UPPER COLUMBIA RIVER

FINAL
Quality Assurance Project Plan for the Phase 3 Sediment Study – Sediment Facies Mapping

Prepared for

Teck American Incorporated
P.O. Box 3087
Spokane, WA 99220-3087

Prepared by

1180 Eugenia Place, Suite 204
Carpinteria, CA 93013

In Association and Consultation with

HDR, David Evans and Associates, Inc., Windward Environmental LLC, Gravity Consulting LLC, and Parametrix, Inc.

August 2018

SECTION A: PROJECT MANAGEMENT

A1 TITLE AND APPROVAL SHEET

QUALITY ASSURANCE PROJECT PLAN FOR THE PHASE 3 SEDIMENT STUDY – SEDIMENT FACIES MAPPING

EPA Project Manager	Kathryn Cerise	Date	8/29/18
TAI Project Coordinator	Kris McCaig	Date	8/23/18
TAI Assistant Project Coordinator	Denise Mills	Date	08/23/18
EPA Region 10 Quality Assurance Manager	Donald Brown	Date	9/1/2018
Principal Investigator	Jennifer Holder	Date	8/23/18
Senior Technical Advisor	Jon Dasler	Date	8/22/2018
Task Manager	Tim McClinton	Date	8/22/2018
Task Manager	Victoria Price-Doucet	Date	8/29/18
Field Supervisor Jennifer Pretare	~~TBD~~	Date	10-4-18
Acoustic and Underwater Imagery Subcontractor Coordinator	Cristy Kessel	Date	8/24/18
Acoustic and Underwater Imagery Project Manager Shawn Hinz	~~TBD~~	Date	10-8-18
Acoustic and Underwater Imagery QA Manager Tim McClinton	~~TBD~~	Date	10/4/18
Database Administrator	Randy O'Boyle	Date	8/22/18

10/08/2018 - Updated to include field supervisor and data acquisition personnel: Dr. Jennifer Pretare (AECOM), Dr. Timothy McClinton (David Evans and Associates), and Shawn Hinz (Gravity Consulting).

REVISED
10:24 am, Oct 08, 2018

A2 CONTENTS

LIST OF APPENDICES

LIST OF FIGURES

LIST OF MAPS

LIST OF TABLES

ACRONYMS AND ABBREVIATIONS

ADCP	acoustic Doppler current profiler
Agreement	June 2, 2006, Settlement Agreement
AOI	area of interest
BERA	baseline ecological risk assessment
CCT	Confederated Tribes of the Colville Reservation
COPC	constituent of potential concern
DEA	David Evans and Associates, Inc.
DEM	digital elevation model
DGPS	differential global positioning system
DQO	data quality objective
DMP	data management plan
Ecology	Washington State Department of Ecology
EPA	U.S. Environmental Protection Agency
ESRI	Environmental Systems Research Institute, Inc.
EUNIS	European Nature Information System
FSP	field sampling plan
GIS	geographic information system
GPS	global positioning system
LOE	level of effort
MBES	multibeam echosounder
MMU	minimum mapping unit
MQO	measurement quality objective
OU	operable unit
QA	quality assurance
QA/QC	quality assurance and quality control
QAPP	quality assurance project plan
QC	quality control
RI/FS	remedial investigation and feasibility study
RM	river mile
RTK	real-time kinematic
SHSP	Site Health and Safety Plan
Site	Upper Columbia River site
SOP	standard operating procedure
TAI	Teck American Incorporated
TBD	to be determined
TIE	toxicity identification evaluation
UCR	Upper Columbia River
USACE	U.S. Army Corps of Engineers
USGS	U.S. Geological Survey

UNITS OF MEASURE

cm	centimeter(s)
dB	decibel(s)
ft	foot/feet
in.	inch(es)
m	meter(s)
m^2	meter(s) squared
mm	millimeter(s)
kHz	kilohertz

A3 DISTRIBUTION LIST

EPA Project Manager	Kathryn Cerise
EPA Region 10 QA Manager	Donald Brown
TAI Project Coordinator	Kris McCaig
TAI Assistant Project Coordinator	Denise Mills
Principal Investigator	Jennifer Holder
Senior Technical Advisor	Jon Dasler
Task Manager	Tim McClinton
Task Manager	Victoria Price-Doucet
Field Supervisor	TBD
Database Administrator	Randy O'Boyle
Acoustic and Underwater Imagery Subcontractor Coordinator	Cristy Kessel
Acoustic and Underwater Imagery Subcontractor Project Manager (TBD)	TBD
Acoustic and Underwater Imagery Subcontractor QA Manager (TBD)	TBD

A4 INTRODUCTION AND TASK ORGANIZATION

A4.1 Introduction

This document presents the quality assurance project plan (QAPP) for the Phase 3 sediment study for sediment facies mapping (hereafter, the "study") of the Upper Columbia River (UCR; hereafter, the Site[1]). This study represents one of the tasks being completed as part of the remedial investigation and feasibility study (RI/FS) and baseline ecological risk assessment (BERA) being completed for the Site under an agreement between Teck American Incorporated (TAI) and the U.S. Environmental Protection Agency (EPA). The overall objective of the RI/FS is to investigate the nature and extent of contamination and potential for risk to humans and the environment. TAI is conducting the RI/FS and the current sediment facies mapping with EPA oversight.

This QAPP describes the organization, data quality objectives (DQOs), study design, data collection activities, and quality assurance and quality control (QA/QC) procedures upon which the study will be based. The field sampling plan (FSP) describes field procedures and protocols that will be followed and is presented in Appendix A. This QAPP is formatted consisted with EPA QAPP guidance (USEPA 2002).

The primary objective of this study is to collect high-resolution data to identify and map sediment grain size fractions and texture of the UCR sediment bed. Further characterization of sediment bed attributes is needed to inform and support other subsequent Phase 3 efforts to characterize sediment chemistry and reduce uncertainties regarding potential risk to benthos.

The development of the requirements and design rationale for data collection activities presented in this QAPP was guided by a level of effort (LOE) issued to TAI by EPA in a letter dated January 8, 2018 (USEPA 2018a). The LOE required additional characterization (i.e., sediment bed mapping and nature and extent sampling) to determine the spatial extent of areas in the upper reaches of the Site, where sediments potentially toxic to benthic organisms might be present. EPA identified these reaches as the Upper Reach Operable Unit (OU), which encompasses the UCR from Marcus Flats at river mile (RM) 708 to the international border north of RM 744 (Map A4-1). The LOE states that existing data are not sufficient to understand the nature, extent, and volume of contaminated

[1] The Site as defined within the June 2, 2006, Settlement Agreement is the areal extent of hazardous substances contamination within the United States in or adjacent to the Upper Columbia River, including the Franklin D. Roosevelt Lake, from the U.S. – Canada border to the Grand Coulee Dam, and those areas in proximity to the contamination that are suitable and necessary for implementation of response actions.

sediment within the OU at a level of resolution necessary for BERA and RI/FS decision making. Through discussions that followed issuance of the LOE, TAI and EPA agreed that five study elements, subsequently designated DQOs 1 through 5, would comprise the Phase 3 sediment study. The first study element, sediment bed mapping (DQO 1), will be conducted throughout the entire Upper Reach OU, and additional higher-resolution nature and extent sampling of shallow sediment (DQO 2) will be conducted in three areas of interest (AOIs): 1) Deadman's Eddy, 2) China Bend, and 3) an area upstream of Marcus Flats (Map A4-1). TAI and EPA also agreed that additional data collection activities will be conducted in the three AOIs to obtain data to support the BERA and reduce uncertainty, including porewater evaluations (DQO 3), toxicity identification evaluations (TIEs) (DQO 4, and a benthic macroinvertebrate survey and colonization study (DQO 5).

Communications relating to the LOE and subsequent refinements of the Phase 3 sediment study scope include:

- A letter dated January 8, 2018, from Kathryn Cerise, EPA, to Kris McCaig, TAI, identifying the upper reaches of the riverine portion of the UCR Site as an OU; identifying data gaps in a LOE for the Upper Reach OU that include sediment facies mapping and 19 unsampled depositional features requiring surface sediment samples and sediment cores; and requiring TAI to submit a draft QAPP to fill the site characterization data gaps identified in the LOE (USEPA 2018a)
- A letter dated January 23, 2018, from Kris McCaig, TAI, to Kathryn Cerise, EPA, notifying EPA of TAI's dispute of the January 8, 2018, LOE letter (TAI 2018a)
- A letter dated February 13, 2018, from Kris McCaig, TAI, to Kathryn Cerise, EPA, providing TAI's proposed guiding principles and a conceptual proposal for another sediments field program in order to facilitate negotiation during the informal dispute resolution period (TAI 2018b)
- A letter dated February 14, 2018, from Kathryn Cerise, EPA, to Kris McCaig, TAI, acknowledging TAI's proposal and agreeing to modify the requirements of the LOE under conditions stipulated by EPA (USEPA 2018b)
- A letter dated February 15, 2018, from Kris McCaig, TAI, to Kathryn Cerise, EPA, providing TAI's response to EPA's February 14, 2018, letter and requesting a study design process to include development and agreement on DQOs prior to preparation of a QAPP (TAI 2018c)
- A letter dated February 16, 2018, from Kathryn Cerise, EPA, to Kris McCaig, TAI, providing EPA's final proposal and identifying the three AOIs as a further compromise from the initial LOE (USEPA 2018c)

- A letter dated February 16, 2018, from Kathryn Cerise, EPA, to Kris McCaig, TAI, acknowledging that EPA and TAI have come to an agreement on the terms of resolution of the informal dispute and agreeing that the timing for the Phase 3 sediment QAPP will be determined after finalizing DQOs (USEPA 2018d)
- A packet containing draft DQOs 1 through 5 prepared by TAI and provided to EPA on March 22, 2018 (TAI 2018d)
- A scoping meeting held in Seattle, Washington, on March 22 and 23, 2018, during which TAI, EPA, and Agency representatives discussed the draft DQOs and modifications that may be required to address EPA's concerns
- A summary of scoping meeting outcomes, prepared by TAI and approved by EPA on April 12, 2018, to document the agreements and action items from the March 22 and 23, 2018 scoping meeting (TAI 2018e)
- A table of comments from EPA and the Parties on the March 22, 2018, draft DQOs 1 through 5 provided by Kathryn Cerise, EPA, to Kris McCaig, TAI, on April 13, 2018 (USEPA 2018e)
- A technical conference call between TAI and EPA on April 20, 2018, to clarify comments on draft DQOs
- Responses to comments from EPA/Parties and revised draft Phase 3 Sediment DQOs 1 and 3 through 5 submitted to Kathryn Cerise, EPA, by Kris McCaig, TAI, on May 8, 2018 (TAI 2018f)
- A table of comments from EPA and the Parties on the May 8, 2018, revised draft DQOs provided by Kathryn Cerise, EPA, to Kris McCaig, TAI, on May 18, 2018 (USEPA 2018f)
- A technical conference call between TAI and EPA on May 30, 2018, to clarify May 18, 2018, EPA comments on DQO 1
- Responses to comments from EPA/Parties and a revised draft DQO 1 submitted to Kathryn Cerise, EPA, by Kris McCaig, TAI, on June 1, 2018 (TAI 2018g)
- A letter dated June 4, 2018, from Kris McCaig, TAI, to Kathryn Cerise, EPA, providing the final DQO 1 (TAI 2018h)
- Receipt of EPA's approval of the revised draft DQO 1, provided by Kathryn Cerise, EPA, to Kris McCaig, TAI, on June 4, 2018 (USEPA 2018g)
- A draft QAPP for this study, submitted by TAI to EPA on June 28, 2018 (TAI 2018i)

- A QAPP workshop in Portland, Oregon, on July 10 and 11, 2018, during which TAI answered preliminary questions from EPA on the draft QAPP, and TAI and EPA discussed the schedule and potential revisions for the draft final QAPP
- A table of comments from EPA on the June 28, 2018, draft QAPP provided by Kathryn Cerise, EPA, to Kris McCaig, TAI, on July 19, 2018 (USEPA 2018h)
- A technical conference call between TAI and EPA on July 26, 2018, to clarify EPA's July 17, 2018 comments
- Responses to comments from EPA and a draft final QAPP showing changes in redline-strikeout submitted to Kathryn Cerise, EPA, by Kris McCaig, TAI, on August 10, 2018 (TAI 2018j)
- A summary of workshop outcomes, prepared by TAI and approved by EPA on August 10, 2018, to document the key discussions and action items from the July 10 and 11, 2018 QAPP workshop (TAI 2018k)
- A letter dated August 17, 2018, from Kathryn Cerise, EPA, to Kris McCaig, TAI, providing EPA's approval of the draft final QAPP for this study (USEPA 2018i).

Through the Phase 3 sediment study scoping process described above, EPA and TAI agreed that there will be five study elements (DQOs) for the Upper Reach OU Phase 3 sediment characterization. These DQOs are generally described as:

DQO 1—Sediment facies mapping (this study)

DQO 2—Characterization of chemical/physical properties of surface sediment

DQO 3—Characterization of sediment porewater

DQO 4—Sediment bioassays and toxicity identification evaluation

DQO 5—Benthic invertebrate study.

As agreed to by TAI and EPA during a scoping meeting on March 22 and 23, 2018, and during subsequent discussions, the Phase 3 sediment study will be completed in a phased approach. Sediment facies mapping (DQO 1) will be completed during 2018. Sediment bed maps developed using data collected in 2018 will be used to refine the sample design (for DQO 2) for the three AOIs.

This QAPP describes sediment facies mapping (DQO 1) only. TAI will work in consultation with EPA to develop DQOs and subsequent QAPP(s) for the remaining four study elements (DQOs 2 through 5).

A4.2 Task Organization

This section presents the organizational structure for activities associated with the study, including task management and oversight, field data collection, and data management. Contact information for team task members is provided in Table A4-1.

A4.2.1 EPA Organization and Responsibilities

EPA will oversee TAI activities associated with the study and will coordinate the comments and review completed by the following parties: U.S. Department of the Interior, Washington State Department of Ecology (Ecology), and local tribes (i.e., the Confederated Tribes of the Colville Reservation [CCT] and the Spokane Tribe of Indians). In addition, EPA, under Section 106 of the National Historic Preservation Act, has the primary responsibility for consulting with interested parties. EPA's project manager, Kathryn Cerise, will be responsible for ensuring that the work performed is consistent with all applicable EPA guidance. The EPA Region 10 quality assurance (QA) manager is Donald Brown. The responsibilities of the QA manager or QA designee will include review and approval of the QAPP and any subsequent addenda.

A4.2.2 TAI Organization and Responsibilities

Kris McCaig will serve as TAI's project coordinator and will have the primary responsibility for ensuring that TAI meets all the requirements and associated deliverables specified within the June 2, 2006, Settlement Agreement (Agreement) (USEPA 2006a). Denise Mills will serve as TAI's assistant project coordinator working closely with Ms. McCaig to ensure the above.

A4.2.3 Key Task Personnel

TAI technical team members for the study and their respective responsibilities are identified below. No sediment samples will be collected or analyzed for the Phase 3 sediment facies mapping study; therefore, no analytical laboratory personnel are included in the project team.

Principal Investigator—Dr. Jennifer Holder (ERM) will serve as principal investigator and will oversee and approve all project activities, review QA reports, approve final project QA needs, and authorize necessary actions and adjustments needed to accomplish program QA objectives.

Senior Technical Advisor—Jon Dasler (David Evans and Associates, Inc. [DEA]) will serve as the senior technical advisor for the study and is responsible for providing technical oversight in the study design, implementation, and data interpretation.

Task Managers—Dr. Tim McClinton (DEA) and Victoria Price-Doucet (DEA) will lead data collection and data interpretation to identify and map sediment grain size fractions and texture of the UCR sediment bed. As part of data interpretation, the task managers will review and verify the quality of the field data and associated postprocessing. The task managers will inform the principal investigator when problems occur and will communicate and document corrective actions taken.

Acoustic and Underwater Imagery Subcontractor Coordinator—Cristy Kessel (TAI) is the acoustic and underwater imagery subcontractor coordinator. She is responsible for ensuring that field equipment and method selection and/or development is satisfactorily completed prior to data collection; coordinating with the acoustic and underwater imagery subcontractor(s) and tracking their progress; verifying that the subcontractor(s) has implemented the requirements of this QAPP; addressing QA issues related to field data collection and data management; ensuring that subcontractor capacities are sufficient to perform the required data collection and data management activities in a timely manner; and addressing scheduling issues related to data management and reporting by the subcontractor(s). Ms. Kessel will report directly to TAI's project coordinator and will work closely with the principal investigator.

Database Administrator—Randy O'Boyle (Exponent, Inc.) is the database administrator and will have primary responsibility for data management and database maintenance and development. Mr. O'Boyle is responsible for overseeing and/or conducting the following activities: establishing storage formats and procedures appropriate for data collected; ensuring all data deliverables are complete and delivered in the correct format; maintaining the integrity and completeness of the database; and providing data summaries to data users for interpretation and reporting. Mr. O'Boyle will report directly to the TAI project coordinator and will work closely with the task managers and the acoustic and underwater imagery subcontractor(s).

Field Supervisor—The field supervisor, to be determined (TBD), is responsible for overseeing the planning and coordination of the field data collection efforts to ensure that appropriate data collection, QA, and documentation procedures are used. In the event that changes in the QAPP or FSP (Appendix A) are needed, the field supervisor will ensure that proposed changes are coordinated with EPA's project coordinators, its staff, and its authorized representative(s) in the field, and with TAI's project coordinator according to the established lines of communication among the TAI technical team, TAI, and EPA.

A4.2.4 Acoustic and Underwater Imagery Subcontractor(s)

One or more subcontractors will perform the field data collection and post-field data processing. The following responsibilities apply to the project manager(s) and QA manager(s) who will support this project.

Acoustic and Underwater Imagery Subcontractor Project Manager—The acoustic and underwater imagery subcontractor project manager(s) is responsible for the successful and timely completion of field data collection, management of raw data, data postprocessing, and data compilation/documentation. Subcontractor project manager responsibilities include:

- Ensuring that data is collected following this QAPP, the associated FSP (Appendix A), and the standard operating procedures (SOPs) included as attachments to the FSP
- Apprising the TAI acoustic and underwater imagery subcontractor coordinator of the schedule and status of field mobilization, data collection activities, and demobilization
- Notifying the task managers and TAI acoustic and underwater imagery subcontractor coordinator if problems occur during data collection or data postprocessing, such as failure to meet QC criteria
- Taking appropriate corrective action as necessary
- Reporting data and supporting QA information as specified in this QAPP
- Providing geospatial data in a format consistent and compatible with the UCR electronic database.

Acoustic and Underwater Imagery Subcontractor QA Manager—The acoustic and underwater imagery subcontractor QA manager(s) is responsible for ensuring the quality of the raw data and postprocessed data and of the final data compilation/documentation prepared by the subcontractor for this study. The subcontractor QA manager is separate from day-to-day data acquisition and postprocessing. Specific responsibilities include the following:

- Ensuring that QA/QC procedures are implemented and documented to provide a record that data conforms to specifications as required during data collection and postprocessing
- Performing and documenting an independent technical review of final data deliverables

- Reviewing and addressing or approving corrective action reports
- Coordinating responses to any quality control (QC) issues that affect this task with the task managers and TAI acoustic and underwater imagery subcontractor coordinator.

A5 PROBLEM DEFINITION AND BACKGROUND

The UCR riverbed is composed of substrates that include mixtures of unconsolidated fine-grained sediments (i.e., sediments <2 mm), gravels, cobbles, and rock. Sediment organisms utilize these substrates differentially and constituent of potential concern (COPC) concentrations may differ as a function of sediment composition and bed characteristics, with finer-grained deposits potentially containing granulated slag, which may be a source of elevated concentrations of COPCs. Sediment (or sedimentary) facies describe physical, chemical, and biological aspects of bed composition. In the Upper Reach OU portion of the UCR (Map A4-1), the larger grain sizes are very common and create sediment facies that are discontinuous and highly variable. This study will focus on acquisition of high-resolution data covering nearly all the riverbed, identifying areas where finer-grained sediments predominate hence refining the understanding of riverbed physical characteristics, particularly grain size fractions and texture. Further characterization of sediment facies and related bed attributes (e.g., geomorphology) is needed to inform and support other subsequent Phase 3 efforts to characterize sediment chemistry and reduce uncertainties regarding potential risk to benthos.

A6 PROJECT DESCRIPTION

This section provides a summary of the work to be performed, products to be produced, and the schedule for implementation. More detailed descriptions of the work to be performed, products to be produced, and the schedule for implementation are provided in Section B of this QAPP. This section also describes conceptually how data from this study will be interpreted to create sediment facies maps.

The goal of this study is to collect high-resolution acoustic data and georeferenced images of the riverbed to identify and map sediment grain size fractions and texture. The following data will be collected throughout the Upper Reach OU:

- Bathymetry and backscatter using a multibeam echosounder (MBES)
- Vertical velocity profile measurements via acoustic Doppler current profiler (ADCP)
- Underwater imagery using a drop-frame camera equipped with scaling lasers.

The output from this study will be a series of geospatial data layers, maps, and georeferenced sediment bed photographs. The following maps will be developed to illustrate the geospatial data:

- Riverbed elevation from bathymetry data
- Acoustic backscatter data, shown as a backscatter mosaic
- Point data for the sediment bed coefficient of friction and apparent roughness height calculated from ADCP measurements
- Final underwater photograph locations with interpreted sediment grain size fraction composition.

Field data collection will be performed during one survey in approximately late September through October 2018. As required by the Agreement (USEPA 2006a), the draft data summary report will be delivered to EPA within 150 days of completion of field data collection activities.

The conceptual process for developing sediment facies maps from the data collected for this study is shown in Figure A6-1. The interpretation steps that follow postprocessing of field data are described at a conceptual level below and elsewhere in this QAPP. Prescriptive descriptions of interpretations are not provided because they do not affect field data collection methods and data reporting. Furthermore, because the methods for interpretation are greatly dependent on the data, selection of the interpretation method should be performed after data collection and postprocessing are completed.

The general steps for developing sediment facies maps from postprocessed data deliverables from this study include the following:

1. Postprocessed MBES data are spatially and statistically analyzed to produce terrain statistics from bathymetry and acoustic backscatter statistics. These statistics will be related to ground reference data to develop a relationship between backscatter/bathymetry statistics and sediment bed composition during the classification step.
2. Ground reference data, which describes sediment composition or bed characteristics at point locations, are prepared from interpreted underwater imagery and ADCP measurement from this study. Data from previous studies will also be evaluated and incorporated, if helpful, to supplement the ground reference dataset used for developing and/or validating the backscatter/bathymetry-sediment composition relationship. It is expected that the data from previous studies to be evaluated includes underwater video collected by the CCT in 2017

and grain size analysis results for surface sediment samples collected during previous investigation phases completed under the Agreement. Incorporation of the CCT underwater video data would allow evaluation of other transects, such as transects oriented along the river thalweg or along riverbed features.

3. Bathymetry and backscatter statistics and ground reference data classification will relate bathymetry/backscatter signals to substrate type, i.e., sediment composition. It is anticipated that a combination of statistical classification methods[2] will be suitable for interpreting sediment composition from backscatter data within the Upper Reach OU. After developing the classification relationship, ground reference data are used to perform an accuracy assessment to validate the classification. If the classification does not pass the accuracy assessment, then the classification step is repeated using different approaches until a classification is produced that passes the accuracy assessment.

4. The classification is then applied to backscatter and bathymetry data to produce gridded calculated/interpreted sediment composition maps showing percent of sediment grain size fractions (mud, sand, gravel, boulders, cobbles) and bedrock. The gridded sediment composition map layers provide the information needed for mapping any combination of sediment textures.

5. A sediment classification system defining sediment texture classes will be identified or developed for the project. The term sediment texture covers the range of possible mixtures of different substrates in any area. Example sediment texture diagrams are shown in Figure A6-2. The Folk classification system, which is typically used to classify marine sediments, uses a set of two ternary diagrams to define sediment classes (Folk 1954, 1974). A simplification of the Folk system, which was developed to support the European Nature Information System (EUNIS) habitat classification system, uses a single ternary diagram to define fine (sandy mud and muddy sand), coarse, and mixed sediment textures based on percent gravel and the ratio of sand to mud (Long 2006). Other standard systems for classifying sediment textures also exist (Poppe et al. 2003); however, it is anticipated that classification of sediment textures would be a project-specific approach based on a standard system (such as a modified Folk system) that is tailored to UCR conditions and to support development of the sample design for DQO 2 and for other ongoing evaluations of benthic habitats.

[2] See Section A9.2 for a discussion of potential statistical classification methods.

6. The sediment classification system will be applied to the sediment composition maps to produce a preliminary sediment facies map that can be used to support the sample design for DQO 2.

Sediment composition maps and preliminary sediment facies maps will not be included in the data summary report, but will be provided as an interim deliverable prior to finalization of the DQO 2 sample design.

A7 DATA QUALITY OBJECTIVES, CRITERIA, AND DESIGN RATIONALE

EPA's seven-step DQO process (USEPA 2006b) was used to guide the design rationale for this study. Each step is presented below.

A7.1 Step 1—State the Problem

As noted in Section A5, the UCR riverbed is composed of substrates that include mixtures of unconsolidated fine-grained sediments (i.e., sediments <2 mm), gravels, cobbles, and bedrock. Sediment organisms utilize these substrates differentially and COPC concentrations may differ as a function of sediment composition and bed characteristics, with finer-grained deposits potentially containing granulated slag, which may be a source of elevated concentrations of COPCs. Sediment (or sedimentary) facies describe physical, chemical, and biological aspects of bed composition. In the Upper Reach OU portion of the UCR (see Map A7-1), the larger grain sizes are very common and create sediment facies that are discontinuous and highly variable. This study will focus on acquisition of high-resolution data covering nearly all the riverbed, identifying areas where finer-grained sediments predominate hence refining the understanding of riverbed physical characteristics, particularly grain size fractions and texture. Further characterization of sediment facies and related bed attributes (e.g., geomorphology) is needed to inform and support other subsequent Phase 3 efforts to characterize sediment chemistry and reduce uncertainties regarding potential risk to benthos.

A7.1.1 Team Members and Roles

Team members and their roles are described in Section A4.2 of this QAPP.

A7.1.2 Schedule

It is anticipated that the field-collection portion of work will be conducted during late September through October 2018; for improved safety and access conditions, the survey will be timed to occur when the reservoir is at or near high pool and low flow (approximately late August through October).

Data from the study will be provided to EPA in a draft data summary report to be delivered to EPA within 150 days of completion of field data collection activities as required in the Agreement (USEPA 2006a).

A7.2 Step 2—Identify the Goals of the Study

The goal will be to collect high-resolution acoustic data (i.e., bathymetry, backscatter, velocities) and georeferenced images of the riverbed to identify and map sediment grain size fractions and texture. Maps will be used to illustrate sediment composition between RM 708 and just north of RM 744 (Upper Reach OU). Spatial detail regarding sediment composition and other bed characteristics will support development of sample design for DQO 2 and for other ongoing evaluations of benthic habitats and areas of potential risk due to COPC concentrations as part of DQOs 3, 4, and 5.

A7.3 Step 3—Identify Information Inputs

The following information inputs represent data to be acquired that will be processed and interpreted to generate a sediment facies map to support development of remaining Phase 3 sediment study elements.

- High-resolution acoustic data collection using multibeam echosounder (MBES) to express bathymetry in terms of sediment bed elevations (tied to known horizontal and vertical elevation benchmarks) and acoustic backscatter to relate acoustic signals to sediment composition (grain size fractions and texture)
- Georeferenced video images of sediment bed composition that include a scale of known dimensions such that predominant grain sizes and the occurrence of large clasts can be inferred
- ADCP water column velocity profiles to estimate flow resistance (e.g., roughness heights) and other hydrodynamic factors related to bed characteristics.

A7.4 Step 4—Define the Boundaries of the Study

A7.4.1 Geographic Boundaries

This study will be performed throughout the Upper Reach OU, with particular focus on the three Phase 3 sediment AOIs, which are Deadman's Eddy, China Bend, and upstream of Marcus Flats where subsequent Phase 3 sediment investigations will be performed (DQOs 2 through 5).

The noninvasive/remote sensing methods to be used for sediment facies mapping essentially measure the sediment surface only; therefore, the vertical boundary of the study is limited to the river sediment bed surface.

A7.4.2 Temporal Considerations

One survey will be performed. For improved safety and access conditions, the survey will be timed to occur when the reservoir is at or near high pool and low flow (typically late August through October). It is recognized that ADCP data collected will reflect seasonal flow velocities representative of the time of sampling; however, flow resistance coefficients derived from ADCP measurements are reasonably expected to be relatively independent of flow.

Information generated as part of sediment facies mapping efforts is expected to inform the planning and development of Phase 3 sediment characterization activities that will occur subsequent to this study element.

A7.5 Step 5—Define the Analytical Approach

This step describes how data collected in this study will be analyzed to produce the sediment facies map for the Upper Reach OU.

- High-resolution, full-coverage MBES bathymetry and backscatter data along with video imagery, velocity measurements, and standard geomorphological principles will be used to refine evaluations of sediment bed properties.
- Interpretation of video images will involve estimation of sediment grain size fractions within the field of view relative to the scale defined by the spacing between laser pointer beams (i.e., approximately 102 mm [4 inches]).
- Consistent with prior TAI mapping efforts and studies performed by the U.S. Geological Survey (USGS) (e.g., in the Lower Granite Reservoir), the following sediment grain size fractions will be interpreted from backscatter data:
  - Bedrock
  - Boulders and cobbles (> 64 mm)
  - Gravels (> 2 to 64 mm)
  - Sands (0.063 to 2 mm)
  - Mud (< 0.063 mm; silts and clays).
- Backscatter data will be trained to sediment compositions (grain size fractions) using data obtained or derived from imagery analysis, bathymetry, and/or ADCP measurements. Sediment textures will be classified based on the combination of

grain size fractions present at each location using a standardized or project-specific texture triangle approach (e.g., Folk classification system or similar[3]).

Inferences to be drawn from these data will be inherently nonstatistical in nature.

- Given the resolution of digital images and ability to zoom in on areas of images during processing, this scale is expected to be sufficient to determine sediment size fractions and differentiate areas where predominant grain sizes are larger or smaller than 2 mm.
- As future elements of the Phase 3 sediment study are completed, grain size analyses on samples collected as part of sediment characterization efforts (DQO 2) will be used to further refine assignments of sediment grain size fractions and texture classes identified using video images and to iteratively refine interpretations and maps developed as part of sediment facies evaluations.[4]
- Velocity data will be used to estimate apparent roughness heights, flow resistance coefficients, and other hydrodynamic factors related to bed characteristics. Such information is anticipated to be useful to corroborate relationships between acoustic signals and substrate characteristics and to support selection of sampling locations for subsequent Phase 3 study elements defined in DQOs 2 through 5.
- If data are applicable, imagery and measurements of acceptable quality from USGS[5] and CCT studies will be used to provide additional information to infer sediment bed properties.

[3] The example sediment texture triangles shown in Figure A6-2 illustrate how grain size composition (e.g., percent mud, percent sand, and percent gravel) can be combined to define sediment textures. As described in Section A6, it is anticipated that classification of sediment textures would use a project-specific approach based on a standard system (such as a modified Folk system) that is tailored to UCR conditions and to support use for support development of sample design for DQO 2 and for other ongoing evaluations of benthic habitats. See https://pubs.usgs.gov/of/2003/of03-001/htmldocs/nomenclature.htm or https://pubs.usgs.gov/of/2006/1195/htmldocs/nomenclature.htm for additional detail regarding relationships between sediment grain size fractions and sediment texture classifications.

[4] Initial sediment facies maps developed based on acoustic data will provide a foundation that can be refined using data resulting from future sampling efforts. However, the method(s) for performing refinements using future data will be dependent on the data and are not described in this QAPP.

[5] For example, data from Weakland, R.J., Fosness, R.L., Williams, M.L., and Barton, G.J., 2011, Bathymetric and sediment facies maps for China Bend and Marcus Flats, Franklin D. Roosevelt Lake, Washington, 2008 and 2009: U.S. Geological Survey Scientific Investigations Map 3150, 1 sheet.

A7.6 Step 6—Specify Performance or Acceptance Criteria

The performance standard will be for field crews conducting surveys to attempt data collection along all planned transects and data collection intervals across the channel. If a planned location cannot be surveyed due to physical access or safety constraints, field crews will adjust locations and collect images and measurements at the nearest location without access or safety constraints. Field crews may not be able to acquire data in locations such as Little Dalles[6] due to safety considerations; such locations will be visually assessed in the field to decide whether conditions are conducive to safely conducting surveys.

Survey results will be tied to known elevation and locational benchmarks to document survey accuracy, precision, and overall quality.

Section B4 of this QAPP and the FSP and associated SOPs (Appendix A) provide more detailed information related to performance criteria for specific equipment and procedures.

A7.7 Step 7—Develop the Plan for Collecting Data

Detailed discussions of the various study components are presented in Section B1 of this QAPP.

High-resolution bathymetry and backscatter data will be acquired throughout the Upper Reach OU using a full-coverage MBES survey consisting of contiguous swaths with sufficient overlap to ensure quality coverage (e.g., 10 to 50 percent overlap):

- Bathymetry and backscatter data will be acquired using a MBES system and required hardware and software systems to support data acquisition, vessel positioning and navigation, and system calibrations. Bathymetry and backscatter data will be processed to produce a digital bathymetric model and an acoustic backscatter mosaic. For anticipated water depths in the survey area, bathymetry and backscatter data resolution is expected to be 1 square meter (1 m^2) or finer.
- As an additional check on acoustic survey accuracy, a standard crossline analysis will be conducted by comparing acoustic data acquired along additional survey lines oriented perpendicular to the main survey lines. The expectation is that bathymetry and backscatter at individual locations should not substantially vary as a function of survey vessel direction. Differences in measurements will provide information to define overall survey accuracy.

[6] Little Dalles poses a safety hazard for field surveys due to the presence of Class 3 rapids.

Underwater video images and velocity profiles will be acquired at point locations along transects throughout the Upper Reach OU and with increased frequency within the three AOIs (see Maps A7-1 through A7-4):

- Video images will be collected using a submersible camera system. Velocity profiles will be acquired using an ADCP.
- Outside of the three AOIs, transects will have a nominal spacing of 0.5 mile. Transects will be oriented perpendicular to the flow path of the river and will be located based on anticipated geomorphological characteristics of the river, including but not limited to submerged bars, benches, and terraces. Video images and ADCP measurements will be acquired at up to five discrete locations along each transect. The location for data acquisition along each transect will reflect anticipated geomorphological characteristics of the river, including submerged bars, benches, terraces, and the river thalweg (e.g., near-left bank, near-left thalweg edge, mid-thalweg, near-right thalweg edge, near-right bank).
- Within AOIs for Deadman's Eddy (approximately RM 738 to RM 739), China Bend (approximately RM 721 to RM 722), and upstream of Marcus Flats (approximately RM 707 to RM 709), transects will have a nominal spacing of 0.25 mile. Transects will be oriented perpendicular to the flow path of the river and will be located based on anticipated geomorphological characteristics of the river, including but not limited to submerged bars, benches, and terraces. Video images and ADCP measurements will be acquired at up to ten discrete locations along each transect. Locations for data acquisition along each transect will reflect anticipated geomorphological characteristics of the river, including submerged bars, benches, terraces, and the river thalweg (e.g., near-left bank, near-left thalweg edge, mid-thalweg, near-right thalweg edge, near-right bank). The closer spacing of transects and higher density of underwater video image and ADCP measurement points along transects in the AOIs is intended to help ensure that imagery and ADCP measurements are collected from the full range representative geomorphic features in these areas.

Final transects and locations along each transect were selected in the AOIs, where appropriate, based on review of river bathymetry from the U.S. Bureau of Reclamation and the and other site information, including MBES bathymetry and accompanying backscatter mosaic obtained by the CCT between 2015 and 2017 and provided to TAI by EPA. Underwater imagery and ADCP data collection point locations are listed in

Table A7-1. Ad hoc imagery measurement locations along transects may be added in the field at the time of data collection.[7]

Transects and survey areas may require adjustment in the field as a consequence of physical access constraints (e.g., shoals and other water depth limitations) and safety considerations.

A8 SPECIAL TRAINING/CERTIFICATES

TAI has assembled a technical team with the requisite experience and technical skills to successfully complete the study.

Field survey personnel will be familiar with the Site cultural resources coordination plan (Appendix B). Field survey personnel will report any materials that might be considered a cultural resource to an archaeological monitor or Tribal representative participating in the field sampling program, if such observers are present. In the event that suspected or evident artifacts or other archaeological deposits are encountered when an archaeological monitor or Tribal representative is not present, the immediate vicinity of the discovery will be secured and appropriate notifications will be made by the TAI Project Coordinator or designee per the Site cultural resources coordination plan (Appendix B).

A9 DOCUMENTATION AND RECORDS

This section identifies field data and records to be maintained for this project, information to be included in project reports, data reporting format, and document control procedures to be used. Critical records required for this study are identified below with descriptive or supporting information as appropriate. Records will include instrument testing, calibration, and operation documentation; raw field data collected during surveys; postprocessed data and associated metadata describing postprocessing procedures followed; and final data deliverables with accompanying documentation. Data reports of geospatial data products will be made available through integration into the project database web tool. Briefly, this will be an electronic data management system that is accessible via an external website. The QAPP, FSP (Appendix A), site health and safety plan (SHSP) (TCAI 2007), and the general SHSP addendum (Attachment A1 to Appendix A) will be provided to each person listed in Section A3 (distribution list). Any

[7] Ad hoc imagery locations are also described in the FSP (Appendix A), which describes in Section 2.7.2 the kinds of situations that may trigger collection of ad hoc imagery/ADCP measurements: "If clearly defined geomorphological features are observed from the live feed or based on a review of bathymetry or acoustic backscatter data, additional images may be collected ad hoc along transects to help ensure that images collected represent the full range representative acoustic signatures and geomorphic features."

revisions or amendments to any of the documents that comprise the FSP will also be provided to these individuals.

A9.1 Field Documentation and Raw Data

The TAI field supervisor will ensure that the field team receives the final approved version of the QAPP prior to the initiation of field activities. Minimum general field records that will be maintained include the following:

- Field logbooks
- Photo documentation of surveying activities
- Documentation required by permits (if any).

Additional content, information, and use of the above-listed documents are further described in the FSP (Appendix A).

The specific field documentation and raw data to be collected and maintained by the acoustic and underwater imagery subcontractor(s) for each survey method are described in the SOPs (Attachment A2 to Appendix A).

- Bathymetry and backscatter by MBES
  - Patch test results
  - Instrument operational settings (frequency, power/gain)
  - Real-time kinematic (RTK) global positioning system (GPS) data, including base station information and raw GPS data files
  - MBES raw data
  - Vessel navigation records
  - Survey start and stop times and personnel for each survey date
  - Sound velocity depth profiles and records of calibration for sound velocity depth profiling instrumentation
- Velocity profiles by ADCP
  - Calibration records
  - Operation records
  - RTK GPS data, including base station information and raw GPS data files
  - ADCP raw data
  - Survey start and stop times and personnel for each survey date
- Underwater imagery by drop-frame camera
  - Daily camera focus calibration documentation
  - Daily laser scale calibration documentation

- Daily camera time and date stamp verification
- RTK GPS data, including base station information and raw GPS data files
- Water depths at imagery collection locations as measured using vessel sonar or lead line
- Survey navigation point data
- Video data files
- Still image data files
- Survey start and stop times and personnel for each survey date.

Field data collection activities completed by the acoustic and underwater imagery subcontractor(s) will be documented in a survey report. The survey report shall include, at a minimum, the following:

- A narrative of survey procedures and dates completed
- A description of the coordinate system(s) and datum(s) used in the performance of the work, including all survey control used and any real-time or postprocessing mathematical coordinate transformations made either real-time or postprocessed
- Description of QC procedures including results of position checks, bar checks, patch tests, cross line analysis, and/or any other calibration/quality tests performed to ensure data meets the QC criteria specified in this QAPP
- A list of equipment used
- Copies of applicable field notes
- Raw data files.

A9.2 Postprocessed Data

Raw data collected in the field will be postprocessed to yield the final data deliverables to be included in the data summary report and to be used for subsequent mapping of sediment facies. MBES backscatter data will serve as the primary source data for determining sediment compositions (grain size fractions), guided by empirical and analytical data obtained or derived from imagery analysis, MBES bathymetry, and/or ADCP measurements. The data summary report will include:

- MBES bathymetry as a digital elevation model (DEM) formatted as a raster (georeferenced tagged image file format [GeoTIFF] or similar)

- MBES backscatter as a normalized/calibrated[8] backscatter intensity (time series) image mosaic formatted as a raster (GeoTIFF or similar)
- Underwater imagery formatted as georeferenced images and point data including interpreted sediment composition (percent composition of each grain size class) formatted as an Environmental Systems Research Institute, Inc. (ESRI) shapefile
- Point sediment bed roughness parameters (apparent roughness height and coefficient of friction) derived from ADCP measurements, formatted as an ESRI shapefile.

The postprocessing procedures to generate the data products listed above are described in the SOPs (Attachment A2 to Appendix A).

Interpretation of sediment composition from acoustic backscatter data in riverine settings such as the Upper Reach OU presents a challenge due to relatively high bathymetric relief, the prevalence of larger grain sizes, and the presence of sediment facies that are discontinuous and highly variable. There have been many approaches described for interpreting acoustic backscatter data using grain size analysis or other ground reference data (e.g., interpreted photography or videography) to qualitatively relate the backscatter signal to substrate type and to provide quantitative "training data" for various statistical classification methods. These methods encompass both pixel- and object-based techniques and include:

- Supervised classification (e.g., support vector machine, maximum likelihood, decision tree/forest, random trees, etc.)
- Principal component analysis
- Textural analysis
- Pixel-based classification
- Object-based classification.

It is anticipated that a combination of these methods will be suitable for interpreting sediment composition from backscatter data within the Upper Reach OU. However, because the preferred method(s) for interpretation are greatly dependent on the data,

[8] Backscatter imagery depicts the intensity of reflected acoustic energy and is a direct indicator of bottom morphology, texture, and sediment type. Harder, rougher, and coarser substrates will reflect acoustic energy more efficiently than softer, smoother, and finer substrates. However, not all MBES systems produce the same type of backscatter imagery. During this study, "normalized" or "calibrated" backscatter data will be acquired so that acoustic returns for each substrate type are consistent throughout the study area. Otherwise, acoustic returns may vary from day to day based on different sonar settings and/or environmental conditions.

selection of the interpretation method(s) will be performed after data collection and postprocessing is completed.

During classification, data from previous studies will also be evaluated and incorporated, if helpful, to supplement the ground reference dataset used for developing and/or validating the backscatter/bathymetry-sediment composition relationship. It is expected that the data from previous studies to be evaluated includes underwater video collected by the CCT in 2017 and grain size analysis results for surface sediment samples collected during previous investigation phases completed under the Agreement. Point data locations for these existing data sources are shown in Maps A9-1 through A9-4.

Preliminary grain size composition and sediment facies maps will be interim deliverables between the draft data summary report and finalization of DQO 2. The preliminary grain size composition and sediment facies maps may be further refined with data collected in DQO 2 (i.e., grain size data from discrete samples).

A9.3 Data Quality Documentation

Data verification (i.e., confirming the accuracy and completeness of field and postprocessed data) will be performed by the acoustic and underwater imagery subcontractor(s) for data generated in the field, and by the TAI task leaders for postprocessed results. Data quality assessment for this task will be completed by the TAI task leaders and the results will be provided to the principal investigators.

Metadata and formatting of the final geospatial deliverables will be verified by, or under the direction of, the database administrator. Any changes to data stored in the database will be recorded in the database change log.

SECTION B: DATA GENERATION AND ACQUISITION

B1 SEDIMENT FACIES MAPPING DESIGN

This section describes the design for the sediment bed surveys that will result in a data set that supports the identification and mapping of sediment grain size fractions and texture in the Upper Reach OU to support development of sample design for Phase 3 Sediment Study DQO 2 and for other ongoing evaluations of benthic habitats and areas of potential risk due to COPC concentrations as part of Phase 3 Sediment DQOs 3, 4, and 5.

