location as presented in the *March 2007 Sediment Report*. The reference sample location (LWS-071907) was selected because, based on field observations, this location most closely resembled the sediment collected from the vicinity of sample location B1-72. A negative control sediment sample was collected by NW Aquatic personnel on July 27, 2007, from Beaver Creek, located about 8 miles south of Newport, Oregon. The negative control sample was press sieved through a 1.0 millimeter screen.

Copyright 2007 Kleinfelder

NW Aquatic conducted the exposure portion of the test, reference, and control sediments for a period of 28 days. The exposures were conducted according to protocols based on EPA Method 100.3, EPA document 600/R-99-024, EPA document EPA-B-98-004 (the Inland Testing Manual), and ASTM E-1688-97a. Five sets of each target species were developed to provide the appropriate controls and replicates. Specific details of the test procedures are presented in NW Aquatic's reports which are included in Appendix E.

7.5 SECOND PHASE OF LABORATORY ACTIVITY FOR BIOACCUMULATION EVALUATION

NW Aquatic provided the following sets of tissue samples to the Brooks Rand laboratory in Seattle, Washington:

- Five sets of *Corbicula* tissues and five sets of *Lumbriculus* tissue that were exposed to the Northwestern Lake test sediments.
- Five sets of *Corbicula* tissues and five sets of *Lumbriculus* tissue that were exposed to the reference sediments.
- Five sets of *Corbicula* tissues and five sets of *Lumbriculus* tissue that were exposed to the control sediments.
- Five sets of *Corbicula* tissues and five sets of *Lumbriculus* tissue that were not exposed to any sediments.

Brooks Rand personnel shucked the clam samples the day after receipt. The clam samples and the worm samples were then homogenized prior to mercury analysis. Homogenization blanks were also prepared at that time.

The samples were tested for mercury using an appendix to EPA Method 1631. Further information on the sample preparation is included in Brooks Rand's report, which is included in Appendix F. The results of Brooks Rand's mercury analysis is included in Appendix F and are summarized in Table 10.

7.6 DISCUSSION OF BIOACCUMULATION EVALUATION TEST RESULTS

Mercury was detected in all the tissue samples, but not the homogenization blanks. The highest level of mercury was detected in the worm tissues exposed to the Northwestern Lake sediments. The mercury concentrations in the worm tissues exposed to the Northwestern Lake sediments ranged from 0.340 mg/Kg to 0.357 mg/Kg, with an average mercury concentration of 0.347 mg/Kg. Mercury

Copyright 2007 Kleinfelder

concentrations in the fish tissues were similar, although slightly lower, ranging from 0.185 mg/Kg to 0.308 mg/Kg, with an average of 0.263 mg/Kg.

Mercury concentrations in the clam tissue samples were negligible when compared to the control and pre-exposure samples. Specifically, the test and reference samples averaged about 0.04 mg/Kg and the control and pre-exposure samples averaged about 0.03 mg/Kg. In contrast, worm tissues exposed to Northwestern Lake sediments averaged 0.3 mg/Kg, the control worm tissues averaged 0.01 mg/Kg, the reference worm tissues averaged 0.005 mg/Kg, and the pre-exposed worm tissues averaged 0.004 mg/Kg.

The State of Washington currently has not published tissue criteria for acceptable levels that would not endanger the health of humans or other possible ecological receptors. Washington has been evaluating the mercury concentrations of fish in the state. An initial Washington study focused on bass in Whatcom County (*Mercury Concentrations in Edible Muscle of Lake Whatcom Fish*, March 2001). The Whatcom County study found a mean concentration of mercury in bass of 0.49 mg/Kg and noted a significant dependence on length and age. The Whatcom County study did include some cutthroat trout, which were found to have a mean mercury concentration of 0.07 mg/Kg.

In 2002, WDOE expanded their study to include 18 lakes and 2 rivers in 13 counties. Kitsap and Skamania Counties were not included in the selected counties. This study (*Mercury in Edible Fish Tissue and Sediments from Selected Lakes and Rivers of Washington State*, June 2003) found that over 50 percent of the fish tissue analyzed exceeded a draft criterion of 0.150 mg/Kg. The mean mercury concentration in fish tissue reported in the 2003 WDOE report was 0.217 mg/Kg. In review, the mean mercury concentration in fish tissue for Northwestern Lake was 0.263 mg/Kg. The relationship between age and increased mercury concentration in fish tissue was again supported by the study reported in the 2003 WDOE report.