A sediment facies mapping approach utilizing high-resolution bathymetry and underwater imagery was first described by EPA in the January 2018 LOE. Use of acoustic backscatter to determine sediment composition was described by EPA during discussions between TAI and EPA that followed issuance of the LOE. The final study design, which is described in Section A7.7, was developed collaboratively by TAI and EPA through the DQO process.

High-resolution bathymetry and backscatter data will be acquired throughout the Upper Reach OU using a full-coverage MBES survey consisting of contiguous swaths with sufficient overlap to ensure quality coverage (e.g., 10 to 50 percent overlap). The MBES survey will be performed to support a minimum mapping unit (MMU) of 1 m^2 (i.e., 1 m x 1 m grid). The MMU is the smallest contiguous area that will be digitized or classified on the final map, in this case the acoustic backscatter map that will serve as the primary source data for determining sediment compositions (grain size fractions). The MMU defines the basic scale of analysis and, therefore, controls spatial resolution requirements. As a rule of thumb, to be able to image and map a feature, data should be acquired with a resolution of half the size of the feature. For example, a MMU of 1 m x 1 m would require a spatial resolution of 50 cm by 50 cm, thus providing 4 pixels of data to reliably distinguish and delineate the feature. Features that are smaller than the MMU can be identified but will not be mapped. Features that are smaller than the spatial resolution of the data cannot be identified and will not be mapped. The MMU and the corresponding spatial resolution requirements drive the data acquisition parameters, as the data must be acquired with a sufficient density to be gridded (averaged) at the defined cell size.

Underwater imagery and ADCP velocity profiles will be acquired at discrete points along transects throughout the Upper Reach OU and with increased frequency within the three AOIs. Transects and imagery/ADCP point locations are shown in Maps A7-1 through A7-4. Imagery/ADCP point locations and coordinates are listed in Table A7-1. Outside of the three AOIs, transects will have a nominal spacing of 0.5 mile. Within AOIs for

Deadman's Eddy (approximately RM 738 to RM 739), China Bend (approximately RM 721 to RM 722), and upstream of Marcus Flats (approximately RM 707 to RM 709), transects will have a nominal spacing of 0.25 mile. Video images and ADCP measurements will be acquired at ten locations along each transect within the AOIs and at up to five discrete locations along each transect outside of the AOIs. The closer spacing of transects and higher density of underwater video image and ADCP measurement points along transects in the AOIs are intended to help ensure that imagery and ADCP measurements are collected from the full range representative acoustic signatures and geomorphic features in these areas. Transects will typically be oriented perpendicular to the flow path to provide representative coverage of the riverbed (e.g., near-left bank, near-left thalweg edge, mid-thalweg, near-right thalweg edge, near-right bank). Imagery measurement locations along transects may be added in the field at the time of data collection.

The location and orientation of transects and point locations for ADCP and imagery data acquisition within the AOIs were selected to reflect anticipated geomorphological characteristics of the river, including submerged bars, benches, terraces, and relative to the river thalweg based on review of river bathymetry data from the U.S. Bureau of Reclamation and CCT and MBES backscatter mosaic from the CCT. Because of a gap in the bathymetry and backscatter data around the Deadman's Eddy AOI, the CCT data could only be used to help select transect and point locations at the upstream of Marcus Flats and China Bend AOIs. The CCT data used to help guide selection of transect and point locations are shown in Maps B1-1 through B1-4.

The approach for identifying transect and point locations at the upstream of Marcus Flats and China Bend AOIs included the following steps, all performed using GIS:

1. Begin with transects spaced at 0.25-mile intervals oriented perpendicular to the thalweg and extending across the anticipated wetted river channel for late September to October. Place ten points at equal intervals along each transect.
2. In GIS, classify CCT backscatter mosaic into 5 discrete classes using natural breaks in the data.
3. Combine CCT bathymetry data, which was generally limited to the main river channel, with U.S. Bureau of Reclamation bathymetry data.
4. Review each transect location and orientation and adjust, when necessary, to pass through the full range of acoustic signature classes present in the transect vicinity, and to pass through representative features evident from bathymetry (e.g., terraces, dunes, and slopes).

5. If depositional areas requiring characterization identified in the January 2018 LOE are present, adjust transect location and orientation to ensure one or more transects passes through the depositional areas.
6. On each transect, review each of the ten point locations and adjust, as appropriate and as possible, to distribute points so that at least three points each are within the channel left of the channel, and right of the channel. Point locations were also adjusted to capture the range of acoustic signatures and to include a combination of areas with uniform signature and areas with variable signals. Point locations were also adjusted based on bathymetry, to locate some points within geomorphologic features and other points in transition areas between features; for example: at the base of slopes.
7. If depositional areas requiring characterization identified in the January 2018 LOE are present, then points were adjusted to target at least three points per depositional area.
8. Within the China Bend AOI only, one Phase 3 transect and one associated point location were adjusted at the request of EPA to provide a location that would be co-located with a Phase 2 sediment study sample where the sediment sample was analyzed in the laboratory to determine slag content. As shown in Map A9-3, Transect 60 in the China Bend AOI was positioned to place one imagery/ADCP measurement point at the recorded Phase 2 3-SE-B-8 sample location.

The same general process was also used to locate transect and point locations within the Deadman's Eddy AOI but without the CCT bathymetry and backscatter data.

B2 FIELD DATA COLLECTION METHODS

Field data collection will be performed by three sediment bed survey methods: MBES, ADCP, and underwater imagery collection. Each of these survey methods employs multiple pieces of equipment. Table B2-1 identifies for each survey method the types of equipment to be used and the general specifications and setup or operation settings, as applicable. Field data collection methods for sediment bed survey are described in the FSP (Appendix A). The FSP includes the following topics:

- Field equipment and supplies (Section 2.4)
- Survey methods (Section 2.5)
- Vessel positioning (Section 2.5.4)

- Survey contingencies (Section 2.6)
- Field QA/QC checks (Section 2.7)
- Field documentation and procedures (field logbooks and photo documentation) (Section 3.0)
- Field electronic data management (Section 3.2).

SOPs for each survey method are provided in Attachment A2 of the FSP (Appendix A).

In the event that unanticipated or changed circumstances occur in the field, the field supervisor, in consultation with EPA or its representatives in the field, and the TAI project coordinator will institute the necessary corrective actions, complete a corrective action record, and ensure that the appropriate procedures are followed. If corrective actions require a departure from the FSP, these changes will be documented on a field change request form (refer to Attachment A3 of Appendix A for examples of these and other forms) and submitted to the TAI project coordinator and EPA project manager for review and approval. In any other circumstances where survey conditions are unexpected, the appropriate survey actions consistent with the objectives of this task will be conducted. This change will be noted by the field supervisor in the field log, and a change request form will be completed for the project files and submitted to EPA. Any problems that cannot be easily resolved or that affect the final quality of the work product will be brought to the attention of the principal investigator, TAI project coordinator, and EPA (and EPA's representative[s] in the field). EPA will be notified of any problems that may affect the final outcome of this task. Additional information regarding corrective actions and related documentation is provided in Section C1.

B3 DATA POSTPROCESSING AND ANALYSIS

As described in Section A9.2, raw data collected in the field will undergo postprocessing or interpretation to yield the final data deliverables to be included in the data summary report and to be used for subsequent mapping of sediment facies. The outputs from data postprocessing to be included in the data summary report are:

- MBES bathymetry results as a DEM formatted as a raster (GeoTIFF or similar) with elevations tied to a known vertical datum (i.e., NAVD88)
- Acoustic backscatter results as a normalized/calibrated backscatter image (time series) formatted as a raster (GeoTIFF or similar)

- Underwater imagery formatted as georeferenced images and point data including interpreted sediment composition (percent composition of each grain size class) formatted as an ESRI shapefile (point format with sediment composition results included in attribute table)
- Point sediment bed roughness parameters (apparent roughness height and coefficient of friction) derived from ADCP measurements, formatted as an ESRI shapefile (point format with derived parameters included in attribute table).

The procedures for data postprocessing and interpretation to generate the data products listed above are described in the SOPs (Attachment A2 to Appendix A). All raw data will be archived and can be made available if different postprocessing methods are identified for subsequent use of the data.

B4 QUALITY CONTROL

This section describes the QC activities that will be performed in association with the sediment bed surveys and the performance criteria for QC activities. The overall quality objective for this task is to develop and implement procedures that will ensure the collection of representative data of known and acceptable quality for the intended use of the data. QC activities that will be used for this task are based on U.S. Army Corps of Engineers (USACE) and USGS guidance, including:

- Mueller et al. 2013. *Measuring discharge with acoustic Doppler current profilers from a moving boat: USGS Techniques and Methods 3A–22*
- USACE. 2013. *Engineering and design – Hydrographic surveying. Manual No. 1110-2-1003. U.S. Army Corps of Engineers, Washington D.C. November 30.*

Measurement quality objectives (MQOs) presented in Table B4-1 are the target performance criteria for data to be collected in this study. Where possible, the performance criteria identified in Table B4-1 are related to the planned utility of each data type for supporting the ultimate data use in mapping sediment facies. All survey results will be tied to known elevation and locational benchmarks to document survey accuracy, precision, and overall quality. Other performance criteria include:

- Spatial resolution of MBES data to support a 1 m^2 MMU
- Target accuracy for MBES data +/- 0.1 m at 95 percent confidence, as determined from crossline analysis
- Co-registration of backscatter and depth sounding MBES data

- Patch tests and calibrations/correction for MBES backscatter data acquisition
- Vessel station positioning for ADCP measurements
- Verification of automated imagery analysis by manual imagery interpretation
- Precision of sediment composition interpretations from imagery based on duplicate image collection and analysis
- Precision of sediment bed roughness parameters derived from ADCP measurements based on duplicate ADCP measurements.

Procedures for the QC activities identified in Table B4-1 are described in the SOPs (Attachment A2 to Appendix A).

The performance criterion for completeness will be for field crews conducting surveys to attempt surveys continuously throughout the Upper Reach OU (for MBES survey) and at all underwater imagery/ADCP measurement point locations. If a planned location cannot be surveyed due to physical access or safety constraints, field crews will adjust locations and collect images and ADCP measurements at the nearest location without access or safety constraints. As described in Section A7.6, field crews may not be able to acquire MBES or imagery/ADCP data in some locations due to safety considerations.

B5 INSTRUMENT/EQUIPMENT TESTING, INSPECTION, AND MAINTENANCE

Instrument/equipment testing, inspection, and maintenance will be conducted by the acoustic and underwater imagery subcontractor(s) in accordance with requirements identified in the field SOPs (Attachment A2 to Appendix A) and per manufacturer instructions. Instrument/equipment maintenance and repair will be documented in the field log book as described in the FSP (Appendix A).

B6 INSTRUMENT/EQUIPMENT CALIBRATION AND FREQUENCY

Before beginning each survey, and during surveys, as appropriate, instruments/equipment will be properly calibrated, and the calibration will be verified with appropriate checks. Instrument/equipment calibration procedures and schedules will conform to analytical protocol requirements, and descriptions are provided in the field SOPs (Attachment A2 to Appendix A) and the manufacturer instruction manuals.

B7 INSPECTION/ACCEPTANCE OF SUPPLIES AND CONSUMABLES

No significant supplies or consumables are expected for the surveys because data will be collected using geophysical/remote sensing techniques; there will be no collection or analysis of any physical samples.

B8 DATA MANAGEMENT

Data for this study will be generated both in the field and during postprocessing of field data. Field data generated during the study include hard-copy documentation and electronic raw data from survey equipment/instrumentation. Field documentation and field survey data to be generated for the study are described in Section A9.1. Procedures for managing field data are described in the FSP (Appendix A) and the SOPs (Attachment A2 to Appendix A).

Postprocessed data and data deliverables to be generated for the study are described in Section A9.2 as listed in Table B4-1. The final repository for geospatial study data will be the relational database housed at http://teck-ucr.exponent.com. Procedures used to transfer data from the point of generation to the database are described in this section.

The data management plan (DMP) and its draft amendment (Exponent, Inc. 2010) established standard procedures for the management of all documents and environmental data (field and laboratory) generated during the RI/FS. The DMP describes data management procedures relating to the creation, acquisition, handling, storage, and distribution of task-related data. Data management systems and procedures described below are intended to establish and maintain an efficient organization of large volumes of complex environmental information for a diverse combination of data types. To accomplish this task, the following four management systems will be used to provide organized and efficient data management and retrieval:

- **Project database**. Stores environmental sampling and analysis data, information pertaining to geographic information system (GIS) files, and citations of documents related to collection, analysis, or interpretation of environmental data stored in the database. Both current and historical data are stored in the project database. Access to the data is password controlled, with various levels of access available to users on a "need to know" basis, as determined by the project manager.
- **GIS**. Stores spatial data and enables the cartographic presentation of data trends and patterns.

- **Hard copy files**. Maintains a record and archive of documents from field studies and resulting reports.
- **Website** (http://www.ucr-rifs.com). Makes available draft documents and other project information via the secure domain. Users with appropriate privileges are able to download draft documents. Any user is able to download final documents.

Study activities will use spatial data sets and analyses for planning, data interpretation, decision support, and data presentation. Links between data in the project database and GIS files will be established via common identifiers for sampling locations and other geographic features.

SECTION C: ASSESSMENT AND OVERSIGHT

This task will rely on the knowledge and expertise of the TAI technical team. The field team (comprising the acoustic and underwater imagery subcontractor[s] and field supervisor) will stay in close verbal contact with the principal investigator and the task leaders during all phases of this study. This level of communication will serve to keep the management team apprised of activities and events, and will allow for informal but continuous task oversight.

C1 ASSESSMENTS AND RESPONSE ACTIONS

Assessment activities will include readiness reviews prior to beginning sediment bed surveys and prior to release of the final data to the data users, as well as internal review while work is in progress. A technical systems audit may be conducted by either EPA or TAI if problems are encountered during any phase of this task.

Readiness reviews typically are conducted to ensure that all necessary preparations have been made for efficient and effective completion of each critical phase of work. The first readiness review will be conducted prior to the beginning of survey activities. The acoustic and underwater imagery subcontractor coordinator will verify that all acoustic and underwater imagery subcontractor personnel and survey equipment/ instrumentation are available for mobilization to the Site. The acoustic and underwater imagery subcontractor coordinator will also verify that the field supervisor and acoustic and underwater imagery subcontractor[s] have been scheduled and briefed (including review of the SHSP and the cultural resources coordination plan), and that the contract for the subcontractor has been signed by both parties. Any deficiencies noted during this readiness review will be corrected prior to initiation of sampling activities.

The second readiness review will be completed before final data are released for use. The database administrator will verify that all required data products have been received from the acoustic and underwater imagery subcontractor and data quality assessments have been completed. Any deficiencies noted during this review will be corrected by the database administrator, the task managers, or their designees. Data will not be released for final use until all data have been approved by EPA. No written report will be prepared in conjunction with the readiness reviews.

Technical review of intermediate and final work products generated for this task will be completed throughout the course of all surveying and data postprocessing activities to ensure that every phase of work is accurate and complete and follows the QA procedures outlined in this QAPP. Any problems that are encountered will be resolved between the

reviewer and the person completing the work. Any problems that cannot be easily resolved or that affect the final quality of the work product will be brought to the attention of the principal investigator and TAI project coordinator. EPA will be notified of any problems that may affect the final outcome of this task, according to the Agreement. EPA assessment and/or oversight of surveying and/or data postprocessing will be conducted as directed by the EPA project manager.

The acoustic and underwater imagery subcontractor is required to have implemented a review system that serves as a formal surveillance mechanism for data generated for this study. An independent technical review for each phase of work will be completed by the acoustic and underwater imagery subcontractor QA manager before data are approved for release.

Technical system audits may be conducted if serious problems are encountered during survey or data postprocessing analysis operations. If completed, these audits will be conducted by the task managers or designee, or by the underwater imagery subcontractor QA manager, as appropriate. These audits may consist of on-site reviews of any phase of field activities or data management. Results of any technical systems audits will be provided in the draft data summary report and verbally to the acoustic and underwater imagery subcontractor project manager.

Any task team member who discovers or suspects a nonconformance is responsible for reporting the nonconformance to the principal investigator, the task managers, or the acoustic and underwater imagery subcontractor project or QA manager, as applicable. The task managers will ensure that no additional work dependent on the nonconforming activity is performed until a confirmed nonconformance is corrected. Any confirmed nonconformance issues will be communicated to the TAI project coordinator and to EPA.

C2 REPORTS TO MANAGEMENT

The acoustic and underwater imagery subcontractor(s) will keep the acoustic and underwater imagery subcontractor coordinator and task manager(s) apprised of their progress on a regular basis. The acoustic and underwater imagery subcontractor(s) will provide the following information:

- Status of survey completion
- Summaries of nonconformances or field conditions that resulted in a requirement for corrective action and a description of the corrective actions implemented

- Descriptions and justification for any significant changes in methodology or QA/QC procedures and accompanying change request and/or protocol modification forms (Attachment A3 to Appendix A).

The acoustic and underwater imagery subcontractor coordinator and task managers will provide this information to the principal investigator and the TAI project coordinator.

The acoustic and underwater imagery subcontractor(s) will be required to have implemented routine systems of reporting nonconformance issues and resolutions. These procedures will be described in a quality control plan which is to be submitted to TAI by the subcontractor for review and approval prior to performing survey work. Nonconformance issues will also be described in the data summary report.

Geospatial data deliverables and associated raw data will be prepared by the acoustic and underwater imagery subcontractor(s) upon completion of data postprocessing and the final independent technical review. The data deliverable transmittal will include a description of any problems encountered, QC target limit exceedances (if applicable), and any rejected data and a description and rationale for any deviations from procedures described in the SOPs (Attachment A2 to Appendix A). Copies of corrective action reports generated by the acoustic and underwater imagery subcontractor will also be included in the data summary report with the data package.

Geospatial data deliverables will be provided electronically to EPA. These data will also be described and presented (e.g., as maps) with the data summary report containing an overview of the field surveys, survey methods, data postprocessing methods, and rationale for any deviations from the FSP and/or QAPP according to the Agreement.

SECTION D: DATA VALIDATION AND USABILITY

This section describes QA activities that will be performed after the field data collection and postprocessing activities have been completed. Survey data collected in the field and generated from postprocessing raw data will be verified and validated according to criteria and procedures described in this section. Data quality and usability will be evaluated, and a discussion will be included in the data summary report.

D1 DATA REVIEW, VERIFICATION, AND VALIDATION

Data verification is the process for evaluating the completeness, correctness, and conformance of a data set against method or procedural specifications. The criteria for data verification are identified as performance criteria in Table B4-1.

The objective of data validation is to determine the quality of the data set relative to the end use, i.e., to identify and map sediment grain size fractions and texture for mapping sediment facies. The utility of each type of survey for sediment facies mapping is described in Table B4-1. The principal criteria for data validation relate to answering the following questions:

- Do the data have known horizontal/vertical accuracy and resolution to support a MMU of 1 square meter?
- Does the quality of data allow combinations of particle types > 2 mm to be distinguished from those that are < 2 mm and differentiation between primarily sand areas and areas that are mixtures of sand and gravel/ cobbles/ boulders?

D2 VERIFICATION AND VALIDATION METHODS

Survey data verification will be performed by the task managers or their designees. Survey data will be verified by reviewing for completeness, accuracy, conformance to the performance criteria specifications identified in Table B4-1, and agreement with the methods and requirements described in the FSP (Appendix A) and SOPs (Attachment A2 to Appendix A). Data completeness will be checked to determine if there was any loss of data due to file corruption, storage issues (erasure or over-writing), or data processing. In addition to the verification methods described above, the continuity of MBES bathymetry data and presence of anomalies and/or artifacts will be assessed qualitatively by inspection of a hillshade derived from the bathymetry DEM.

An objective of this study is to acquire MBES data in contiguous swaths over the wetted surface area of the riverbed. Survey crews should be prepared to establish and/or adjust

equipment settings and swath widths to ensure that data are acquired at a frequency (or frequencies) to support a 50 cm by 50 cm beam footprint ("cell") resolution with corresponding position information for each cell. Such adjustments are likely to be needed in areas where river velocities are higher than typical (e.g., in narrow reaches such as Little Dalles) and/or along the outer edges of swaths as the survey vessel turns. Consideration will also be given to survey vessel speed and water depth combinations to ensure that MBES ping rates and positioning data capture rates are sufficient to meet the target cell size given the two-way time of travel of sound waves.

It is recognized that data quality may differ (and might be lower) across the site as a consequence of variable field conditions, particularly in shallow (e.g., nearshore) areas or other locations where data are acquired along the outer extents of swaths. Data acquired from such areas will be evaluated and included bathymetric and backscatter maps generated from this study. These maps will identify zones (if any) where data quality differs during postprocessing steps.

Validation of survey data will be performed on postprocessed geospatial deliverables by the acoustic and underwater imagery subcontractor QA manager in consultation with the task managers and senior technical advisor. During data validation, the draft geospatial data deliverables will be reviewed to assess whether the data are of adequate quality to support the intended uses of the data. Validation will also include a review of postprocessing methods, including equations used for calculations and underlying assumptions. Data qualifiers will not be assigned during data validation; however, data may be rejected if performance criteria are not met to a degree that significantly compromises the usability of the data. Rejected data will be excluded from final geospatial data deliverables, and the data summary report will describe the specific data that were rejected and the reason(s) for rejection.

D3 RECONCILIATION WITH USER REQUIREMENTS

Through the data verification process, the survey accuracy and precision will be evaluated against study MQOs. During data validation, the quality of survey data will be relative to the end use, i.e., to identify and map sediment grain size fractions and texture for mapping sediment facies. Data that are rejected during verification or validation will not be used for any mapping purpose and will be indicated as rejected within the project database.

Data users, in coordination with the principal investigator and task managers, are responsible for assessing the uncertainty of survey data (as expressed by accuracy or precision) relative to data use. For this study, the anticipated use of survey data is for subsequent mapping of sediment facies. As described in Section A9.2, MBES backscatter

data will serve as the primary source data for determining sediment compositions (grain size fractions), guided by data obtained or derived from imagery analysis, MBES bathymetry, and/or ADCP measurements. The interpretation method(s) for relating backscatter data to sediment composition will be identified after data collection and postprocessing is completed. Preliminary grain size composition and sediment facies maps will be interim deliverables between the draft data summary report and finalization of DQO 2. These interim deliverables will discuss potential impacts of survey data quality on data usability, and will define to the extent practicable any limitations on sediment facies mapping associated with the survey data.

SECTION E: REFERENCES

Exponent, Inc. 2010. Upper Columbia River data management plan, Amendment No. 1. Prepared for Teck American Incorporated. Exponent, Bellevue, WA.

Folk, R.L. 1954. The distinction between grain size and mineral composition in sedimentary rock nomenclature. *Journal of Geology* 62 (4), 344-359.

Folk, R.L. 1974. The petrology of sedimentary rocks: Austin, Texas. Hemphill Publishing Company. 182 pp.

Long, D. 2006. British Geological Survey detailed explanation of seabed sediment modified folk classification.

Mueller, D.S, C.R. Wagner, M.S. Rehmel, K.A. Oberg, and F. Rainville. 2013. Measuring discharge with Acoustic Doppler Current Profilers from a moving boat. USGS Techniques and Methods 3–A22.

Poppe, L.J., V.F. Paskevich, S.J. Williams, M.E. Hastings, J.T., Kelley, D.F. Belknap, L.G. Ward, D.M. Fitzgerald, and P.F. Larsen. 2003. Surficial sediment data from the Gulf of Maine, Georges Bank, and vicinity—a GIS compilation. U.S. Geological Survey Open-File Report 03-001, CD-ROM. Available online at http://pubs.usgs.gov/of/2003/of03-001/index.htm

TCAI. 2007. Upper Columbia River draft general site health and safety plan for the remedial investigation and feasibility study. Prepared for Teck Cominco American Incorporated. December 27, 2007. Integral Consulting Inc., Mercer Island, WA, and Parametrix, Bellevue, WA.

TAI. 2018a. Letter from Kris McCaig, TAI Project Coordinator, to Kathryn Cerise, USEPA Project Coordinator, regarding notice of dispute, Upper Columbia River Remedial Investigation and Feasibility Study—Response to EPA's Level of Effort (dated January 8, 2018). Teck American Incorporated. January 23.

TAI. 2018b. Letter from Kris McCaig, TAI Project Coordinator, to Kathryn Cerise, USEPA Project Coordinator, providing TAI's proposal for an alternate sediments field program. Teck American Incorporated. February 13.

TAI. 2018c. Letter from Kris McCaig, TAI Project Coordinator, to Kathryn Cerise, USEPA Project Coordinator, providing TAI's concerns with EPA's counter proposal for a sediments field program (dated February 14, 2018). Teck American Incorporated. February 15.

TAI. 2018d. Letter from Kris McCaig, TAI Project Coordinator, to Kathryn Cerise, USEPA Project Coordinator, providing TAI's draft data quality objectives for a Phase 3 sediment study. Teck American Incorporated. March 22.

TAI. 2018e. Final UCR Phase 3 Sediment Study DQO Scoping Outcomes Summary. Teck American Incorporated. April 12.

TAI. 2018f. Letter from Kris McCaig, TAI Project Coordinator, to Kathryn Cerise, USEPA Project Coordinator, providing TAI's draft final data quality objectives 1 and 3 through 5 for the Phase 3 sediment study. Teck American Incorporated. May 8.

TAI. 2018g. Letter from Kris McCaig, TAI Project Coordinator, to Kathryn Cerise, USEPA Project Coordinator, providing TAI's revised draft final data quality objective 1 for the Phase 3 sediment study. June 1.

TAI. 2018h. Letter from Kris McCaig, TAI Project Coordinator, to Kathryn Cerise, USEPA Project Coordinator, providing TAI's final data quality objective 1 for the Phase 3 sediment study. June 4.

TAI. 2018i. Draft Quality Assurance Project Plan for the Phase 3 Sediment Study—Sediment Facies Mapping. June 28.

TAI. 2018j. Letter from Kris McCaig, TAI Project Coordinator, to Kathryn Cerise, USEPA Project Coordinator, providing the Draft Final Phase 3 Sediment Study Sediment Facies Mapping Quality Assurance Project Plan (August 2018). Teck American Incorporated. August 10.

TAI. 2018k. Final UCR Phase 3 Sediment Study Sediment Facies Mapping QAPP Workshop Outcomes Summary. Teck American Incorporated. August 10.

USACE. 2013. Engineering and design – Hydrographic surveying. Manual No. 1110-2-1003. U.S. Army Corps of Engineers, Washington D.C. November 30.

USEPA. 2002. Guidance for quality assurance project plans. EPA QA/G-5. EPA/240/R-02/009. U.S. Environmental Protection Agency, Office of Environmental Information, Washington, D.C.

USEPA. 2006a. Settlement agreement for implementation of remedial investigation and feasibility study at the Upper Columbia River Site. June 2, 2006. U.S. Environmental Protection Agency, Region 10, Seattle, WA.

USEPA. 2006b. Guidance for the data quality objectives process. EPA QA/G-4. EPA/600/R-96/055. U.S. Environmental Protection Agency, Office of Environmental Information, Washington, D.C.

USEPA. 2018a. Letter from Kathryn Cerise, USEPA Project Manager, to Kris McCaig, TAI Project Manager, defining the upper reaches of the riverine portion of the UCR Site as a separable OU and identifying the Level of Effort (LOE) for additional characterization in the OU; Level of Effort for Nature and Extent of Sediment Contamination in Upper Reach Operable Unit technical memorandum attached. USEPA Region 10 Seattle, WA. January 8.

USEPA. 2018b. Letter from Kathryn Cerise, USEPA Project Manager, to Kris McCaig, TAI Project Manager, providing EPA's counter proposal for modifying the LOE in response to TAIs proposal (dated February 13, 2018). USEPA Region 10 Seattle, WA. February 14.

USEPA. 2018c. Letter from Kathryn Cerise, USEPA Project Manager, to Kris McCaig, TAI Project Manager, providing a further compromise for the sediments field program and constituting EPA's final offer to resolve TAI's dispute (dated January 23, 2018) during informal dispute resolution. USEPA Region 10 Seattle, WA. February 16.

USEPA. 2018d. Letter from Kathryn Cerise, USEPA Project Manager, to Kris McCaig, TAI Project Manager, acknowledging that EPA and TAI have come to agreement on the terms of resolution of the informal dispute and agreeing that the timing for the Phase 3 sediment QAPP will be determined after finalizing data quality objectives. USEPA Region 10 Seattle, WA. February 16.

USEPA. 2018e. Letter from Kathryn Cerise, USEPA Project Manager, to Kris McCaig, TAI Project Manager, providing consolidated comments from USEPA and the Parties on TAI's draft data quality objectives for a Phase 3 sediment study (dated March 22, 2018). April 13.

USEPA. 2018f. Letter from Kathryn Cerise, USEPA Project Manager, to Kris McCaig, TAI Project Manager, providing EPA comments on TAI's draft data quality objectives for the Phase 3 sediment study (dated May 8, 2018). May 18.

USEPA. 2018g. Letter from Kathryn Cerise, USEPA Project Manager, to Kris McCaig, TAI Project Manager, providing EPA approval of TAI's revised draft final data quality objective 1 for the Phase 3 sediment study (dated June 1, 2018). June 4.

USEPA. 2018h. Email from Kathryn Cerise, USEPA Project Manager, to Kris McCaig, TAI Project Manager, providing EPA comments on TAI's Quality Assurance Project Plan for the Phase 3 Sediment Study—Sediment Facies Mapping (dated June 28, 2018). July 19.

USEPA. 2018i. Letter from Kathryn Cerise, USEPA Project Manager, to Kris McCaig, TAI Project Manager, providing EPA approval of the Draft Final Phase 3 Sediment Study Sediment Facies Mapping Quality Assurance Project Plan (August 2018). August 17.

Windward (Windward Environmental LLC). 2018. Upper Columbia River final macroinvertebrate tissue study data summary report. Prepared for Teck American Incorporated. Seattle, Washington.

FIGURES

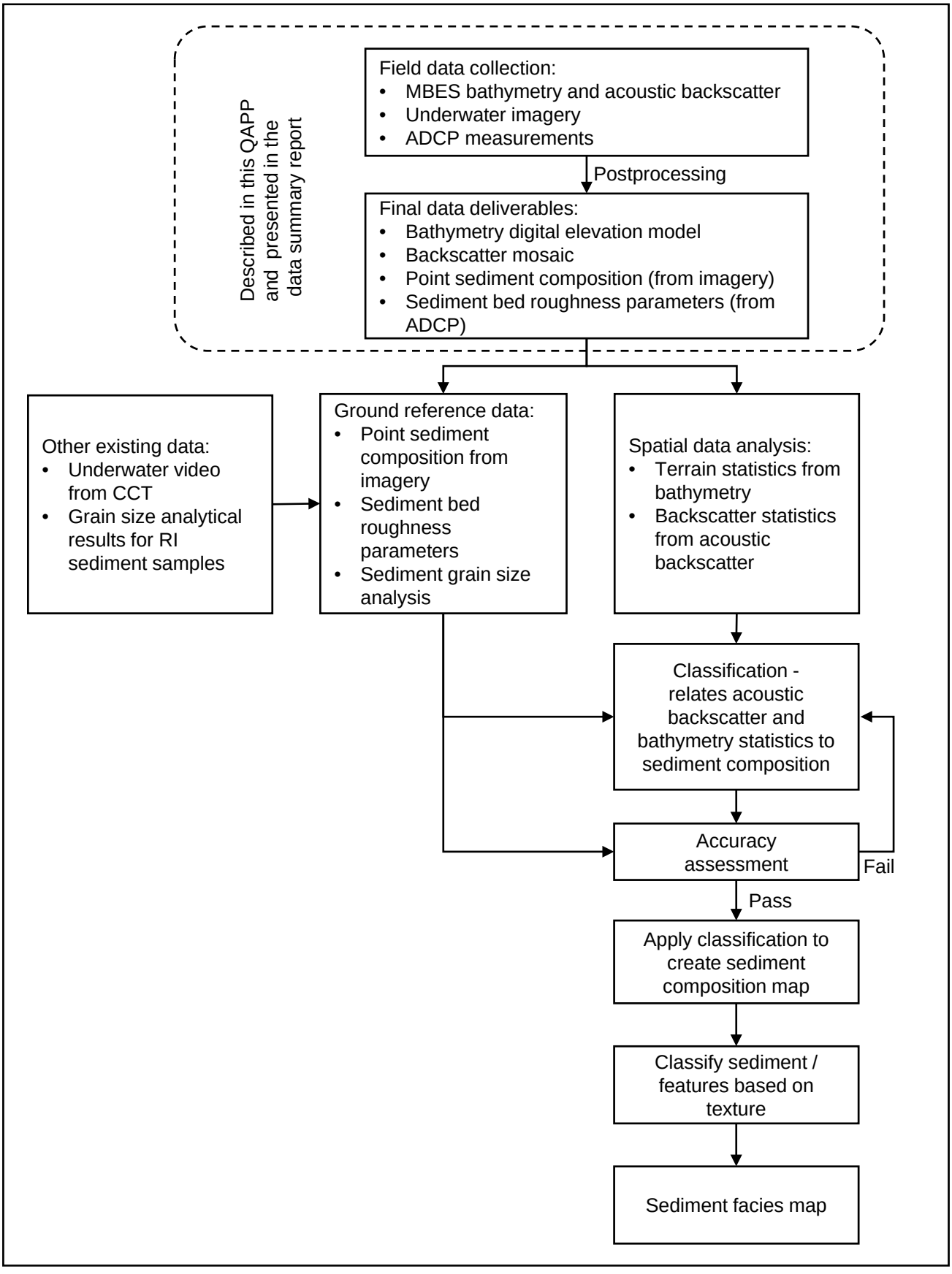
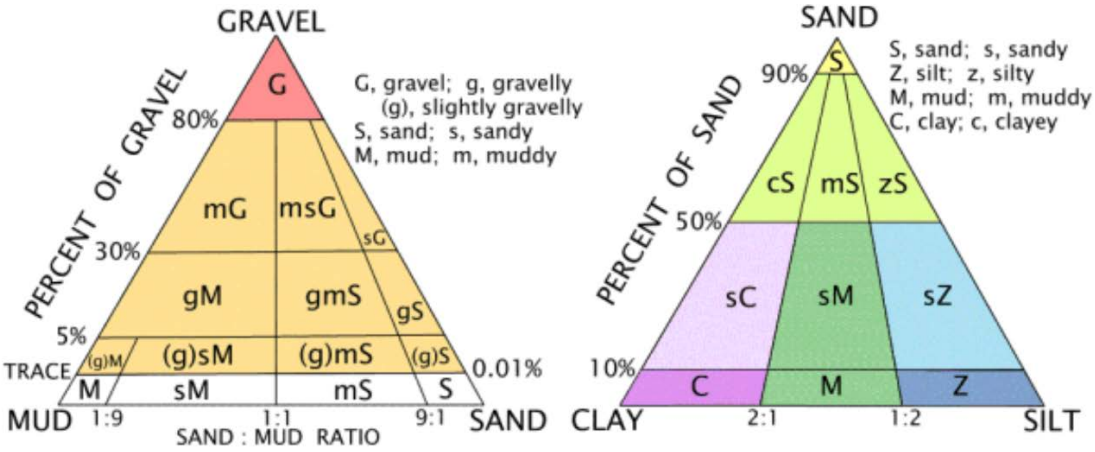


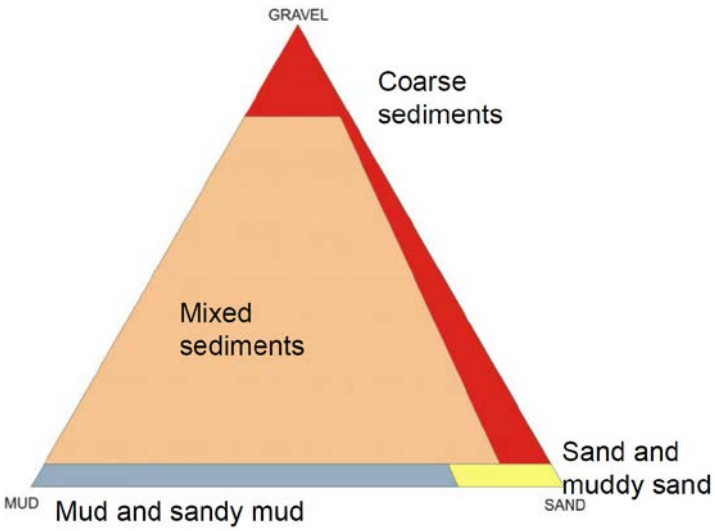
Figure A6-1. Conceptual Overview of Sediment Facies Map Development

Example A – Folk's Classification System



Source: U.S. Geological Survey Open-File Report 03-001, https://pubs.usgs.gov/of/2003/of03-001/htmldocs/nomenclature.htm

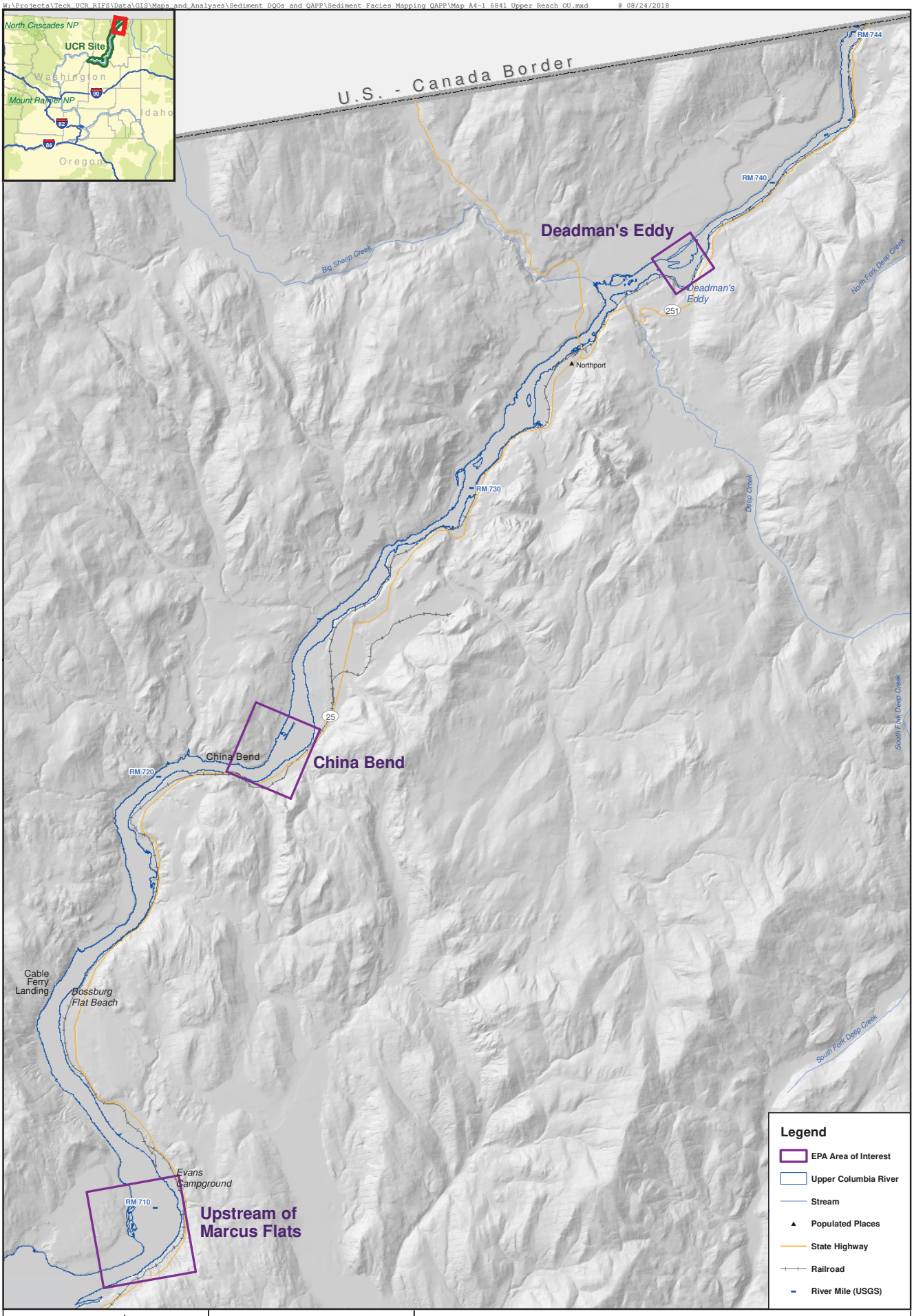
Example B – Simplified (Modified Folk) Classification System



Source: Long (2006)