A third WDOE study was documented in a 2007 report for fish samples collected in 2005. The 2007 report also found a strong correlation between increased fish age and increased mercury concentration in the fish tissues. The 2005 study also focused on bass but only tested six sites. Generally, the mercury concentrations were lower than the concentrations reported in the 2003 WDOE report.

Copyright 2007 Kleinfelder

The Oregon Department of Environmental Quality (DEQ), a co-member of the RSET with WDOE and others, has published its *Guidance for Assessing Bioaccumulative Chemicals of Concern in Sediment* (April 3, 2007). DEQ's guidance provides the following numerical criteria for mercury.

Acceptable Tissue Levels (ATLs):

• Humans	General / recreational:	0.40 mg/Kg
	Subsistence / Tribal:	0.049 mg/Kg
• Mammals	Individual:	0.12 mg/Kg
	Population:	0.20 mg/Kg
• Birds	Individual:	0.074 mg/Kg
	Eagle eggs:	0.18 mg/Kg
	Population:	0.15 mg/Kg
	Osprey eggs:	0.89 mg/Kg
Freshwater Critical Tissue Level (CTL):		0.088 mg/Kg

The Oregon ATLs for humans are the derived concentrations of mercury in fish tissue that will not result in an unacceptable risk to humans who consume the fish at a rate of 0.0175 kilograms per day (Kg/day) for recreational and general populations and 0.1424 Kg/day for Tribal and other subsistence fishers. The Oregon ATLs for humans are equivalent to the EPA's screening values for similar receptors. The Oregon ATLs for birds and mammals are based on a similar formula with the ingestion rate for birds (based on a Great Blue Heron) of 0.42 Kg/day and for minks of 0.137 Kg/day.

The concentrations of mercury reported for the three fish samples exceeded the Oregon ATL for tribal and subsistence fishers but not the general population Oregon ATL. The fish tissue concentrations also exceeded the Oregon ATLs for individual and populations of piscivorous birds and eagle eggs. The fish tissue concentrations also exceeded the individual and population of mammals, except for the fish collected near Northwestern Lake Park, located in the upstream end of Northwestern Lake, which only exceeded the individual Oregon ATL.

Worm tissues are not routinely ingested by humans, however, the nature of bioaccumulative chemicals results in the bioconcentration of the toxin as one organism ingests another organism that has retained the toxin. For example, as worms that have retained mercury are ingested by fish, the mercury is transferred to the fish in the worm tissues. The concentrations of mercury in the worms exceed the Tribal and

Copyright 2007 Kleinfelder

Subsistence Fishers Oregon ATL, the individual and population Avian Oregon ATLs, the individual (eagle) egg Oregon ATL, and both mammal Oregon ATLs. The worm tissues from the reference sample, the control sample, and pre-exposed tissues did not exceed an Oregon ATL.

None of the clam tissues exceeded an Oregon ATL or Oregon mercury CTL. All mercury concentrations in the fish tissues and worm tissues of this study exceeded the Oregon mercury CTL.

The EPA has published a recommended fish tissue criterion of 0.3 mg/Kg. In review, the average mercury in fish tissue concentration for the three trout samples collected from Northwestern Lake was 0.26333 mg/Kg. The EPA has also published a National Toxics Rule human health criterion for mercury in edible fish of 0.825 mg/Kg. None of the tissue samples exceeded the National Toxics Rule human health criterion for mercury in edible fish. The U.S. Food and Drug Administration (FDA) has an action level of 1.000 mg/Kg, which is used to determine when fish must be removed from the marketplace. None of the tissue samples exceeded the FDA's action level for mercury in edible fish.