Figure A6-2. Example Sediment Texture Classification Systems

MAPS



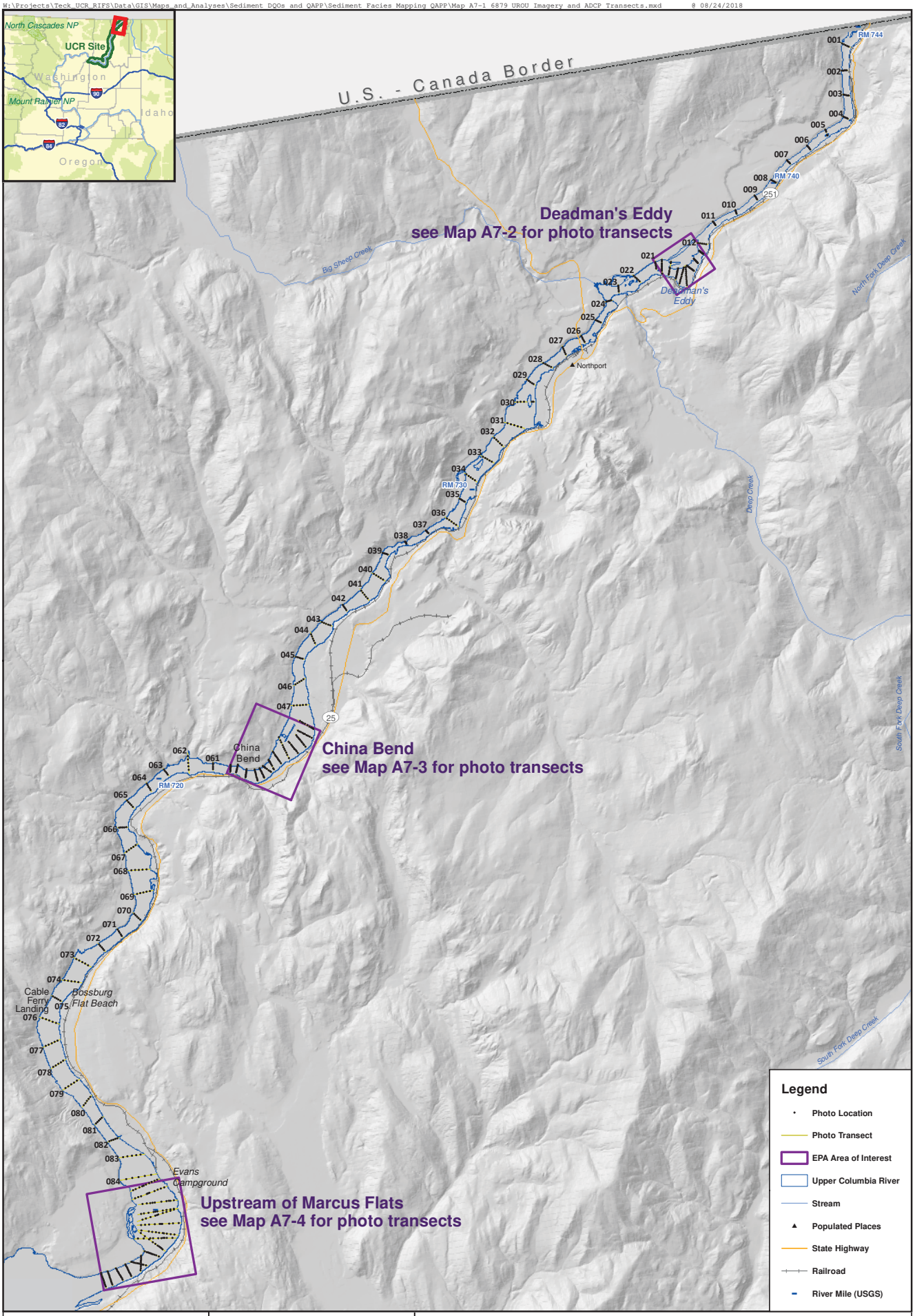
Windward environmental LLC

0 2 4 Km

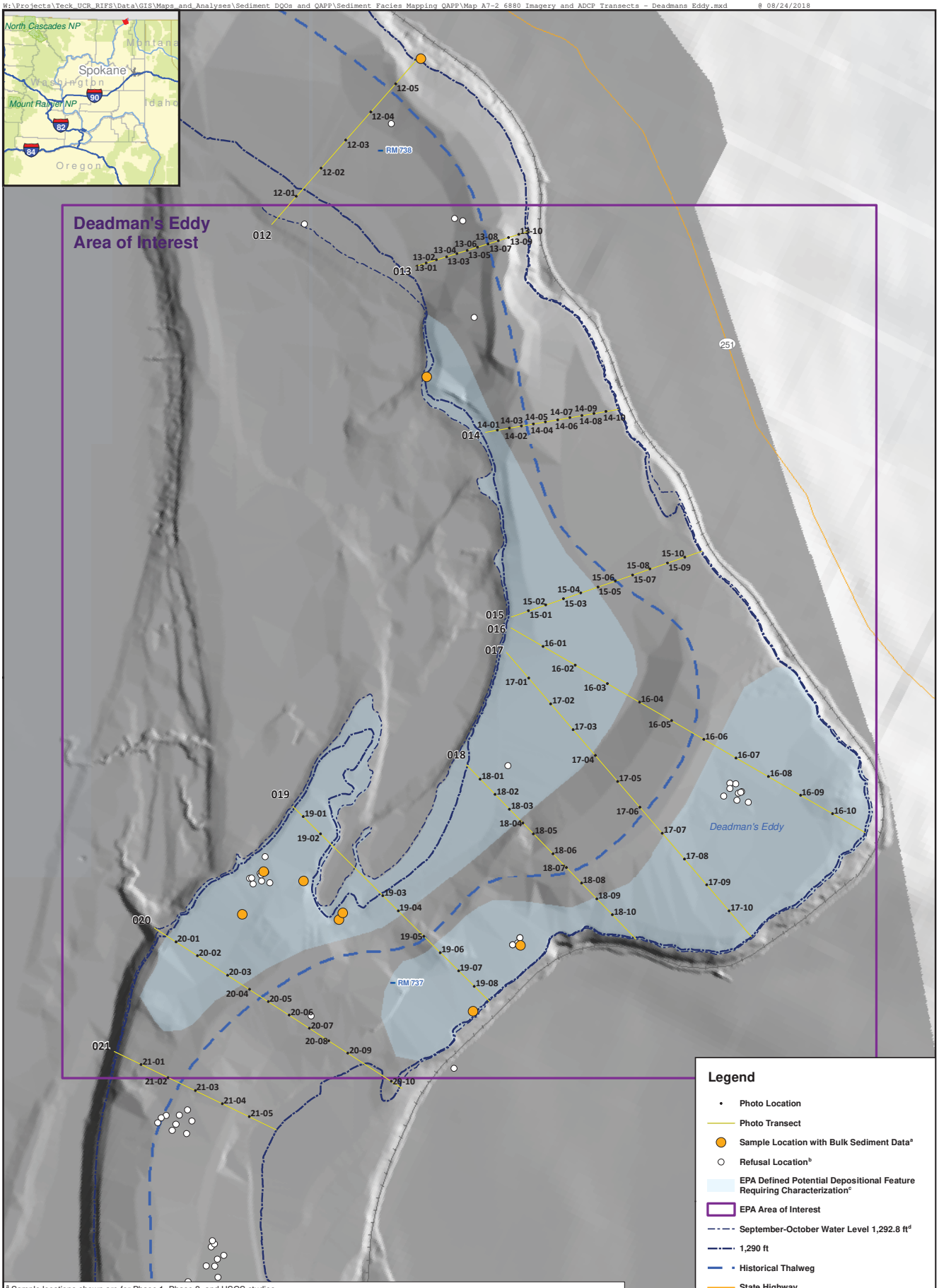
0 1 2 Miles

N

Map A4-1. **Upper Reach Operable Unit and Phase 3 Sediment Areas of Interest**
Upper Columbia River, WA



Map A7-1. **Upper Reach Operable Unit Imagery and Acoustic Doppler Current Profiler Transects**
Upper Columbia River, WA



Legend

- Photo Location
- Photo Transect
- Sample Location with Bulk Sediment Data[a]
- Refusal Location[b]
- EPA Defined Potential Depositional Feature Requiring Characterization[c]
- EPA Area of Interest
- September-October Water Level 1,292.8 ft[d]
- 1,290 ft
- Historical Thalweg
- State Highway
- Railroad
- River Mile (USGS)

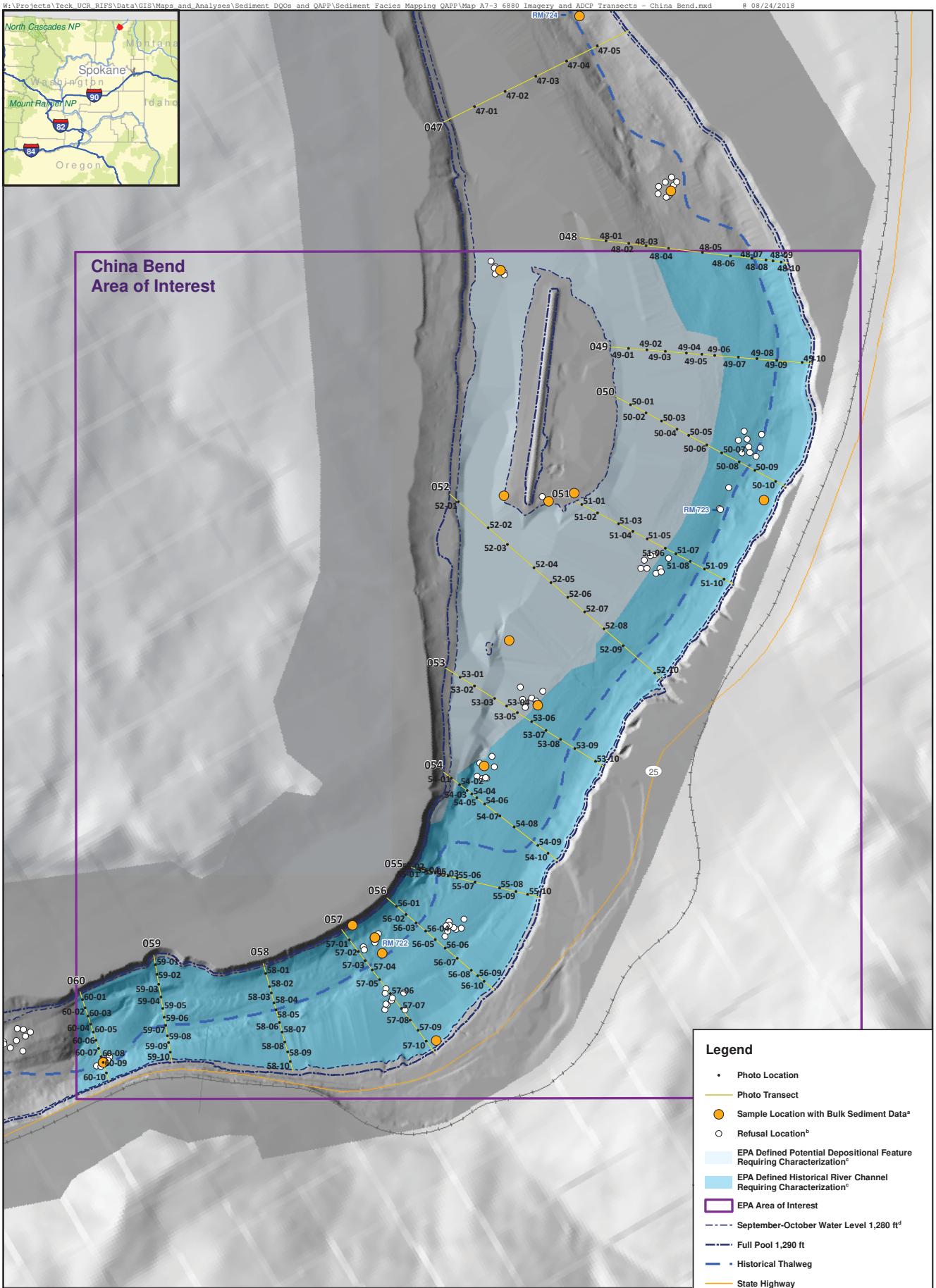
[a] Sample locations shown are for Phase 1, Phase 2, and USGS studies.
[b] Refusal locations shown are for Phase 1, Phase 2, and beach studies.
[c] Source: Level of Effort for Nature and Extent of Sediment Contamination in Upper Reach Operable Unit (USEPA 2018a).
[d] 1,292.8 ft represents the approximate water level during the anticipated sampling period (September-October). This elevation is based upon 2016 benthic macroinvertebrate tissue study (Windward 2018).
Bathymetry hillshade source: Franklin D. Roosevelt Lake – Grand Coulee Dam 2010-11 Survey, U.S. Department of the Interior Bureau of Reclamation, June 2012.

Windward environmental LLC

0 0.1 0.2 Km
0 0.05 0.1 Miles

Map A7-2. **Imagery and Acoustic Doppler Current Profiler Transects in Deadman's Eddy Area of Interest**

Upper Columbia River, WA

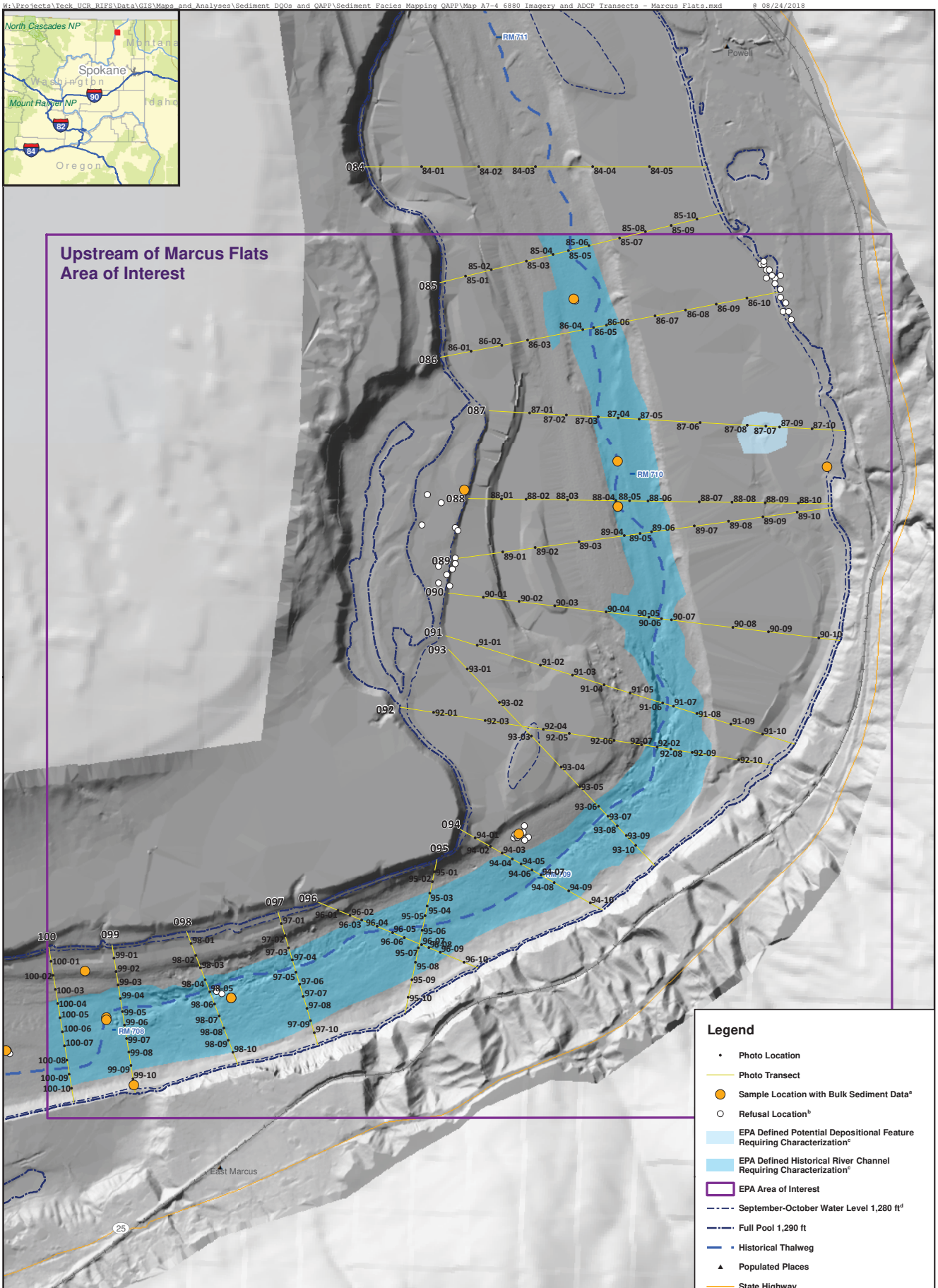


[a] Sample locations shown are for Phase 1, Phase 2, and USGS studies.
[b] Refusal locations shown are for Phase 1, Phase 2, and beach studies.
[c] Source: Level of Effort for Nature and Extent of Sediment Contamination in Upper Reach Operable Unit (USEPA 2018a).
[d] 1,280 ft represents the low water level during the anticipated sampling period (September-October). This elevation is based on Lake Roosevelt water elevations at the USGS gauge.
Bathymetry hillshade source: Franklin D. Roosevelt Lake – Grand Coulee Dam 2010-11 Survey, U.S. Department of the Interior Bureau of Reclamation, June 2012.

Windward environmental LLC

0 0.2 0.4 Km
0 0.1 0.2 Miles
N

Map A7-3. **Imagery and Acoustic Doppler Current Profiler Transects in China Bend Area of Interest**
Upper Columbia River, WA

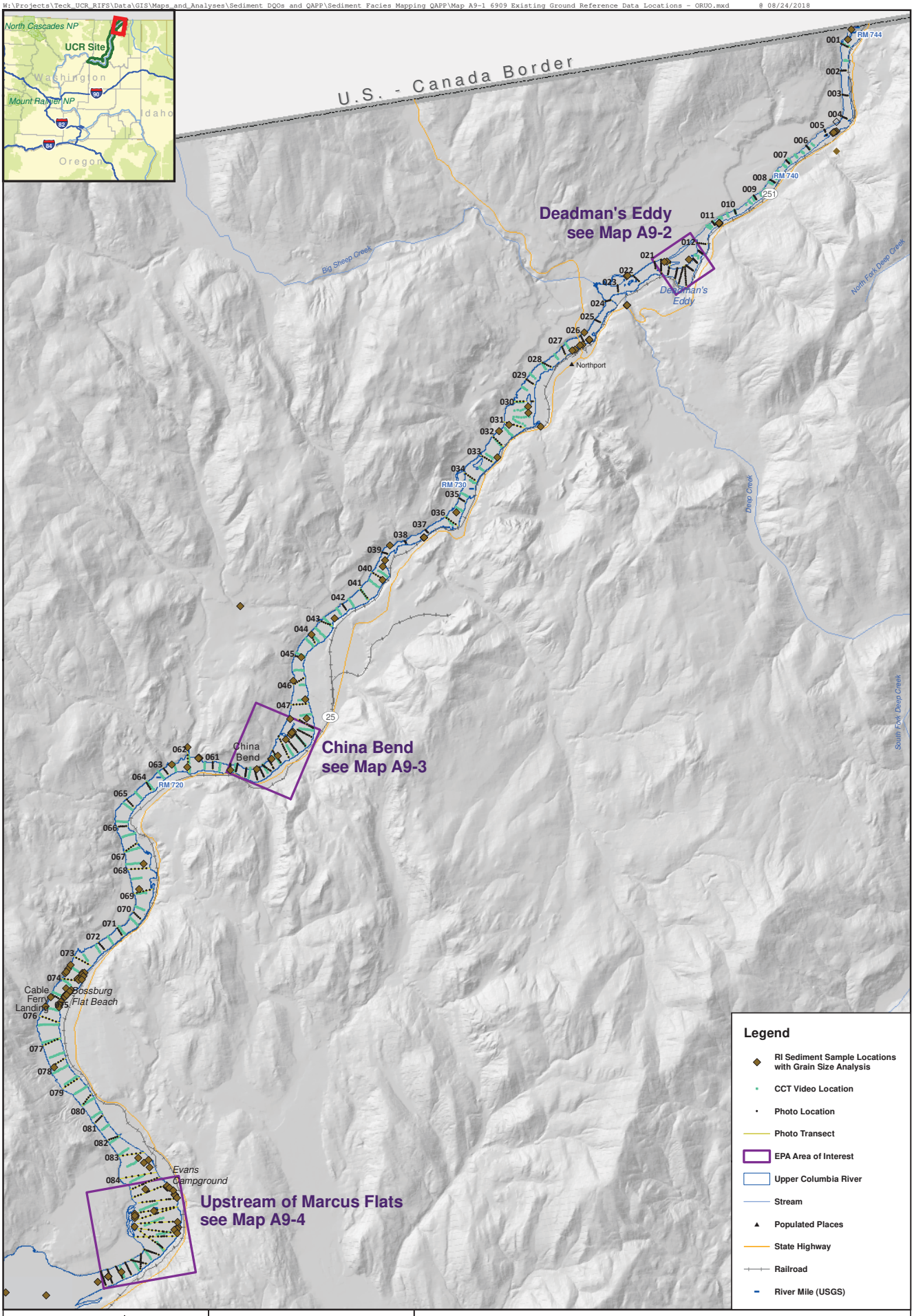


[a] Sample locations shown are for Phase 1, Phase 2, and USGS studies.
[b] Refusal locations shown are for Phase 1, Phase 2, and beach studies.
[c] Source: Level of Effort for Nature and Extent of Sediment Contamination in Upper Reach Operable Unit (USEPA 2018a).
[d] 1,280 ft represents the low water level during the anticipated sampling period (September-October). This elevation is based on Lake Roosevelt water elevations at the USGS gauge.
Bathymetry hillshade source: Franklin D. Roosevelt Lake – Grand Coulee Dam 2010-11 Survey, U.S. Department of the Interior Bureau of Reclamation, June 2012.

Windward environmental LLC

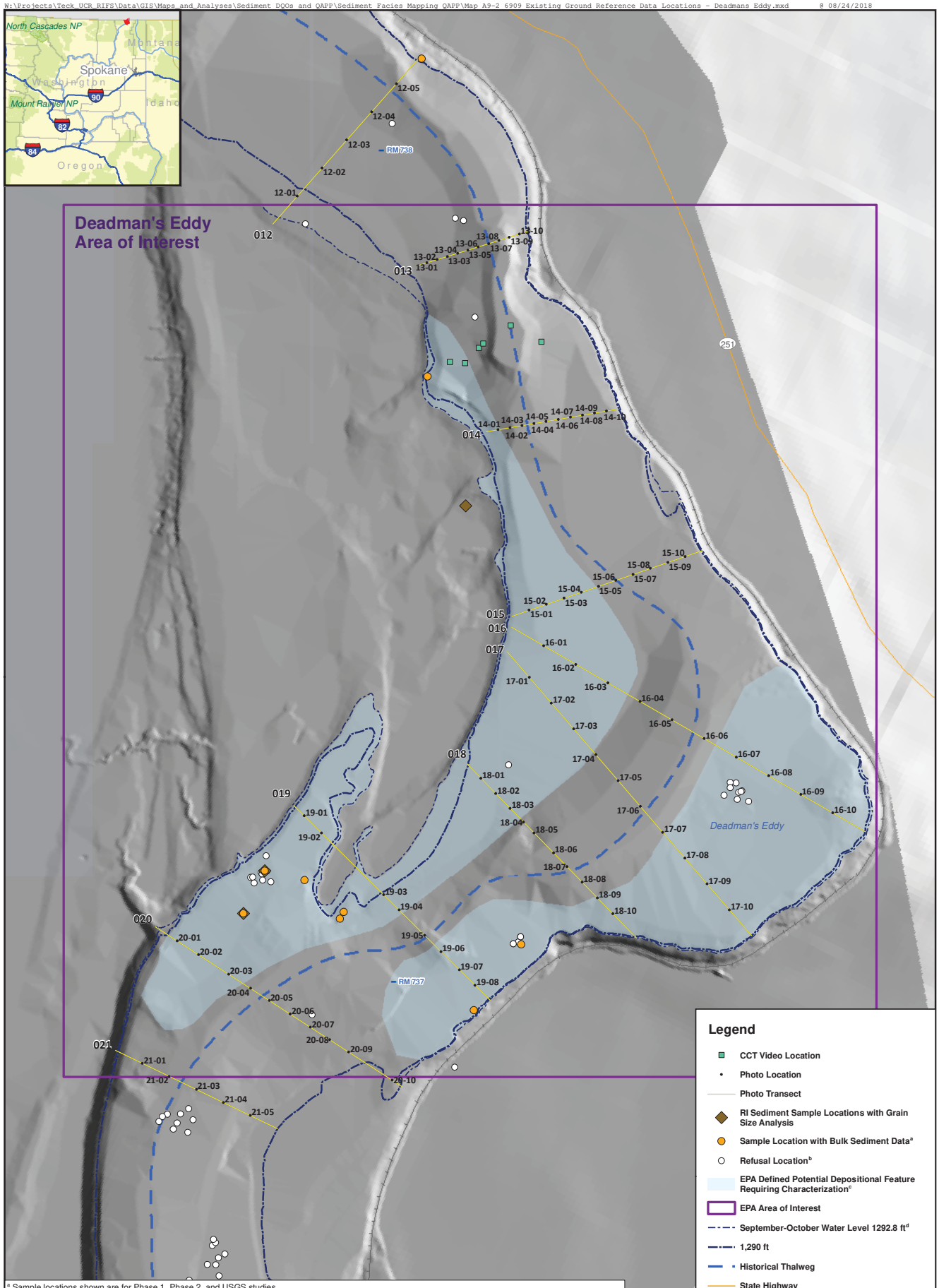
0 0.2 0.4 Km
0 0.1 0.2 Miles
N

Map A7-4. **Imagery and Acoustic Doppler Current Profiler Transects in Upstream of Marcus Flats Area of Interest**
Upper Columbia River, WA



Windward LLC environmental

Map A9-1. **Existing Ground Reference Data Locations in Upper Reach Operable Unit**
Upper Columbia River, WA



Legend

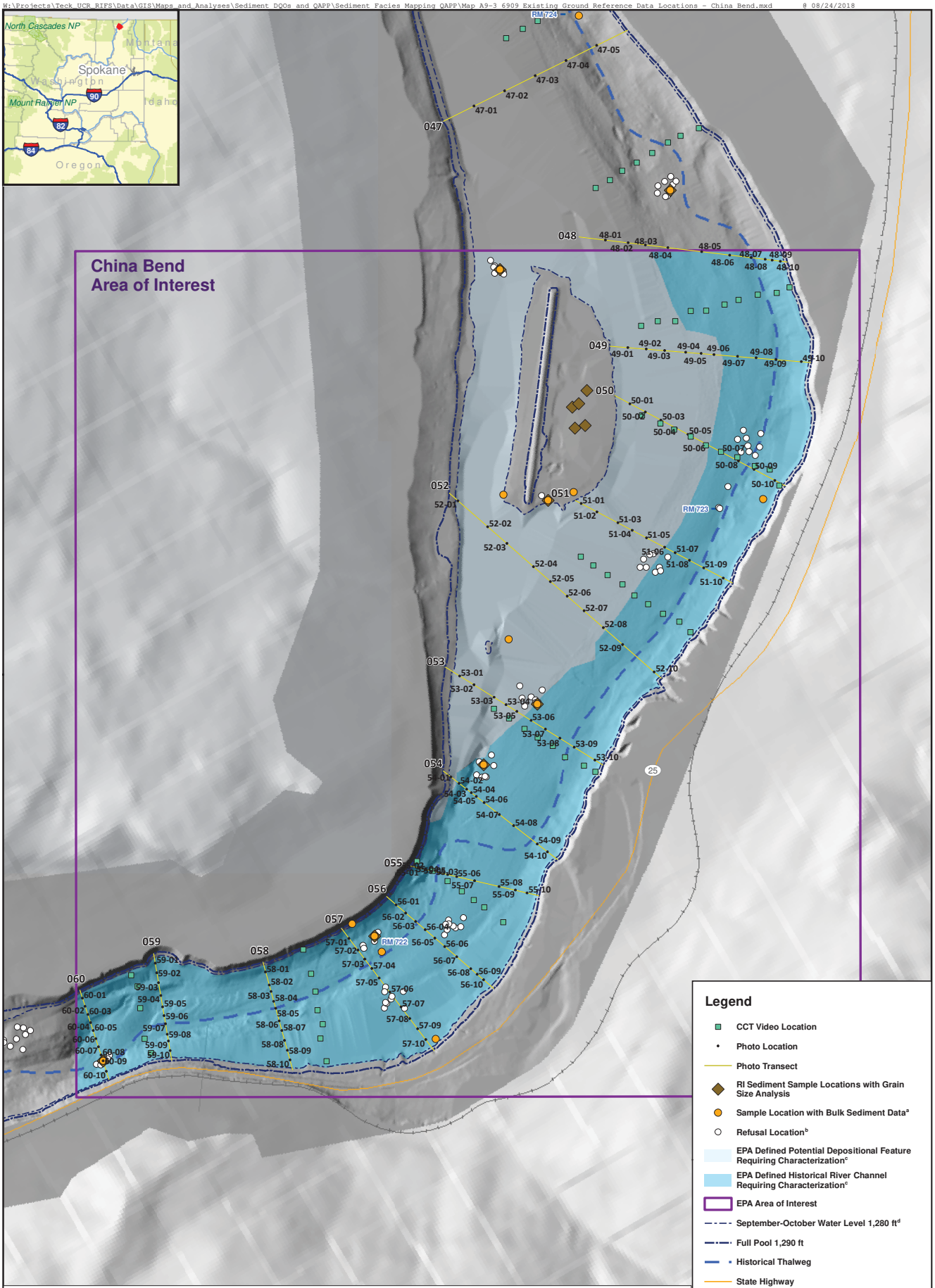
- CCT Video Location
- Photo Location
- Photo Transect
- RI Sediment Sample Locations with Grain Size Analysis
- Sample Location with Bulk Sediment Data[a]
- Refusal Location[b]
- EPA Defined Potential Depositional Feature Requiring Characterization[c]
- EPA Area of Interest
- September-October Water Level 1292.8 ft[d]
- 1,290 ft
- Historical Thalweg
- State Highway
- Railroad
- River Mile (USGS)

[a] Sample locations shown are for Phase 1, Phase 2, and USGS studies.
[b] Refusal locations shown are for Phase 1, Phase 2, and beach studies.
[c] Source: Level of Effort for Nature and Extent of Sediment Contamination in Upper Reach Operable Unit (USEPA 2018a).
[d] 1,292.8 ft represents the approximate water level during the anticipated sampling period (September-October). This elevation is based upon 2016 benthic macroinvertebrate tissue study (Windward 2018).
Bathymetry hillshade source: Franklin D. Roosevelt Lake – Grand Coulee Dam 2010-11 Survey, U.S. Department of the Interior Bureau of Reclamation, June 2012.

Windward environmental LLC

Km 0 0.1 0.2
Miles 0 0.05 0.1

Map A9-2. **Existing Ground Reference Data Locations in Deadman's Eddy Area of Interest**
Upper Columbia River, WA

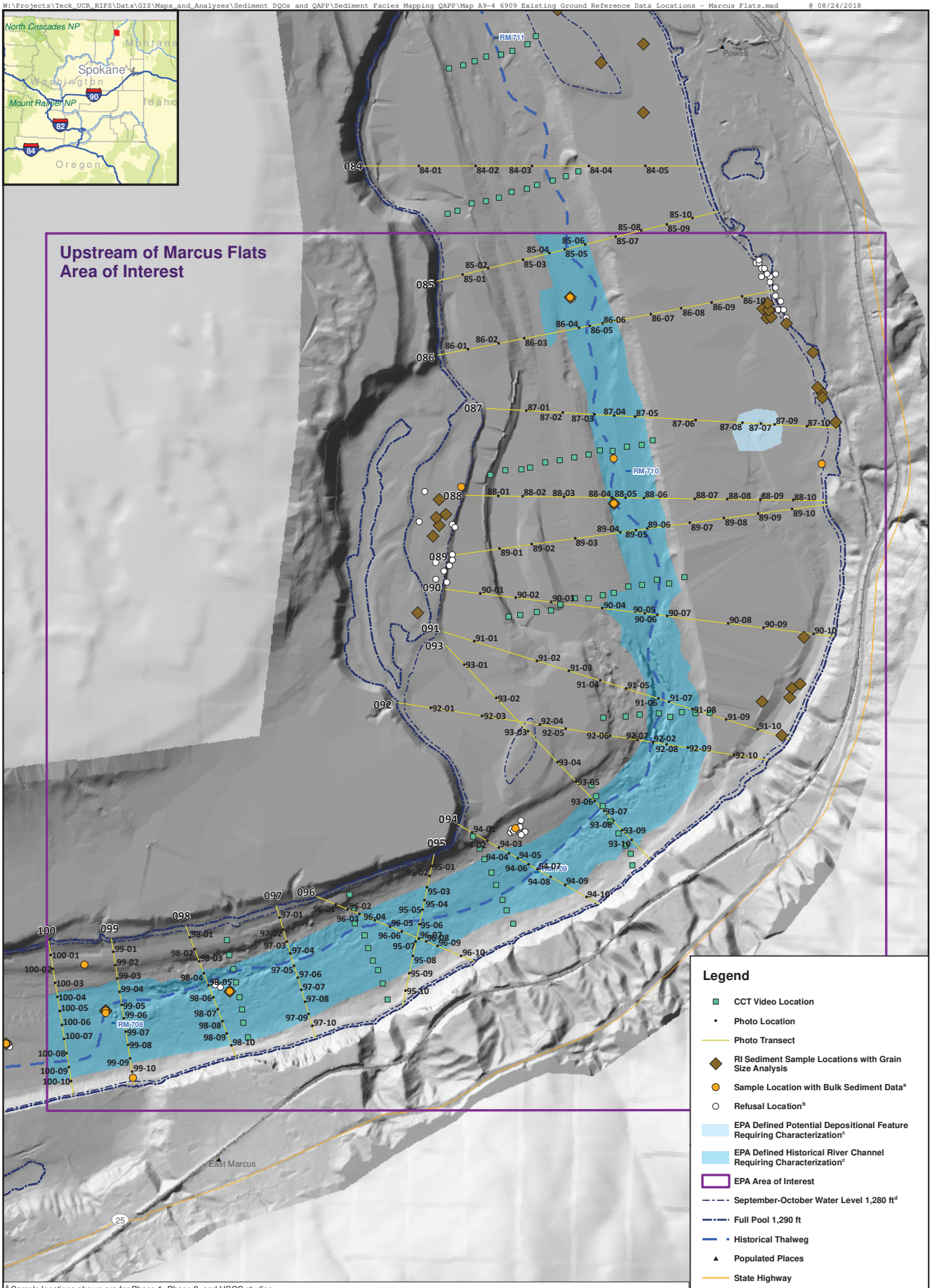


[a] Sample locations shown are for Phase 1, Phase 2, and USGS studies.
[b] Refusal locations shown are for Phase 1, Phase 2, and beach studies.
[c] Source: Level of Effort for Nature and Extent of Sediment Contamination in Upper Reach Operable Unit (USEPA 2018a).
[d] 1,280 ft represents the low water level during the anticipated sampling period (September-October). This elevation is based on Lake Roosevelt water elevations at the USGS gauge.
Bathymetry hillshade source: Franklin D. Roosevelt Lake – Grand Coulee Dam 2010-11 Survey, U.S. Department of the Interior Bureau of Reclamation, June 2012.

Windward environmental LLC

0 0.2 0.4 Km
0 0.1 0.2 Miles
N

Map A9-3. **Existing Ground Reference Data Locations in China Bend Area of Interest**
Upper Columbia River, WA



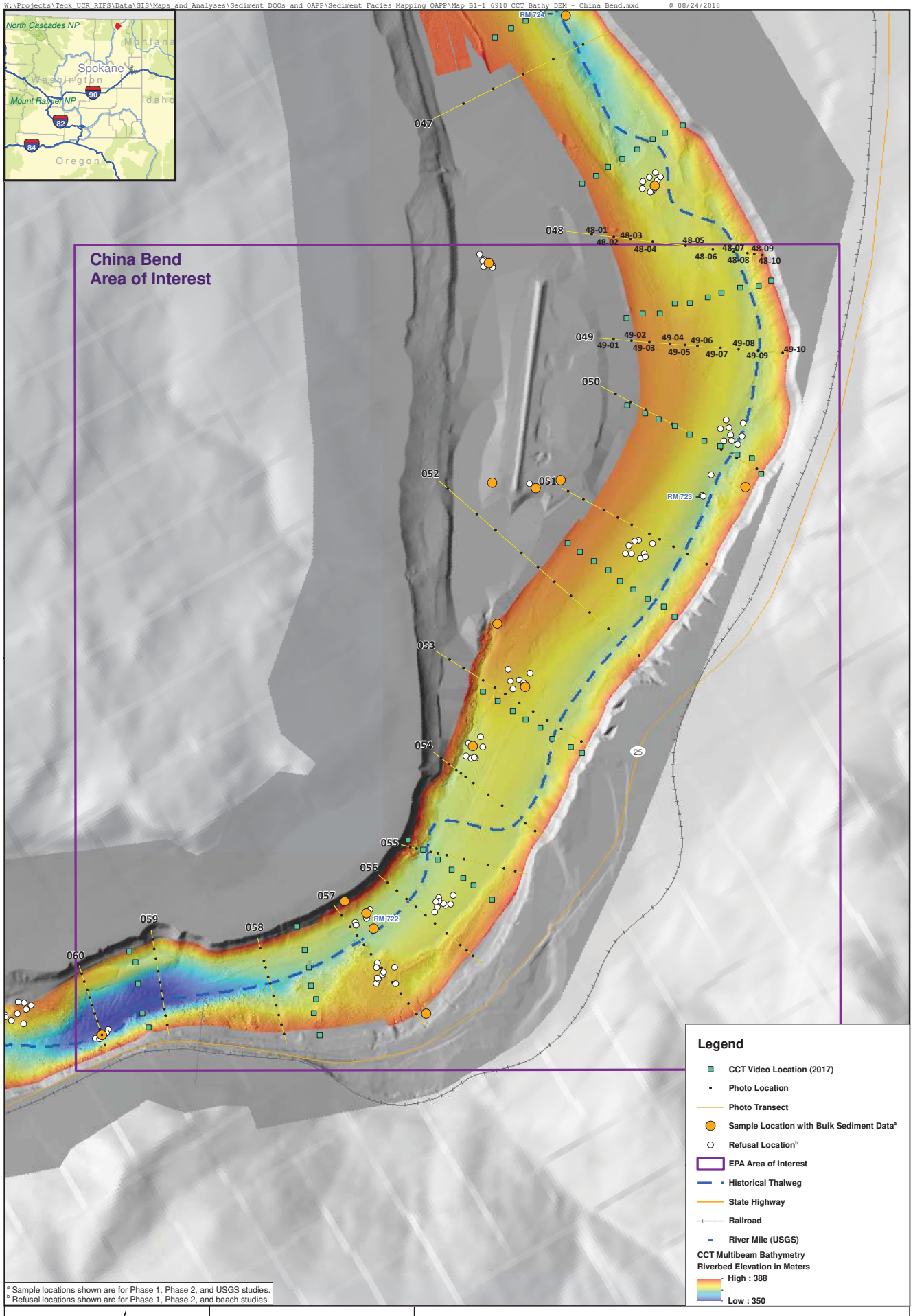
[a] Sample locations shown are for Phase 1, Phase 2, and USGS studies.
[b] Refusal locations shown are for Phase 1, Phase 2, and beach studies.
[c] Source: Level of Effort for Nature and Extent of Sediment Contamination in Upper Reach Operable Unit (USEPA 2018a).
[d] 1,280 ft represents the low water level during the anticipated sampling period (September-October). This elevation is based on Lake Roosevelt water elevations at the USGS gauge.
Bathymetry hillshade source: Franklin D. Roosevelt Lake – Grand Coulee Dam 2010-11 Survey, U.S. Department of the Interior Bureau of Reclamation, June 2012.

Windward environmental LLC

Km 0 0.2 0.4
Miles 0 0.1 0.2
N

Map A9-4. **Existing Ground Reference Data Locations in Upstream of Marcus Flats Area of Interest**
Upper Columbia River, WA

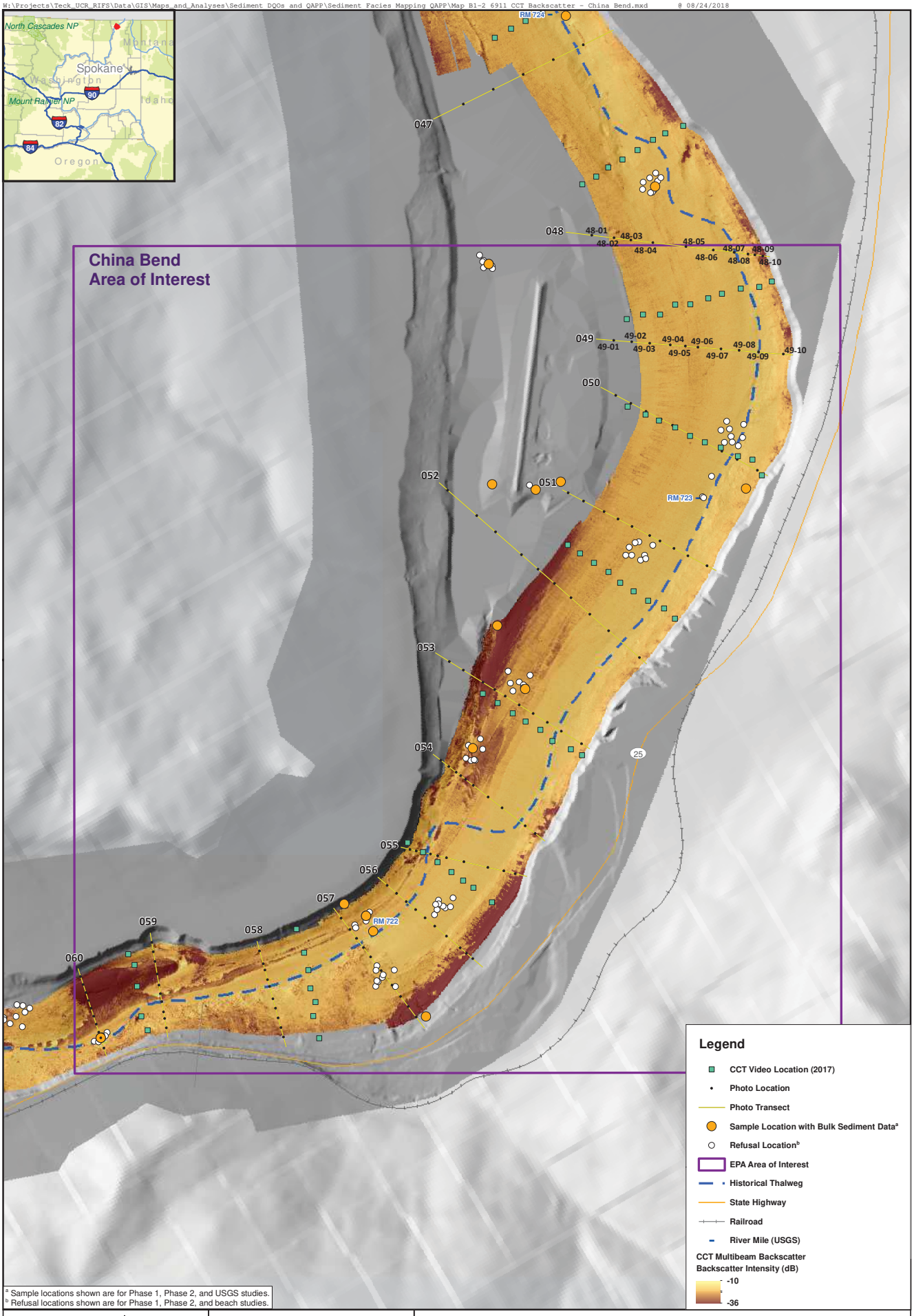
W:\Projects\Teck_UCR_RIFS\Data\GIS\Maps_and_Analyses\Sediment DQOs and QAPP\Sediment Facies Mapping QAPP\Map B1-1 6910 CCT Bathy DEM - China Bend.mxd @ 08/24/2018



Map B1-1. **Bathymetry Digital Elevation Model from Confederated Tribes of Colville Reservation Study 2015 – 2017 in China Bend Area of Interest**

Upper Columbia River, WA

W:\Projects\Teck_UCR_RIFS\Data\GIS\Maps_and_Analyses\Sediment DQOs and QAPP\Sediment Facies Mapping QAPP\Map B1-2 6911 CCT Backscatter - China Bend.mxd @ 08/24/2018

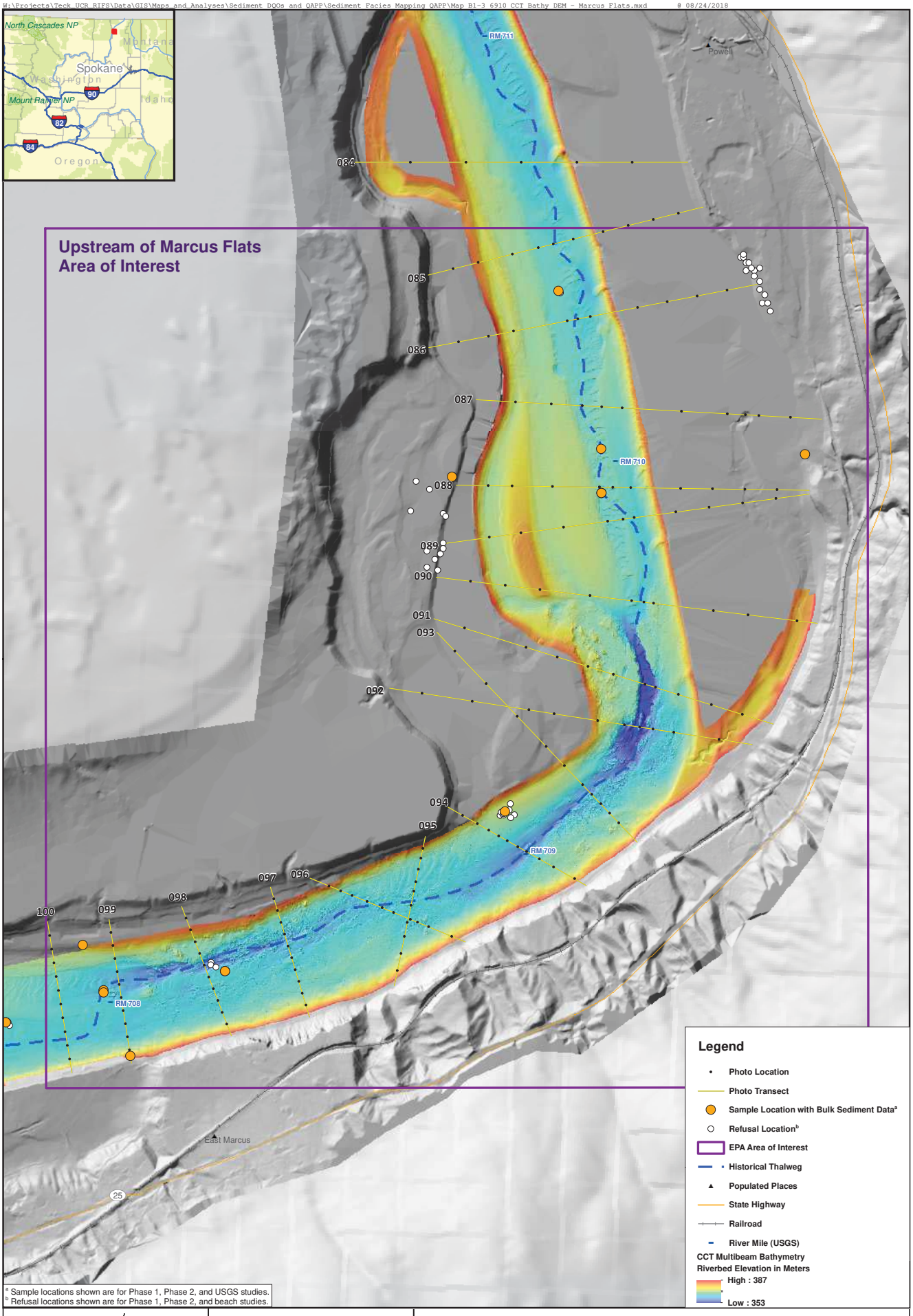


[a] Sample locations shown are for Phase 1, Phase 2, and USGS studies.
[b] Refusal locations shown are for Phase 1, Phase 2, and beach studies.