Copyright 2007 Kleinfelder

8.0 SUMMARY AND CONCLUSIONS

Sediment sampling and analysis for environmental and physical characteristics of sediments has been conducted to provide supplemental information on the distribution and bioavailability of mercury in Northwestern Lake. Focused bioassays on two species and bioaccumulation studies on three species were completed to evaluate the sediments according to guidelines in the *NWRSEF*. The following conclusions are based on the information presented in this report:

- Chemical analysis of sediments in Northwestern Lake indicates that mercury is present. The mercury has consistently been detected in the sediments since the sediment evaluation began in 1994. Mercury concentrations detected during this supplemental investigation ranged from 0.020 mg/Kg to 1.1 mg/Kg. Elutriate testing and prior sampling investigations have demonstrated that the mercury is primarily associated with the fine grained silts and clays in the sediments.

- Mercury was detected above the NWRSEF lower screening level (SL1) in five of the seven sediment samples collected to evaluate the mercury distribution in the near-dam sediments. The mercury concentrations in four of those five sediment samples also exceeded the NWRSEF upper screening level (SL2) of 0.75 mg/Kg. The seven sediment samples were all found to consist of greater than 90 percent silt or finer grained material.

- Mercury was detected above the NWRSEF lower screening level (SL1) in two of the ten sediment or soil samples collected to estimate a background mercury concentration in the local area. None of those mercury concentrations exceeded the NWRSEF upper screening level (SL2). Supplemental mercury analyses was conducted on the portions of sediment that were not retained on the Number 200 sieve or greater. In seven of those ten samples, mercury concentrations were found to be at least one order of magnitude greater than the mercury concentrations detected in the unsieved samples. Specifically, four of the seven mercury concentrations for the sieved samples exceeded the NWRSEF lower screen level (SL1) and two of the four also exceeded the NWRSEF upper screening level (SL2) for mercury.

- The highest mercury concentration (1.2 mg/Kg) was detected in a sample collected outside of the near-dam, lower basin sample site (vicinity of sample B1-72). This

Copyright 2007 Kleinfelder

concentration was found in the sieved portion of the sample collected at the mouth of Mill Creek. Mill Creek flows into Northwestern Lake from the west.

- Mercury is a native element commonly found in rocks associated with Cascade Range volcanic activity. Numerous geologic publications discuss the presence of mercury in hydrothermally altered rocks, specifically argillic or fine grained rocks. Hydrothermally altered rocks are related to volcanic activity. The White Salmon River receives direct runoff from nearby Mount Adams, a Cascades Range volcano and from the Big Lava Bed Geologic Area located west of the White Salmon River.

- According to USGS Professional Paper 1270, background mercury concentrations are considered to be between 0.32 mg/Kg and 2.0 mg/Kg in the White Salmon River area. The mercury concentrations encountered in the 2007 sediment samples ranged from 0.014 mg/Kg to 1.2 mg/Kg. In 2006, the mercury concentrations ranged from 0.020 mg/Kg to 2.030 mg/Kg, and in 1994, the mercury concentrations ranged from less than 0.025 mg/Kg to 1.1 mg/Kg. Based on the study reported herein, the estimated background mercury concentration for fine-grained sediments is about 0.5 mg/Kg. The average mercury concentration in the fine grained sediments of Northwestern Lake sampled in 2007 is 0.6 mg/Kg. This average increases to 0.7 mg/Kg when the 2006 sample results are included in the average.

- Bioassays were conducted on “worst-case” sediments, which were selected based on the highest reported mercury concentration for samples collected in the vicinity of the previously reported highest reported mercury concentration. The bioassay testing indicates that the sediments will not adversely impact the biota of the Columbia River system.

- Mercury is a known bioaccumulative toxin. A field collection effort for representative biota only provided trout for an evaluation of mercury bioaccumulation. The fish tissue samples prepared from the captured trout were found to contain levels of mercury that exceeded the numerical criteria adopted by the State of Oregon for subsistence fishers (typically tribal members). The mercury concentrations in the fish tissues did not exceed Oregon’s Acceptable Tissue Level (ATL) for the general public. Washington has not adopted numerical fish tissue criteria as of November 2007.

Copyright 2007 Kleinfelder

- The mercury concentration in fish tissues also exceeded Oregon's Avian ATL's for eagles and ospreys, as well as eagle eggs. In addition, the mercury concentration in fish tissue exceeded the Individual Mammal ATL and two of the three concentrations exceeded the Mammal Population ATL.