Windward environmental LLC

0 0.2 0.4 Km
0 0.1 0.2 Miles
N

Map B1-2. **Acoustic Backscatter Mosaic from Confederated Tribes of Colville Reservation Study 2015 – 2017 in China Bend Area of Interest**
Upper Columbia River, WA



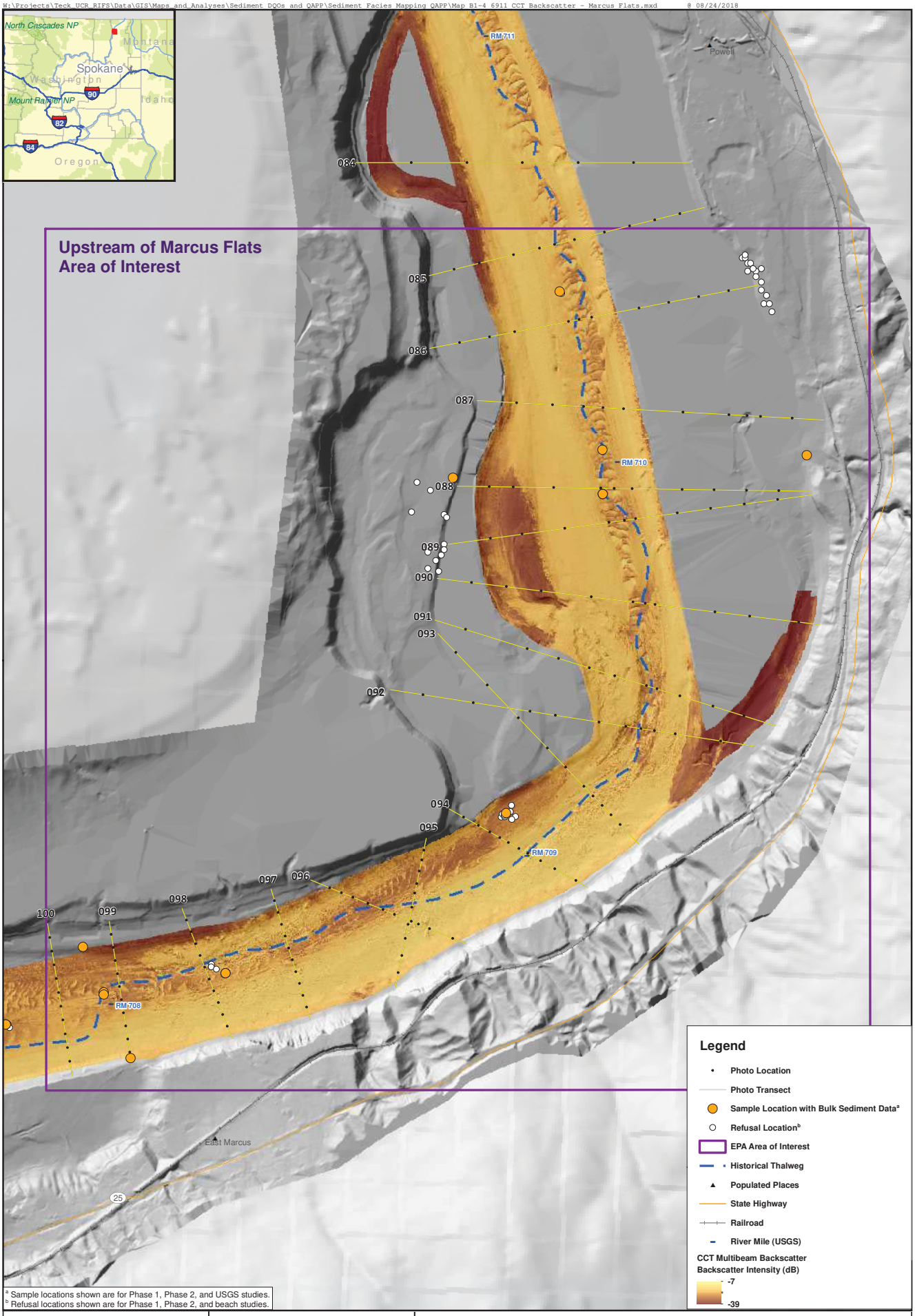
[a] Sample locations shown are for Phase 1, Phase 2, and USGS studies.
[b] Refusal locations shown are for Phase 1, Phase 2, and beach studies.

Windward environmental LLC

0 0.2 0.4 Km
0 0.1 0.2 Miles

N

Map B1-3. **Bathymetry Digital Elevation Model from Confederated Tribes of Colville Reservation Study 2015 – 2017 in Upstream of Marcus Flats Area of Interest**
Upper Columbia River, WA



[a] Sample locations shown are for Phase 1, Phase 2, and USGS studies.
[b] Refusal locations shown are for Phase 1, Phase 2, and beach studies.

Windward environmental LLC

0 0.2 0.4 Km
0 0.1 0.2 Miles

N

Map B1-4. **Acoustic Backscatter Mosaic from Confederated Tribes of Colville Reservation Study 2015 – 2017 in Upstream of Marcus Flats Area of Interest**
Upper Columbia River, WA

TABLES

Table A4-1. Technical Team Task Member Information

Name	Task Role	Phone	Email
Teck American Incorporated			
Kris McCaig	TAI Project Coordinator	(509) 623-4501	Kris.McCaig@teck.com
Denise Mills	TAI Assistant Project Coordinator	(509) 623-4515	Denise.Mills@teck.com
Cristy Kessel	Acoustic and Underwater Imagery Subcontractor Coordinator	(509) 496-1160	Cristy.Kessel@teck.com
U.S. Environmental Protection Agency			
Kathryn Cerise	EPA Project Manager	(206) 553-2589	Cerise.Kathryn@epa.gov
Donald Brown	EPA Region 10 QA Manager	(206) 553-0717	Brown.DonaldM@epa.gov
Consultant Team			
Jennifer Holder	Principal Investigator	(805) 684-2801	jennifer.holder@erm.com
Jon Dasler	Senior Technical Advisor	(360) 314-3200	Jld@deainc.com
Tim McClinton	Task Manager	(843) 883-7425	TMcClinton@deainc.com
Victoria Price-Doucet	Task Manager	(360) 314-3203	Victoria.Price@deainc.com
TBD	Field Supervisor		
Randy O'Boyle	Database Administrator	(425) 519-8727	roboyle@exponent.com
Acoustic and Underwater Imagery Subcontractor(s)			
TBD	Acoustic and Underwater Imagery Subcontractor Project Manager		
TBD	Acoustic and Underwater Imagery Subcontractor QA Manager		

Table A7-1. Underwater Imagery and Acoustic Doppler Current Profiler Measurement Locations

Transect No.	Station No.	Station ID	WA StatePlane N X (ft)	WA StatePlane N Y (ft)	UTM 11N X (m)	UTM 11N Y (m)	River Segment	Map No.	Approximate River Mile
1	1	001-01	2406994	743988	453210	5427193	Upstream of DME	A7-1	744.5
1	2	001-02	2407157	743878	453258	5427157	Upstream of DME	A7-1	744.5
1	3	001-03	2407320	743768	453306	5427121	Upstream of DME	A7-1	744.5
1	4	001-04	2407483	743658	453354	5427085	Upstream of DME	A7-1	744.5
1	5	001-05	2407646	743548	453402	5427049	Upstream of DME	A7-1	744.4
2	1	002-01	2406601	741115	453047	5426324	Upstream of DME	A7-1	743.9
2	2	002-02	2406727	741102	453085	5426319	Upstream of DME	A7-1	743.9
2	3	002-03	2406854	741090	453123	5426313	Upstream of DME	A7-1	743.9
2	4	002-04	2406981	741077	453162	5426307	Upstream of DME	A7-1	743.9
2	5	002-05	2407108	741065	453200	5426301	Upstream of DME	A7-1	743.9
3	1	003-01	2406439	738536	452958	5425542	Upstream of DME	A7-1	743.5
3	2	003-02	2406574	738493	452999	5425527	Upstream of DME	A7-1	743.4
3	3	003-03	2406709	738451	453039	5425512	Upstream of DME	A7-1	743.4
3	4	003-04	2406844	738409	453079	5425497	Upstream of DME	A7-1	743.4
3	5	003-05	2406978	738367	453120	5425482	Upstream of DME	A7-1	743.4
4	1	004-01	2406130	736194	452829	5424834	Upstream of DME	A7-1	743.0
4	2	004-02	2406240	736129	452861	5424813	Upstream of DME	A7-1	743.0
4	3	004-03	2406350	736063	452893	5424791	Upstream of DME	A7-1	743.0
4	4	004-04	2406460	735998	452926	5424769	Upstream of DME	A7-1	743.0
4	5	004-05	2406570	735933	452958	5424748	Upstream of DME	A7-1	743.0
5	1	005-01	2404053	735061	452179	5424521	Upstream of DME	A7-1	742.5
5	2	005-02	2404076	734945	452185	5424485	Upstream of DME	A7-1	742.5
5	3	005-03	2404100	734829	452190	5424450	Upstream of DME	A7-1	742.5
5	4	005-04	2404172	734470	452207	5424339	Upstream of DME	A7-1	742.4
5	5	005-05	2404184	734408	452209	5424320	Upstream of DME	A7-1	742.4
6	1	006-01	2401893	733587	451500	5424105	Upstream of DME	A7-1	742.0
6	2	006-02	2401963	733483	451519	5424073	Upstream of DME	A7-1	742.0
6	3	006-03	2402033	733379	451539	5424040	Upstream of DME	A7-1	742.0
6	4	006-04	2402102	733276	451559	5424007	Upstream of DME	A7-1	742.0
6	5	006-05	2402172	733172	451578	5423975	Upstream of DME	A7-1	742.0
7	1	007-01	2399564	732316	450772	5423754	Upstream of DME	A7-1	741.5
7	2	007-02	2399632	732220	450791	5423724	Upstream of DME	A7-1	741.5
7	3	007-03	2399699	732124	450810	5423693	Upstream of DME	A7-1	741.5
7	4	007-04	2399767	732028	450829	5423663	Upstream of DME	A7-1	741.5
7	5	007-05	2399835	731932	450848	5423633	Upstream of DME	A7-1	741.5
8	1	008-01	2397615	730444	450150	5423214	Upstream of DME	A7-1	741.0
8	2	008-02	2397727	730360	450183	5423187	Upstream of DME	A7-1	741.0
8	3	008-03	2397838	730276	450215	5423159	Upstream of DME	A7-1	741.0
8	4	008-04	2397949	730191	450248	5423132	Upstream of DME	A7-1	741.0
8	5	008-05	2398061	730107	450281	5423105	Upstream of DME	A7-1	741.0
9	1	009-01	2395655	728986	449531	5422800	Upstream of DME	A7-1	740.5
9	2	009-02	2395707	728879	449546	5422767	Upstream of DME	A7-1	740.5
9	3	009-03	2395758	728771	449560	5422733	Upstream of DME	A7-1	740.5
9	4	009-04	2395810	728663	449574	5422699	Upstream of DME	A7-1	740.5
9	5	009-05	2395862	728555	449588	5422666	Upstream of DME	A7-1	740.5
10	1	010-01	2393403	727704	448827	5422444	Upstream of DME	A7-1	740.0
10	2	010-02	2393424	727607	448832	5422415	Upstream of DME	A7-1	740.0
10	3	010-03	2393446	727511	448837	5422385	Upstream of DME	A7-1	740.0
10	4	010-04	2393468	727415	448842	5422355	Upstream of DME	A7-1	740.0
10	5	010-05	2393489	727319	448847	5422326	Upstream of DME	A7-1	740.0
11	1	011-01	2390909	726774	448054	5422199	Upstream of DME	A7-1	739.5
11	2	011-02	2390964	726674	448069	5422168	Upstream of DME	A7-1	739.5
11	3	011-03	2391019	726574	448084	5422137	Upstream of DME	A7-1	739.5
11	4	011-04	2391075	726474	448100	5422105	Upstream of DME	A7-1	739.5
11	5	011-05	2391130	726374	448115	5422074	Upstream of DME	A7-1	739.5
12	1	012-01	2389050	724698	447457	5421596	Upstream of DME	A7-1	739.0
12	2	012-02	2389257	724645	447519	5421576	Upstream of DME	A7-1	739.0
12	3	012-03	2389464	724591	447581	5421557	Upstream of DME	A7-1	739.0
12	4	012-04	2389670	724538	447643	5421538	Upstream of DME	A7-1	739.0
12	5	012-05	2389877	724485	447705	5421518	Upstream of DME	A7-1	739.0
13	1	013-01	2389044	723868	447442	5421343	DME	A7-2	738.8
13	2	013-02	2389087	723824	447454	5421329	DME	A7-2	738.8
13	3	013-03	2389129	723780	447467	5421315	DME	A7-2	738.8
13	4	013-04	2389172	723736	447479	5421301	DME	A7-2	738.8
13	5	013-05	2389215	723692	447491	5421287	DME	A7-2	738.8
13	6	013-06	2389258	723648	447504	5421273	DME	A7-2	738.8
13	7	013-07	2389300	723604	447516	5421259	DME	A7-2	738.8
13	8	013-08	2389343	723560	447528	5421245	DME	A7-2	738.8
13	9	013-09	2389386	723516	447541	5421231	DME	A7-2	738.8
13	10	013-10	2389429	723472	447553	5421217	DME	A7-2	738.8
14	1	014-01	2388378	723077	447227	5421113	DME	A7-2	738.6
14	2	014-02	2388420	723021	447239	5421095	DME	A7-2	738.6
14	3	014-03	2388461	722965	447251	5421077	DME	A7-2	738.6
14	4	014-04	2388503	722909	447263	5421060	DME	A7-2	738.6
14	5	014-05	2388544	722853	447275	5421042	DME	A7-2	738.6
14	6	014-06	2388586	722797	447286	5421024	DME	A7-2	738.6
14	7	014-07	2388628	722742	447298	5421007	DME	A7-2	738.6
14	8	014-08	2388669	722686	447310	5420989	DME	A7-2	738.6
14	9	014-09	2388711	722630	447322	5420972	DME	A7-2	738.6
14	10	014-10	2388753	722574	447334	5420954	DME	A7-2	738.6
15	1	015-01	2387541	722453	446963	5420936	DME	A7-2	738.5
15	2	015-02	2387616	722381	446985	5420912	DME	A7-2	738.5
15	3	015-03	2387690	722308	447006	5420889	DME	A7-2	738.5
15	4	015-04	2387765	722236	447028	5420866	DME	A7-2	738.5
15	5	015-05	2387840	722163	447050	5420843	DME	A7-2	738.5
15	6	015-06	2387915	722090	447072	5420819	DME	A7-2	738.5
15	7	015-07	2387990	722018	447093	5420796	DME	A7-2	738.5
15	8	015-08	2388065	721945	447115	5420773	DME	A7-2	738.5
15	9	015-09	2388140	721872	447137	5420750	DME	A7-2	738.5
15	10	015-10	2388215	721800	447158	5420726	DME	A7-2	738.5

Table A7-1. Underwater Imagery and Acoustic Doppler Current Profiler Measurement Locations

Transect No.	Station No.	Station ID	WA StatePlane N X (ft)	WA StatePlane N Y (ft)	UTM 11N X (m)	UTM 11N Y (m)	River Segment	Map No.	Approximate River Mile
16	1	016-01	2387397	722288	446917	5420888	DME	A7-2	738.4
16	2	016-02	2387385	722077	446910	5420824	DME	A7-2	738.4
16	3	016-03	2387373	721866	446903	5420760	DME	A7-2	738.4
16	4	016-04	2387361	721655	446896	5420695	DME	A7-2	738.3
16	5	016-05	2387349	721444	446889	5420631	DME	A7-2	738.3
16	6	016-06	2387337	721233	446882	5420567	DME	A7-2	738.3
16	7	016-07	2387325	721021	446876	5420503	DME	A7-2	738.3
16	8	016-08	2387313	720810	446869	5420439	DME	A7-2	738.3
16	9	016-09	2387301	720599	446862	5420375	DME	A7-2	738.3
16	10	016-10	2387289	720388	446855	5420311	DME	A7-2	738.3
17	1	017-01	2387199	722280	446856	5420888	DME	A7-2	738.4
17	2	017-02	2387124	722100	446831	5420835	DME	A7-2	738.3
17	3	017-03	2387050	721921	446806	5420781	DME	A7-2	738.3
17	4	017-04	2386976	721741	446780	5420728	DME	A7-2	738.3
17	5	017-05	2386901	721562	446755	5420674	DME	A7-2	738.3
17	6	017-06	2386827	721382	446730	5420621	DME	A7-2	738.2
17	7	017-07	2386753	721203	446704	5420567	DME	A7-2	738.2
17	8	017-08	2386678	721023	446679	5420514	DME	A7-2	738.2
17	9	017-09	2386604	720844	446654	5420460	DME	A7-2	738.2
17	10	017-10	2386530	720664	446628	5420407	DME	A7-2	738.2
18	1	018-01	2386560	722266	446662	5420893	DME	A7-2	738.1
18	2	018-02	2386520	722150	446648	5420859	DME	A7-2	738.1
18	3	018-03	2386482	722039	446635	5420826	DME	A7-2	738.1
18	4	018-04	2386447	721936	446622	5420795	DME	A7-2	738.1
18	5	018-05	2386419	721854	446613	5420770	DME	A7-2	738.2
18	6	018-06	2386367	721703	446595	5420725	DME	A7-2	738.2
18	7	018-07	2386332	721601	446582	5420694	DME	A7-2	738.2
18	8	018-08	2386292	721484	446568	5420660	DME	A7-2	738.2
18	9	018-09	2386251	721366	446554	5420624	DME	A7-2	738.2
18	10	018-10	2386210	721245	446540	5420588	DME	A7-2	738.2
19	1	019-01	2385915	723067	446478	5421147	DME	A7-2	738.0
19	2	019-02	2385871	722933	446462	5421107	DME	A7-2	738.0
19	3	019-03	2385718	722460	446409	5420965	DME	A7-2	738.0
19	4	019-04	2385680	722342	446395	5420930	DME	A7-2	738.0
19	5	019-05	2385616	722146	446373	5420871	DME	A7-2	738.0
19	6	019-06	2385576	722021	446359	5420834	DME	A7-2	738.0
19	7	019-07	2385530	721882	446343	5420792	DME	A7-2	738.0
19	8	019-08	2385492	721763	446329	5420757	DME	A7-2	738.0
20	1	020-01	2384952	723390	446190	5421260	DME	A7-2	737.8
20	2	020-02	2384936	723245	446183	5421216	DME	A7-2	737.8
20	3	020-03	2384914	723041	446173	5421154	DME	A7-2	737.8
20	4	020-04	2384898	722894	446166	5421110	DME	A7-2	737.8
20	5	020-05	2384885	722767	446160	5421072	DME	A7-2	737.8
20	6	020-06	2384870	722627	446153	5421029	DME	A7-2	737.8
20	7	020-07	2384855	722490	446146	5420988	DME	A7-2	737.9
20	8	020-08	2384841	722360	446140	5420948	DME	A7-2	737.9
20	9	020-09	2384827	722231	446134	5420909	DME	A7-2	737.9
20	10	020-10	2384795	721939	446120	5420821	DME	A7-2	737.9
21	1	021-01	2384239	723250	445970	5421228	Between DME and CB	A7-1	737.7
21	2	021-02	2384242	723079	445969	5421176	Between DME and CB	A7-1	737.7
21	3	021-03	2384245	722909	445967	5421124	Between DME and CB	A7-1	737.7
21	4	021-04	2384248	722738	445965	5421072	Between DME and CB	A7-1	737.7
21	5	021-05	2384251	722567	445964	5421020	Between DME and CB	A7-1	737.8
22	1	022-01	2381769	722060	445201	5420904	Between DME and CB	A7-1	737.3
22	2	022-02	2381901	721901	445239	5420853	Between DME and CB	A7-1	737.3
22	3	022-03	2382033	721742	445276	5420803	Between DME and CB	A7-1	737.3
22	4	022-04	2382165	721583	445314	5420753	Between DME and CB	A7-1	737.3
22	5	022-05	2382298	721424	445352	5420702	Between DME and CB	A7-1	737.3
23	1	023-01	2379990	721241	444647	5420681	Between DME and CB	A7-1	736.9
23	2	023-02	2379985	721081	444643	5420633	Between DME and CB	A7-1	736.9
23	3	023-03	2379979	720921	444639	5420584	Between DME and CB	A7-1	736.9
23	4	023-04	2379973	720761	444634	5420536	Between DME and CB	A7-1	736.9
23	5	023-05	2379967	720601	444630	5420487	Between DME and CB	A7-1	736.9
24	1	024-01	2378510	719707	444173	5420237	Between DME and CB	A7-1	736.3
24	2	024-02	2378640	719718	444213	5420239	Between DME and CB	A7-1	736.3
24	3	024-03	2378771	719729	444253	5420240	Between DME and CB	A7-1	736.3
24	4	024-04	2378902	719740	444293	5420241	Between DME and CB	A7-1	736.3
24	5	024-05	2379032	719751	444333	5420243	Between DME and CB	A7-1	736.3
25	1	025-01	2377126	717876	443724	5419701	Between DME and CB	A7-1	735.7
25	2	025-02	2377251	717797	443761	5419675	Between DME and CB	A7-1	735.7
25	3	025-03	2377377	717718	443798	5419649	Between DME and CB	A7-1	735.7
25	4	025-04	2377503	717639	443835	5419623	Between DME and CB	A7-1	735.7
25	5	025-05	2377629	717560	443873	5419597	Between DME and CB	A7-1	735.7
26	1	026-01	2375388	716370	443173	5419269	Between DME and CB	A7-1	735.1
26	2	026-02	2375451	716210	443189	5419220	Between DME and CB	A7-1	735.1
26	3	026-03	2375515	716050	443206	5419170	Between DME and CB	A7-1	735.1
26	4	026-04	2375578	715889	443223	5419120	Between DME and CB	A7-1	735.1
26	5	026-05	2375642	715729	443240	5419070	Between DME and CB	A7-1	735.1
27	1	027-01	2373268	715427	442513	5419014	Between DME and CB	A7-1	734.7
27	2	027-02	2373322	715236	442527	5418956	Between DME and CB	A7-1	734.7
27	3	027-03	2373375	715046	442540	5418897	Between DME and CB	A7-1	734.6
27	4	027-04	2373429	714856	442553	5418838	Between DME and CB	A7-1	734.6
27	5	027-05	2373482	714666	442567	5418780	Between DME and CB	A7-1	734.6
28	1	028-01	2371033	713981	441811	5418608	Between DME and CB	A7-1	734.1
28	2	028-02	2371214	713858	441864	5418568	Between DME and CB	A7-1	734.1
28	3	028-03	2371396	713736	441918	5418528	Between DME and CB	A7-1	734.2
28	4	028-04	2371577	713613	441971	5418488	Between DME and CB	A7-1	734.2
28	5	028-05	2371758	713491	442024	5418448	Between DME and CB	A7-1	734.2
29	1	029-01	2369090	712432	441196	5418167	Between DME and CB	A7-1	733.6
29	2	029-02	2369242	712296	441240	5418123	Between DME and CB	A7-1	733.6

Table A7-1. Underwater Imagery and Acoustic Doppler Current Profiler Measurement Locations

Transect No.	Station No.	Station ID	WA StatePlane N X (ft)	WA StatePlane N Y (ft)	UTM 11N X (m)	UTM 11N Y (m)	River Segment	Map No.	Approximate River Mile
29	3	029-03	2369394	712160	441285	5418079	Between DME and CB	A7-1	733.6
29	4	029-04	2369546	712024	441329	5418036	Between DME and CB	A7-1	733.6
29	5	029-05	2369699	711889	441373	5417992	Between DME and CB	A7-1	733.6
30	1	030-01	2367756	710217	440757	5417513	Between DME and CB	A7-1	733.1
30	2	030-02	2368097	710179	440860	5417496	Between DME and CB	A7-1	733.1
30	3	030-03	2368437	710142	440963	5417480	Between DME and CB	A7-1	733.1
30	4	030-04	2369292	710048	441221	5417438	Between DME and CB	A7-1	733.1
30	5	030-05	2369447	710031	441268	5417431	Between DME and CB	A7-1	733.1
31	1	031-01	2366408	708094	440314	5416887	Between DME and CB	A7-1	732.5
31	2	031-02	2366756	707940	440418	5416835	Between DME and CB	A7-1	732.5
31	3	031-03	2367105	707785	440521	5416783	Between DME and CB	A7-1	732.5
31	4	031-04	2367454	707631	440625	5416731	Between DME and CB	A7-1	732.6
31	5	031-05	2367802	707477	440729	5416679	Between DME and CB	A7-1	732.6
32	1	032-01	2364818	706688	439809	5416484	Between DME and CB	A7-1	732.1
32	2	032-02	2364992	706476	439859	5416417	Between DME and CB	A7-1	732.1
32	3	032-03	2365167	706263	439909	5416349	Between DME and CB	A7-1	732.1
32	4	032-04	2365342	706051	439959	5416282	Between DME and CB	A7-1	732.1
32	5	032-05	2365517	705838	440009	5416215	Between DME and CB	A7-1	732.1
33	1	033-01	2363353	704856	439335	5415949	Between DME and CB	A7-1	731.7
33	2	033-02	2363571	704693	439399	5415896	Between DME and CB	A7-1	731.7
33	3	033-03	2363789	704531	439463	5415843	Between DME and CB	A7-1	731.7
33	4	033-04	2364007	704368	439527	5415790	Between DME and CB	A7-1	731.7
33	5	033-05	2364225	704206	439591	5415738	Between DME and CB	A7-1	731.7
34	1	034-01	2361365	703200	438705	5415475	Between DME and CB	A7-1	731.2
34	2	034-02	2361568	703012	438764	5415415	Between DME and CB	A7-1	731.2
34	3	034-03	2361771	702824	438823	5415354	Between DME and CB	A7-1	731.2
34	4	034-04	2361973	702635	438882	5415294	Between DME and CB	A7-1	731.2
34	5	034-05	2362176	702447	438940	5415234	Between DME and CB	A7-1	731.2
35	1	035-01	2360331	700700	438352	5414730	Between DME and CB	A7-1	730.6
35	2	035-02	2360451	700604	438387	5414699	Between DME and CB	A7-1	730.6
35	3	035-03	2360571	700508	438423	5414668	Between DME and CB	A7-1	730.6
35	4	035-04	2360691	700412	438458	5414637	Between DME and CB	A7-1	730.6
35	5	035-05	2360812	700317	438493	5414606	Between DME and CB	A7-1	730.6
36	1	036-01	2358713	698774	437831	5414168	Between DME and CB	A7-1	730.1
36	2	036-02	2358935	698572	437895	5414104	Between DME and CB	A7-1	730.1
36	3	036-03	2359157	698370	437960	5414039	Between DME and CB	A7-1	730.1
36	4	036-04	2359379	698168	438024	5413974	Between DME and CB	A7-1	730.1
36	5	036-05	2359601	697966	438089	5413909	Between DME and CB	A7-1	730.1
37	1	037-01	2356294	697790	437080	5413906	Between DME and CB	A7-1	729.6
37	2	037-02	2356352	697707	437096	5413880	Between DME and CB	A7-1	729.6
37	3	037-03	2356411	697624	437113	5413854	Between DME and CB	A7-1	729.6
37	4	037-04	2356470	697541	437129	5413827	Between DME and CB	A7-1	729.6
37	5	037-05	2356529	697458	437146	5413801	Between DME and CB	A7-1	729.6
38	1	038-01	2353960	696877	436355	5413663	Between DME and CB	A7-1	729.1
38	2	038-02	2353987	696818	436363	5413645	Between DME and CB	A7-1	729.1
38	3	038-03	2354015	696760	436370	5413627	Between DME and CB	A7-1	729.1
38	4	038-04	2354043	696701	436378	5413609	Between DME and CB	A7-1	729.1
38	5	038-05	2354070	696643	436386	5413591	Between DME and CB	A7-1	729.1
39	1	039-01	2351440	695965	435575	5413424	Between DME and CB	A7-1	728.6
39	2	039-02	2351564	695910	435612	5413406	Between DME and CB	A7-1	728.6
39	3	039-03	2351688	695855	435648	5413387	Between DME and CB	A7-1	728.6
39	4	039-04	2351812	695800	435685	5413368	Between DME and CB	A7-1	728.6
39	5	039-05	2351936	695744	435722	5413350	Between DME and CB	A7-1	728.6
40	1	040-01	2350199	693847	435165	5412799	Between DME and CB	A7-1	728.2
40	2	040-02	2350421	693670	435230	5412741	Between DME and CB	A7-1	728.2
40	3	040-03	2350644	693493	435295	5412684	Between DME and CB	A7-1	728.1
40	4	040-04	2350867	693317	435360	5412627	Between DME and CB	A7-1	728.1
40	5	040-05	2351089	693140	435425	5412570	Between DME and CB	A7-1	728.1
41	1	041-01	2348645	692229	434667	5412330	Between DME and CB	A7-1	727.7
41	2	041-02	2348785	692002	434706	5412259	Between DME and CB	A7-1	727.7
41	3	041-03	2348924	691775	434745	5412187	Between DME and CB	A7-1	727.7
41	4	041-04	2349063	691548	434784	5412116	Between DME and CB	A7-1	727.6
41	5	041-05	2349203	691321	434823	5412045	Between DME and CB	A7-1	727.6
42	1	042-01	2346532	690955	434005	5411974	Between DME and CB	A7-1	727.2
42	2	042-02	2346603	690809	434024	5411929	Between DME and CB	A7-1	727.2
42	3	042-03	2346674	690664	434044	5411884	Between DME and CB	A7-1	727.2
42	4	042-04	2346745	690518	434063	5411838	Between DME and CB	A7-1	727.2
42	5	042-05	2346816	690373	434083	5411793	Between DME and CB	A7-1	727.2
43	1	043-01	2344078	689405	433235	5411540	Between DME and CB	A7-1	726.7
43	2	043-02	2344286	689295	433296	5411503	Between DME and CB	A7-1	726.7
43	3	043-03	2344493	689185	433358	5411467	Between DME and CB	A7-1	726.7
43	4	043-04	2344701	689075	433419	5411430	Between DME and CB	A7-1	726.7
43	5	043-05	2344908	688964	433481	5411393	Between DME and CB	A7-1	726.6
44	1	044-01	2342755	688269	432815	5411214	Between DME and CB	A7-1	726.3
44	2	044-02	2342825	688027	432832	5411140	Between DME and CB	A7-1	726.3
44	3	044-03	2342894	687786	432850	5411065	Between DME and CB	A7-1	726.2
44	4	044-04	2342964	687544	432867	5410991	Between DME and CB	A7-1	726.2
44	5	044-05	2343034	687303	432885	5410916	Between DME and CB	A7-1	726.2
45	1	045-01	2340849	686072	432201	5410575	Between DME and CB	A7-1	725.8
45	2	045-02	2341021	686001	432252	5410551	Between DME and CB	A7-1	725.8
45	3	045-03	2341192	685931	432304	5410527	Between DME and CB	A7-1	725.8
45	4	045-04	2341364	685860	432355	5410503	Between DME and CB	A7-1	725.8
45	5	045-05	2341536	685790	432406	5410478	Between DME and CB	A7-1	725.8
46	1	046-01	2340420	683144	432026	5409690	Between DME and CB	A7-1	725.3
46	2	046-02	2340648	683256	432097	5409721	Between DME and CB	A7-1	725.3
46	3	046-03	2340877	683369	432169	5409752	Between DME and CB	A7-1	725.3
46	4	046-04	2341105	683481	432240	5409783	Between DME and CB	A7-1	725.4
46	5	046-05	2341334	683594	432311	5409813	Between DME and CB	A7-1	725.4
47	1	047-01	2339969	680913	431855	5409018	Between DME and CB	A7-1	724.9
47	2	047-02	2340294	680891	431954	5409007	Between DME and CB	A7-1	724.9

Table A7-1. Underwater Imagery and Acoustic Doppler Current Profiler Measurement Locations

Transect No.	Station No.	Station ID	WA StatePlane N X (ft)	WA StatePlane N Y (ft)	UTM 11N X (m)	UTM 11N Y (m)	River Segment	Map No.	Approximate River Mile
47	3	047-03	2340619	680870	432052	5408995	Between DME and CB	A7-1	724.9
47	4	047-04	2340944	680848	432151	5408984	Between DME and CB	A7-1	724.9
47	5	047-05	2341269	680827	432249	5408972	Between DME and CB	A7-1	724.9
48	1	048-01	2340408	679180	431962	5408484	CB	A7-3	724.6
48	2	048-02	2340583	679048	432013	5408441	CB	A7-3	724.5
48	3	048-03	2340715	678948	432052	5408409	CB	A7-3	724.5
48	4	048-04	2340887	678818	432103	5408367	CB	A7-3	724.5
48	5	048-05	2341145	678624	432178	5408304	CB	A7-3	724.5
48	6	048-06	2341360	678461	432241	5408251	CB	A7-3	724.4
48	7	048-07	2341524	678337	432289	5408211	CB	A7-3	724.4
48	8	048-08	2341630	678257	432320	5408185	CB	A7-3	724.4
48	9	048-09	2341684	678217	432336	5408172	CB	A7-3	724.4
48	10	048-10	2341748	678169	432355	5408156	CB	A7-3	724.4
49	1	049-01	2340080	678185	431847	5408186	CB	A7-3	724.4
49	2	049-02	2340223	678085	431889	5408154	CB	A7-3	724.3
49	3	049-03	2340367	677986	431932	5408121	CB	A7-3	724.3
49	4	049-04	2340532	677870	431980	5408084	CB	A7-3	724.3
49	5	049-05	2340653	677787	432016	5408057	CB	A7-3	724.2
49	6	049-06	2340754	677717	432045	5408034	CB	A7-3	724.2
49	7	049-07	2340940	677587	432100	5407992	CB	A7-3	724.2
49	8	049-08	2341083	677488	432142	5407959	CB	A7-3	724.2
49	9	049-09	2341239	677380	432188	5407924	CB	A7-3	724.2
49	10	049-10	2341439	677241	432246	5407879	CB	A7-3	724.2
50	1	050-01	2339828	677712	431763	5408046	CB	A7-3	724.0
50	2	050-02	2339916	677570	431788	5408002	CB	A7-3	724.0
50	3	050-03	2340004	677429	431813	5407958	CB	A7-3	724.0
50	4	050-04	2340092	677287	431837	5407913	CB	A7-3	724.0
50	5	050-05	2340158	677182	431856	5407880	CB	A7-3	724.0
50	6	050-06	2340262	677015	431885	5407828	CB	A7-3	724.0
50	7	050-07	2340346	676881	431908	5407786	CB	A7-3	724.0
50	8	050-08	2340445	676721	431936	5407735	CB	A7-3	724.0
50	9	050-09	2340533	676580	431961	5407691	CB	A7-3	724.0
50	10	050-10	2340653	676388	431994	5407631	CB	A7-3	724.0
51	1	051-01	2338948	677122	431487	5407880	CB	A7-3	723.8
51	2	051-02	2339038	676978	431512	5407835	CB	A7-3	723.8
51	3	051-03	2339157	676788	431545	5407775	CB	A7-3	723.8
51	4	051-04	2339239	676658	431568	5407735	CB	A7-3	723.8
51	5	051-05	2339321	676528	431591	5407694	CB	A7-3	723.8
51	6	051-06	2339425	676363	431620	5407642	CB	A7-3	723.8
51	7	051-07	2339485	676267	431637	5407612	CB	A7-3	723.8
51	8	051-08	2339566	676137	431660	5407571	CB	A7-3	723.8
51	9	051-09	2339648	676007	431683	5407530	CB	A7-3	723.8
51	10	051-10	2339760	675828	431714	5407474	CB	A7-3	723.8
52	1	052-01	2337947	677733	431191	5408082	CB	A7-3	723.7
52	2	052-02	2338067	677378	431222	5407972	CB	A7-3	723.7
52	3	052-03	2338145	677147	431243	5407900	CB	A7-3	723.7
52	4	052-04	2338253	676829	431271	5407802	CB	A7-3	723.7
52	5	052-05	2338321	676626	431288	5407739	CB	A7-3	723.7
52	6	052-06	2338389	676424	431306	5407676	CB	A7-3	723.7
52	7	052-07	2338457	676224	431324	5407614	CB	A7-3	723.7
52	8	052-08	2338535	675993	431344	5407543	CB	A7-3	723.7
52	9	052-09	2338613	675762	431364	5407471	CB	A7-3	723.7
52	10	052-10	2338741	675384	431397	5407355	CB	A7-3	723.7
53	1	053-01	2337122	676282	430918	5407652	CB	A7-3	723.5
53	2	053-02	2337197	676140	430939	5407608	CB	A7-3	723.5
53	3	053-03	2337303	675940	430968	5407546	CB	A7-3	723.5
53	4	053-04	2337366	675819	430986	5407508	CB	A7-3	723.5
53	5	053-05	2337422	675714	431001	5407475	CB	A7-3	723.5
53	6	053-06	2337497	675572	431022	5407430	CB	A7-3	723.5
53	7	053-07	2337572	675430	431042	5407386	CB	A7-3	723.5
53	8	053-08	2337647	675288	431063	5407342	CB	A7-3	723.5
53	9	053-09	2337722	675146	431084	5407297	CB	A7-3	723.5
53	10	053-10	2337831	674939	431114	5407233	CB	A7-3	723.5
54	1	054-01	2336566	675488	430737	5407419	CB	A7-3	723.3
54	2	054-02	2336603	675396	430747	5407391	CB	A7-3	723.3
54	3	054-03	2336638	675311	430756	5407364	CB	A7-3	723.3
54	4	054-04	2336658	675261	430762	5407349	CB	A7-3	723.3
54	5	054-05	2336681	675206	430768	5407332	CB	A7-3	723.3
54	6	054-06	2336716	675117	430777	5407304	CB	A7-3	723.3
54	7	054-07	2336785	674948	430795	5407251	CB	A7-3	723.3
54	8	054-08	2336850	674787	430813	5407201	CB	A7-3	723.3
54	9	054-09	2336957	674522	430841	5407119	CB	A7-3	723.3
54	10	054-10	2337003	674408	430854	5407084	CB	A7-3	723.3
55	1	055-01	2335871	674887	430516	5407247	CB	A7-3	723.1
55	2	055-02	2335916	674845	430529	5407233	CB	A7-3	723.1
55	3	055-03	2335981	674784	430548	5407214	CB	A7-3	723.1
55	4	055-04	2336020	674747	430560	5407202	CB	A7-3	723.1
55	5	055-05	2336073	674698	430575	5407186	CB	A7-3	723.1
55	6	055-06	2336137	674638	430594	5407167	CB	A7-3	723.1
55	7	055-07	2336263	674520	430630	5407129	CB	A7-3	723.2
55	8	055-08	2336439	674355	430681	5407076	CB	A7-3	723.2
55	9	055-09	2336555	674247	430715	5407042	CB	A7-3	723.2
55	10	055-10	2336639	674169	430739	5407017	CB	A7-3	723.2
56	1	056-01	2335502	674697	430401	5407195	CB	A7-3	723.0
56	2	056-02	2335542	674581	430412	5407159	CB	A7-3	723.0
56	3	056-03	2335583	674466	430422	5407123	CB	A7-3	723.0
56	4	056-04	2335623	674351	430433	5407087	CB	A7-3	723.0
56	5	056-05	2335663	674235	430443	5407052	CB	A7-3	723.0
56	6	056-06	2335703	674120	430454	5407016	CB	A7-3	723.0
56	7	056-07	2335753	673978	430467	5406972	CB	A7-3	723.0

Table A7-1. Underwater Imagery and Acoustic Doppler Current Profiler Measurement Locations