- Representative test populations of an imported worm and non-native clams were obtained and exposed to the sediments in a controlled laboratory environment. Subsequent analysis of the worm tissues found similar, although slightly higher, results as the fish tissue mercury concentrations. Mercury concentrations in the clam tissues were not significantly different than the control and reference samples, indicating no bioaccumulation of mercury by the clams.

In summary, mercury is present in the fine-grained sediments impounded by Condit Dam. It is our opinion that the mercury is from natural sources in the uplands drained by the White Salmon River. The mercury can be ingested by some of the aquatic organisms and may accumulate in the food chain by bioconcentrating in the biotic elements of the food chain. The current concentrations represent a possible health risk for individuals or populations that ingest a diet consisting primarily of tissue obtained from Northwestern Lake.

Copyright 2007 Kleinfelder

9.0 REFERENCES

Friedli, Hans and Christine Wiedinmyer, 2007. *Mercury Emission Estimates from Fires: An Initial Inventory for the United States, in Environmental Science and Technology*, October 17, 2007.

Kleinfelder, 2007. *Sediment Sampling and Analysis Report, Northwestern Lake, Condit Hydroelectric Project, FERC Project No. 2342, White Salmon, Washington, Kleinfelder Project No. 53886 / 4,* March 2007.

Olson, Todd (PacifiCorp), 2007. Personal Communication with Thomas O'Keefe, PhD (Pacific Northwest Stewardship Director, American Whitewater), June 5, 2007 forwarding Personal Communication with James Rytuba (USGS), May 9, 2007.

Oregon Department of Environmental Quality (ODEQ), 2007. *Guidance for Assessing Bioaccumulative Chemicals of Concern in Sediment*, Updated April 3, 2007.

Rapp, Shawn R. (Kleinfelder), 2007. Personal Communication with Mark A. Engle, PhD, USGS, May 1, 2007.

Rytuba, James J., 2005. *Geogenic and Mining Sources of Mercury to the Environment,* Chapter 2 in *Mercury Sources, Measurements, Cycles, and Effects,* Mineralogical Association of Canada Short Course Series, Volume 34, Halifax, Nova Scotia, 2005.

Squier Associates, 1994. *Condit Hydroelectric Project (FERC Project No. 2342) Northwestern Lake Sediment Characterization Study, White Salmon, Washington*.

Squier Associates, 1997. *Additional Geotechnical Exploration and Laboratory Testing at the Condit Hydroelectric Project (Contract No. P018780).*

Squier | Kleinfelder, 2005. *Suitability Evaluation of Northwestern Lake Sediment Characterization Study, Squier Associates*, *April 1994*.

United States Army Corps of Engineers (USACOE), 1998. *Dredged Material Evaluation Framework, Lower Columbia River Management Area*, *November 1998*.

USACOE, 2006. *Draft Letter to PacifiCorp Hydro Licensing / Hydro Resources, April 12, 2006*.

Copyright 2007 Kleinfelder

USACOE et al., 2006. *Interim Final Sediment Evaluation Framework for The Pacific Northwest,* September 2006.

United States Environmental Protection Agency (USEPA) Office of Water and Office of Science and Technology, 2004. National Recommended Water Quality Criteria, 4304T.

USEPA, 2007. Mercury Basic Information, http://www.epa.gov/mercury/about.htm, August 7, 2007.

United States Geological Survey (USGS), 1982. *Element Concentrations In Soils and Other Surficial Materials of the Conterminous United States*, USGS Professional Paper 1270.

Vallance, James W., 1999. *Postglacial Lahars and Potential Hazards in the White Salmon River System on the Southwest Flank of Mount Adams, Washington*, USGS Bulletin 2161.

Washington Administrative Code (WAC) Chapter 173-201A, 2006. *Water Quality Standards for Surface Waters of the State of Washington,* November 20, 2006.

Washington State Department of Ecology (WDOE), 1992. *Chemicals of Special Concern in Washington State,* 92-66, July 1992.

WDOE, 2001. *Mercury Concentrations in Edible Muscle of Lake Whatcom Fish*, Publication No. 01-03-012, March 2001.

WDOE, 2003. *Mercury in Edible Fish Tissue and Sediments from Selected Lakes and Rivers of Washington State*, Publication No. 03-03-026, June 2003.