Transect No.	Station No.	Station ID	WA StatePlane N X (ft)	WA StatePlane N Y (ft)	UTM 11N X (m)	UTM 11N Y (m)	River Segment	Map No.	Approximate River Mile
56	8	056-08	2335811	673812	430482	5406921	CB	A7-3	723.0
56	9	056-09	2335838	673736	430489	5406897	CB	A7-3	723.0
56	10	056-10	2335865	673659	430496	5406873	CB	A7-3	723.0
57	1	057-01	2334955	674644	430234	5407187	CB	A7-3	722.9
57	2	057-02	2334972	674503	430237	5407144	CB	A7-3	722.9
57	3	057-03	2334985	674397	430239	5407111	CB	A7-3	722.9
57	4	057-04	2334999	674287	430242	5407078	CB	A7-3	722.9
57	5	057-05	2335013	674173	430244	5407043	CB	A7-3	722.9
57	6	057-06	2335033	674007	430248	5406992	CB	A7-3	722.9
57	7	057-07	2335055	673830	430252	5406938	CB	A7-3	722.9
57	8	057-08	2335071	673693	430255	5406896	CB	A7-3	722.9
57	9	057-09	2335086	673572	430258	5406859	CB	A7-3	722.9
57	10	057-10	2335102	673443	430260	5406819	CB	A7-3	722.9
58	1	058-01	2334108	674766	429978	5407237	CB	A7-3	722.8
58	2	058-02	2334075	674641	429966	5407199	CB	A7-3	722.8
58	3	058-03	2334059	674579	429960	5407181	CB	A7-3	722.8
58	4	058-04	2334034	674485	429951	5407153	CB	A7-3	722.7
58	5	058-05	2334016	674416	429945	5407132	CB	A7-3	722.7
58	6	058-06	2333985	674298	429934	5407096	CB	A7-3	722.7
58	7	058-07	2333961	674204	429925	5407068	CB	A7-3	722.7
58	8	058-08	2333936	674111	429916	5407040	CB	A7-3	722.7
58	9	058-09	2333912	674017	429907	5407012	CB	A7-3	722.7
58	10	058-10	2333887	673923	429898	5406984	CB	A7-3	722.7
59	1	059-01	2333242	675365	429723	5407432	CB	A7-3	722.6
59	2	059-02	2333209	675277	429712	5407406	CB	A7-3	722.6
59	3	059-03	2333176	675189	429701	5407380	CB	A7-3	722.6
59	4	059-04	2333132	675072	429686	5407345	CB	A7-3	722.6
59	5	059-05	2333094	674969	429672	5407314	CB	A7-3	722.6
59	6	059-06	2333064	674889	429662	5407290	CB	A7-3	722.6
59	7	059-07	2333037	674817	429653	5407269	CB	A7-3	722.6
59	8	059-08	2333001	674722	429641	5407240	CB	A7-3	722.6
59	9	059-09	2332979	674661	429633	5407222	CB	A7-3	722.6
59	10	059-10	2332946	674573	429621	5407196	CB	A7-3	722.6
60	1	060-01	2332475	675425	429491	5407462	CB	A7-3	722.4
60	2	060-02	2332458	675345	429485	5407438	CB	A7-3	722.4
60	3	060-03	2332441	675266	429478	5407414	CB	A7-3	722.4
60	4	060-04	2332424	675186	429472	5407390	CB	A7-3	722.4
60	5	060-05	2332407	675106	429466	5407366	CB	A7-3	722.4
60	6	060-06	2332390	675027	429459	5407342	CB	A7-3	722.4
60	7	060-07	2332373	674947	429453	5407318	CB	A7-3	722.4
60	8	060-08	2332356	674867	429446	5407294	CB	A7-3	722.4
60	9	060-09	2332344	674809	429442	5407277	CB	A7-3	722.4
60	10	060-10	2332322	674708	429434	5407246	CB	A7-3	722.4
61	1	061-01	2330618	675851	428932	5407620	Between CB and UMF	A7-1	722.1
61	2	061-02	2330595	675693	428923	5407572	Between CB and UMF	A7-1	722.1
61	3	061-03	2330572	675534	428914	5407524	Between CB and UMF	A7-1	722.1
61	4	061-04	2330549	675375	428904	5407476	Between CB and UMF	A7-1	722.1
61	5	061-05	2330526	675217	428895	5407428	Between CB and UMF	A7-1	722.1
62	1	062-01	2328024	676963	428160	5407998	Between CB and UMF	A7-1	721.6
62	2	062-02	2328005	676596	428149	5407887	Between CB and UMF	A7-1	721.6
62	3	062-03	2327986	676228	428137	5407775	Between CB and UMF	A7-1	721.6
62	4	062-04	2327967	675861	428126	5407663	Between CB and UMF	A7-1	721.6
62	5	062-05	2327948	675493	428115	5407552	Between CB and UMF	A7-1	721.6
63	1	063-01	2325330	675838	427323	5407697	Between CB and UMF	A7-1	721.1
63	2	063-02	2325418	675690	427348	5407650	Between CB and UMF	A7-1	721.1
63	3	063-03	2325506	675542	427372	5407604	Between CB and UMF	A7-1	721.1
63	4	063-04	2325594	675393	427397	5407557	Between CB and UMF	A7-1	721.1
63	5	063-05	2325682	675245	427421	5407511	Between CB and UMF	A7-1	721.1
64	1	064-01	2323335	674560	426697	5407338	Between CB and UMF	A7-1	720.7
64	2	064-02	2323411	674378	426717	5407281	Between CB and UMF	A7-1	720.7
64	3	064-03	2323487	674196	426737	5407225	Between CB and UMF	A7-1	720.7
64	4	064-04	2323563	674014	426758	5407168	Between CB and UMF	A7-1	720.7
64	5	064-05	2323639	673831	426778	5407112	Between CB and UMF	A7-1	720.7
65	1	065-01	2320998	673010	425962	5406902	Between CB and UMF	A7-1	720.2
65	2	065-02	2321133	672831	426000	5406845	Between CB and UMF	A7-1	720.2
65	3	065-03	2321268	672652	426039	5406789	Between CB and UMF	A7-1	720.2
65	4	065-04	2321404	672473	426077	5406732	Between CB and UMF	A7-1	720.2
65	5	065-05	2321539	672294	426115	5406676	Between CB and UMF	A7-1	720.2
66	1	066-01	2319795	670252	425554	5406081	Between CB and UMF	A7-1	719.8
66	2	066-02	2319985	670241	425611	5406075	Between CB and UMF	A7-1	719.7
66	3	066-03	2320175	670231	425669	5406069	Between CB and UMF	A7-1	719.7
66	4	066-04	2320365	670220	425727	5406063	Between CB and UMF	A7-1	719.7
66	5	066-05	2320555	670210	425784	5406056	Between CB and UMF	A7-1	719.7
67	1	067-01	2320280	667614	425661	5405271	Between CB and UMF	A7-1	719.3
67	2	067-02	2320542	667752	425743	5405309	Between CB and UMF	A7-1	719.3
67	3	067-03	2320804	667890	425825	5405347	Between CB and UMF	A7-1	719.3
67	4	067-04	2321066	668029	425907	5405385	Between CB and UMF	A7-1	719.3
67	5	067-05	2321327	668167	425988	5405423	Between CB and UMF	A7-1	719.3
68	1	068-01	2320536	665561	425708	5404642	Between CB and UMF	A7-1	718.8
68	2	068-02	2320939	665536	425830	5404628	Between CB and UMF	A7-1	718.9
68	3	068-03	2321343	665511	425953	5404615	Between CB and UMF	A7-1	718.9
68	4	068-04	2321746	665486	426075	5404601	Between CB and UMF	A7-1	718.9
68	5	068-05	2322150	665461	426197	5404587	Between CB and UMF	A7-1	718.9
69	1	069-01	2320833	662976	425759	5403851	Between CB and UMF	A7-1	718.4
69	2	069-02	2321181	663010	425865	5403856	Between CB and UMF	A7-1	718.4
69	3	069-03	2321529	663045	425972	5403861	Between CB and UMF	A7-1	718.4
69	4	069-04	2321877	663080	426078	5403867	Between CB and UMF	A7-1	718.4
69	5	069-05	2322225	663114	426185	5403872	Between CB and UMF	A7-1	718.4
70	1	070-01	2320266	660878	425554	5403221	Between CB and UMF	A7-1	718.0
70	2	070-02	2320402	660706	425593	5403167	Between CB and UMF	A7-1	717.9

Table A7-1. Underwater Imagery and Acoustic Doppler Current Profiler Measurement Locations

Transect No.	Station No.	Station ID	WA StatePlane N X (ft)	WA StatePlane N Y (ft)	UTM 11N X (m)	UTM 11N Y (m)	River Segment	Map No.	Approximate River Mile
70	3	070-03	2320538	660535	425632	5403113	Between CB and UMF	A7-1	717.9
70	4	070-04	2320675	660363	425671	5403058	Between CB and UMF	A7-1	717.9
70	5	070-05	2320811	660192	425710	5403004	Between CB and UMF	A7-1	717.9
71	1	071-01	2318304	659435	424935	5402812	Between CB and UMF	A7-1	717.4
71	2	071-02	2318388	659254	424958	5402756	Between CB and UMF	A7-1	717.4
71	3	071-03	2318473	659074	424981	5402699	Between CB and UMF	A7-1	717.4
71	4	071-04	2318557	658893	425004	5402643	Between CB and UMF	A7-1	717.4
71	5	071-05	2318641	658712	425027	5402587	Between CB and UMF	A7-1	717.4
72	1	072-01	2316119	658122	424250	5402446	Between CB and UMF	A7-1	717.0
72	2	072-02	2316235	657954	424283	5402393	Between CB and UMF	A7-1	717.0
72	3	072-03	2316351	657786	424316	5402340	Between CB and UMF	A7-1	717.0
72	4	072-04	2316468	657618	424349	5402287	Between CB and UMF	A7-1	717.0
72	5	072-05	2316584	657450	424382	5402234	Between CB and UMF	A7-1	717.0
73	1	073-01	2313514	656870	423439	5402104	Between CB and UMF	A7-1	716.5
73	2	073-02	2313805	656663	423524	5402037	Between CB and UMF	A7-1	716.5
73	3	073-03	2314096	656456	423610	5401969	Between CB and UMF	A7-1	716.5
73	4	073-04	2314388	656249	423695	5401902	Between CB and UMF	A7-1	716.5
73	5	073-05	2314679	656043	423781	5401835	Between CB and UMF	A7-1	716.6
74	1	074-01	2311997	654766	422945	5401487	Between CB and UMF	A7-1	716.0
74	2	074-02	2312352	654670	423052	5401452	Between CB and UMF	A7-1	716.1
74	3	074-03	2312707	654574	423158	5401418	Between CB and UMF	A7-1	716.1
74	4	074-04	2313061	654478	423265	5401383	Between CB and UMF	A7-1	716.1
74	5	074-05	2313416	654382	423371	5401348	Between CB and UMF	A7-1	716.2
75	1	075-01	2310536	653199	422477	5401032	Between CB and UMF	A7-1	715.7
75	2	075-02	2310714	653064	422529	5400989	Between CB and UMF	A7-1	715.7
75	3	075-03	2310892	652929	422581	5400945	Between CB and UMF	A7-1	715.7
75	4	075-04	2311070	652793	422633	5400901	Between CB and UMF	A7-1	715.6
75	5	075-05	2311248	652658	422685	5400857	Between CB and UMF	A7-1	715.6
76	1	076-01	2309132	651036	422016	5400395	Between CB and UMF	A7-1	715.2
76	2	076-02	2309477	650863	422119	5400337	Between CB and UMF	A7-1	715.2
76	3	076-03	2309822	650689	422221	5400279	Between CB and UMF	A7-1	715.2
76	4	076-04	2310166	650516	422323	5400221	Between CB and UMF	A7-1	715.2
76	5	076-05	2310511	650342	422426	5400163	Between CB and UMF	A7-1	715.2
77	1	077-01	2309115	648043	421966	5399485	Between CB and UMF	A7-1	714.8
77	2	077-02	2309443	648145	422067	5399511	Between CB and UMF	A7-1	714.8
77	3	077-03	2309771	648248	422168	5399537	Between CB and UMF	A7-1	714.8
77	4	077-04	2310099	648351	422270	5399564	Between CB and UMF	A7-1	714.8
77	5	077-05	2310427	648454	422371	5399590	Between CB and UMF	A7-1	714.8
78	1	078-01	2309628	645693	422086	5398762	Between CB and UMF	A7-1	714.4
78	2	078-02	2309913	645828	422175	5398799	Between CB and UMF	A7-1	714.4
78	3	078-03	2310198	645964	422264	5398836	Between CB and UMF	A7-1	714.4
78	4	078-04	2310483	646099	422353	5398873	Between CB and UMF	A7-1	714.4
78	5	078-05	2310768	646235	422441	5398909	Between CB and UMF	A7-1	714.4
79	1	079-01	2310649	643297	422360	5398017	Between CB and UMF	A7-1	713.9
79	2	079-02	2310977	643455	422463	5398060	Between CB and UMF	A7-1	713.9
79	3	079-03	2311306	643614	422565	5398104	Between CB and UMF	A7-1	713.9
79	4	079-04	2311635	643772	422668	5398147	Between CB and UMF	A7-1	713.9
79	5	079-05	2311963	643930	422770	5398190	Between CB and UMF	A7-1	713.9
80	1	080-01	2312351	641244	422847	5397366	Between CB and UMF	A7-1	713.4
80	2	080-02	2312552	641442	422911	5397424	Between CB and UMF	A7-1	713.4
80	3	080-03	2312752	641640	422975	5397481	Between CB and UMF	A7-1	713.4
80	4	080-04	2312952	641839	423039	5397538	Between CB and UMF	A7-1	713.5
80	5	080-05	2313152	642037	423103	5397596	Between CB and UMF	A7-1	713.5
81	1	081-01	2313415	639122	423139	5396704	Between CB and UMF	A7-1	713.0
81	2	081-02	2313588	639254	423193	5396742	Between CB and UMF	A7-1	713.0
81	3	081-03	2313762	639387	423248	5396780	Between CB and UMF	A7-1	713.0
81	4	081-04	2313935	639520	423303	5396818	Between CB and UMF	A7-1	713.0
81	5	081-05	2314108	639653	423358	5396856	Between CB and UMF	A7-1	713.0
82	1	082-01	2314613	637075	423472	5396063	Between CB and UMF	A7-1	712.6
82	2	082-02	2314832	637127	423540	5396076	Between CB and UMF	A7-1	712.5
82	3	082-03	2315052	637179	423607	5396088	Between CB and UMF	A7-1	712.5
82	4	082-04	2315271	637231	423675	5396101	Between CB and UMF	A7-1	712.5
82	5	082-05	2315490	637283	423742	5396113	Between CB and UMF	A7-1	712.5
83	1	083-01	2315858	635207	423823	5395476	Between CB and UMF	A7-1	712.1
83	2	083-02	2316325	635215	423965	5395471	Between CB and UMF	A7-1	712.1
83	3	083-03	2316792	635223	424107	5395467	Between CB and UMF	A7-1	712.1
83	4	083-04	2317260	635230	424249	5395462	Between CB and UMF	A7-1	712.0
83	5	083-05	2317727	635238	424392	5395457	Between CB and UMF	A7-1	712.0
84	1	084-01	2315873	632813	423791	5394747	Between CB and UMF	A7-1	711.7
84	2	084-02	2316548	632847	423997	5394747	Between CB and UMF	A7-1	711.7
84	3	084-03	2317223	632881	424202	5394747	Between CB and UMF	A7-1	711.7
84	4	084-04	2317898	632915	424408	5394747	Between CB and UMF	A7-1	711.6
84	5	084-05	2318572	632948	424614	5394747	Between CB and UMF	A7-1	711.6
85	1	085-01	2316458	631540	423949	5394351	UMF	A7-4	711.5
85	2	085-02	2316758	631631	424042	5394374	UMF	A7-4	711.5
85	3	085-03	2317170	631755	424169	5394405	UMF	A7-4	711.5
85	4	085-04	2317483	631849	424266	5394429	UMF	A7-4	711.5
85	5	085-05	2317660	631902	424321	5394443	UMF	A7-4	711.5
85	6	085-06	2317900	631974	424395	5394461	UMF	A7-4	711.5
85	7	085-07	2318261	632083	424506	5394489	UMF	A7-4	711.5
85	8	085-08	2318562	632173	424599	5394512	UMF	A7-4	711.4
85	9	085-09	2318863	632264	424692	5394535	UMF	A7-4	711.4
85	10	085-10	2319163	632354	424785	5394557	UMF	A7-4	711.4
86	1	086-01	2316568	630654	423969	5394080	UMF	A7-4	711.3
86	2	086-02	2316928	630742	424080	5394101	UMF	A7-4	711.3
86	3	086-03	2317232	630816	424174	5394119	UMF	A7-4	711.3
86	4	086-04	2317876	630974	424372	5394157	UMF	A7-4	711.3
86	5	086-05	2318006	631006	424412	5394165	UMF	A7-4	711.3
86	6	086-06	2318157	631043	424459	5394174	UMF	A7-4	711.3
86	7	086-07	2318725	631182	424634	5394207	UMF	A7-4	711.3

Table A7-1. Underwater Imagery and Acoustic Doppler Current Profiler Measurement Locations

Transect No.	Station No.	Station ID	WA StatePlane N X (ft)	WA StatePlane N Y (ft)	UTM 11N X (m)	UTM 11N Y (m)	River Segment	Map No.	Approximate River Mile
86	8	086-08	2319085	631270	424745	5394229	UMF	A7-4	711.3
86	9	086-09	2319444	631358	424855	5394250	UMF	A7-4	711.3
86	10	086-10	2319804	631446	424966	5394271	UMF	A7-4	711.2
87	1	087-01	2317299	629956	424181	5393856	UMF	A7-4	711.1
87	2	087-02	2317732	629953	424313	5393849	UMF	A7-4	711.1
87	3	087-03	2318114	629951	424429	5393842	UMF	A7-4	711.1
87	4	087-04	2318350	629949	424501	5393838	UMF	A7-4	711.1
87	5	087-05	2318601	629948	424577	5393834	UMF	A7-4	711.1
87	6	087-06	2319324	629943	424797	5393821	UMF	A7-4	711.0
87	7	087-07	2320103	629938	425034	5393808	UMF	A7-4	711.0
87	8	087-08	2319884	629940	424968	5393812	UMF	A7-4	711.0
87	9	087-09	2320267	629937	425084	5393805	UMF	A7-4	711.0
87	10	087-10	2320651	629935	425201	5393799	UMF	A7-4	711.0
88	1	088-01	2317015	628919	424079	5393545	UMF	A7-4	711.0
88	2	088-02	2317308	628930	424168	5393544	UMF	A7-4	710.9
88	3	088-03	2317797	628947	424317	5393541	UMF	A7-4	710.9
88	4	088-04	2318371	628968	424492	5393539	UMF	A7-4	710.9
88	5	088-05	2318533	628973	424542	5393538	UMF	A7-4	710.9
88	6	088-06	2318753	628981	424609	5393537	UMF	A7-4	710.9
88	7	088-07	2319360	629003	424794	5393535	UMF	A7-4	710.9
88	8	088-08	2319750	629017	424913	5393533	UMF	A7-4	710.8
88	9	088-09	2320141	629031	425032	5393531	UMF	A7-4	710.8
88	10	088-10	2320532	629044	425151	5393529	UMF	A7-4	710.8
89	1	089-01	2317062	628291	424084	5393353	UMF	A7-4	710.8
89	2	089-02	2317444	628362	424201	5393369	UMF	A7-4	710.8
89	3	089-03	2317956	628458	424358	5393390	UMF	A7-4	710.8
89	4	089-04	2318491	628558	424523	5393413	UMF	A7-4	710.8
89	5	089-05	2318678	628593	424580	5393420	UMF	A7-4	710.8
89	6	089-06	2318811	628618	424621	5393426	UMF	A7-4	710.8
89	7	089-07	2319315	628713	424776	5393447	UMF	A7-4	710.8
89	8	089-08	2319719	628788	424900	5393464	UMF	A7-4	710.8
89	9	089-09	2320122	628864	425024	5393481	UMF	A7-4	710.8
89	10	089-10	2320525	628939	425148	5393498	UMF	A7-4	710.8
90	1	090-01	2316861	627744	424014	5393190	UMF	A7-4	710.7
90	2	090-02	2317285	627714	424143	5393174	UMF	A7-4	710.7
90	3	090-03	2317710	627684	424272	5393158	UMF	A7-4	710.7
90	4	090-04	2318321	627640	424457	5393136	UMF	A7-4	710.7
90	5	090-05	2318832	627604	424612	5393117	UMF	A7-4	710.6
90	6	090-06	2318983	627593	424658	5393111	UMF	A7-4	710.6
90	7	090-07	2319099	627585	424693	5393107	UMF	A7-4	710.6
90	8	090-08	2319832	627533	424915	5393080	UMF	A7-4	710.6
90	9	090-09	2320256	627503	425044	5393065	UMF	A7-4	710.6
90	10	090-10	2320854	627460	425225	5393043	UMF	A7-4	710.5
91	1	091-01	2316816	627169	423992	5393015	UMF	A7-4	710.6
91	2	091-02	2317578	626972	424221	5392944	UMF	A7-4	710.6
91	3	091-03	2317960	626874	424335	5392908	UMF	A7-4	710.6
91	4	091-04	2318341	626776	424450	5392872	UMF	A7-4	710.5
91	5	091-05	2318654	626695	424544	5392843	UMF	A7-4	710.5
91	6	091-06	2319046	626594	424662	5392806	UMF	A7-4	710.5
91	7	091-07	2319177	626560	424701	5392794	UMF	A7-4	710.4
91	8	091-08	2319457	626488	424785	5392768	UMF	A7-4	710.4
91	9	091-09	2319867	626382	424908	5392730	UMF	A7-4	710.4
91	10	091-10	2320248	626284	425023	5392694	UMF	A7-4	710.4
92	1	092-01	2316340	626346	423834	5392772	UMF	A7-4	709.9
92	7	092-02	2319005	626067	424641	5392646	UMF	A7-4	710.4
92	2	092-03	2316955	626281	424021	5392743	UMF	A7-4	710.0
92	3	092-04	2317651	626209	424231	5392710	UMF	A7-4	710.2
92	4	092-05	2317958	626176	424324	5392696	UMF	A7-4	710.2
92	5	092-06	2318492	626120	424486	5392671	UMF	A7-4	710.4
92	6	092-07	2318820	626086	424585	5392655	UMF	A7-4	710.4
92	8	092-08	2319171	626049	424692	5392639	UMF	A7-4	710.4
92	9	092-09	2319424	626023	424768	5392627	UMF	A7-4	710.3
92	10	092-10	2319980	625964	424936	5392601	UMF	A7-4	710.3
93	1	093-01	2316712	626884	423956	5392930	UMF	A7-4	710.6
93	2	093-02	2317112	626503	424072	5392808	UMF	A7-4	710.5
93	3	093-03	2317512	626123	424188	5392686	UMF	A7-4	710.1
93	4	093-04	2317879	625774	424294	5392575	UMF	A7-4	710.1
93	5	093-05	2318113	625552	424362	5392503	UMF	A7-4	710.1
93	6	093-06	2318346	625330	424429	5392432	UMF	A7-4	710.1
93	7	093-07	2318464	625218	424464	5392396	UMF	A7-4	710.1
93	8	093-08	2318579	625108	424497	5392361	UMF	A7-4	710.1
93	9	093-09	2318693	625000	424530	5392327	UMF	A7-4	710.1
93	10	093-10	2318813	624886	424565	5392290	UMF	A7-4	710.2
94	1	094-01	2316906	624883	423985	5392318	UMF	A7-4	709.9
94	2	094-02	2317092	624790	424040	5392287	UMF	A7-4	709.9
94	3	094-03	2317233	624719	424081	5392263	UMF	A7-4	709.9
94	4	094-04	2317360	624655	424119	5392242	UMF	A7-4	709.9
94	5	094-05	2317464	624602	424150	5392224	UMF	A7-4	709.9
94	6	094-06	2317596	624536	424189	5392202	UMF	A7-4	709.9
94	7	094-07	2317706	624481	424222	5392184	UMF	A7-4	710.0
94	8	094-08	2317867	624400	424270	5392157	UMF	A7-4	710.0
94	9	094-09	2318042	624311	424322	5392127	UMF	A7-4	710.0
94	10	094-10	2318306	624179	424400	5392083	UMF	A7-4	710.0
95	1	095-01	2316442	624454	423837	5392195	UMF	A7-4	709.7
95	2	095-02	2316424	624338	423829	5392160	UMF	A7-4	709.7
95	3	095-03	2316402	624201	423821	5392118	UMF	A7-4	709.7
95	4	095-04	2316378	624047	423811	5392072	UMF	A7-4	709.7
95	5	095-05	2316359	623930	423804	5392037	UMF	A7-4	709.7
95	6	095-06	2316332	623753	423792	5391983	UMF	A7-4	709.7
95	7	095-07	2316299	623543	423779	5391920	UMF	A7-4	709.6

Table A7-1. Underwater Imagery and Acoustic Doppler Current Profiler Measurement Locations

Transect No.	Station No.	Station ID	WA StatePlane N X (ft)	WA StatePlane N Y (ft)	UTM 11N X (m)	UTM 11N Y (m)	River Segment	Map No.	Approximate River Mile
95	8	095-08	2316272	623372	423768	5391868	UMF	A7-4	709.6
95	9	095-09	2316239	623164	423755	5391805	UMF	A7-4	709.6
95	10	095-10	2316205	622951	423742	5391741	UMF	A7-4	709.6
96	1	096-01	2315325	623943	423489	5392056	UMF	A7-4	709.5
96	2	096-02	2315471	623891	423533	5392038	UMF	A7-4	709.5
96	3	096-03	2315613	623840	423575	5392021	UMF	A7-4	709.5
96	4	096-04	2315796	623775	423630	5391998	UMF	A7-4	709.6
96	5	096-05	2315983	623709	423686	5391975	UMF	A7-4	709.6
96	6	096-06	2316125	623659	423728	5391958	UMF	A7-4	709.6
96	7	096-07	2316333	623585	423790	5391932	UMF	A7-4	709.7
96	8	096-08	2316421	623554	423817	5391921	UMF	A7-4	709.7
96	9	096-09	2316560	623505	423858	5391904	UMF	A7-4	709.7
96	10	096-10	2316847	623403	423944	5391869	UMF	A7-4	709.7
97	1	097-01	2314661	623752	423284	5392008	UMF	A7-4	709.4
97	2	097-02	2314712	623610	423297	5391964	UMF	A7-4	709.4
97	3	097-03	2314762	623469	423310	5391920	UMF	A7-4	709.4
97	4	097-04	2314813	623327	423324	5391876	UMF	A7-4	709.4
97	5	097-05	2314863	623185	423337	5391833	UMF	A7-4	709.4
97	6	097-06	2314914	623044	423350	5391789	UMF	A7-4	709.4
97	7	097-07	2314965	622902	423363	5391745	UMF	A7-4	709.4
97	8	097-08	2315015	622760	423377	5391701	UMF	A7-4	709.4
97	9	097-09	2315066	622619	423390	5391657	UMF	A7-4	709.4
97	10	097-10	2315116	622477	423403	5391613	UMF	A7-4	709.4
98	1	098-01	2313604	623463	422958	5391936	UMF	A7-4	709.2
98	2	098-02	2313666	623322	422975	5391892	UMF	A7-4	709.2
98	3	098-03	2313728	623181	422992	5391849	UMF	A7-4	709.2
98	4	098-04	2313791	623041	423008	5391805	UMF	A7-4	709.2
98	5	098-05	2313853	622900	423025	5391761	UMF	A7-4	709.2
98	6	098-06	2313916	622759	423042	5391717	UMF	A7-4	709.2
98	7	098-07	2313978	622619	423059	5391674	UMF	A7-4	709.2
98	8	098-08	2314040	622478	423076	5391630	UMF	A7-4	709.2
98	9	098-09	2314103	622337	423093	5391586	UMF	A7-4	709.2
98	10	098-10	2314165	622197	423109	5391542	UMF	A7-4	709.2
99	1	099-01	2312699	623243	422679	5391883	UMF	A7-4	709.0
99	2	099-02	2312732	623085	422687	5391835	UMF	A7-4	709.0
99	3	099-03	2312765	622928	422695	5391786	UMF	A7-4	709.0
99	4	099-04	2312798	622770	422702	5391738	UMF	A7-4	709.0
99	5	099-05	2312832	622612	422710	5391689	UMF	A7-4	709.0
99	6	099-06	2312865	622454	422718	5391640	UMF	A7-4	709.0
99	7	099-07	2312898	622296	422725	5391592	UMF	A7-4	709.0
99	8	099-08	2312931	622139	422733	5391543	UMF	A7-4	709.0
99	9	099-09	2312964	621981	422741	5391495	UMF	A7-4	709.0
99	10	099-10	2312997	621823	422748	5391446	UMF	A7-4	709.0
100	1	100-01	2311954	623169	422451	5391872	UMF	A7-4	708.9
100	2	100-02	2311989	623003	422460	5391821	UMF	A7-4	708.9
100	3	100-03	2312025	622837	422468	5391770	UMF	A7-4	708.9
100	4	100-04	2312060	622671	422476	5391719	UMF	A7-4	708.9
100	5	100-05	2312096	622505	422484	5391668	UMF	A7-4	708.9
100	6	100-06	2312131	622338	422493	5391616	UMF	A7-4	708.8
100	7	100-07	2312167	622172	422501	5391565	UMF	A7-4	708.8
100	8	100-08	2312202	622006	422509	5391514	UMF	A7-4	708.8
100	9	100-09	2312238	621840	422518	5391463	UMF	A7-4	708.8
100	10	100-10	2312273	621674	422526	5391412	UMF	A7-4	708.8

Notes:
CB – China Bend
DME – Deadman's Eddy
UMF – Upstream of Marcus Flats
UTM – Universal Transvers Mercator

Table B2-1. Data Acquisition Equipment and Operation

Survey Method	Data Type	Equipment / Instrumentation	Operation	SOP Reference (Attachment A2 to Appendix A)
MBES Bathymetry and Backscatter	Bottom soundings	MBES with integrated sound velocity sensor	Approx. 300-450 kHz	SOP-1
	Acoustic backscatter	MBES configured for normalized time-series data collection		
	Sound velocity profile	CTD probe	Configured to measure conductivity, temperature and depth	
	Positioning	Survey grade RTK GNSS and MRU		SOP-4
Underwater Video/photo	Still images	Drop-frame with digital SLR camera with wide-angle lens and LED lights for low-light conditions	ISO configured for lighting conditions Time stamp	SOP-2
	Scale	Laser pointers set at know distance (approximately 102 mm or 4 inches)		
	Video	Digital video camera		
	Drop-frame elevation above riverbed	Altimeter		
	Positioning	Survey grade RTK GNSS		SOP-4
ADCP Velocity Profiles	Velocity profiles	ADCP	600 or 1200 kHz and appropriate water mode (WM) for depth, sensor, and conditions	SOP-3
	Depth	200 kHz single beam sonar or lead line	Point	
	Positioning	Survey grade RTK GNSS and MRU		SOP-4

Notes:
ADCP – acoustic Doppler current profile
CTD – conductivity, temperature, and depth
GNSS – global navigation satellite system
ISO - International Organization for Standardization
MBES – multi-beam echo-sounder
MRU – motion reference unit
RTK – real-time kinematic
SLR – single lens reflex
SOP – standard operating procedure

Table B4-1. Measurement Quality Objectives

Data Type	Data Deliverable	Utility for Sediment Facies Mapping	Data Quality Requirements (Drivers for Specifications)	Performance Criteria (Specifications)
Multibeam Bathymetry				
	Bathymetric surface *Format: DEM in one of several formats (e.g., GeoTIFF), with FGDC metadata [a] included*	Riverbed elevation and geomorphology Quantitative data for substrate mapping (derivatives such as slope, aspect, rugosity)	Full bathymetric coverage throughout Upper Reach OU (i.e., no data gaps filled by interpolation in postprocessing)	100 percent quality bathymetric coverage to water depth supported by MBES instrumentation (expected 2 m to 3 m depth contour)
	Raw multibeam data files [b]		Spatial resolution to support meter-scale project MMU of 1 m x 1 m	Spatial resolution to support MMU: 1 m x 1 m MMU = 50 cm x 50 cm bathymetric data resolution
	Ancillary data (sound velocity profiles, GPS files, etc.) [b, c]		High horizontal/vertical accuracy and precision with position checks relative to the Washington State Reference Network	RTK GPS positioning with position checks relative to the Washington State Reference Network Bathymetric survey meeting or exceeding the applicable standards established by the USACE Engineering and Design Manual for Hydrographic Surveying (EM 1110-2-1003) (USACE 2013) Crossline analysis using data acquired along additional survey lines oriented perpendicular to the main survey lines to provide information to define overall survey accuracy. Crosslines are gridded at the same resolution as main scheme (primary) lines and analyzed. Ninety-five percent of the data (2 sigma) must meet or exceed the vertical accuracy requirement (10 cm).

Table B4-1. Measurement Quality Objectives

Data Type	Data Deliverable	Utility for Sediment Facies Mapping	Data Quality Requirements (Drivers for Specifications)	Performance Criteria (Specifications)
Multibeam Backscatter				
	Normalized/calibrated backscatter image (time series) *Format: GeoTIFF, with FGDC metadata [a] included* Raw multibeam data files [d] Ancillary data (sound velocity profiles, GPS files, etc.) [b, c]	Riverbed texture and roughness Quantitative data for substrate mapping (return is primarily related to sediment grain size and bottom texture)	Differentiate sediment composition (percent of grain size fractions) and textures (mixtures of different grain size fractions) Full coverage throughout Upper Reach OU and spatially coincident with multibeam bathymetry Normalized/calibrated backscatter intensity with units in absolute dB Inter- and intra-sonar calibration for consistency and repeatability Spatial resolution to support meter-scale project MMU of 1 m x 1 m	Simultaneous acquisition with multibeam bathymetry for native coregistration of bathymetry and backscatter Spatial resolution to support MMU: 1 m x 1 m MMU = 50 cm x 50 cm bathymetric data resolution SOP that describes corrections and/or calibrations for source level and transmit/receive beam patterns; if using multiple systems, perform backscatter comparison (patch test) to confirm consistency and repeatability; see SOP-1 in Attachment A2 to Appendix A

Table B4-1. Measurement Quality Objectives

Data Type	Data Deliverable	Utility for Sediment Facies Mapping	Data Quality Requirements (Drivers for Specifications)	Performance Criteria (Specifications)
Underwater Video/Photo				
	Georeferenced video/photo files in native resolution	Visual interpretation of sediment grain size composition using image processing software	Image quality to support: 1) Differentiation between sediment <2 mm and >2 mm	RTK GPS positioning [b] Lasers or scale bar included for scale
	Point data file containing interpreted grain size composition (percentage of each grain size class) for each photo location *Format: ESRI Shapefile, with FGDC metadata [a] included*	Point data for training and validation of backscatter sediment classification method	2) Differentiation between primarily sand areas and areas of sand mixed with gravel, cobbles, and/or boulders Positioning precision and accuracy comparable to or better than multibeam data Assessment of variability and precision variability of imagery collection and interpretation	Position/time data included in video to facilitate extraction of individual photos Manual classification of sediment composition for 10 percent of photographs to verify results from automated image analysis RPD of percent of sediment less than 2 mm as determined from analysis of duplicate images collected at 5 percent of imagery/ADCP measurement locations [e]

Table B4-1. Measurement Quality Objectives

Data Type	Data Deliverable	Utility for Sediment Facies Mapping	Data Quality Requirements (Drivers for Specifications)	Performance Criteria (Specifications)
ADCP				
	Point data file containing calculated coefficient of friction and apparent roughness height for each location *Format: ESRI Shapefile, with FGDC metadata [a] included* Vector point data [d] *Format: ASCII text file, with x, y, z, time, u, v, w* *(Two ASCII files of velocity data provided: raw data and spatially/temporally averaged data)* Raw ADCP data files [f]	Point data to supplement sediment facies mapping Quantitative data for subsequent Phase 3 Sediment Study sample designs and/or potential future sediment transport modeling	3-m radius spatial averaging, as deemed appropriate by designated survey design and hardware specifications 0.01 to 0.5 m depth averaging, as deemed appropriate by water depth, designated survey design, and hardware specifications Assessment of variability and precision of sediment bed roughness parameters derived from ADCP measurements	RTK GPS positioning [b] Vessel position maintained within 3 m radius of target location ADCP data points falling outside of 3 m averaging radius excluded from the final spatially/temporally averaged values SOP that describes corrections and/or calibrations (i.e., compass calibration, moving-bed tests) to USGS suggestions for accuracy and precision (USGS Techniques and Methods 3–A22; Mueller and Wagner 2009); see SOP-3 in Attachment A2 to Appendix A. RPD of sediment bed roughness parameters (apparent roughness height and coefficient of friction) calculated from primary and duplicate ADCP measurements at 5 percent of imagery/ADCP measurement locations [g]

Notes:

[a] Federal Geospatial Data Committee (FGDC) metadata will include source of primary (raw) data and all associated postprocessing performed to create the final geospatial data.

[b] Raw data files for global positioning system (GPS) and multibeam echosounder (MBES) will include time stamps to allow postprocessing kinematic corrections, if necessary.

[c] Raw data and ancillary data files will be archived in a separate database from the digital elevation model (DEM) and not posted on the project database web tool. These data will be available upon request.

[d] Raw data and ancillary data files will be archived in a separate database from the backscatter image geo-referenced tagged image file format (GeoTIFF) and not posted on the project database web tool. These data will be available upon request.

[e] Duplicate photographs will be collected at 5% of the imagery locations. After collecting the primary photograph, a duplicate photograph will be collected by leaving the drop frame on the sediment for about 5 to 10 minutes and then capturing a second photograph. This approach will capture temporal variability (lighting, suspended solids in the water column, sediment bed disturbance) and variability in image interpretation without effects from small-scale spatial sediment bed heterogeneity, which would confound comparison of duplicate photographs if not collected from the same location. Variability and precision between the primary and duplicate image analyses would be reported as the percent of sediment less than 2 mm for each photograph and the associated relative percent difference (RPD).

[f] Raw acoustic Doppler current profile (ADCP) data files and vector point data will be archived in a separate database from the point data file containing calculated coefficient of friction and apparent roughness height and not posted on the project database web tool. These data will be available upon request.

[g] ADCP duplicate measurements will be collected at 5% of the measurement locations. ADCP data from the duplicate measurements will be postprocessed independently of the primary measurements to generate paired sediment bed roughness parameters (apparent roughness height and coefficient of friction). The paired values and associated RPD will be reported to provide an indication of variability and precision of values derived from ADCP measurements.

ASCII – American Standard Code for Information Interchange
ESRI – Environmental Systems Research Institute
MMU – minimum mapping unit
OU – operable unit
RTK – real-time kinematic
SOP – standard operating procedure
USACE – U.S. Army Corps of Engineers
USGS – U.S. Geological Survey

APPENDIX A

FIELD SAMPLING PLAN FOR THE PHASE 3 SEDIMENT STUDY – SEDIMENT FACIES MAPPING SURVEY

CONTENTS

LIST OF MAPS

LIST OF TABLES

ACRONYMS AND ABBREVIATIONS

ABS	acoustic backscatter
ADCP	acoustic Doppler current profiling
AOI	area of interest
BERA	baseline ecological risk assessment
CB	China Bend
COPC	constituent of potential concern
DEM	digital elevation model
DME	Deadman's Eddy
DSLR	digital single-lens reflex
EPA	U.S. Environmental Protection Agency
FCC	Federal Communications Commission
FSP	field sampling plan
GNSS	global navigation satellite system
HD	high definition
LOE	level of effort
MBES	multibeam echosounder
MRU	motion reference unit
NGS	National Geodetic Survey
OU	operable unit
QA	quality assurance
QA/QC	quality assurance and quality control
QAPP	quality assurance project plan
QC	quality control
RI/FS	remedial investigation and feasibility study
RM	river mile
RPD	relative percent difference
RTK	real-rime kinematic
SHSP	site health and safety plan
Site	Upper Columbia River site
SLR	single-lens reflex
SOP	standard operating procedure
TAI	Teck American Incorporated
UCR	Upper Columbia River
UMF	upstream of Marcus Flats
USACE	U.S. Army Corps of Engineers
UTM	Universal Transvers Mercator
WSRN	Washington State Reference Network

UNITS OF MEASURE

cm	centimeter(s)
ft	foot/feet
in.	inch(es)
kHz	kilohertz
m^2	square meter(s)
MB	megabyte
m	meter(s)
mm	millimeter(s)
m/s	millisecond(s)

1 INTRODUCTION

This document presents the field sampling plan (FSP) for the Phase 3 Sediment Study Sediment Facies Mapping (hereafter referred to as the "study") Quality Assurance Project Plan (QAPP) for the Upper Columbia River (UCR, hereafter the Site[1]). Information collected in this study will be used to support the baseline ecological risk assessment (BERA) and remedial investigation and feasibility study (RI/FS) being completed by Teck American Incorporated (TAI).

The primary objective of this study is to collect high-resolution data to identify and map sediment grain size fractions and texture of the UCR sediment bed. Further characterization of sediment bed attributes is needed to inform and support other subsequent Phase 3 efforts to characterize sediment chemistry and reduce uncertainties regarding potential risk to benthos.

1.1 OVERVIEW

The UCR riverbed is composed of substrates that include mixtures of unconsolidated fine-grained sediments (i.e., sediments < 2 mm), gravels, cobbles, and rock. Sediment organisms utilize these substrates differentially and constituent of potential concern (COPC) concentrations may differ as a function of sediment composition and bed characteristics, with finer-grained deposits potentially containing granulated slag, which may be a source of elevated concentrations of COPCs. Sediment (or sedimentary) facies describe physical, chemical, and biological aspects of bed composition. In the Upper Reach Operable Unit (OU) portion of the UCR (Map A1), the larger grain sizes are very common and create sediment facies that are discontinuous and highly variable. This study will focus on acquisition of high-resolution data covering nearly all the riverbed, identifying areas where finer-grained sediments predominate hence refining the understanding of riverbed physical characteristics, particularly grain size fractions and texture. Further characterization of sediment facies and related bed attributes (e.g., geomorphology) is needed to inform and support subsequent Phase 3 efforts to characterize sediment chemistry and reduce uncertainties regarding the potential risk to benthos.

[1] The UCR Site as defined within the June 2, 2006, Settlement Agreement is the areal extent of hazardous substances contamination within the United States in or adjacent to the Upper Columbia River, including the Franklin D. Roosevelt Lake, from the U.S. – Canada border to the Grand Coulee Dam, and those areas in proximity to the contamination that are suitable and necessary for implementation of response actions.

The following types of information will be acquired during this study:

- High-resolution acoustic data collected using a multibeam echosounder (MBES) to express bathymetry in terms of sediment bed elevations (tied to known horizontal and vertical elevation benchmarks) and acoustic backscatter to relate acoustic signals to sediment composition (grain size fractions and texture)
- Georeferenced video images of sediment bed composition that include a scale of known dimensions such that predominant grain sizes and the occurrence of large clasts can be inferred
- Acoustic Doppler current profiler (ADCP) velocity profile measurements to estimate flow resistance (e.g., apparent roughness height and coefficient of friction) and other hydrodynamic factors related to bed characteristics.

These data will be processed and subsequently interpreted to generate a sediment facies map to support development of remaining Phase 3 sediment study elements. Sediment facies mapping will be performed using sediment textures defined by sediment grain size fractions. MBES backscatter data will serve as the primary source data for determining sediment compositions (grain size fractions), guided by empirical and analytical data obtained or derived from imagery analysis, MBES bathymetry, and/or ADCP measurements.

1.2 ORGANIZATION

This FSP describes field methods that will be used to characterize the sediment bed. Section 2 of this FSP describes the field procedures that will be followed. Section 3 describes the procedures for field documentation. References cited in this document are listed in Section 4.

Attachments to this FSP are:

- **Attachment A1—General Site Health and Safety Plan (SHSP) Addendum.** Describes site-specific requirements and procedures to minimize the safety risk to personnel who carry out the field study program.[2]

[2] Subcontractors that are contracted to perform field work associated with the RI/FS may adopt the general SHSP and this Addendum or develop and follow their own SHSPs; however, subcontractor SHSPs must be consistent with the provisions outlined in the Addendum and the general SHSP, and any discrepancies will follow the most protective practices.

- **Attachment A2—Standard Operating Procedures (SOPs).** Detailed field procedures to be used include:
  - SOP-1—Multibeam Echosounder (MBES) and Acoustic Backscatter Survey for Riverbed Classification
  - SOP-2—Drop Camera Surveys
  - SOP-3—Acoustic Doppler Current Profiler (ADCP) Operation and Deployment
  - SOP-4—Vessel Positioning.
- **Attachment A3—Examples of Various Field Forms.** Contains examples of various forms that will be used during field surveying (change request form, protocol modification form, and photograph log).

2 SURVEY METHODOLOGY AND PROCESSING

This section describes procedures and methods that will be used during the study, including MBES surveys, georeferenced video and imagery collection, collection of ADCP velocity profiles, record keeping, and field quality control (QC) procedures. All procedures will be conducted in accordance with the SOPs, provided in Attachment A2. Depending on field conditions, procedures specified in the referenced SOPs may be modified if necessary, in consultation with the U.S. Environmental Protection Agency (EPA) and documented in a Protocol Modification Form or Change Request Form (Attachment A3).

2.1 SURVEY AREAS

The EPA issued a level of effort (LOE) to TAI dated January 8, 2018, requiring additional characterization (i.e., sediment bed mapping and nature and extent sampling) to determine the spatial extent of areas in the upper reaches of the Site, where sediments potentially toxic to benthic organisms might be present. EPA identified these reaches as the Upper Reach Operable Unit (OU), which encompasses the UCR from Marcus Flats at river mile (RM) 708 to the international border north of RM 744 (Map A1). Through discussions that followed issuance of the LOE, TAI and EPA agreed that sediment bed mapping would be conducted through the entire Upper Reach OU, and additional sediment nature and extent characterization will be conducted in three areas of interest (AOIs): 1) Deadman's Eddy, 2) China Bend, and 3) an area upstream of Marcus Flats (Map A1).

This study will be performed throughout the Upper Reach OU, with particular focus on the three Phase 3 sediment AOIs where subsequent Phase 3 sediment investigations will be performed. High-resolution bathymetry and backscatter data will be acquired throughout the Upper Reach OU using a full-coverage MBES survey. Underwater video images and ADCP velocity profiles will be acquired at point locations along transects throughout the Upper Reach OU and with increased frequency within the three AOIs (see Maps A2 through A5). Point locations for underwater video images and ADCP measurements are listed in Table A1.

2.2 FIELD SURVEY METHODS

It is anticipated that the survey will be carried out by one or more teams consisting of three to four people each. The primary role of the survey team will be to operate the research vessel and survey equipment and to prioritize the areas to be visited by the survey team. Mobilization to areas will be via vehicles suitable for traversing unmaintained dirt roads.

2.3 TASK SCHEDULE

Subject to EPA approval, the field survey is expected to be conducted in one event, and for safety and accessibility reasons, it will be timed to occur when the reservoir is at or near high pool and low flow (typically late August through October).

Prior to field survey activities, a detailed schedule will be prepared by the field survey crew to facilitate planning and scheduling of EPA oversight personnel.

2.4 FIELD EQUIPMENT AND SUPPLIES

Field equipment and supplies anticipated for this study are detailed in each of the task SOPs and include a research vessel, a MBES, an underwater drop camera, an ADCP, field logbooks (or electronic tablet) (see SOPs in Attachment A2 for details).

2.5 METHODS

This section describes survey methods that will be implemented in the field. These methods are supported by SOPs and summarized in the following subsections. The amount of background information and level of detail provided in the SOPs varies somewhat from method to method, with generally more detail provided in SOP-3 (ADCP surveys) and SOP-4 (vessel positioning) than in SOP-1 (MBES surveys) and SOP-2 (drop camera surveys). Additional detail is provided in SOP-3 to help explain this somewhat nonroutine application of ADCP measurements to support sediment facies mapping, versus more typical applications of ADCP such as for calculating discharge. For SOP-4, additional detail is included to help attain the highest possible precision for positioning and mapping products.

2.5.1 MBES Surveys

Sonar surveys will be conducted using a MBES to provide both bathymetric profiles and acoustic backscatter (ABS) of the riverbed. MBES procedures are described in SOP-1 in Attachment A2.

The MBES Survey will consist of contiguous swaths with sufficient overlap to ensure quality coverage (e.g., 50 percent overlap). This survey will provide a gridded dataset of riverbed bathymetry and morphology, and, when correlated with ABS data, a two--dimensional extent of surface sediment characteristics.

Processed data will be exported to a GIS platform to create a digital elevation model (DEM) and an ABS mosaic map. Refer to SOP-1 in Attachment A2 for more details.

2.5.2 Drop Camera Surveys

Procedures for underwater imagery collection are provided in SOP-2 in Attachment A2. The photo record will capture the primary attributes of the substrate such as bottom type, texture, small bedforms, indications of disturbance, unusual features, and embeddedness. The photo record will also provide ground-truthing of the sediment type that may be interpreted from the MBES data.

A video imaging drop camera system that contains both a high definition (HD) video camera and a still-frame single-lens reflex (SLR) camera to collect images of the sediment bed. Underwater imagery collection will be co-located with ADCP measurements and will be performed at discrete point locations along transects as shown in Maps A2 through A5 and listed in Table A1.

Outside of the three AOIs, transects will have a nominal spacing of 0.5 mile.

Within AOIs for Deadman's Eddy (approximately RM 738 to RM 739), China Bend (approximately RM 721 to RM 722), and upstream of Marcus Flats (approximately RM 707 to RM 709), transects will have a nominal spacing of 0.25 mile. Video images (and ADCP measurements) will be acquired at ten locations along each transect within the AOIs and at up to five discrete locations along each transect outside of the AOIs. Transects will be oriented perpendicular to the flow path of the river to provide representative coverage of the riverbed (e.g., near-left bank, near-left thalweg edge, mid-thalweg, near-right thalweg edge, near-right bank). The closer spacing of transects and higher density of underwater video image and ADCP measurement points along transects in the AOIs is intended to help ensure that imagery and ADCP measurements are collected from the full representative range of acoustic signatures and geomorphic features in these areas.

The location and orientation of transects and point locations for ADCP and imagery data acquisition within the AOIs were selected to reflect anticipated geomorphological characteristics of the river, including submerged bars, benches, terraces, and relative to the river thalweg based on review of existing river bathymetry and MBES backscatter data.

Ad hoc imagery acquisition (and ADCP measurement) locations along transects may be added in the field at the time of data collection, as described in Section 2.7.2. In addition, transects and survey areas may require adjustment in the field as a consequence of physical access constraints (e.g., shoals and other water depth limitations) and safety considerations. Duplicate measurements at 5 percent of the locations will be collected to assess the precision and variability of image collection and analysis.

After completion of the field drop camera survey, images from each location will be interpreted to quantify the percent grain size fraction composition within the field of view. Image processing and analysis are described in Section 2.7.2 below and in Attachment A2, SOP-2.

2.5.3 ADCP Surveys

ADCP procedures are provided in SOP-3 in Attachment A2. At each station, the ADCP will record a minimum of 300 ensembles (or velocity profiles) at regular, consistently sized bin intervals (e.g., 1 m). The log-fit method will be used to calculate apparent roughness height and a bottom coefficient of friction for each point location.

ADCP measurements will be co-located with the underwater imagery collection point locations. Duplicate ADCP measurements will be collected at 5 percent of the locations, analyzed independently, and compared to primary measurement to assess the variability and precision of sediment bed roughness parameters derived from ADCP measurements.

2.5.4 Vessel Positioning

Because the surveys require higher position accuracy (less than 1 m) than what a typical differential GPS can provide, a real-rime kinematic (RTK) positioning configuration will be used. RTK is a code-based positioning system that uses carrier-based ranging to provide high accuracy position corrections. RTK positioning can provide GPS corrections up to centimeter accuracy. SOP-4 describes procedures for vessel positioning that will be used during the studies.

All position information will be acquired such that postprocess kinematic corrections can be performed relative to the Washington State Reference Network (WSRN). The primary control network for the project will be the WSRN. In areas of good cellular coverage, RTK satellite signal correctors will be acquired from the WRSN real-time broadcast and applied to global navigation satellite system (GNSS) receivers for precise positioning. Due to the poor cellular coverage in some remote areas of the Site, RTK corrections will be sent to the vessel GNSS receiver system via radio broadcast when cellular service is not available or limited. With a Federal Communication Commission (FCC) license and programmed to FCC protocols, an RTK base station radio will be used that can broadcast at a power level of 5 watts (or 25 watts with a joint FCC and Canadian license).

Given the terrain of the survey area and the quality of the signal required, it is estimated that additional base stations may be required. Control point locations for GNSS base station sites will be selected with open sky access and on high ground to maximize both satellite coverage and radio broadcast range. Sites will be selected on land that is publicly owned, has access agreements, or on dry banks accessible by land or vessel. To provide control points for GNSS base station occupation, a control network will be established under the direction of a Washington-licensed land surveyor. In addition to base station control, the network will include control points suitably located for conducting position checks from the survey vessel for each base station deployment.

2.5.5 Data Processing and Analysis

Raw data files from the MBES survey will be processed using a software package used to create a gridded bathymetric data set and a DEM of the survey areas. This data will depict both bathymetric relief of the riverbed, as well as obvious morphologic features (e.g., rock outcrops, dunes, sand waves). ABS data will be extracted from MBES data at the same resolution and processed. Processed ABS data will be used to create a gridded ABS mosaic which will be used to map sediment facies over the survey areas. A more detailed description of data processing for sonar surveys is outlined in SOP-1.

Underwater images (primarily still-frame pictures) will be analyzed to determine the percent composition of surface sediments for each of the following grain size fractions:

- Bedrock
- Boulders and cobbles (> 64 mm)
- Gravels (> 2 to 64 mm)
- Sands (0.063 to 2 mm)
- Mud (< 0.063 mm; silts and clays).

Still images and video will also be analyzed to differentiate between primarily sand areas and areas of sand mixed with gravel/cobbles/boulders. Results from imagery interpretation will be compiled as point attributes in a GIS file.

ADCP data will be processed using software to produce a mean velocity depth profile from the ADCP raw data for each point measurement location. Apparent roughness height and a coefficient of friction will be derived from ADCP data using the log-profile method. A more detailed explanation of ADCP processing is included in SOP-3.

2.6 SURVEY CONTINGENCIES

Field crews will attempt to conduct survey measurements along all planned transects and sampling intervals across the channel. If a planned location cannot be surveyed due to physical access or safety constraints, field crews will adjust locations and collect images and measurements at the nearest location without access or safety constraints. Field crews may not be able to acquire data in locations such as Little Dalles[3] due to safety considerations; such locations will be visually assessed in the field to decide whether conditions are conducive to safely conducting the survey.

[3] Little Dalles poses a safety hazard for field surveys due to the presence of Class 3 rapids.

2.7 QUALITY ASSURANCE

2.7.1 MBES Surveys

The U.S. Army Corps of Engineers (USACE) hydrographic surveying manual (USACE 2013) provides guidance for quality assurance (QA) and quality control (QC) for this bathymetric survey. Survey results will be tied to known elevation and locational benchmarks to document survey accuracy, precision, and overall quality. The survey team will comply with the calibration and control criteria recommended by the USACE manual for general surveys and studies.

A calibration patch test must be performed when sonar configuration has changed. As a best practice, start-of-project and end-of-project patch tests will also be performed. Latency, roll, pitch, and yaw tests will be performed daily or at predefined transects as described in SOP-1. Patch test data will be processed to find angular offsets. Sound velocity casts will be acquired a minimum of hourly, when the sonar surface sound velocity sensor detects more than two meters per second change in sound velocity, or when the hydrographer suspects changes in the sound velocity profile.

A crossline analysis will be conducted to evaluate overall system performance and assess survey accuracy against project requirements. Crosslines will be acquired once per day in a relatively flat area avoiding steep slopes. Crosslines will also be acquired after any modification to the survey system that would impact the computation of depth or position.

To preserve data quality, sounding frequency will be increased with increased vessel speed to maintain a target minimum density of one sounding per 50 cm. For planning purposes, an optimum survey speed over ground of approximately 4 to 6 knots will be targeted. In some areas, the minimal steerable speed may prevent achieving the target minimum density.

More detail for MBES quality assurance/quality control (QA/QC) can be found in SOP-1.

2.7.2 Drop Camera Surveys

The SLR drop camera will be calibrated daily. Because the frame holds the camera at a known distance above the seabed, the scaling lasers can be quickly adjusted on the vessel deck. To adjust laser scales, a calibration picture will be captured daily with the SLR camera showing the lasers and a ruler. Camera focus will also be set daily using a calibration card (e.g., Canon calibration card or comparable) on the deck. Finally, the SLR camera time stamp will be synchronized with vessel computer time. After scale, time, and focus parameters have been verified, the system is ready for deployment.

All images and video will be recorded using a HD recording system and digitally stamped

with date and time. Both HD video and digital single-lens reflex (DSLR) live-view images will be viewed on the vessel. One image will be captured on the riverbed and one minute of video will be recorded with each camera deployment. Video will be used as a backup image analysis in the event the still image captured from the SLR camera is blurry, improperly exposed, or the resolution quality is insufficient for postprocessing and analysis. Images will be observed and assessed in real-time at each of the drop locations. If clearly defined geomorphological features are observed from the live feed or based on a review of bathymetry or acoustic backscatter data, additional images may be collected ad-hoc along transects to help ensure that images collected represent the full range representative acoustic signatures and geomorphic features.

To provide an indication of variability and precision of image collection and analysis, duplicate photographs will be collected at 5 percent of the imagery locations. After collecting the primary photograph, a duplicate photograph will be collected by leaving the drop frame on the sediment for about 5 to 10 minutes and then capturing a second photograph. This approach will capture temporal variability (lighting, suspended solids in the water column, sediment bed disturbance) and variability in image interpretation without effects from small-scale spatial sediment bed heterogeneity, which would confound comparison of duplicate photographs if not collected at the same location. Variability and precision between the primary and duplicate image analyses will be reported as the percent of sediment less than 2 mm for each photograph and the associated relative percent difference (RPD).

2.7.3 ADCP Surveys

ADCP current meters measure water velocity throughout the water column by transmitting an acoustic signal of known frequency and inferring water velocity from the Doppler shifted frequency of the reflected signal. The package consists of four Doppler transducers (send and receive). Three of the transducers measure velocity in three dimensions: u, v, and w. The fourth transducer head on the ADCP provides a built-in error estimate of the errors in measuring water velocities (u, v, and w). Because the geometry of the transducer heads is fixed (e.g., 20 degrees rotation out of the horizontal plane) the uncertainty estimates of the upwelling/downwelling term, w, will be larger than for the horizontal components u (east-west) and v (north-south). The ADCP software will also measure correlation, or the measurement of how much the particle distribution has changed between the outgoing and reflected signal, and is a measure of the signal-to-noise ratio. A low change in distribution will result in a high correlation, with an acceptable value of strong correlation being greater than 128 counts. As an additional QA check, only pings with strong correlations between the outgoing and reflected signals will be retained.

Boat captains will maintain vessel position as close to the target location as possible given the river current and wind conditions. Only pings collected within 3 m of the target station will be accepted for use in calculating flow resistance characteristics at a given station. Data collected outside of 3 m will be excluded from processing but still recorded and archived.

To provide an indication of variability and precision of values derived from ADCP measurements, sequential duplicate 300-ensemble samples will be collected at 5 percent of the measurement locations, using the same anchored point on station to conduct the duplicate measurements. The roughness length and coefficient of friction will be calculated from each duplicate measurement set and compared to the calculated values from the primary measurement at the station. The paired values and associated RPD will be reported to provide an indication of variability and precision of values derived from ADCP measurements.

2.7.4 Horizontal and Vertical Position Checks

Horizontal and vertical accuracies will be checked daily, or whenever the base station is moved, to ensure the reference GNSS base station height and position was entered correctly and the navigation and acquisition software is using the correct geodetic parameters. Horizontal and vertical position checks are described in Attachment A2, SOP-4.

2.8 CULTURAL RESOURCES

The bathymetry data collection and underwater imagery equipment is noninvasive and will not result in ground disturbance. Therefore, the UCR Cultural Resources Working Group is not requiring a professional archaeologist or tribal representative for this sediment facies mapping study, although a monitor may opt to participate at any time. In the event suspected or evident artifacts or other archaeological deposits are encountered when an archaeological monitor or Tribal representative is not present, the immediate vicinity of the discovery will be secured and appropriate notifications will be made by the TAI project coordinator or designee per the Site cultural resources coordination plan (QAPP Appendix B).

2.9 STUDY-DERIVED WASTE

All disposable materials and supplies used for the survey and processing (e.g., paper towels, gloves) will be placed in heavyweight garbage bags or other appropriate containers. This waste will be placed in a normal refuse container for disposal at a solid waste landfill.

3 FIELD DOCUMENTATION

Field notes will be taken during all survey activities in field logbooks that will be stored by the field supervisor. Following each day of surveying, a daily summary report will be sent electronically to the field supervisor. The report will provide a summary of work completed, including: number of MBES swaths completed, number of imagery/ADCP transects and locations completed, number of ad hoc imagery/ADCP locations added (if any), and a summary of any issues and associated corrective actions.

3.1 FIELD LOGBOOK

All field activities and observations will be noted in a field logbook (refer to SOP-1 through SOP-3 for details). The field logbook will be either a bound document containing individual field forms or an electronic tablet (backed up daily) containing the same documentation. Information will include personnel, date, time, survey event, equipment deployed, and general observations. Any changes that occur during the survey (e.g., personnel, responsibilities, deviations from the FSP) and the reasons for these changes will be documented in the field logbook. The logbook will identify onsite visitors (if any) and the number of photographs taken at each survey location. The field supervisor is responsible for ensuring that the field logbook and all field forms are correct; if electronic records are kept, the field supervisor will daily upload those records to the secure project website, or as often as practical. Requirements for keeping logbooks include the following:

- If paper logbooks are used
  - Logbooks will be bound all-weather paper, with consecutively numbered pages.
  - Removal of any pages, even if illegible, will be prohibited.
  - Entries will be made legibly with black (or dark) waterproof ink.
  - Corrections will be made by drawing a single line through the original entry, with the corrected entry written alongside the original. Corrections will be initialed and dated and may require a footnote for explanation.
- The first entry of each day will be made on a new, blank page
- Easy to understand, descriptive language will be used
- Entries will be made while activities are in progress or as soon afterward as possible (the date and time that the notation is made should be noted, as well as the time of the observation itself)

- Blank lines on a page or blank pages in the logbook will be lined out to indicate that the pages were intentionally left blank
- The date and time, based on a 24-hour clock (e.g., 0900 for 9:00 am and 2100 for 9:00 pm), will appear on each page
- The field supervisor must sign and date the last page of each daily entry in the field logbook (either electronic or hardcopy).

In addition to the preceding requirements, if a paper logbook is used, the person recording the information must initial and date each page of the field logbook. If more than one individual makes entries on the same page, each recorder must initial and date each entry. The bottom of the page must be signed and dated by the individual who makes the last entry. The field supervisor, after reading the entries for that day, also must sign and date the last page of each daily entry in the field logbook.

The type of information that may be included in the field logbook includes the following:

- Task name and survey location(s)
- Survey type (MBES, drop camera, or ADCP)
- Task start date and end date
- Weather conditions
- Name of person making entries and other field staff (including EPA oversight personnel)
- Onsite visitors, if any
- Date of survey and start and end times
- The survey location name(s)
- Names of persons obtaining and reviewing images/video
- Names of persons operating vessel and/or equipment
- Weather conditions (and/or any changes in weather)
- Water depths
- Coordinates of control points, drop camera stations, and ADCP stations
- Specific information on each type of survey activity
- Observations made during the survey
- Number of photographs taken at each survey location
- A record of site health and safety meetings, updates, and related monitoring
- Any deviation from the QAPP or FSP and reasons for deviation.

It is advisable to, when possible, photocopy entries for each day to provide a backup copy that can be kept at a secure location (e.g., hotel room). When field activities are complete, the logbook(s) will be retained by TAI and its technical team as hardcopy and/or pdf files. These documents will be entered into the TAI technical team project file.

3.2 ELECTRONIC DATA

During all three surveys, a significant amount of electronic data will be collected each day. Raw and processed data files from all instrumentation will be saved and organized according to each survey and instrument type.

Separate folders will be made for each survey type (i.e., MBES, ADCP, Imagery), and data will be saved at the end of each day in separates subfolders matching the date of data acquisition. Additionally, if possible, data files will be saved with a date and time stamp, as well as an indication to the data type.

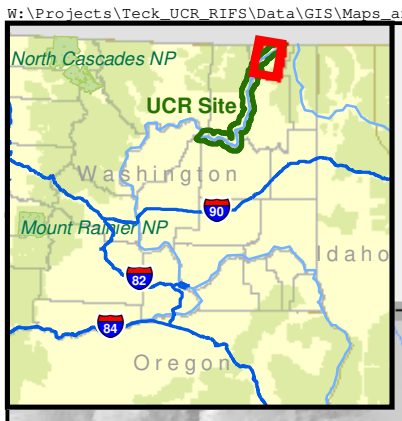
Data will be backed up daily, saving a copy of all data files to a secondary location (i.e., external hard drive). Additionally, data will be saved to a secure virtual location for safety and storage.

4 REFERENCES

USACE (U.S. Army Corps of Engineers). 2013. Engineering and design—Hydrographic surveying. Manual No. 1110-2-1003. U.S. Army Corps of Engineers, Washington D.C. November 30.

Maps

W:\Projects\Teck_UCR_RIFS\Data\GIS\Maps_and_Analyses\Sediment DQOs and QAPP\Sediment Facies Mapping QAPP\Field Sampling Plan\Map A1 6841 Upper Reach OU.mxd @ 08/24/2018



U.S. - Canada Border

RM 744

RM 740

Deadman's Eddy

Big Sheep Creek

Deadman's Eddy

North Fork Deep Creek

251

Northport

RM 730

Deep Creek

25

China Bend

China Bend

RM 720

South Fork Deep Creek

Cable Ferry Landing

Bossburg Flat Beach

Evans Campground

RM 710

Upstream of Marcus Flats

South Fork Deep Creek

Legend

- EPA Area of Interest
- Upper Columbia River
- Stream
- Populated Places
- State Highway
- Railroad
- River Mile (USGS)

Windward environmental LLC

0 2 4 Km

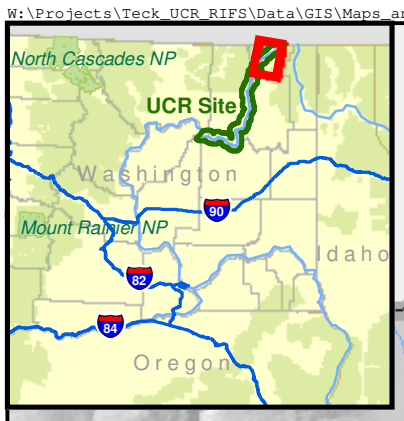
0 1 2 Miles

N

Map A1. **Upper Reach Operable Unit and Phase 3 Sediment Areas of Interest**

Upper Columbia River, WA

W:\Projects\Teck_UCR_RIFS\Data\GIS\Maps_and_Analyses\Sediment DQOs and QAPP\Sediment Facies Mapping QAPP\Field Sampling Plan\Map A2 6879 UROU Imagery and ADCP Transects.mxd @ 08/24/2018



U.S. - Canada Border

RM 744

RM 740

RM 730

RM 720

Deadman's Eddy
see Map A3 for photo transects

Deadman's Eddy

China Bend
see Map A4 for photo transects

China Bend

Upstream of Marcus Flats
see Map A5 for photo transects

Evans Campground

Bossburg

Flat Beach

Cable Ferry Landing

Northport

Big Sheep Creek

North Fork Deep Creek

Deep Creek

South Fork Deep Creek

251

25

Legend

- Photo Location
- Photo Transect
- EPA Area of Interest
- Upper Columbia River
- Stream
- Populated Places
- State Highway
- Railroad
- River Mile (USGS)

Windward environmental LLC

0 2 4 Km

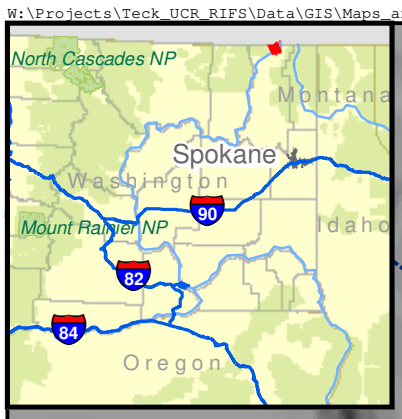
0 1 2 Miles

N

Map A2. **Upper Reach Operable Unit Imagery and Acoustic Doppler Current Profiler Transects**

Upper Columbia River, WA

W:\Projects\Teck_UCR_RIFS\Data\GIS\Maps_and_Analyses\Sediment DQOs and QAPP\Sediment Facies Mapping QAPP\Field Sampling Plan\Map A3 6880 Imagery and ADCP Transects - Deadmans Eddy.mxd @ 08/24/2018



Deadman's Eddy Area of Interest

012: 12-01, 12-02, 12-03, 12-04, 12-05

013: 13-01, 13-02, 13-03, 13-04, 13-05, 13-06, 13-07, 13-08, 13-09, 13-10

014: 14-01, 14-02, 14-03, 14-04, 14-05, 14-06, 14-07, 14-08, 14-09, 14-10

015: 15-01, 15-02, 15-03, 15-04, 15-05, 15-06, 15-07, 15-08, 15-09, 15-10

016: 16-01, 16-02, 16-03, 16-04, 16-05, 16-06, 16-07, 16-08, 16-09, 16-10

017: 17-01, 17-02, 17-03, 17-04, 17-05, 17-06, 17-07, 17-08, 17-09, 17-10

018: 18-01, 18-02, 18-03, 18-04, 18-05, 18-06, 18-07, 18-08, 18-09, 18-10

019: 19-01, 19-02, 19-03, 19-04, 19-05, 19-06, 19-07, 19-08

020: 20-01, 20-02, 20-03, 20-04, 20-05, 20-06, 20-07, 20-08, 20-09, 20-10

021: 21-01, 21-02, 21-03, 21-04, 21-05

RM 738

RM 737

251

Deadman's Eddy

Legend

- Photo Location
- Photo Transect
- Sample Location with Bulk Sediment Data[a]
- Refusal Location[b]
- EPA Defined Potential Depositional Feature Requiring Characterization[c]
- EPA Area of Interest
- September-October Water Level 1,292.8 ft[d]
- 1,290 ft
- Historical Thalweg
- State Highway
- Railroad
- River Mile (USGS)

[a] Sample locations shown are for Phase 1, Phase 2, and USGS studies.
[b] Refusal locations shown are for Phase 1, Phase 2, and beach studies.
[c] Source: Level of Effort for Nature and Extent of Sediment Contamination in Upper Reach Operable Unit (USEPA 2018a).
[d] 1,292.8 ft represents the approximate water level during the anticipated sampling period (September-October). This elevation is based upon 2016 benthic macroinvertebrate tissue study (Windward 2018).
Bathymetry hillshade source: Franklin D. Roosevelt Lake – Grand Coulee Dam 2010-11 Survey, U.S. Department of the Interior Bureau of Reclamation, June 2012.

Windward environmental LLC

0 0.1 0.2 Km

0 0.05 0.1 Miles

N

Map A3. **Imagery and Acoustic Doppler Current Profiler Transects in Deadman's Eddy Area of Interest**

Upper Columbia River, WA

W:\Projects\Teck_UCR_RIFS\Data\GIS\Maps_and_Analyses\Sediment DQOs and QAPP\Sediment Facies Mapping QAPP\Field Sampling Plan\Map A4 6880 Imagery and ADCP Transects - China Bend.mxd @ 08/24/2018

China Bend Area of Interest

RM 724
RM 723
RM 722

047: 47-01, 47-02, 47-03, 47-04, 47-05
048: 48-01, 48-02, 48-03, 48-04, 48-05, 48-06, 48-07, 48-08, 48-09, 48-10
049: 49-01, 49-02, 49-03, 49-04, 49-05, 49-06, 49-07, 49-08, 49-09, 49-10
050: 50-01, 50-02, 50-03, 50-04, 50-05, 50-06, 50-07, 50-08, 50-09, 50-10
051: 51-01, 51-02, 51-03, 51-04, 51-05, 51-06, 51-07, 51-08, 51-09, 51-10
052: 52-01, 52-02, 52-03, 52-04, 52-05, 52-06, 52-07, 52-08, 52-09, 52-10
053: 53-01, 53-02, 53-03, 53-04, 53-05, 53-06, 53-07, 53-08, 53-09, 53-10
054: 54-01, 54-02, 54-03, 54-04, 54-05, 54-06, 54-07, 54-08, 54-09, 54-10
055: 55-01, 55-02, 55-03, 55-04, 55-05, 55-06, 55-07, 55-08, 55-09, 55-10
056: 56-01, 56-02, 56-03, 56-04, 56-05, 56-06, 56-07, 56-08, 56-09, 56-10
057: 57-01, 57-02, 57-03, 57-04, 57-05, 57-06, 57-07, 57-08, 57-09, 57-10
058: 58-01, 58-02, 58-03, 58-04, 58-05, 58-06, 58-07, 58-08, 58-09, 58-10
059: 59-01, 59-02, 59-03, 59-04, 59-05, 59-06, 59-07, 59-08, 59-09, 59-10
060: 60-01, 60-02, 60-03, 60-04, 60-05, 60-06, 60-07, 60-08, 60-09, 60-10

25

Legend

- Photo Location
- Photo Transect
- Sample Location with Bulk Sediment Data[a]
- Refusal Location[b]
- EPA Defined Potential Depositional Feature Requiring Characterization[c]
- EPA Defined Historical River Channel Requiring Characterization[c]
- EPA Area of Interest
- September-October Water Level 1,280 ft[d]
- Full Pool 1,290 ft
- Historical Thalweg
- State Highway
- Railroad
- River Mile (USGS)

[a] Sample locations shown are for Phase 1, Phase 2, and USGS studies.
[b] Refusal locations shown are for Phase 1, Phase 2, and beach studies.
[c] Source: Level of Effort for Nature and Extent of Sediment Contamination in Upper Reach Operable Unit (USEPA 2018a).
[d] 1,280 ft represents the low water level during the anticipated sampling period (September-October). This elevation is based on Lake Roosevelt water elevations at the USGS gauge.
Bathymetry hillshade source: Franklin D. Roosevelt Lake – Grand Coulee Dam 2010-11 Survey, U.S. Department of the Interior Bureau of Reclamation, June 2012.

Windward environmental LLC

0 0.2 0.4 Km
0 0.1 0.2 Miles
N

Map A4. **Imagery and Acoustic Doppler Current Profiler Transects in China Bend Area of Interest**
Upper Columbia River, WA

W:\Projects\Teck_UCR_RIFS\Data\GIS\Maps_and_Analyses\Sediment DQOs and QAPP\Sediment Facies Mapping QAPP\Field Sampling Plan\Map A5 6880 Imagery and ADCP Transects - Marcus Flats.mxd @ 08/24/2018

Upstream of Marcus Flats Area of Interest

RM 711
Powell
084
084-01
084-02
084-03
084-04
084-05
085
085-01
085-02
085-03
085-04
085-05
085-06
085-07
085-08
085-09
085-10
086
086-01
086-02
086-03
086-04
086-05
086-06
086-07
086-08
086-09
086-10
087
087-01
087-02
087-03
087-04
087-05
087-06
087-07
087-08
087-09
087-10
RM 710
088
088-01
088-02
088-03
088-04
088-05
088-06
088-07
088-08
088-09
088-10
089
089-01
089-02
089-03
089-04
089-05
089-06
089-07
089-08
089-09
089-10
090
090-01
090-02
090-03
090-04
090-05
090-06
090-07
090-08
090-09
090-10
091
091-01
091-02
091-03
091-04
091-05
091-06
091-07
091-08
091-09
091-10
093
093-01
093-02
093-03
093-04
093-05
093-06
093-07
093-08
093-09
093-10
092
092-01
092-02
092-03
092-04
092-05
092-06
092-07
092-08
092-09
092-10
094
094-01
094-02
094-03
094-04
094-05
094-06
094-07
094-08
094-09
094-10
095
095-01
095-02
095-03
095-04
095-05
095-06
095-07
095-08
095-09
095-10
RM 709
097
096
096-01
096-02
096-03
096-04
096-05
096-06
096-07
096-08
096-09
096-10
097-01
097-02
097-03
097-04
097-05
097-06
097-07
097-08
097-09
097-10
098
098-01
098-02
098-03
098-04
098-05
098-06
098-07
098-08
098-09
098-10
100
099
099-01
099-02
099-03
099-04
099-05
099-06
099-07
099-08
099-09
099-10
100-01
100-02
100-03
100-04
100-05
100-06
100-07
100-08
100-09
100-10
RM 708
East Marcus
25

Legend

- Photo Location
- Photo Transect
- Sample Location with Bulk Sediment Data[a]
- Refusal Location[b]
- EPA Defined Potential Depositional Feature Requiring Characterization[c]
- EPA Defined Historical River Channel Requiring Characterization[c]
- EPA Area of Interest
- September-October Water Level 1,280 ft[d]
- Full Pool 1,290 ft
- Historical Thalweg
- Populated Places
- State Highway
- Railroad
- River Mile (USGS)

[a] Sample locations shown are for Phase 1, Phase 2, and USGS studies.
[b] Refusal locations shown are for Phase 1, Phase 2, and beach studies.
[c] Source: Level of Effort for Nature and Extent of Sediment Contamination in Upper Reach Operable Unit (USEPA 2018a).
[d] 1,280 ft represents the low water level during the anticipated sampling period (September-October). This elevation is based on Lake Roosevelt water elevations at the USGS gauge.
Bathymetry hillshade source: Franklin D. Roosevelt Lake – Grand Coulee Dam 2010-11 Survey, U.S. Department of the Interior Bureau of Reclamation, June 2012.

Windward environmental LLC

Km: 0 0.2 0.4
Miles: 0 0.1 0.2
N

Map A5. **Imagery and Acoustic Doppler Current Profiler Transects in Upstream of Marcus Flats Area of Interest**
Upper Columbia River, WA

TABLES

Table A1. Underwater Imagery and Acoustic Doppler Current Profiler Measurement Locations

Transect No.	Station No.	Station ID	WA StatePlane N X (ft)	WA StatePlane N Y (ft)	UTM 11N X (m)	UTM 11N Y (m)	River Segment	Map No.	Approximate River Mile
1	1	001-01	2406994	743988	453210	5427193	Upstream of DME	A2	744.5
1	2	001-02	2407157	743878	453258	5427157	Upstream of DME	A2	744.5
1	3	001-03	2407320	743768	453306	5427121	Upstream of DME	A2	744.5
1	4	001-04	2407483	743658	453354	5427085	Upstream of DME	A2	744.5
1	5	001-05	2407646	743548	453402	5427049	Upstream of DME	A2	744.4
2	1	002-01	2406601	741115	453047	5426324	Upstream of DME	A2	743.9
2	2	002-02	2406727	741102	453085	5426319	Upstream of DME	A2	743.9
2	3	002-03	2406854	741090	453123	5426313	Upstream of DME	A2	743.9
2	4	002-04	2406981	741077	453162	5426307	Upstream of DME	A2	743.9
2	5	002-05	2407108	741065	453200	5426301	Upstream of DME	A2	743.9
3	1	003-01	2406439	738536	452958	5425542	Upstream of DME	A2	743.5
3	2	003-02	2406574	738493	452999	5425527	Upstream of DME	A2	743.4
3	3	003-03	2406709	738451	453039	5425512	Upstream of DME	A2	743.4
3	4	003-04	2406844	738409	453079	5425497	Upstream of DME	A2	743.4
3	5	003-05	2406978	738367	453120	5425482	Upstream of DME	A2	743.4
4	1	004-01	2406130	736194	452829	5424834	Upstream of DME	A2	743.0
4	2	004-02	2406240	736129	452861	5424813	Upstream of DME	A2	743.0
4	3	004-03	2406350	736063	452893	5424791	Upstream of DME	A2	743.0
4	4	004-04	2406460	735998	452926	5424769	Upstream of DME	A2	743.0
4	5	004-05	2406570	735933	452958	5424748	Upstream of DME	A2	743.0
5	1	005-01	2404053	735061	452179	5424521	Upstream of DME	A2	742.5
5	2	005-02	2404076	734945	452185	5424485	Upstream of DME	A2	742.5
5	3	005-03	2404100	734829	452190	5424450	Upstream of DME	A2	742.5
5	4	005-04	2404172	734470	452207	5424339	Upstream of DME	A2	742.4
5	5	005-05	2404184	734408	452209	5424320	Upstream of DME	A2	742.4
6	1	006-01	2401893	733587	451500	5424105	Upstream of DME	A2	742.0
6	2	006-02	2401963	733483	451519	5424073	Upstream of DME	A2	742.0
6	3	006-03	2402033	733379	451539	5424040	Upstream of DME	A2	742.0
6	4	006-04	2402102	733276	451559	5424007	Upstream of DME	A2	742.0
6	5	006-05	2402172	733172	451578	5423975	Upstream of DME	A2	742.0
7	1	007-01	2399564	732316	450772	5423754	Upstream of DME	A2	741.5
7	2	007-02	2399632	732220	450791	5423724	Upstream of DME	A2	741.5
7	3	007-03	2399699	732124	450810	5423693	Upstream of DME	A2	741.5
7	4	007-04	2399767	732028	450829	5423663	Upstream of DME	A2	741.5
7	5	007-05	2399835	731932	450848	5423633	Upstream of DME	A2	741.5
8	1	008-01	2397615	730444	450150	5423214	Upstream of DME	A2	741.0
8	2	008-02	2397727	730360	450183	5423187	Upstream of DME	A2	741.0
8	3	008-03	2397838	730276	450215	5423159	Upstream of DME	A2	741.0
8	4	008-04	2397949	730191	450248	5423132	Upstream of DME	A2	741.0
8	5	008-05	2398061	730107	450281	5423105	Upstream of DME	A2	741.0
9	1	009-01	2395655	728986	449531	5422800	Upstream of DME	A2	740.5
9	2	009-02	2395707	728879	449546	5422767	Upstream of DME	A2	740.5
9	3	009-03	2395758	728771	449560	5422733	Upstream of DME	A2	740.5
9	4	009-04	2395810	728663	449574	5422699	Upstream of DME	A2	740.5
9	5	009-05	2395862	728555	449588	5422666	Upstream of DME	A2	740.5
10	1	010-01	2393403	727704	448827	5422444	Upstream of DME	A2	740.0
10	2	010-02	2393424	727607	448832	5422415	Upstream of DME	A2	740.0
10	3	010-03	2393446	727511	448837	5422385	Upstream of DME	A2	740.0
10	4	010-04	2393468	727415	448842	5422355	Upstream of DME	A2	740.0
10	5	010-05	2393489	727319	448847	5422326	Upstream of DME	A2	740.0
11	1	011-01	2390909	726774	448054	5422199	Upstream of DME	A2	739.5
11	2	011-02	2390964	726674	448069	5422168	Upstream of DME	A2	739.5
11	3	011-03	2391019	726574	448084	5422137	Upstream of DME	A2	739.5
11	4	011-04	2391075	726474	448100	5422105	Upstream of DME	A2	739.5
11	5	011-05	2391130	726374	448115	5422074	Upstream of DME	A2	739.5
12	1	012-01	2389050	724698	447457	5421596	Upstream of DME	A2	739.0
12	2	012-02	2389257	724645	447519	5421576	Upstream of DME	A2	739.0
12	3	012-03	2389464	724591	447581	5421557	Upstream of DME	A2	739.0
12	4	012-04	2389670	724538	447643	5421538	Upstream of DME	A2	739.0
12	5	012-05	2389877	724485	447705	5421518	Upstream of DME	A2	739.0
13	1	013-01	2389044	723868	447442	5421343	DME	A3	738.8
13	2	013-02	2389087	723824	447454	5421329	DME	A3	738.8
13	3	013-03	2389129	723780	447467	5421315	DME	A3	738.8
13	4	013-04	2389172	723736	447479	5421301	DME	A3	738.8
13	5	013-05	2389215	723692	447491	5421287	DME	A3	738.8
13	6	013-06	2389258	723648	447504	5421273	DME	A3	738.8
13	7	013-07	2389300	723604	447516	5421259	DME	A3	738.8
13	8	013-08	2389343	723560	447528	5421245	DME	A3	738.8
13	9	013-09	2389386	723516	447541	5421231	DME	A3	738.8
13	10	013-10	2389429	723472	447553	5421217	DME	A3	738.8
14	1	014-01	2388378	723077	447227	5421113	DME	A3	738.6
14	2	014-02	2388420	723021	447239	5421095	DME	A3	738.6
14	3	014-03	2388461	722965	447251	5421077	DME	A3	738.6
14	4	014-04	2388503	722909	447263	5421060	DME	A3	738.6
14	5	014-05	2388544	722853	447275	5421042	DME	A3	738.6
14	6	014-06	2388586	722797	447286	5421024	DME	A3	738.6
14	7	014-07	2388628	722742	447298	5421007	DME	A3	738.6
14	8	014-08	2388669	722686	447310	5420989	DME	A3	738.6
14	9	014-09	2388711	722630	447322	5420972	DME	A3	738.6
14	10	014-10	2388753	722574	447334	5420954	DME	A3	738.6
15	1	015-01	2387541	722453	446963	5420936	DME	A3	738.5
15	2	015-02	2387616	722381	446985	5420912	DME	A3	738.5
15	3	015-03	2387690	722308	447006	5420889	DME	A3	738.5
15	4	015-04	2387765	722236	447028	5420866	DME	A3	738.5
15	5	015-05	2387840	722163	447050	5420843	DME	A3	738.5
15	6	015-06	2387915	722090	447072	5420819	DME	A3	738.5
15	7	015-07	2387990	722018	447093	5420796	DME	A3	738.5
15	8	015-08	2388065	721945	447115	5420773	DME	A3	738.5
15	9	015-09	2388140	721872	447137	5420750	DME	A3	738.5
15	10	015-10	2388215	721800	447158	5420726	DME	A3	738.5

Table A1. Underwater Imagery and Acoustic Doppler Current Profiler Measurement Locations

Transect No.	Station No.	Station ID	WA StatePlane N X (ft)	WA StatePlane N Y (ft)	UTM 11N X (m)	UTM 11N Y (m)	River Segment	Map No.	Approximate River Mile
16	1	016-01	2387397	722288	446917	5420888	DME	A3	738.4
16	2	016-02	2387385	722077	446910	5420824	DME	A3	738.4
16	3	016-03	2387373	721866	446903	5420760	DME	A3	738.4
16	4	016-04	2387361	721655	446896	5420695	DME	A3	738.3
16	5	016-05	2387349	721444	446889	5420631	DME	A3	738.3
16	6	016-06	2387337	721233	446882	5420567	DME	A3	738.3
16	7	016-07	2387325	721021	446876	5420503	DME	A3	738.3
16	8	016-08	2387313	720810	446869	5420439	DME	A3	738.3
16	9	016-09	2387301	720599	446862	5420375	DME	A3	738.3
16	10	016-10	2387289	720388	446855	5420311	DME	A3	738.3
17	1	017-01	2387199	722280	446856	5420888	DME	A3	738.4
17	2	017-02	2387124	722100	446831	5420835	DME	A3	738.3
17	3	017-03	2387050	721921	446806	5420781	DME	A3	738.3
17	4	017-04	2386976	721741	446780	5420728	DME	A3	738.3
17	5	017-05	2386901	721562	446755	5420674	DME	A3	738.3
17	6	017-06	2386827	721382	446730	5420621	DME	A3	738.2
17	7	017-07	2386753	721203	446704	5420567	DME	A3	738.2
17	8	017-08	2386678	721023	446679	5420514	DME	A3	738.2
17	9	017-09	2386604	720844	446654	5420460	DME	A3	738.2
17	10	017-10	2386530	720664	446628	5420407	DME	A3	738.2
18	1	018-01	2386560	722266	446662	5420893	DME	A3	738.1
18	2	018-02	2386520	722150	446648	5420859	DME	A3	738.1
18	3	018-03	2386482	722039	446635	5420826	DME	A3	738.1
18	4	018-04	2386447	721936	446622	5420795	DME	A3	738.1
18	5	018-05	2386419	721854	446613	5420770	DME	A3	738.2
18	6	018-06	2386367	721703	446595	5420725	DME	A3	738.2
18	7	018-07	2386332	721601	446582	5420694	DME	A3	738.2
18	8	018-08	2386292	721484	446568	5420660	DME	A3	738.2
18	9	018-09	2386251	721366	446554	5420624	DME	A3	738.2
18	10	018-10	2386210	721245	446540	5420588	DME	A3	738.2
19	1	019-01	2385915	723067	446478	5421147	DME	A3	738.0
19	2	019-02	2385871	722933	446462	5421107	DME	A3	738.0
19	3	019-03	2385718	722460	446409	5420965	DME	A3	738.0
19	4	019-04	2385680	722342	446395	5420930	DME	A3	738.0
19	5	019-05	2385616	722146	446373	5420871	DME	A3	738.0
19	6	019-06	2385576	722021	446359	5420834	DME	A3	738.0
19	7	019-07	2385530	721882	446343	5420792	DME	A3	738.0
19	8	019-08	2385492	721763	446329	5420757	DME	A3	738.0
20	1	020-01	2384952	723390	446190	5421260	DME	A3	737.8
20	2	020-02	2384936	723245	446183	5421216	DME	A3	737.8
20	3	020-03	2384914	723041	446173	5421154	DME	A3	737.8
20	4	020-04	2384898	722894	446166	5421110	DME	A3	737.8
20	5	020-05	2384885	722767	446160	5421072	DME	A3	737.8
20	6	020-06	2384870	722627	446153	5421029	DME	A3	737.8
20	7	020-07	2384855	722490	446146	5420988	DME	A3	737.9
20	8	020-08	2384841	722360	446140	5420948	DME	A3	737.9
20	9	020-09	2384827	722231	446134	5420909	DME	A3	737.9
20	10	020-10	2384795	721939	446120	5420821	DME	A3	737.9
21	1	021-01	2384239	723250	445970	5421228	Between DME and CB	A2	737.7
21	2	021-02	2384242	723079	445969	5421176	Between DME and CB	A2	737.7
21	3	021-03	2384245	722909	445967	5421124	Between DME and CB	A2	737.7
21	4	021-04	2384248	722738	445965	5421072	Between DME and CB	A2	737.7
21	5	021-05	2384251	722567	445964	5421020	Between DME and CB	A2	737.8
22	1	022-01	2381769	722060	445201	5420904	Between DME and CB	A2	737.3
22	2	022-02	2381901	721901	445239	5420853	Between DME and CB	A2	737.3
22	3	022-03	2382033	721742	445276	5420803	Between DME and CB	A2	737.3
22	4	022-04	2382165	721583	445314	5420753	Between DME and CB	A2	737.3
22	5	022-05	2382298	721424	445352	5420702	Between DME and CB	A2	737.3
23	1	023-01	2379990	721241	444647	5420681	Between DME and CB	A2	736.9
23	2	023-02	2379985	721081	444643	5420633	Between DME and CB	A2	736.9
23	3	023-03	2379979	720921	444639	5420584	Between DME and CB	A2	736.9
23	4	023-04	2379973	720761	444634	5420536	Between DME and CB	A2	736.9
23	5	023-05	2379967	720601	444630	5420487	Between DME and CB	A2	736.9
24	1	024-01	2378510	719707	444173	5420237	Between DME and CB	A2	736.3
24	2	024-02	2378640	719718	444213	5420239	Between DME and CB	A2	736.3
24	3	024-03	2378771	719729	444253	5420240	Between DME and CB	A2	736.3
24	4	024-04	2378902	719740	444293	5420241	Between DME and CB	A2	736.3
24	5	024-05	2379032	719751	444333	5420243	Between DME and CB	A2	736.3
25	1	025-01	2377126	717876	443724	5419701	Between DME and CB	A2	735.7
25	2	025-02	2377251	717797	443761	5419675	Between DME and CB	A2	735.7
25	3	025-03	2377377	717718	443798	5419649	Between DME and CB	A2	735.7
25	4	025-04	2377503	717639	443835	5419623	Between DME and CB	A2	735.7
25	5	025-05	2377629	717560	443873	5419597	Between DME and CB	A2	735.7
26	1	026-01	2375388	716370	443173	5419269	Between DME and CB	A2	735.1
26	2	026-02	2375451	716210	443189	5419220	Between DME and CB	A2	735.1
26	3	026-03	2375515	716050	443206	5419170	Between DME and CB	A2	735.1
26	4	026-04	2375578	715889	443223	5419120	Between DME and CB	A2	735.1
26	5	026-05	2375642	715729	443240	5419070	Between DME and CB	A2	735.1
27	1	027-01	2373268	715427	442513	5419014	Between DME and CB	A2	734.7
27	2	027-02	2373322	715236	442527	5418956	Between DME and CB	A2	734.7
27	3	027-03	2373375	715046	442540	5418897	Between DME and CB	A2	734.6
27	4	027-04	2373429	714856	442553	5418838	Between DME and CB	A2	734.6
27	5	027-05	2373482	714666	442567	5418780	Between DME and CB	A2	734.6
28	1	028-01	2371033	713981	441811	5418608	Between DME and CB	A2	734.1
28	2	028-02	2371214	713858	441864	5418568	Between DME and CB	A2	734.1
28	3	028-03	2371396	713736	441918	5418528	Between DME and CB	A2	734.2
28	4	028-04	2371577	713613	441971	5418488	Between DME and CB	A2	734.2
28	5	028-05	2371758	713491	442024	5418448	Between DME and CB	A2	734.2
29	1	029-01	2369090	712432	441196	5418167	Between DME and CB	A2	733.6
29	2	029-02	2369242	712296	441240	5418123	Between DME and CB	A2	733.6