WDOE, 2005. *Model Toxics Control Act Chapter 70.105D RCW (Amended 2005) and Cleanup Regulation Chapter 173-340 WAC (Amended February 12, 2001), Publication No. 94-06,* October 2005.

WDOE, 2007. *Measuring Mercury Trends in Freshwater Fish in Washington State: 2005 Sampling Results*, Publication No. 07-03-007, February 2007

Copyright 2007 Kleinfelder

10.0 LIMITATIONS

We have prepared this report for use by PacifiCorp, their authorized agents, and regulatory agencies for specific application to this site. If, during future site operations, conditions are encountered which vary appreciably from those described herein, Kleinfelder should be notified for review of the recommendations of this report, if necessary.

This report may be used only by PacifiCorp, their authorized agents, and regulatory agencies and only for the purposes stated, within a reasonable time from its issuance. Land use, site conditions (both on- and off-site), or other factors may change over time and could materially affect our recommended sampling scheme. The *DMEF* provides for a period of seven years as the length of time that an analytical set may be considered to validly represent a Low Management Ranking Dredged Material Management Unit.

Therefore, this report should not be relied upon after seven years from its date of issue. Kleinfelder should be notified if use of the report is delayed by more than seven years from the date of this report so that a review of site conditions can be made, and recommendations revised, if appropriate.

Any party other than PacifiCorp, their authorized agents, and regulatory agencies who wishes to use this report shall notify Kleinfelder of such intended use. Based on the intended use of the report, Kleinfelder may require that additional work be performed and that an updated report be issued. Non-compliance with any of these requirements by the clients or anyone else will release Kleinfelder from any liability resulting from the use of this report by any unauthorized party.

No warranty, expressed or implied, is made.

Copyright 2007 Kleinfelder

Important Information About Your Geoenvironmental Report

Geoenvironmental studies are commissioned to gain information about environmental conditions on and beneath the surface of a site. The more comprehensive the study, the more reliable the assessment is likely to be. But remember: Any such assessment is to a greater or lesser extent based on professional opinions about conditions that cannot be seen or tested. Accordingly, no matter how many data are developed, risks created by unanticipated conditions will always remain. *Have realistic expectations.* Work with your geoenvironmental consultant to manage known and unknown risks. Part of that process should already have been accomplished, through the risk allocation provisions you and your geoenvironmental professional discussed and included in your contract's general terms and conditions. This document is intended to explain some of the concepts that may be included in your agreement, and to pass along information and suggestions to help you manage your risk.

Beware of Change; Keep Your Geoenvironmental Professional Advised

The design of a geoenvironmental study considers a variety of factors that are subject to change. Changes can undermine the applicability of a report's findings, conclusions, and recommendations. *Advise your geoenvironmental professional about any changes you become aware of.* Geoenvironmental professionals cannot accept responsibility or liability for problems that occur because a report fails to consider conditions that did not exist when the study was designed. Ask your geoenvironmental professional about the types of changes you should be particularly alert to. Some of the most common include:

- modification of the proposed development or ownership group,
- sale or other property transfer,
- replacement of or additions to the financing entity,
- amendment of existing regulations or introduction of new ones, or
- changes in the use or condition of adjacent property.

Should you become aware of any change, *do not rely on a geoenvironmental report.* Advise your geoenvironmental professional immediately; follow the professional's advice.

Recognize the Impact of Time

A geoenvironmental professional's findings, recommendations, and conclusions cannot remain valid indefinitely. The more time that passes, the more likely it is that important latent changes will occur. *Do not rely on a geoenvironmental report if too much time has elapsed since it was completed.* Ask your environmental professional to define "too much time." In the case of Phase I Environmental Site Assessments (ESAs), for example, more than 180 days after submission is generally considered "too much."

Prepare To Deal with Unanticipated Conditions

The findings, recommendations, and conclusions of a Phase I ESA report typically are based on a review of historical information, interviews, a site "walkover," and other forms of noninvasive research. When site subsurface conditions are not sampled in any way, the risk of unanticipated conditions is higher than it would otherwise be.