Table A1. Underwater Imagery and Acoustic Doppler Current Profiler Measurement Locations

Transect No.	Station No.	Station ID	WA StatePlane N X (ft)	WA StatePlane N Y (ft)	UTM 11N X (m)	UTM 11N Y (m)	River Segment	Map No.	Approximate River Mile
29	3	029-03	2369394	712160	441285	5418079	Between DME and CB	A2	733.6
29	4	029-04	2369546	712024	441329	5418036	Between DME and CB	A2	733.6
29	5	029-05	2369699	711889	441373	5417992	Between DME and CB	A2	733.6
30	1	030-01	2367756	710217	440757	5417513	Between DME and CB	A2	733.1
30	2	030-02	2368097	710179	440860	5417496	Between DME and CB	A2	733.1
30	3	030-03	2368437	710142	440963	5417480	Between DME and CB	A2	733.1
30	4	030-04	2369292	710048	441221	5417438	Between DME and CB	A2	733.1
30	5	030-05	2369447	710031	441268	5417431	Between DME and CB	A2	733.1
31	1	031-01	2366408	708094	440314	5416887	Between DME and CB	A2	732.5
31	2	031-02	2366756	707940	440418	5416835	Between DME and CB	A2	732.5
31	3	031-03	2367105	707785	440521	5416783	Between DME and CB	A2	732.5
31	4	031-04	2367454	707631	440625	5416731	Between DME and CB	A2	732.6
31	5	031-05	2367802	707477	440729	5416679	Between DME and CB	A2	732.6
32	1	032-01	2364818	706688	439809	5416484	Between DME and CB	A2	732.1
32	2	032-02	2364992	706476	439859	5416417	Between DME and CB	A2	732.1
32	3	032-03	2365167	706263	439909	5416349	Between DME and CB	A2	732.1
32	4	032-04	2365342	706051	439959	5416282	Between DME and CB	A2	732.1
32	5	032-05	2365517	705838	440009	5416215	Between DME and CB	A2	732.1
33	1	033-01	2363353	704856	439335	5415949	Between DME and CB	A2	731.7
33	2	033-02	2363571	704693	439399	5415896	Between DME and CB	A2	731.7
33	3	033-03	2363789	704531	439463	5415843	Between DME and CB	A2	731.7
33	4	033-04	2364007	704368	439527	5415790	Between DME and CB	A2	731.7
33	5	033-05	2364225	704206	439591	5415738	Between DME and CB	A2	731.7
34	1	034-01	2361365	703200	438705	5415475	Between DME and CB	A2	731.2
34	2	034-02	2361568	703012	438764	5415415	Between DME and CB	A2	731.2
34	3	034-03	2361771	702824	438823	5415354	Between DME and CB	A2	731.2
34	4	034-04	2361973	702635	438882	5415294	Between DME and CB	A2	731.2
34	5	034-05	2362176	702447	438940	5415234	Between DME and CB	A2	731.2
35	1	035-01	2360331	700700	438352	5414730	Between DME and CB	A2	730.6
35	2	035-02	2360451	700604	438387	5414699	Between DME and CB	A2	730.6
35	3	035-03	2360571	700508	438423	5414668	Between DME and CB	A2	730.6
35	4	035-04	2360691	700412	438458	5414637	Between DME and CB	A2	730.6
35	5	035-05	2360812	700317	438493	5414606	Between DME and CB	A2	730.6
36	1	036-01	2358713	698774	437831	5414168	Between DME and CB	A2	730.1
36	2	036-02	2358935	698572	437895	5414104	Between DME and CB	A2	730.1
36	3	036-03	2359157	698370	437960	5414039	Between DME and CB	A2	730.1
36	4	036-04	2359379	698168	438024	5413974	Between DME and CB	A2	730.1
36	5	036-05	2359601	697966	438089	5413909	Between DME and CB	A2	730.1
37	1	037-01	2356294	697790	437080	5413906	Between DME and CB	A2	729.6
37	2	037-02	2356352	697707	437096	5413880	Between DME and CB	A2	729.6
37	3	037-03	2356411	697624	437113	5413854	Between DME and CB	A2	729.6
37	4	037-04	2356470	697541	437129	5413827	Between DME and CB	A2	729.6
37	5	037-05	2356529	697458	437146	5413801	Between DME and CB	A2	729.6
38	1	038-01	2353960	696877	436355	5413663	Between DME and CB	A2	729.1
38	2	038-02	2353987	696818	436363	5413645	Between DME and CB	A2	729.1
38	3	038-03	2354015	696760	436370	5413627	Between DME and CB	A2	729.1
38	4	038-04	2354043	696701	436378	5413609	Between DME and CB	A2	729.1
38	5	038-05	2354070	696643	436386	5413591	Between DME and CB	A2	729.1
39	1	039-01	2351440	695965	435575	5413424	Between DME and CB	A2	728.6
39	2	039-02	2351564	695910	435612	5413406	Between DME and CB	A2	728.6
39	3	039-03	2351688	695855	435648	5413387	Between DME and CB	A2	728.6
39	4	039-04	2351812	695800	435685	5413368	Between DME and CB	A2	728.6
39	5	039-05	2351936	695744	435722	5413350	Between DME and CB	A2	728.6
40	1	040-01	2350199	693847	435165	5412799	Between DME and CB	A2	728.2
40	2	040-02	2350421	693670	435230	5412741	Between DME and CB	A2	728.2
40	3	040-03	2350644	693493	435295	5412684	Between DME and CB	A2	728.1
40	4	040-04	2350867	693317	435360	5412627	Between DME and CB	A2	728.1
40	5	040-05	2351089	693140	435425	5412570	Between DME and CB	A2	728.1
41	1	041-01	2348645	692229	434667	5412330	Between DME and CB	A2	727.7
41	2	041-02	2348785	692002	434706	5412259	Between DME and CB	A2	727.7
41	3	041-03	2348924	691775	434745	5412187	Between DME and CB	A2	727.7
41	4	041-04	2349063	691548	434784	5412116	Between DME and CB	A2	727.6
41	5	041-05	2349203	691321	434823	5412045	Between DME and CB	A2	727.6
42	1	042-01	2346532	690955	434005	5411974	Between DME and CB	A2	727.2
42	2	042-02	2346603	690809	434024	5411929	Between DME and CB	A2	727.2
42	3	042-03	2346674	690664	434044	5411884	Between DME and CB	A2	727.2
42	4	042-04	2346745	690518	434063	5411838	Between DME and CB	A2	727.2
42	5	042-05	2346816	690373	434083	5411793	Between DME and CB	A2	727.2
43	1	043-01	2344078	689405	433235	5411540	Between DME and CB	A2	726.7
43	2	043-02	2344286	689295	433296	5411503	Between DME and CB	A2	726.7
43	3	043-03	2344493	689185	433358	5411467	Between DME and CB	A2	726.7
43	4	043-04	2344701	689075	433419	5411430	Between DME and CB	A2	726.7
43	5	043-05	2344908	688964	433481	5411393	Between DME and CB	A2	726.6
44	1	044-01	2342755	688269	432815	5411214	Between DME and CB	A2	726.3
44	2	044-02	2342825	688027	432832	5411140	Between DME and CB	A2	726.3
44	3	044-03	2342894	687786	432850	5411065	Between DME and CB	A2	726.2
44	4	044-04	2342964	687544	432867	5410991	Between DME and CB	A2	726.2
44	5	044-05	2343034	687303	432885	5410916	Between DME and CB	A2	726.2
45	1	045-01	2340849	686072	432201	5410575	Between DME and CB	A2	725.8
45	2	045-02	2341021	686001	432252	5410551	Between DME and CB	A2	725.8
45	3	045-03	2341192	685931	432304	5410527	Between DME and CB	A2	725.8
45	4	045-04	2341364	685860	432355	5410503	Between DME and CB	A2	725.8
45	5	045-05	2341536	685790	432406	5410478	Between DME and CB	A2	725.8
46	1	046-01	2340420	683144	432026	5409690	Between DME and CB	A2	725.3
46	2	046-02	2340648	683256	432097	5409721	Between DME and CB	A2	725.3
46	3	046-03	2340877	683369	432169	5409752	Between DME and CB	A2	725.3
46	4	046-04	2341105	683481	432240	5409783	Between DME and CB	A2	725.4
46	5	046-05	2341334	683594	432311	5409813	Between DME and CB	A2	725.4
47	1	047-01	2339969	680913	431855	5409018	Between DME and CB	A2	724.9
47	2	047-02	2340294	680891	431954	5409007	Between DME and CB	A2	724.9

Table A1. Underwater Imagery and Acoustic Doppler Current Profiler Measurement Locations

Transect No.	Station No.	Station ID	WA StatePlane N X (ft)	WA StatePlane N Y (ft)	UTM 11N X (m)	UTM 11N Y (m)	River Segment	Map No.	Approximate River Mile
47	3	047-03	2340619	680870	432052	5408995	Between DME and CB	A2	724.9
47	4	047-04	2340944	680848	432151	5408984	Between DME and CB	A2	724.9
47	5	047-05	2341269	680827	432249	5408972	Between DME and CB	A2	724.9
48	1	048-01	2340408	679180	431962	5408484	CB	A4	724.6
48	2	048-02	2340583	679048	432013	5408441	CB	A4	724.5
48	3	048-03	2340715	678948	432052	5408409	CB	A4	724.5
48	4	048-04	2340887	678818	432103	5408367	CB	A4	724.5
48	5	048-05	2341145	678624	432178	5408304	CB	A4	724.5
48	6	048-06	2341360	678461	432241	5408251	CB	A4	724.4
48	7	048-07	2341524	678337	432289	5408211	CB	A4	724.4
48	8	048-08	2341630	678257	432320	5408185	CB	A4	724.4
48	9	048-09	2341684	678217	432336	5408172	CB	A4	724.4
48	10	048-10	2341748	678169	432355	5408156	CB	A4	724.4
49	1	049-01	2340080	678185	431847	5408186	CB	A4	724.4
49	2	049-02	2340223	678085	431889	5408154	CB	A4	724.3
49	3	049-03	2340367	677986	431932	5408121	CB	A4	724.3
49	4	049-04	2340532	677870	431980	5408084	CB	A4	724.3
49	5	049-05	2340653	677787	432016	5408057	CB	A4	724.2
49	6	049-06	2340754	677717	432045	5408034	CB	A4	724.2
49	7	049-07	2340940	677587	432100	5407992	CB	A4	724.2
49	8	049-08	2341083	677488	432142	5407959	CB	A4	724.2
49	9	049-09	2341239	677380	432188	5407924	CB	A4	724.2
49	10	049-10	2341439	677241	432246	5407879	CB	A4	724.2
50	1	050-01	2339828	677712	431763	5408046	CB	A4	724.0
50	2	050-02	2339916	677570	431788	5408002	CB	A4	724.0
50	3	050-03	2340004	677429	431813	5407958	CB	A4	724.0
50	4	050-04	2340092	677287	431837	5407913	CB	A4	724.0
50	5	050-05	2340158	677182	431856	5407880	CB	A4	724.0
50	6	050-06	2340262	677015	431885	5407828	CB	A4	724.0
50	7	050-07	2340346	676881	431908	5407786	CB	A4	724.0
50	8	050-08	2340445	676721	431936	5407735	CB	A4	724.0
50	9	050-09	2340533	676580	431961	5407691	CB	A4	724.0
50	10	050-10	2340653	676388	431994	5407631	CB	A4	724.0
51	1	051-01	2338948	677122	431487	5407880	CB	A4	723.8
51	2	051-02	2339038	676978	431512	5407835	CB	A4	723.8
51	3	051-03	2339157	676788	431545	5407775	CB	A4	723.8
51	4	051-04	2339239	676658	431568	5407735	CB	A4	723.8
51	5	051-05	2339321	676528	431591	5407694	CB	A4	723.8
51	6	051-06	2339425	676363	431620	5407642	CB	A4	723.8
51	7	051-07	2339485	676267	431637	5407612	CB	A4	723.8
51	8	051-08	2339566	676137	431660	5407571	CB	A4	723.8
51	9	051-09	2339648	676007	431683	5407530	CB	A4	723.8
51	10	051-10	2339760	675828	431714	5407474	CB	A4	723.8
52	1	052-01	2337947	677733	431191	5408082	CB	A4	723.7
52	2	052-02	2338067	677378	431222	5407972	CB	A4	723.7
52	3	052-03	2338145	677147	431243	5407900	CB	A4	723.7
52	4	052-04	2338253	676829	431271	5407802	CB	A4	723.7
52	5	052-05	2338321	676626	431288	5407739	CB	A4	723.7
52	6	052-06	2338389	676424	431306	5407676	CB	A4	723.7
52	7	052-07	2338457	676224	431324	5407614	CB	A4	723.7
52	8	052-08	2338535	675993	431344	5407543	CB	A4	723.7
52	9	052-09	2338613	675762	431364	5407471	CB	A4	723.7
52	10	052-10	2338741	675384	431397	5407355	CB	A4	723.7
53	1	053-01	2337122	676282	430918	5407652	CB	A4	723.5
53	2	053-02	2337197	676140	430939	5407608	CB	A4	723.5
53	3	053-03	2337303	675940	430968	5407546	CB	A4	723.5
53	4	053-04	2337366	675819	430986	5407508	CB	A4	723.5
53	5	053-05	2337422	675714	431001	5407475	CB	A4	723.5
53	6	053-06	2337497	675572	431022	5407430	CB	A4	723.5
53	7	053-07	2337572	675430	431042	5407386	CB	A4	723.5
53	8	053-08	2337647	675288	431063	5407342	CB	A4	723.5
53	9	053-09	2337722	675146	431084	5407297	CB	A4	723.5
53	10	053-10	2337831	674939	431114	5407233	CB	A4	723.5
54	1	054-01	2336566	675488	430737	5407419	CB	A4	723.3
54	2	054-02	2336603	675396	430747	5407391	CB	A4	723.3
54	3	054-03	2336638	675311	430756	5407364	CB	A4	723.3
54	4	054-04	2336658	675261	430762	5407349	CB	A4	723.3
54	5	054-05	2336681	675206	430768	5407332	CB	A4	723.3
54	6	054-06	2336716	675117	430777	5407304	CB	A4	723.3
54	7	054-07	2336785	674948	430795	5407251	CB	A4	723.3
54	8	054-08	2336850	674787	430813	5407201	CB	A4	723.3
54	9	054-09	2336957	674522	430841	5407119	CB	A4	723.3
54	10	054-10	2337003	674408	430854	5407084	CB	A4	723.3
55	1	055-01	2335871	674887	430516	5407247	CB	A4	723.1
55	2	055-02	2335916	674845	430529	5407233	CB	A4	723.1
55	3	055-03	2335981	674784	430548	5407214	CB	A4	723.1
55	4	055-04	2336020	674747	430560	5407202	CB	A4	723.1
55	5	055-05	2336073	674698	430575	5407186	CB	A4	723.1
55	6	055-06	2336137	674638	430594	5407167	CB	A4	723.1
55	7	055-07	2336263	674520	430630	5407129	CB	A4	723.2
55	8	055-08	2336439	674355	430681	5407076	CB	A4	723.2
55	9	055-09	2336555	674247	430715	5407042	CB	A4	723.2
55	10	055-10	2336639	674169	430739	5407017	CB	A4	723.2
56	1	056-01	2335502	674697	430401	5407195	CB	A4	723.0
56	2	056-02	2335542	674581	430412	5407159	CB	A4	723.0
56	3	056-03	2335583	674466	430422	5407123	CB	A4	723.0
56	4	056-04	2335623	674351	430433	5407087	CB	A4	723.0
56	5	056-05	2335663	674235	430443	5407052	CB	A4	723.0
56	6	056-06	2335703	674120	430454	5407016	CB	A4	723.0
56	7	056-07	2335753	673978	430467	5406972	CB	A4	723.0

Table A1. Underwater Imagery and Acoustic Doppler Current Profiler Measurement Locations

Transect No.	Station No.	Station ID	WA StatePlane N X (ft)	WA StatePlane N Y (ft)	UTM 11N X (m)	UTM 11N Y (m)	River Segment	Map No.	Approximate River Mile
56	8	056-08	2335811	673812	430482	5406921	CB	A4	723.0
56	9	056-09	2335838	673736	430489	5406897	CB	A4	723.0
56	10	056-10	2335865	673659	430496	5406873	CB	A4	723.0
57	1	057-01	2334955	674644	430234	5407187	CB	A4	722.9
57	2	057-02	2334972	674503	430237	5407144	CB	A4	722.9
57	3	057-03	2334985	674397	430239	5407111	CB	A4	722.9
57	4	057-04	2334999	674287	430242	5407078	CB	A4	722.9
57	5	057-05	2335013	674173	430244	5407043	CB	A4	722.9
57	6	057-06	2335033	674007	430248	5406992	CB	A4	722.9
57	7	057-07	2335055	673830	430252	5406938	CB	A4	722.9
57	8	057-08	2335071	673693	430255	5406896	CB	A4	722.9
57	9	057-09	2335086	673572	430258	5406859	CB	A4	722.9
57	10	057-10	2335102	673443	430260	5406819	CB	A4	722.9
58	1	058-01	2334108	674766	429978	5407237	CB	A4	722.8
58	2	058-02	2334075	674641	429966	5407199	CB	A4	722.8
58	3	058-03	2334059	674579	429960	5407181	CB	A4	722.8
58	4	058-04	2334034	674485	429951	5407153	CB	A4	722.7
58	5	058-05	2334016	674416	429945	5407132	CB	A4	722.7
58	6	058-06	2333985	674298	429934	5407096	CB	A4	722.7
58	7	058-07	2333961	674204	429925	5407068	CB	A4	722.7
58	8	058-08	2333936	674111	429916	5407040	CB	A4	722.7
58	9	058-09	2333912	674017	429907	5407012	CB	A4	722.7
58	10	058-10	2333887	673923	429898	5406984	CB	A4	722.7
59	1	059-01	2333242	675365	429723	5407432	CB	A4	722.6
59	2	059-02	2333209	675277	429712	5407406	CB	A4	722.6
59	3	059-03	2333176	675189	429701	5407380	CB	A4	722.6
59	4	059-04	2333132	675072	429686	5407345	CB	A4	722.6
59	5	059-05	2333094	674969	429672	5407314	CB	A4	722.6
59	6	059-06	2333064	674889	429662	5407290	CB	A4	722.6
59	7	059-07	2333037	674817	429653	5407269	CB	A4	722.6
59	8	059-08	2333001	674722	429641	5407240	CB	A4	722.6
59	9	059-09	2332979	674661	429633	5407222	CB	A4	722.6
59	10	059-10	2332946	674573	429621	5407196	CB	A4	722.6
60	1	060-01	2332475	675425	429491	5407462	CB	A4	722.4
60	2	060-02	2332458	675345	429485	5407438	CB	A4	722.4
60	3	060-03	2332441	675266	429478	5407414	CB	A4	722.4
60	4	060-04	2332424	675186	429472	5407390	CB	A4	722.4
60	5	060-05	2332407	675106	429466	5407366	CB	A4	722.4
60	6	060-06	2332390	675027	429459	5407342	CB	A4	722.4
60	7	060-07	2332373	674947	429453	5407318	CB	A4	722.4
60	8	060-08	2332356	674867	429446	5407294	CB	A4	722.4
60	9	060-09	2332344	674809	429442	5407277	CB	A4	722.4
60	10	060-10	2332322	674708	429434	5407246	CB	A4	722.4
61	1	061-01	2330618	675851	428932	5407620	Between CB and UMF	A2	722.1
61	2	061-02	2330595	675693	428923	5407572	Between CB and UMF	A2	722.1
61	3	061-03	2330572	675534	428914	5407524	Between CB and UMF	A2	722.1
61	4	061-04	2330549	675375	428904	5407476	Between CB and UMF	A2	722.1
61	5	061-05	2330526	675217	428895	5407428	Between CB and UMF	A2	722.1
62	1	062-01	2328024	676963	428160	5407998	Between CB and UMF	A2	721.6
62	2	062-02	2328005	676596	428149	5407887	Between CB and UMF	A2	721.6
62	3	062-03	2327986	676228	428137	5407775	Between CB and UMF	A2	721.6
62	4	062-04	2327967	675861	428126	5407663	Between CB and UMF	A2	721.6
62	5	062-05	2327948	675493	428115	5407552	Between CB and UMF	A2	721.6
63	1	063-01	2325330	675838	427323	5407697	Between CB and UMF	A2	721.1
63	2	063-02	2325418	675690	427348	5407650	Between CB and UMF	A2	721.1
63	3	063-03	2325506	675542	427372	5407604	Between CB and UMF	A2	721.1
63	4	063-04	2325594	675393	427397	5407557	Between CB and UMF	A2	721.1
63	5	063-05	2325682	675245	427421	5407511	Between CB and UMF	A2	721.1
64	1	064-01	2323335	674560	426697	5407338	Between CB and UMF	A2	720.7
64	2	064-02	2323411	674378	426717	5407281	Between CB and UMF	A2	720.7
64	3	064-03	2323487	674196	426737	5407225	Between CB and UMF	A2	720.7
64	4	064-04	2323563	674014	426758	5407168	Between CB and UMF	A2	720.7
64	5	064-05	2323639	673831	426778	5407112	Between CB and UMF	A2	720.7
65	1	065-01	2320998	673010	425962	5406902	Between CB and UMF	A2	720.2
65	2	065-02	2321133	672831	426000	5406845	Between CB and UMF	A2	720.2
65	3	065-03	2321268	672652	426039	5406789	Between CB and UMF	A2	720.2
65	4	065-04	2321404	672473	426077	5406732	Between CB and UMF	A2	720.2
65	5	065-05	2321539	672294	426115	5406676	Between CB and UMF	A2	720.2
66	1	066-01	2319795	670252	425554	5406081	Between CB and UMF	A2	719.8
66	2	066-02	2319985	670241	425611	5406075	Between CB and UMF	A2	719.7
66	3	066-03	2320175	670231	425669	5406069	Between CB and UMF	A2	719.7
66	4	066-04	2320365	670220	425727	5406063	Between CB and UMF	A2	719.7
66	5	066-05	2320555	670210	425784	5406056	Between CB and UMF	A2	719.7
67	1	067-01	2320280	667614	425661	5405271	Between CB and UMF	A2	719.3
67	2	067-02	2320542	667752	425743	5405309	Between CB and UMF	A2	719.3
67	3	067-03	2320804	667890	425825	5405347	Between CB and UMF	A2	719.3
67	4	067-04	2321066	668029	425907	5405385	Between CB and UMF	A2	719.3
67	5	067-05	2321327	668167	425988	5405423	Between CB and UMF	A2	719.3
68	1	068-01	2320536	665561	425708	5404642	Between CB and UMF	A2	718.8
68	2	068-02	2320939	665536	425830	5404628	Between CB and UMF	A2	718.9
68	3	068-03	2321343	665511	425953	5404615	Between CB and UMF	A2	718.9
68	4	068-04	2321746	665486	426075	5404601	Between CB and UMF	A2	718.9
68	5	068-05	2322150	665461	426197	5404587	Between CB and UMF	A2	718.9
69	1	069-01	2320833	662976	425759	5403851	Between CB and UMF	A2	718.4
69	2	069-02	2321181	663010	425865	5403856	Between CB and UMF	A2	718.4
69	3	069-03	2321529	663045	425972	5403861	Between CB and UMF	A2	718.4
69	4	069-04	2321877	663080	426078	5403867	Between CB and UMF	A2	718.4
69	5	069-05	2322225	663114	426185	5403872	Between CB and UMF	A2	718.4
70	1	070-01	2320266	660878	425554	5403221	Between CB and UMF	A2	718.0
70	2	070-02	2320402	660706	425593	5403167	Between CB and UMF	A2	717.9

Table A1. Underwater Imagery and Acoustic Doppler Current Profiler Measurement Locations

Transect No.	Station No.	Station ID	WA StatePlane N X (ft)	WA StatePlane N Y (ft)	UTM 11N X (m)	UTM 11N Y (m)	River Segment	Map No.	Approximate River Mile
70	3	070-03	2320538	660535	425632	5403113	Between CB and UMF	A2	717.9
70	4	070-04	2320675	660363	425671	5403058	Between CB and UMF	A2	717.9
70	5	070-05	2320811	660192	425710	5403004	Between CB and UMF	A2	717.9
71	1	071-01	2318304	659435	424935	5402812	Between CB and UMF	A2	717.4
71	2	071-02	2318388	659254	424958	5402756	Between CB and UMF	A2	717.4
71	3	071-03	2318473	659074	424981	5402699	Between CB and UMF	A2	717.4
71	4	071-04	2318557	658893	425004	5402643	Between CB and UMF	A2	717.4
71	5	071-05	2318641	658712	425027	5402587	Between CB and UMF	A2	717.4
72	1	072-01	2316119	658122	424250	5402446	Between CB and UMF	A2	717.0
72	2	072-02	2316235	657954	424283	5402393	Between CB and UMF	A2	717.0
72	3	072-03	2316351	657786	424316	5402340	Between CB and UMF	A2	717.0
72	4	072-04	2316468	657618	424349	5402287	Between CB and UMF	A2	717.0
72	5	072-05	2316584	657450	424382	5402234	Between CB and UMF	A2	717.0
73	1	073-01	2313514	656870	423439	5402104	Between CB and UMF	A2	716.5
73	2	073-02	2313805	656663	423524	5402037	Between CB and UMF	A2	716.5
73	3	073-03	2314096	656456	423610	5401969	Between CB and UMF	A2	716.5
73	4	073-04	2314388	656249	423695	5401902	Between CB and UMF	A2	716.5
73	5	073-05	2314679	656043	423781	5401835	Between CB and UMF	A2	716.6
74	1	074-01	2311997	654766	422945	5401487	Between CB and UMF	A2	716.0
74	2	074-02	2312352	654670	423052	5401452	Between CB and UMF	A2	716.1
74	3	074-03	2312707	654574	423158	5401418	Between CB and UMF	A2	716.1
74	4	074-04	2313061	654478	423265	5401383	Between CB and UMF	A2	716.1
74	5	074-05	2313416	654382	423371	5401348	Between CB and UMF	A2	716.2
75	1	075-01	2310536	653199	422477	5401032	Between CB and UMF	A2	715.7
75	2	075-02	2310714	653064	422529	5400989	Between CB and UMF	A2	715.7
75	3	075-03	2310892	652929	422581	5400945	Between CB and UMF	A2	715.7
75	4	075-04	2311070	652793	422633	5400901	Between CB and UMF	A2	715.6
75	5	075-05	2311248	652658	422685	5400857	Between CB and UMF	A2	715.6
76	1	076-01	2309132	651036	422016	5400395	Between CB and UMF	A2	715.2
76	2	076-02	2309477	650863	422119	5400337	Between CB and UMF	A2	715.2
76	3	076-03	2309822	650689	422221	5400279	Between CB and UMF	A2	715.2
76	4	076-04	2310166	650516	422323	5400221	Between CB and UMF	A2	715.2
76	5	076-05	2310511	650342	422426	5400163	Between CB and UMF	A2	715.2
77	1	077-01	2309115	648043	421966	5399485	Between CB and UMF	A2	714.8
77	2	077-02	2309443	648145	422067	5399511	Between CB and UMF	A2	714.8
77	3	077-03	2309771	648248	422168	5399537	Between CB and UMF	A2	714.8
77	4	077-04	2310099	648351	422270	5399564	Between CB and UMF	A2	714.8
77	5	077-05	2310427	648454	422371	5399590	Between CB and UMF	A2	714.8
78	1	078-01	2309628	645693	422086	5398762	Between CB and UMF	A2	714.4
78	2	078-02	2309913	645828	422175	5398799	Between CB and UMF	A2	714.4
78	3	078-03	2310198	645964	422264	5398836	Between CB and UMF	A2	714.4
78	4	078-04	2310483	646099	422353	5398873	Between CB and UMF	A2	714.4
78	5	078-05	2310768	646235	422441	5398909	Between CB and UMF	A2	714.4
79	1	079-01	2310649	643297	422360	5398017	Between CB and UMF	A2	713.9
79	2	079-02	2310977	643455	422463	5398060	Between CB and UMF	A2	713.9
79	3	079-03	2311306	643614	422565	5398104	Between CB and UMF	A2	713.9
79	4	079-04	2311635	643772	422668	5398147	Between CB and UMF	A2	713.9
79	5	079-05	2311963	643930	422770	5398190	Between CB and UMF	A2	713.9
80	1	080-01	2312351	641244	422847	5397366	Between CB and UMF	A2	713.4
80	2	080-02	2312552	641442	422911	5397424	Between CB and UMF	A2	713.4
80	3	080-03	2312752	641640	422975	5397481	Between CB and UMF	A2	713.4
80	4	080-04	2312952	641839	423039	5397538	Between CB and UMF	A2	713.5
80	5	080-05	2313152	642037	423103	5397596	Between CB and UMF	A2	713.5
81	1	081-01	2313415	639122	423139	5396704	Between CB and UMF	A2	713.0
81	2	081-02	2313588	639254	423193	5396742	Between CB and UMF	A2	713.0
81	3	081-03	2313762	639387	423248	5396780	Between CB and UMF	A2	713.0
81	4	081-04	2313935	639520	423303	5396818	Between CB and UMF	A2	713.0
81	5	081-05	2314108	639653	423358	5396856	Between CB and UMF	A2	713.0
82	1	082-01	2314613	637075	423472	5396063	Between CB and UMF	A2	712.6
82	2	082-02	2314832	637127	423540	5396076	Between CB and UMF	A2	712.5
82	3	082-03	2315052	637179	423607	5396088	Between CB and UMF	A2	712.5
82	4	082-04	2315271	637231	423675	5396101	Between CB and UMF	A2	712.5
82	5	082-05	2315490	637283	423742	5396113	Between CB and UMF	A2	712.5
83	1	083-01	2315858	635207	423823	5395476	Between CB and UMF	A2	712.1
83	2	083-02	2316325	635215	423965	5395471	Between CB and UMF	A2	712.1
83	3	083-03	2316792	635223	424107	5395467	Between CB and UMF	A2	712.1
83	4	083-04	2317260	635230	424249	5395462	Between CB and UMF	A2	712.0
83	5	083-05	2317727	635238	424392	5395457	Between CB and UMF	A2	712.0
84	1	084-01	2315873	632813	423791	5394747	Between CB and UMF	A2	711.7
84	2	084-02	2316548	632847	423997	5394747	Between CB and UMF	A2	711.7
84	3	084-03	2317223	632881	424202	5394747	Between CB and UMF	A2	711.7
84	4	084-04	2317898	632915	424408	5394747	Between CB and UMF	A2	711.6
84	5	084-05	2318572	632948	424614	5394747	Between CB and UMF	A2	711.6
85	1	085-01	2316458	631540	423949	5394351	UMF	A5	711.5
85	2	085-02	2316758	631631	424042	5394374	UMF	A5	711.5
85	3	085-03	2317170	631755	424169	5394405	UMF	A5	711.5
85	4	085-04	2317483	631849	424266	5394429	UMF	A5	711.5
85	5	085-05	2317660	631902	424321	5394443	UMF	A5	711.5
85	6	085-06	2317900	631974	424395	5394461	UMF	A5	711.5
85	7	085-07	2318261	632083	424506	5394489	UMF	A5	711.5
85	8	085-08	2318562	632173	424599	5394512	UMF	A5	711.4
85	9	085-09	2318863	632264	424692	5394535	UMF	A5	711.4
85	10	085-10	2319163	632354	424785	5394557	UMF	A5	711.4
86	1	086-01	2316568	630654	423969	5394080	UMF	A5	711.3
86	2	086-02	2316928	630742	424080	5394101	UMF	A5	711.3
86	3	086-03	2317232	630816	424174	5394119	UMF	A5	711.3
86	4	086-04	2317876	630974	424372	5394157	UMF	A5	711.3
86	5	086-05	2318006	631006	424412	5394165	UMF	A5	711.3
86	6	086-06	2318157	631043	424459	5394174	UMF	A5	711.3
86	7	086-07	2318725	631182	424634	5394207	UMF	A5	711.3

Table A1. Underwater Imagery and Acoustic Doppler Current Profiler Measurement Locations

Transect No.	Station No.	Station ID	WA StatePlane N X (ft)	WA StatePlane N Y (ft)	UTM 11N X (m)	UTM 11N Y (m)	River Segment	Map No.	Approximate River Mile
86	8	086-08	2319085	631270	424745	5394229	UMF	A5	711.3
86	9	086-09	2319444	631358	424855	5394250	UMF	A5	711.3
86	10	086-10	2319804	631446	424966	5394271	UMF	A5	711.2
87	1	087-01	2317299	629956	424181	5393856	UMF	A5	711.1
87	2	087-02	2317732	629953	424313	5393849	UMF	A5	711.1
87	3	087-03	2318114	629951	424429	5393842	UMF	A5	711.1
87	4	087-04	2318350	629949	424501	5393838	UMF	A5	711.1
87	5	087-05	2318601	629948	424577	5393834	UMF	A5	711.1
87	6	087-06	2319324	629943	424797	5393821	UMF	A5	711.0
87	7	087-07	2320103	629938	425034	5393808	UMF	A5	711.0
87	8	087-08	2319884	629940	424968	5393812	UMF	A5	711.0
87	9	087-09	2320267	629937	425084	5393805	UMF	A5	711.0
87	10	087-10	2320651	629935	425201	5393799	UMF	A5	711.0
88	1	088-01	2317015	628919	424079	5393545	UMF	A5	711.0
88	2	088-02	2317308	628930	424168	5393544	UMF	A5	710.9
88	3	088-03	2317797	628947	424317	5393541	UMF	A5	710.9
88	4	088-04	2318371	628968	424492	5393539	UMF	A5	710.9
88	5	088-05	2318533	628973	424542	5393538	UMF	A5	710.9
88	6	088-06	2318753	628981	424609	5393537	UMF	A5	710.9
88	7	088-07	2319360	629003	424794	5393535	UMF	A5	710.9
88	8	088-08	2319750	629017	424913	5393533	UMF	A5	710.8
88	9	088-09	2320141	629031	425032	5393531	UMF	A5	710.8
88	10	088-10	2320532	629044	425151	5393529	UMF	A5	710.8
89	1	089-01	2317062	628291	424084	5393353	UMF	A5	710.8
89	2	089-02	2317444	628362	424201	5393369	UMF	A5	710.8
89	3	089-03	2317956	628458	424358	5393390	UMF	A5	710.8
89	4	089-04	2318491	628558	424523	5393413	UMF	A5	710.8
89	5	089-05	2318678	628593	424580	5393420	UMF	A5	710.8
89	6	089-06	2318811	628618	424621	5393426	UMF	A5	710.8
89	7	089-07	2319315	628713	424776	5393447	UMF	A5	710.8
89	8	089-08	2319719	628788	424900	5393464	UMF	A5	710.8
89	9	089-09	2320122	628864	425024	5393481	UMF	A5	710.8
89	10	089-10	2320525	628939	425148	5393498	UMF	A5	710.8
90	1	090-01	2316861	627744	424014	5393190	UMF	A5	710.7
90	2	090-02	2317285	627714	424143	5393174	UMF	A5	710.7
90	3	090-03	2317710	627684	424272	5393158	UMF	A5	710.7
90	4	090-04	2318321	627640	424457	5393136	UMF	A5	710.7
90	5	090-05	2318832	627604	424612	5393117	UMF	A5	710.6
90	6	090-06	2318983	627593	424658	5393111	UMF	A5	710.6
90	7	090-07	2319099	627585	424693	5393107	UMF	A5	710.6
90	8	090-08	2319832	627533	424915	5393080	UMF	A5	710.6
90	9	090-09	2320256	627503	425044	5393065	UMF	A5	710.6
90	10	090-10	2320854	627460	425225	5393043	UMF	A5	710.5
91	1	091-01	2316816	627169	423992	5393015	UMF	A5	710.6
91	2	091-02	2317578	626972	424221	5392944	UMF	A5	710.6
91	3	091-03	2317960	626874	424335	5392908	UMF	A5	710.6
91	4	091-04	2318341	626776	424450	5392872	UMF	A5	710.5
91	5	091-05	2318654	626695	424544	5392843	UMF	A5	710.5
91	6	091-06	2319046	626594	424662	5392806	UMF	A5	710.5
91	7	091-07	2319177	626560	424701	5392794	UMF	A5	710.4
91	8	091-08	2319457	626488	424785	5392768	UMF	A5	710.4
91	9	091-09	2319867	626382	424908	5392730	UMF	A5	710.4
91	10	091-10	2320248	626284	425023	5392694	UMF	A5	710.4
92	1	092-01	2316340	626346	423834	5392772	UMF	A5	709.9
92	7	092-02	2319005	626067	424641	5392646	UMF	A5	710.4
92	2	092-03	2316955	626281	424021	5392743	UMF	A5	710.0
92	3	092-04	2317651	626209	424231	5392710	UMF	A5	710.2
92	4	092-05	2317958	626176	424324	5392696	UMF	A5	710.2
92	5	092-06	2318492	626120	424486	5392671	UMF	A5	710.4
92	6	092-07	2318820	626086	424585	5392655	UMF	A5	710.4
92	8	092-08	2319171	626049	424692	5392639	UMF	A5	710.4
92	9	092-09	2319424	626023	424768	5392627	UMF	A5	710.3
92	10	092-10	2319980	625964	424936	5392601	UMF	A5	710.3
93	1	093-01	2316712	626884	423956	5392930	UMF	A5	710.6
93	2	093-02	2317112	626503	424072	5392808	UMF	A5	710.5
93	3	093-03	2317512	626123	424188	5392686	UMF	A5	710.1
93	4	093-04	2317879	625774	424294	5392575	UMF	A5	710.1
93	5	093-05	2318113	625552	424362	5392503	UMF	A5	710.1
93	6	093-06	2318346	625330	424429	5392432	UMF	A5	710.1
93	7	093-07	2318464	625218	424464	5392396	UMF	A5	710.1
93	8	093-08	2318579	625108	424497	5392361	UMF	A5	710.1
93	9	093-09	2318693	625000	424530	5392327	UMF	A5	710.1
93	10	093-10	2318813	624886	424565	5392290	UMF	A5	710.2
94	1	094-01	2316906	624883	423985	5392318	UMF	A5	709.9
94	2	094-02	2317092	624790	424040	5392287	UMF	A5	709.9
94	3	094-03	2317233	624719	424081	5392263	UMF	A5	709.9
94	4	094-04	2317360	624655	424119	5392242	UMF	A5	709.9
94	5	094-05	2317464	624602	424150	5392224	UMF	A5	709.9
94	6	094-06	2317596	624536	424189	5392202	UMF	A5	709.9
94	7	094-07	2317706	624481	424222	5392184	UMF	A5	710.0
94	8	094-08	2317867	624400	424270	5392157	UMF	A5	710.0
94	9	094-09	2318042	624311	424322	5392127	UMF	A5	710.0
94	10	094-10	2318306	624179	424400	5392083	UMF	A5	710.0
95	1	095-01	2316442	624454	423837	5392195	UMF	A5	709.7
95	2	095-02	2316424	624338	423829	5392160	UMF	A5	709.7
95	3	095-03	2316402	624201	423821	5392118	UMF	A5	709.7
95	4	095-04	2316378	624047	423811	5392072	UMF	A5	709.7
95	5	095-05	2316359	623930	423804	5392037	UMF	A5	709.7
95	6	095-06	2316332	623753	423792	5391983	UMF	A5	709.7
95	7	095-07	2316299	623543	423779	5391920	UMF	A5	709.6

Table A1. Underwater Imagery and Acoustic Doppler Current Profiler Measurement Locations

Transect No.	Station No.	Station ID	WA StatePlane N X (ft)	WA StatePlane N Y (ft)	UTM 11N X (m)	UTM 11N Y (m)	River Segment	Map No.	Approximate River Mile
95	8	095-08	2316272	623372	423768	5391868	UMF	A5	709.6
95	9	095-09	2316239	623164	423755	5391805	UMF	A5	709.6
95	10	095-10	2316205	622951	423742	5391741	UMF	A5	709.6
96	1	096-01	2315325	623943	423489	5392056	UMF	A5	709.5
96	2	096-02	2315471	623891	423533	5392038	UMF	A5	709.5
96	3	096-03	2315613	623840	423575	5392021	UMF	A5	709.5
96	4	096-04	2315796	623775	423630	5391998	UMF	A5	709.6
96	5	096-05	2315983	623709	423686	5391975	UMF	A5	709.6
96	6	096-06	2316125	623659	423728	5391958	UMF	A5	709.6
96	7	096-07	2316333	623585	423790	5391932	UMF	A5	709.7
96	8	096-08	2316421	623554	423817	5391921	UMF	A5	709.7
96	9	096-09	2316560	623505	423858	5391904	UMF	A5	709.7
96	10	096-10	2316847	623403	423944	5391869	UMF	A5	709.7
97	1	097-01	2314661	623752	423284	5392008	UMF	A5	709.4
97	2	097-02	2314712	623610	423297	5391964	UMF	A5	709.4
97	3	097-03	2314762	623469	423310	5391920	UMF	A5	709.4
97	4	097-04	2314813	623327	423324	5391876	UMF	A5	709.4
97	5	097-05	2314863	623185	423337	5391833	UMF	A5	709.4
97	6	097-06	2314914	623044	423350	5391789	UMF	A5	709.4
97	7	097-07	2314965	622902	423363	5391745	UMF	A5	709.4
97	8	097-08	2315015	622760	423377	5391701	UMF	A5	709.4
97	9	097-09	2315066	622619	423390	5391657	UMF	A5	709.4
97	10	097-10	2315116	622477	423403	5391613	UMF	A5	709.4
98	1	098-01	2313604	623463	422958	5391936	UMF	A5	709.2
98	2	098-02	2313666	623322	422975	5391892	UMF	A5	709.2
98	3	098-03	2313728	623181	422992	5391849	UMF	A5	709.2
98	4	098-04	2313791	623041	423008	5391805	UMF	A5	709.2
98	5	098-05	2313853	622900	423025	5391761	UMF	A5	709.2
98	6	098-06	2313916	622759	423042	5391717	UMF	A5	709.2
98	7	098-07	2313978	622619	423059	5391674	UMF	A5	709.2
98	8	098-08	2314040	622478	423076	5391630	UMF	A5	709.2
98	9	098-09	2314103	622337	423093	5391586	UMF	A5	709.2
98	10	098-10	2314165	622197	423109	5391542	UMF	A5	709.2
99	1	099-01	2312699	623243	422679	5391883	UMF	A5	709.0
99	2	099-02	2312732	623085	422687	5391835	UMF	A5	709.0
99	3	099-03	2312765	622928	422695	5391786	UMF	A5	709.0
99	4	099-04	2312798	622770	422702	5391738	UMF	A5	709.0
99	5	099-05	2312832	622612	422710	5391689	UMF	A5	709.0
99	6	099-06	2312865	622454	422718	5391640	UMF	A5	709.0
99	7	099-07	2312898	622296	422725	5391592	UMF	A5	709.0
99	8	099-08	2312931	622139	422733	5391543	UMF	A5	709.0
99	9	099-09	2312964	621981	422741	5391495	UMF	A5	709.0
99	10	099-10	2312997	621823	422748	5391446	UMF	A5	709.0
100	1	100-01	2311954	623169	422451	5391872	UMF	A5	708.9
100	2	100-02	2311989	623003	422460	5391821	UMF	A5	708.9
100	3	100-03	2312025	622837	422468	5391770	UMF	A5	708.9
100	4	100-04	2312060	622671	422476	5391719	UMF	A5	708.9
100	5	100-05	2312096	622505	422484	5391668	UMF	A5	708.9
100	6	100-06	2312131	622338	422493	5391616	UMF	A5	708.8
100	7	100-07	2312167	622172	422501	5391565	UMF	A5	708.8
100	8	100-08	2312202	622006	422509	5391514	UMF	A5	708.8
100	9	100-09	2312238	621840	422518	5391463	UMF	A5	708.8
100	10	100-10	2312273	621674	422526	5391412	UMF	A5	708.8

Notes:
CB – China Bend
DME – Deadman's Eddy
UMF – Upstream of Marcus Flats
UTM – Universal Transvers Mercator

ATTACHMENT A1

GENERAL SITE HEALTH AND SAFETY PLAN ADDENDUM
PHASE 3 SEDIMENT FACIES MAPPING

CONTENTS

LIST OF TABLES

ACRONYMS AND ABBREVIATIONS

CFR	Code of Federal Regulations
COPC	chemical of potential concern
DEET	diethyl-m-toluamide
ERM	Environmental Resources Management
HAZWOPER	hazardous waste operations and emergency response
OU	operable unit
OSHA	Occupational Safety and Health Administration
PFD	personal flotation device
PPE	personal protective equipment
RI/FS	remedial investigation and feasibility study
SHSP	site health and safety plan
Site	Upper Columbia River site
TAI	Teck American Incorporated
UCR	Upper Columbia River
WISHA	Washington Industrial Safety and Health Act

UNITS OF MEASURE

ft	foot/feet
m	meter(s)

SITE HEALTH AND SAFETY PLAN ADDENDUM APPROVAL

This Addendum to the general site health and safety plan (SHSP) has been reviewed and approved by Teck American Incorporated's (TAI) lead technical consultant (Environmental Resources Management [ERM]) for the Phase 3 Sediment Facies Mapping Study at the Upper Columbia River (UCR) site (Site) in support of the remedial investigation and feasibility study (RI/FS) for the Site.