While borings, installation of monitoring wells, and similar invasive test methods can help reduce the risk of unanticipated conditions, *do not overvalue the effectiveness of testing.* Testing provides information about actual conditions only at the precise locations where samples are taken, and only when they are taken. Your geoenvironmental professional has applied that specific information to develop a general opinion about environmental conditions. *Actual conditions in areas not sampled may differ (sometimes sharply) from those predicted in a report.* For example, a site may contain an unregistered underground storage tank that shows no surface trace of its existence. *Even conditions in areas that were tested can change,* sometimes suddenly, due to any number of events, not the least of which include occurrences at

adjacent sites. Recognize, too, that *even some conditions in tested areas may go undiscovered,* because the tests or analytical methods used were designed to detect only those conditions assumed to exist.

Manage your risks by retaining your geoenvironmental professional to work with you as the project proceeds. Establish a contingency fund or other means to enable your geoenvironmental professional to respond rapidly, in order to limit the impact of unforeseen conditions. And to help prevent any misunderstanding, identify those empowered to authorize changes and the administrative procedures that should be followed.

Do Not Permit Any Other Party To Rely on the Report

Geoenvironmental professionals design their studies and prepare their reports to meet the specific needs of the clients who retain them, in light of the risk management methods that the client and geoenvironmental professional agree to, and the statutory, regulatory, or other requirements that apply. The study designed for a developer may differ sharply from one designed for a lender, insurer, public agency...or even another developer. *Unless the report specifically states otherwise, it was developed for you and only you.* Do not unilaterally permit any other party to rely on it. The report and the study underlying it may not be adequate for another party's needs, and you could be held liable for shortcomings your geoenvironmental professional was powerless to prevent or anticipate. Inform your geoenvironmental professional when you know or expect that someone else—a third-party—will want to use or rely on the report. *Do not permit third-party use or reliance until you first confer with the geoenvironmental professional who prepared the report.* Additional testing, analysis, or study may be required and, in any event, appropriate terms and conditions should be agreed to so both you and your geoenvironmental professional are protected from third-party risks. *Any party who relies on a geoenvironmental report without the express written permission of the professional who prepared it and the client for whom it was prepared may be solely liable for any problems that arise.*

Avoid Misinterpretation of the Report

Design professionals and other parties may want to rely on the report in developing plans and specifications. They need to be advised, in writing, that their needs may not have been considered when the study's scope was developed, and, even if their needs were considered, they might misinterpret geoenvironmental findings, conclusions, and recommendations. *Commission your geoenvironmental professional to explain pertinent elements of the report to others who are permitted to rely on it, and to review any plans, specifications or other instruments of professional service that incorporate any of the report's findings, conclusions, or recommendations.* Your geoenvironmental professional has the best understanding of the issues involved, including the fundamental assumptions that underpinned the study's scope.

Give Contractors Access to the Report

Reduce the risk of delays, claims, and disputes by giving contractors access to the full report, *providing that it is accompanied by a letter of transmittal that can protect you* by making it unquestionably clear that: 1) the study was not conducted and the report was not prepared for purposes of bid development, and 2) the findings, conclusions, and recommendations included in the report are based on a variety of opinions, inferences, and assumptions and are subject to interpretation. Use the letter to also advise contractors to consult with your geoenvironmental professional to obtain clarifications, interpretations, and guidance (a fee may be required for this service), and that—in any event—they should conduct additional studies to obtain the specific type and extent of information each prefers for preparing a bid or cost estimate. Providing access to the full report, with the appropriate caveats, helps prevent formation of adversarial attitudes and claims of concealed or differing conditions. If a contractor elects to ignore the warnings and advice in the letter of transmittal, it would do so at its own risk. Your geoenvironmental professional should be able to help you prepare an effective letter.

Do Not Separate Documentation from the Report

Geoenvironmental reports often include supplemental documentation, such as maps and copies of regulatory files, permits, registrations, citations, and correspondence with regulatory agencies. If subsurface explorations were performed, the report may contain final boring logs and copies of laboratory data. If remediation activities occurred on site, the report may include: copies of daily field reports; waste manifests; and information about the disturbance of subsurface materials, the type and thickness of any fill placed on site, and fill placement practices, among other types of documentation. *Do not separate supplemental documentation from the report. Do not, and do not permit any other party to redraw or modify any of the supplemental documentation for incorporation into other professionals' instruments of service.*

Understand the Role of Standards

Unless they are incorporated into statutes or regulations, standard practices and standard guides developed by the American Society for Testing and Materials (ASTM) and other recognized standards-developing organizations (SDOs) are little more than aspirational methods agreed to by a consensus of a committee. The committees that develop standards may not comprise those best-qualified to establish methods and, no matter what, no standard method can possibly consider the infinite client- and project-specific variables that fly in the face of the theoretical "standard conditions" to which standard practices and standard guides apply. In fact, these variables can be so pronounced that geoenvironmental professionals who comply with every directive of an ASTM or other standard procedure could run afoul of local custom and practice, thus violating the standard of care.

Accordingly, when geoenvironmental professionals indicate in their reports that they have performed a service "in general compliance" with one standard or another, it means they have applied professional judgement in creating and implementing a scope of service designed for the specific client and project involved, and which follows some of the general precepts laid out in the referenced standard. To the extent that a report indicates "general compliance" with a standard, you may wish to speak with your geoenvironmental professional to learn more about what was and was not done. *Do not assume a given standard was followed to the letter.* Research indicates that that seldom is the case.

Realize that Recommendations May Not Be Final

The technical recommendations included in a geoenvironmental report are based on assumptions about actual conditions, and so are preliminary or tentative. Final recommendations can be prepared only by observing actual conditions as they are exposed. For that reason, you should retain the geoenvironmental professional of record to observe construction and/or remediation activities on site, to permit rapid response to unanticipated conditions. *The geoenvironmental professional who prepared the report cannot assume responsibility or liability for the report's recommendations if that professional is not retained to observe relevant site operations.*

Understand That Geotechnical Issues Have Not Been Addressed

Unless geotechnical engineering was specifically included in the scope of professional service, a report is not likely to relate any findings, conclusions, or recommendations about the suitability of subsurface materials for construction purposes, especially when site remediation has been accomplished through the removal, replacement, encapsulation, or chemical treatment of on-site soils. The equipment, techniques, and testing used by geotechnical engineers differ markedly from those used by geoenvironmental professionals; their education, training, and experience are also significantly different. If you plan to build on the subject site, but have not yet had a geotechnical engineering study conducted, your geoenvironmental professional should be able to provide guidance about the next steps you should take. The same firm may provide the services you need.

Read Responsibility Provisions Closely

Geoenvironmental studies cannot be exact; they are based on professional judgement and opinion. Nonetheless, some clients, contractors, and others assume geoenvironmental reports are or certainly should be unerringly precise. Such assumptions have created unrealistic expectations that have led to wholly unwarranted claims and disputes. To help prevent such problems, geoenvironmental professionals have developed a number of report provisions and contract terms that explain who is responsible for what, and how risks are to be allocated. Some people mistake these for "exculpatory clauses," that is, provisions whose purpose is to transfer one party's rightful responsibilities and liabilities to someone else. Read the responsibility provisions included in a report and in the contract you and your geoenvironmental professional agreed to. *Responsibility provisions are not "boilerplate."* They are important.

Rely on Your Geoenvironmental Professional for Additional Assistance

Membership in ASFE exposes geoenvironmental professionals to a wide array of risk management techniques that can be of genuine benefit for everyone involved with a geoenvironmental project. Confer with your ASFE-member geoenvironmental professional for more information.

ASFE

8811 Colesville Road/Suite G106, Silver Spring, MD 20910
Telephone: 301/565-2733 Facsimile: 301/589-2017
e-mail: info@asfe.org www.asfe.org

Copyright 2000 by ASFE, Inc. Duplication, reproduction, or copying of this document, in whole or in part, by any means whatsoever, is strictly prohibited, except with ASFE's specific written permission. Excerpting, quoting, or otherwise extracting wording from this document is permitted only with the express written permission of ASFE, and only for purposes of scholarly research or book review. Because use of this document may imply membership in ASFE, any firm, individual, or other entity that uses this document without being an ASFE Member Firm may be found liable for negligent or intentional (fraudulent) misrepresentation.

IIGR06005.0M