ERM Task Manager	Date
EMR Project Health and Safety Officer	Date

SITE HEALTH AND SAFETY PLAN ADDENDUM ACKNOWLEDGEMENT

This Addendum to the general SHSP (TCAI 2009) is approved by TAI for use at the Site. The general SHSP and Addendum are the minimum health and safety standards for the Site and will be strictly enforced for all personnel conducting field activities associated with the Sediment Facies Mapping element of the Phase 3 Sediment Study at the Site. Subcontracted personnel may request to adopt a subcontractor-specific plan in lieu of this Addendum to the general SHSP, but must obtain prior written approval from TAI and provide written concurrence from the subcontractor that the subcontractor will assume direct responsibility and liability for administering the plan to its employees.

I have reviewed this Addendum to the general SHSP for the study. I have had an opportunity to ask any questions I may have and have been provided with satisfactory responses. I understand the purpose of the plan, and I consent to adhere to its policies, procedures, and guidelines.

Employee signature	Company	Date
Employee signature	Company	Date
Employee signature	Company	Date
Employee signature	Company	Date
Employee signature	Company	Date
Employee signature	Company	Date
Employee signature	Company	Date

1 INTRODUCTION

This Addendum to the Upper Columbia River (UCR) remedial investigation and feasibility study (RI/FS) general site health and safety plan (SHSP) provides specific Upper Columbia River site (Site) information and health and safety provisions to protect workers from potential hazards during bathymetry data and underwater imagery collection activities at locations along the UCR.

Site background information and general health and safety provisions to protect workers from potential hazards during work at the Site are presented in the general SHSP (TCAI 2009).

Subcontractors that are contracted to perform field work associated with the RI/FS may adopt the general SHSP and this Addendum or develop and follow their own SHSPs. However, subcontractor SHSPs must be consistent with the provisions outlined in the Addendum and the general SHSP, and any discrepancies will follow the most protective practices.

It is Environmental Resources Management's (ERM's) policy to provide a safe and healthful work environment. No aspect of the work is more important than protecting the health and safety of all workers.

ERM cannot guarantee the health or safety of any person entering the Site. Because of the potentially hazardous nature of the Site and the activity occurring thereon, it is not possible to regulate personal diligence or to discover, evaluate, and provide protection for all possible hazards that may be encountered. Strict adherence to the health and safety guidelines set forth herein will reduce, but not eliminate, the potential for injury and illness at the Site. The health and safety guidelines in this plan were prepared specifically for the Site and should not be used on any other site without prior evaluation by trained health and safety personnel.

A copy of this Addendum and the general SHSP must be in the custody of the field crew during field activities. All individuals performing field work must read, understand, and comply with this plan before undertaking field activities. Once the information has been read and understood, the individual must sign the Site Health and Safety Acknowledgment Form provided with this Addendum to the general plan. Any changes to the plan will be written in the plan and initialed by all potentially affected field personnel. The signed form and any initialed changes will become part of ERM's project file. A copy of the form will be provided to TAI.

This Addendum may be modified at any time based on the judgment of the site safety officer in consultation with the corporate health and safety officer and project manager or designee. Any modification will be presented to the onsite team during a safety briefing and will be recorded in the field notebook.

1.1 ORGANIZATION

Task-specific safety procedures associated with bathymetry data and underwater imagery collection activities are presented in this Addendum to the general SHSP. In addition, this Addendum provides detailed field study area and hospital location maps, air monitoring requirements, specific requirements for personal protective equipment (PPE), work zone definitions, and key emergency contact information.

The general SHSP (TCAI 2009) provides background site information and general health and safety provisions to protect workers from potential hazards during field activities. The information includes general safety guidelines for physical hazards, a chemical hazard evaluation, health and safety training requirements, general PPE requirements, emergency planning, general decontamination procedures, vehicle safety, and spill containment.

1.2 SCOPE OF WORK

Bathymetry data and underwater imagery collection activities will be conducted by a TAI field contractor during the fall of 2018. As indicated in the QAPP, bathymetry data and underwater imagery will be collected throughout the Upper Reach Operable Unit (OU), which encompasses the UCR river channel from the U.S. – Canada border to an area just north of Marcus Flats within the Site (Attachment A1-1). Sediment bed elevation and acoustic backscatter data will be collected continuously throughout the Upper Reach OU. Water velocity profiles and underwater imagery will be co-located and collected at point locations along transects throughout the Upper Reach OU.

1.3 DEFINITIONS

Contamination reduction zone	Area between the exclusion and support zones that provides a transition between contaminated and clean zones
Exclusion zone	Any area of the Site where hazardous substances are present, or are reasonably suspected to be present, and pose an exposure hazard to personnel

HAZWOPER	Hazardous Waste Operations and Emergency Response standard, as described in 29 Code of Federal Regulations (CFR) Part 1910.120
OSHA	Occupational Safety and Health Administration
Support zone	Any area of the Site, so designated, that is outside the exclusion and contamination reduction zones
WISHA	Washington Industrial Safety and Health Act, as described in Chapter 49.17 Revised Code of Washington

2 SAFETY GUIDELINES FOR PHYSICAL HAZARDS

2.1 GENERAL PROJECT HAZARDS

All work will be done using the buddy system. Depending upon the time of year and the location of work, biting insects, venomous snakes, and other wildlife may be an issue when accessing any of the sampling locations during the sampling events. Table 2-1 summarizes potential physical hazards posed by proposed Site activities. Table 2-2 presents potential physical hazards that are expected to be present during sampling activities.

Table 2-1. Summary of Activities and Potential Hazards

Activity	Potential Hazard
Bathymetry data and underwater imagery collection	Water hazards; uneven terrain/tripping, slippery walking surfaces, cold/hypothermia (depending on sampling event); heat stress (depending on sampling event); material handling; adverse weather; work in remote areas; wildlife; traversing rough terrain

Table 2-2. Potential Physical Hazards and Proposed Safety Procedures

Potential Hazard	Yes	No	Proposed Safety Procedure
Uneven terrain/tripping, slippery walking surfaces	X		Use caution; wear properly fitting shoes or boots with good gripping capacity and ankle support; keep work area orderly.
Cold/hypothermia	X		Keep warm and dry, bring changes of clothes; do not work in extreme conditions without proper equipment and training; follow cold stress information (Attachment A1-2); potential for cold/hypothermia will depend on season.
Heat stress	X		Drink water frequently in hot weather; take work breaks; follow the heat-related illness policy (Attachment A1-3); potential for heat stress will depend on season.
Material handling	X		Lift properly; seek assistance if necessary; do not overfill coolers or boxes.
Adverse weather	X		Seek shelter during storms; work in adverse weather conditions only with proper training, clothing, and equipment.
Drowning	X		All employees, when working in or near water (i.e., within 10 feet/3 meters[m]) where there is a potential to voluntarily, or involuntarily, enter the water must wear a Type III personal flotation device (PFD), Type V work vest, or better. All water work (including work near water) must be performed during daylight hours. Maintain good housekeeping during all activities to prevent slips, trips, and falls. Inspect the PFDs prior to use and do not use defective PFDs. Keep sampling equipment on the shore organized at all times.

Table 2-2. Potential Physical Hazards and Proposed Safety Procedures (continued)

Potential Hazard	Yes	No	Proposed Safety Procedure
Work in remote areas	X		Use the buddy system; carry radio and/or cellular telephone; carry satellite telephone, bring sufficient equipment in case of accident or injury (first aid kit, shelter if appropriate). A satellite telephone is necessary due to the unpredictable cellular network.
Biting insects, ticks, and mosquitos	X		**Biting insects.** Use repellents, as needed. **Ticks.** Wear long-sleeved clothing and ankle length boots and try to avoid excessive contact with tall brush or grass. Personnel should change clothes and inspect their skin and scalps for ticks after every day of field work. If individuals discover a tick embedded in their skin, it should be removed as soon as possible. Grasp the tick with a blunt pair of tweezers as close to the skin as possible and remove it using slow even pressure. Do not break off the head or release fluids from the tick. Gently scrub the area with soap and water after removal. Note the date of the bite and watch for symptoms such as fever, chills, aches, and rashes for a month after the bite. If these symptoms occur, consult a doctor. **Mosquitos.** Use an insect repellent containing N, N-diethyl-m-toluamide (DEET). Wear long-sleeved shirts, pants, and hat; spray clothing with insect repellent containing DEET. Avoid handling dead animals. The risk of getting West Nile Virus is very low. Symptoms include fever, headache, neck stiffness, stupor, disorientation, tremors, convulsions, muscle weakness, paralysis, and body aches. If you develop any of these symptoms, contact your health care provider.
Stinging insects, bees/wasps (allergic reaction)	X		Avoiding wearing bright colors or scents. Use an appropriate insect repellent. Wear long-sleeved shirt, hat, and gloves. Employees must notify supervisor if they have allergies to bee/wasp stings prior to engaging in field activities. Employees with allergies may be required to carry an appropriate antidote kit.
Poisonous plants, poison ivy, poison sumac	X		Poison ivy generally has three green leaves on each stem. The color and appearance can vary throughout the year. Poison sumac generally occurs as a woody shrub or small tree with 7 to 13 leaflets as pairs along a central midrib and a single leaf at the end. The color and appearance can vary throughout the year. It has a smooth texture and is bright orange (spring) or glossy dark green with red midribs (summer). Avoid contact with all parts of the poison ivy or sumac plants. Contact with the oily resins on the plant may cause a skin rash. The rash usually appears within 24 to 48 hours and can last for weeks. If poison ivy or sumac is contacted, remove the affected clothing and wash the skin with soap and water to remove the oil resins as soon as possible.
Wildlife encounter	X		See individual animals listed below.

Table 2-2. Potential Physical Hazards and Proposed Safety Procedures (continued)

Potential Hazard	Yes	No	Proposed Safety Procedure
Poisonous snakes (rattlesnakes)	X		Wear appropriate PPE such as ankle-high leather boots, long pants, snake chaps, long sleeves when possible, a hat, and gloves if cutting brush or handling and moving vegetation. Do not reach into burrows or dens, under rocks, or logs. Walk heavily through brush. Back away if a snake is encountered. Take snake bite kit with a complete set of instructions. In case of a snake bite, seek prompt medical assistance. The injured employee should rest while awaiting (or being transported to) medical assistance. Workers should seek medical attention if bitten.
Black bear (potential attack)	X		If you come in contact with a black bear, stay calm and avoid eye contact. Try to stay upwind and identify yourself as a human being by standing up, talking, and waving your hands above your head. If you cannot safely move away from the bear and the animal does not flee, try to scare it away by clapping your hands or yelling. If the bear attacks, fight back aggressively. As a last resort if the attack continues, protect yourself by curling into a ball or lie on the ground on your stomach playing dead. Do not stand between mother and cub. Take bear mace with a complete set of instructions. All employees must be trained in the proper use of bear spray, which includes reading the manufacturer's instructions and discussion during project planning and daily health and safety meetings.
Grizzly bear/ brown bear (potential attack)	X		If you are attacked by a grizzly bear, play dead. Lie flat on your stomach or curl up in a ball with your hands behind your head. Remain motionless as long as possible. Do not run. Do not stand between mother and cub. Take bear mace with a complete set of instructions. All employees must be trained in the proper use of bear spray, which includes reading the manufacturer's instructions and discussion during project planning and daily health and safety meetings.
Cougar (potential attack)	X		If you come in contact with a cougar, stop, stand tall, and don't run. Try to appear larger than the cougar. Never take your eyes off the animal or turn your back. If the animal displays aggressive behavior, shout, wave your arms, and throw rocks. If the cougar attacks, fight back aggressively and stay on your feet.
Moose (between mother/calf)	X		If you come in contact with a moose, step back. Look for the nearest tree, fence, or building or other obstruction to hide behind. It's usually a good idea to run from a moose because it usually won't chase you far. If a moose knocks you down, curl up in a ball, protect your head with your arms and hands, and hold still. Don't move or try to get up until the moose moves a safe distance away.

2.2 PROJECT-SPECIFIC HAZARDS

Wildlife. As listed above, there is an abundance of wildlife in the study area. Based on previous sampling events in the study area during summer and fall months, there have been encounters with snakes, evidence of bear foraging, and bee/wasp nests both in trees and in the grass. Employees should remain alert and aware of their surroundings during

the field event and follow proposed safety procedures above for wildlife known to inhabit the area. In the event of a wildlife encounter that causes a safety concern, use field vehicles for shelter if the vehicles can be reached safely. Use your best judgement while still following safety tips described above to determine if you can reach the vehicle.

Water work. This work will include sampling by TAI field contractors on or near water where there is a potential to voluntarily, or involuntarily, enter the water. Bathymetry data and underwater imagery collection will be from a boat within waterbodies in the study area. All employees, when working **in** or **near** water (i.e., within 10 ft/3 m) where the danger of drowning exists, must wear a Type III personal flotation device (PFD), Type V work vest, or better. The PFDs must be inspected prior to use and not used if defective. It is recommended that employees wear a PFD during oversight of sampling activities in water (even if the employee is located outside of the 10-ft exclusion zone near the water) in the event that an emergency situation arises, which may require the employee to move into the 10-ft exclusion zone by the water. All water work (including work near water) must be performed during daylight hours. All employees must maintain good housekeeping during all sampling activities to prevent slips, trips, and falls.

Traversing through rough terrain. If traversing unpaved roads or rough terrain, always drive slowly and cautiously onsite and between sites. Do not attempt to drive in areas such as steep, degraded, and/or undrivable roads. If rough terrain is encountered while driving, stop the car in a secure location, and, if safe, attempt to assess the roadway condition on foot. If a roadway is blocked, stop the car, and, if safe by foot, determine if there is a suitable and safe alternative route around the obstruction at that location. Consult local maps to determine if an alternative route is available. If a different route is unavailable, contact the ERM Principal Investigator or TAI Project Coordinator to discuss alternative options.

3 CHEMICAL HAZARD EVALUATION

A chemical hazard evaluation is presented in the general SHSP (TCAI 2009) and incorporated herein by reference.

4 PERSONAL PROTECTIVE EQUIPMENT AND SAFETY EQUIPMENT

The following sections address PPE and safety equipment required for completing the sampling activities.

4.1 PERSONAL PROTECTIVE EQUIPMENT

Based on chemical and physical hazards associated with bathymetry data and underwater imagery collection activities, Tables 4-1 and 4-2 identify the PPE required for sampling.

Table 4-1. Level of Protection Required for Site Activities

Site Activity	Level of Protection	
	Initial[a]	Contingency[b]
Bathymetry data and underwater imagery collection	MD	Leave Site, reassess situation
Sample handling	D	Leave Site, reassess situation

[a] See Table 4-2 for definitions

[b] Based on unexpected change in Site conditions

Table 4-2. Levels of Protection and Personal Protective Equipment

Protection Level	Required	Personal Protective Equipment
Level D	X	Long pants and shirt or work coveralls, safety glasses or goggles (as appropriate), and nitrile, neoprene, or Barrier® 5-layer laminate gloves (as appropriate). Hard hat and hearing protection as needed.
Level MD	X	Same as Level D with modification (M) of adding rain gear and PFD, as needed.

Is there potential for a respirator to be donned during field work? Yes _____ No X

4.2 SAFETY EQUIPMENT

The following safety equipment will be on site during the proposed field activities.

Air Monitoring (check the items required for this project):

- ☐ Photoionization detector
- ☐ Lower explosive limit/oxygen meter
- ☐ Hydrogen sulfide meter
- ☐ Detector pump and tubes
- ☐ Air sampling pumps
- ☐ Miniram
- ☐ Radiation meter
- ☐ Other _____

First Aid Kit (mandatory, including adhesive band-aids, gauze, tape, gloves, cardiopulmonary resuscitation shield, triangle bandage):

[X]	Emergency blanket	[X]	Sunscreen
[X]	Insect repellent	[ ]	Other _____

Other (check the items required for this project):

[X]	Eyewash	[ ]	Fit test supplies
[X]	Drinking water	[X]	Fire extinguisher
[ ]	Stop watch for monitoring heart	[ ]	Windsock
[ ]	Thermoscan® thermometer (or equivalent) for heat stress monitoring	[X]	Cellular telephone
		[X]	Radio sets (if no cellular or satellite telephone service)
[X]	Survival kit	[X]	Global positioning system
[X]	Personal flotation device	[X]	Other: Satellite telephone, hip/chest waders, snake chaps, bear spray

5 AIR MONITORING

The principal constituents of potential concern (COPCs) at the Site are not volatile (i.e., metals). The chemical hazard evaluation presented in the general SHSP (TCAI 2009) concluded that, based on previous evaluations, none of the sediment chemicals are expected to pose a threat to field personnel during bathymetry data and underwater imagery collection activities. If windblown dust becomes problematic to the field crew, operations may be suspended. Tables 5-1 and 5-2 provide air monitoring requirements and action levels to be used during sampling activities.

Table 5-1. Site-specific Air Monitoring Requirements

Monitoring Instrument	Calibration Frequency	Parameters of Interest	Monitoring Frequency
Visual	Not applicable	Dust	Continuous

Table 5-2. Action Levels Established to Determine the Appropriate Level of Personal Protection

Instrument	Reading	Action [a]	Comments
Visual	Visual Dust	Leave Site, if necessary	

6 EMERGENCY PLANNING

In case of any emergency affecting the Site, all affected personnel must immediately evacuate the work area and report to the Site safety officer at the following predetermined location:

DESIGNATED ASSEMBLY LOCATION—Field vehicle

In case of injury, field personnel should take precautions to protect the victim from further harm and notify local emergency services. In remote areas, it will be necessary to have first aid-trained personnel on the field team. The victim may require decontamination prior to treatment—requirements will vary based on Site conditions.

Emergency medical care will be provided by:

[X] Local emergency medical provider (i.e., fire department; see Table 6-1 for local contact information)

[X] First aid-trained field staff (for remote areas only).

Table 6-1. Local Emergency Telephone Numbers

Local Resources	Name	Telephone	Notified Prior to Work (Yes/No)?
Fire	Varies by location	911	Yes. Notify the E911 coordinator for Stevens County (Debby McCanna; 509-684-2555) of the schedule and location of work.
Police	Varies by location	911	Yes (see above)
Ambulance	Varies by location	911	Yes (see above)
Main Hospital	Mount Carmel Hospital, Colville, WA	509-684-2561	No
Directions to Mount Carmel Hospital	Begin traveling southeast on Highway 395. Highway 395 becomes Main Street in Colville. Turn LEFT on E. Columbia Avenue. Go 0.6 mile. Arrive at 982 E. Columbia Avenue. Hospital is on right. (See detailed hospital location maps in Attachment A1-1)		Not applicable
Alternative Hospitals	St. Joseph's Hospital, Cheweleh, WA	509-935-8211	No
	Ferry County Memorial Hospital, Republic, WA	509-775-3333	No
	MultiCare Valley Hospital, Spokane, WA	509-924-6650	No
	Coulee Community Hospital, Grand Coulee, WA	509-633-1753	No
	Holy Family Hospital, Spokane, WA	509-482-0111	No
	Veterans Affairs Medical Center, Spokane, WA	509-434-7032	No
	Sacred Heart Medical Center, Spokane, WA	509-474-3131	No
	Deaconess Medical Center-Spokane, Spokane, WA	509-473-7178	No
	Lincoln Hospital, Davenport, WA	509-725-7101	No

Table 6-1. Local Emergency Telephone Numbers (continued)

Local Resources	Name	Telephone	Notified Prior to Work (Yes/No)?
Field cellular telephone or satellite telephone	Cellular telephone coverage is spotty in the vicinity of the sampling areas. If cellular telephone coverage is lost due to a mountain or hill, drive a little farther to get coverage. If cellular telephone coverage is available, the 911 system will work. A satellite telephone may be necessary for areas with limited cellular telephone coverage.	Cellular or Satellite telephone number TBD	Not applicable
Directions to Mount Carmel Hospital	Begin traveling southeast on Highway 395. Highway 395 becomes Main Street in Colville. Turn LEFT on E. Columbia Avenue. Go 0.6 mile. Arrive at 982 E. Columbia Avenue. Hospital is on right. (See detailed hospital location maps in Attachment A1-1)		Not applicable

In case of serious injuries, death, or other emergency, after local emergency services have been contacted, the TAI Project Coordinator and ERM Task Manager or ERM Principal Investigator must be notified immediately. Contact numbers are listed in Table 6-2.

Table 6-2. Corporate Emergency Telephone Numbers

Corporate Resources	Name	Work/Cellular Telephone
TAI Project Coordinator	Kris McCaig	Work: 509-623-4501 Cellular: 509-434-8542
TAI Assistant Project Coordinator	Denise Mills	Work: 509-623-4515 Cellular: 509-904-9375
ERM Task Manager	Kevin Lundmark	Work: 801-204-4313 Cellular: 801-440-8296
ERM Principal Investigator	Jennifer Holder	Work: 805-684-2801 Cellular: 805-680-8484

Table 6-3 provides local hospital contact and location information. See Attachment A1-1 for a detailed hospital location map.

Table 6-3. Project Area Hospital Information

Facility Name	Open for Emergency Services	Telephone Number	Address	City
Mount Carmel Hospital	24 hours	509-684-2561	982 East Columbia Street	Colville
St Joseph's Hospital	24 hours	509-935-8211	500 East Webster Street	Chewelah
Ferry County Memorial Hospital	24 hours	509-775-3333	36 Klondike Road	Republic
MultiCare Valley Hospital	24 hours	509-924-6650	12606 E. Mission Avenue	Spokane
Coulee Community Hospital	24 hours	509-633-1753	411 Fortuyn Road	Grand Coulee
Holy Family Hospital	Dependent on case	509-482-0111	North 5633 Lidgerwood Avenue	Spokane
Veterans Affairs Medical Center	7:30 am to 4:00 pm	509-434-7032	North 4815 Assembly Street	Spokane
Sacred Heart Medical Center	24 hours	509-474-3131	West 101 Eighth Avenue	Spokane
Deaconess Medical Center-Spokane	24 hours	509-473-7178	West Fifth Avenue	Spokane
Lincoln Hospital	24 hours	509-725-7101	10 Nichols Street	Davenport

If any health or safety issue arises, after the victim receives appropriate medical treatment, the relevant field crew members will be interviewed to formally document, at a minimum, the incident by the Field Supervisor and Task Manager. All incidents will be documented in the field logbook. If applicable, a corrective action form will be filled out (see Field Sampling Plan Attachment A3) to ensure future health and safety issues are addressed.

7 WORK ZONES

The following work zones are defined for the tissue sampling activities:

Exclusion zone. The area immediately around the sampling activities will be designated as the exclusion zone. Traffic cones and/or caution tape will be used to delineate the specific areas.

Contamination reduction zone. Not applicable. All sampling activities will occur within the exclusion zone.

Support zone. Not applicable. All sampling activities will occur within the exclusion zone.

Controls to be used to prevent entry by unauthorized persons. The sampling staff will remain cognizant of people approaching the exclusion zone. All unauthorized persons will be instructed to remain outside of the sampling area.

8 DECONTAMINATION

This section is not applicable to the bathymetry data and underwater imagery collection activities given that no environmental media will be sampled (e.g., water, sediment, etc.).

9 VEHICLE SAFETY, SPILL CONTAINMENT, AND SHIPPING INSTRUCTIONS

Vehicle safety, spill containment, and shipping instructions are presented in the general SHSP (TCAI 2009) and are incorporated herein.

10 TASK-SPECIFIC SAFETY PROCEDURES

Slips, trips, and falls are anticipated to be the greatest hazards to field personnel during the bathymetry data and underwater imagery collection activities, as well as unexpected contact with the sampling equipment. Field personnel should always move about the shore or upland area with caution, and wear properly fitting shoes or boots with non-slip soles and good ankle support.

The Site is located in a remote region with limited cellular telephone coverage. All field crews will have two-way radios or a satellite telephone to maintain communication with the Field Supervisor. The field crews will coordinate departure and expected return times for all field activities with the Field Supervisor. Field crews will provide the Field Supervisor and Principal Investigator with status updates at least every 4 hours while performing field collection activities.

The areas that will be sampled are accessible to the public. Field crew members should always be aware of their surroundings, use the buddy system, and/or keep in line-of-sight contact with other sampling personnel at all times. Samples or sampling equipment should not be left unattended. If a crew member feels threatened, or if the situation feels unpredictable, leave the area immediately.

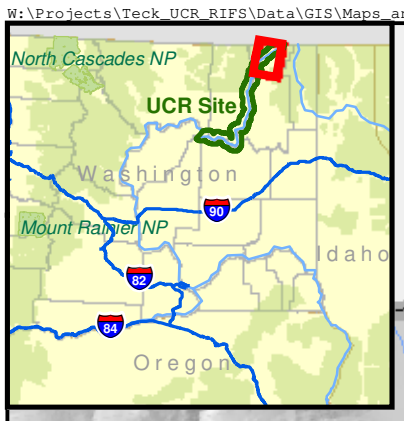
11 REFERENCES

TCAI (Teck Cominco American Incorporated). 2009. Upper Columbia River general site health and safety plan for the remedial investigation and feasibility study. Prepared for Teck American Incorporated. Integral Consulting Inc., Mercer Island, Washington, and Parametrix, Seattle, WA.

ATTACHMENT A1-1

STUDY AREA MAP AND HOSPITAL LOCATION MAP

W:\Projects\Teck_UCR_RIFS\Data\GIS\Maps_and_Analyses\Sediment DQOs and QAPP\Sediment Facies Mapping QAPP\Field Sampling Plan\HASP Attachment A1-1 6879 Study Area Map.mxd @ 08/27/2018



U.S. - Canada Border

RM 744

RM 740

RM 730

RM 720

Deadman's Eddy

China Bend

Upstream of Marcus Flats

Big Sheep Creek

Deadman's Eddy

North Fork Deep Creek

Deep Creek

South Fork Deep Creek

Northport

China Bend

Cable Ferry Landing

Bossburg Flat Beach

Evans Campground

251

25

Bathymetry hillshade source: Franklin D. Roosevelt Lake – Grand Coulee Dam 2010-11 Survey, U.S. Department of the Interior Bureau of Reclamation, June 2012.

Legend

- Photo Location
- Photo Transect
- EPA Area of Interest
- Upper Columbia River
- Stream
- Populated Places
- State Highway
- Local Road
- Railroad
- County Lines
- River Mile (USGS)

Windward environmental LLC

Km 0 2 4

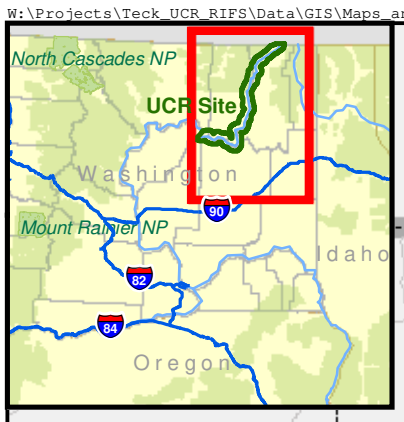
Miles 0 1 2

N

Study Area Map

Upper Columbia River, WA

W:\Projects\Teck_UCR_RIFS\Data\GIS\Maps_and_Analyses\Sediment DQOs and QAPP\Sediment Facies Mapping QAPP\Field Sampling Plan\HASP Attachment A1-1 6900 Hospital Location Map.mxd @ 08/27/2018



U.S. - Canada Border

Deadman's Eddy

China Bend

Upstream of Marcus Flats

Ferry County Memorial Hospital

Providence Mount Carmel Hospital

Providence Saint Joseph's Hospital

Colville Indian Reservation

Spokane Indian Reservation

Coulee Medical Center

Lincoln Hospital

Providence Holy Family Hospital

Mann - Grandstaff Veterans Affairs Medical Center

Multicare Valley Hospital

Multicare Deaconess Hospital

Providence Sacred Heart Medical Center

Odessa Memorial Healthcare Center

Northport

Deadman's Eddy

China Bend

Cable Ferry Landing

Bossburg Flat Beach

Evans Campground

Marcus Flats

Kettle Falls

Colville

Gifford

Keller Ferry

Grand Coulee Dam

Deer Park

Nine Mile Falls

Spokane

Airway Heights

Cheney

RM 744
RM 740
RM 730
RM 720
RM 710
RM 700
RM 690
RM 680
RM 670
RM 660
RM 650
RM 640
RM 630
RM 620
RM 610
RM 600

Legend

- Hospital
- EPA Area of Interest
- Grand Coulee Dam
- Populated Places
- Interstate Highway
- US Highway
- State Highway
- Local Road
- County Lines
- Reservations
- River Mile (USGS)

Windward environmental LLC

0 10 20 Km

0 5 10 Miles

N

Hospital Location Map

Upper Columbia River, WA

ATTACHMENT A1-2

COLD-STRESS FACT SHEET

FROSTBITE

What happens to the body:

Freezing in deep layers of skin and tissue; pale, waxy-white skin color; skin becomes hard and numb; usually affects fingers, hands, toes, feet, ears, and nose.

What to do: (land temperatures)

- Move the person to a warm, dry area. Don't leave the person alone.
- Remove wet or tight clothing that may cut off blood flow to the affected area.
- **Do not** rub the affected area because rubbing damaged the skin and tissue.
- Gently place the affected area in a warm water bath (105°) and monitor the water temperature to **slowly** warm the tissue. Don't pour warm water directly on the affected area because it will warm the tissue too fast, causing tissue damage. Warming takes 25-40 minutes.
- After the affected area has been warmed, it may become puffy and blister. The affected area may have a burning feeling or numbness. When normal feeling, movement, and skin color have returned, the affected area should be dried and wrapped to keep it warm. **Note:** If there is a chance the affected area may get cold again, do not warm the skin. If the skin is warmed and then becomes cold again, it will cause severe tissue damage.
- Seek medical attention as soon as possible.

How to Protect Workers

- Recognize the environmental and workplace conditions that lead to potential cold-induced illnesses and injuries.
- Learn the signs and symptoms of cold-induced illnesses/injuries and what to do to help the worker.
- Train workers about cold-induced illnesses and injuries.
- Select proper clothing for cold, wet, and windy conditions. Layer clothing to adjust to changing environmental temperatures. Wear a hat and gloves, in addition to underwear that will keep water away from the skin (polypropylene.)
- Take frequent short breaks in warm, dry shelters to allow the body to warm up.
- Perform work during the warmest part of the day.
- Avoid exhaustion or fatigue because energy is needed to keep muscles warm.
- Use the buddy system (work in pairs.)
- Drink warm, sweet beverages (sugar water, sports-type drinks.) **Avoid drinks with caffeine** (coffee, tea, or hot chocolate) **or alcohol**.
- Eat warm, high-calorie foods like hot pasta dishes.

Workers are at increased risk when…

- They have predisposing health conditions such as cardiovascular disease, diabetes, and hypertension.
- They take certain medications. Check with your doctor, nurse, or pharmacy and ask if medicines you take affect you while working in cold environments.
- They are in poor physical condition, have a poor diet, or are older.

HYPOTHERMIA - (Medical Emergency)

What happens to the body:

Normal body temperature (98.6°F/37°C) drops to or below 95°F/35°C; fatigue or drowsiness; uncontrolled shivering; cool, bluish skin; slurred speech; clumsy movements; irritable, irrational, or confused behavior.

What to do: (land temperatures)

- Call for emergency help (i.e., ambulance or 911).
- Move the person to a warm, dry area. Don't leave the person alone.
- Remove wet clothing and replace with warm, dry clothing or wrap the person in blankets.
- Have the person drink warm, sweet drinks (sugar water or sports-type drinks) if he is alert. **Avoid drinks with caffeine** (coffee, tea, or hot chocolate) **or alcohol**.
- Have the person move his arms and legs to create muscle heat. If he is unable to do this, place warm bottles or hot packs in the armpits, groin, neck, and head areas. **Do not** rub the person's body or place him in a warm water bath. This may stop his heart.

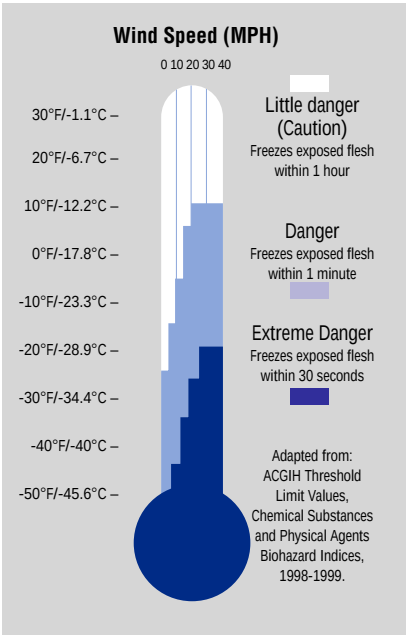
What to do: (water temperatures)

- Call for emergency help (i.e., ambulance or 911). Body heat is lost up to 25 times faster in water.
- **Do not** remove any clothing. Button, buckle, zip, and tighten any collars, cuffs, shoes, and hoods because the layer of trapped water closest to the body provides a layer of insulation that slows the loss of heat. Keep the head out of the water and put on a hat or hood.
- Get out of the water as quickly as possible or climb on anything floating. **Do not** attempt to swim unless a floating object or another person can be reached because swimming or other physical activity uses body heat and reduces survival time by about 50 percent.
- If getting out of the water is not possible, wait quietly and conserve body heat by folding arms across the chest, keeping thighs together, bending knees, and crossing ankles. If another person is in the water, huddle together with chests held closely.

THE COLD STRESS EQUATION

LOW TEMPERATURE + WIND SPEED + WETNESS = INJURIES & ILLNESS

When the body is unable to warm itself, serious cold-related illnesses and injuries may occur, and permanent tissue damage and death may result. **Hypothermia** can occur when *land temperatures* are **above** freezing or *water temperatures* are below 98.6°F/37°C. Cold-related illnesses can slowly overcome a person who has been chilled by low temperatures, brisk winds, or wet clothing.



Oregon Occupational Safety & Health Division
440-3336E-S (9/03)

ATTACHMENT A1-3

HEAT-RELATED ILLNESS PREVENTION POLICY

HEAT EXHAUSTION

What happens to the body:

Headaches, dizziness, or light-headedness, weakness, mood changes, irritability or confusion, feeling sick to your stomach, vomiting, fainting, decreased and dark-colored urine, and pale, clammy skin.

What should be done:

- Move the person to a cool shaded area. Don't leave the person alone. If the person is dizzy or light-headed, lay him on his back and raise his legs about 6-8 inches. If the person is sick to his stomach, lay him on his side.
- Loosen and remove heavy clothing.
- Have the person drink some cool water (a small cup every 15 minutes) if he is not feeling sick to his stomach.
- Try to cool the person by fanning him. Cool the skin with a cool spray mist of water or wet cloth.
- If the person does not feel better in a few minutes call for emergency help (ambulance or call 911.)

(If heat exhaustion is not treated, the illness may advance to heat stroke.)

HEAT STROKE - A Medical Emergency

What happens to the body:

Dry, pale skin (no sweating); hot red skin (looks like a sunburn); mood changes; irritability, confusion, and not making any sense; seizures or fits, and collapse (will not respond).

What should be done:

- Call for emergency help (i.e., ambulance or 911.)
- Move the person to a cool, shaded area. Don't leave the person alone. Lay him on his back and if the person is having seizures, remove objects close to him so he won't hit them. If the person is sick to his stomach, lay him on his side.
- Remove heavy and outer clothing.
- Have the person drink some cool water (a small cup every 15 minutes) if he is alert enough to drink anything and not feeling sick to his stomach.
- Try to cool the person by fanning him or her. Cool the skin with a cool spray mist of water, wet cloth, or wet sheet.
- If ice is available, place ice packs in armpits and groin area.

How to Protect Workers

- Learn the signs and symptoms of heat-induced illnesses and what to do to help the worker.
- Train workers about heat-induced illnesses.
- Perform the heaviest work during the coolest part of the day.
- Slowly build up tolerance to the heat and the work activity (usually takes up to 2 weeks.)
- Use the buddy system (work in pairs.)
- Drink plenty of cool water (one small cup every 15-20 minutes.)
- Wear light, loose-fitting, breathable (like cotton) clothing.
- Take frequent short breaks in cool, shaded areas (allow your body to cool down.)
- Avoid eating large meals before working in hot environments.
- Avoid caffeine and alcoholic beverages (these beverages make the body lose water and increase the risk of heat illnesses.)

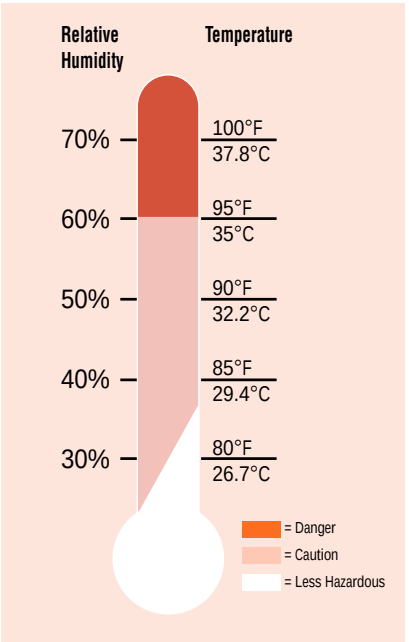
Workers are at increased risk when…

- They take certain medications. Check with your doctor, nurse, or pharmacy to see if medicines you take affect you when working in hot environments.
- They have had a heat-induced illness in the past.
- They wear personal protective equipment.

THE HEAT EQUATION

HIGH TEMPERATURE + HIGH HUMIDITY + PHYSICAL WORK = HEAT ILLNESS

When the body is unable to cool itself through sweating, **serious** heat illnesses may occur. The most severe heat-induced illnesses are **heat exhaustion** and **heat stroke**. If actions are not taken to treat heat exhaustion, the illness could progress to heat stroke and **death**.



Oregon Occupational Safety & Health Division
440-3333E-S(9/03)

ATTACHMENT A2

STANDARD OPERATING PROCEDURES

STANDARD OPERATING PROCEDURE SOP-1

MULTIBEAM ECHOSOUNDER AND ACOUSTIC BACKSCATTER SURVEY FOR RIVERBED CLASSIFICATION

Scope and Application

This standard operating procedure (SOP) is specific to the sediment facies mapping element of the Phase 3 Sediment Study (hereinafter "the study") being conducted for Teck American Incorporated (TAI) in the Upper Reach Operable Unit (OU) of the Upper Columbia River (UCR). The purpose of this SOP is to describe the procedures for collecting multibeam echosounder (MBES) data to characterize riverbed bathymetry and surface sediment composition (grain size) and produce high-resolution, repeatable results.

This SOP details the operation and procedures associated with acquiring MBES and acoustic backscatter (ABS) data. The following procedures provide an explanation for how these datasets will be used for the purpose of riverbed sediment classification and mapping.

Summary of Method

MBES bathymetry and ABS survey will be conducted in a single survey. The survey will include a MBES sonar, between approximately 300 to 450 kHz, and with a predefined transect spacing to cover the entire survey area in contiguous swaths with sufficient overlap to ensure quality coverage. The survey will be run from a fixed vessel-mounted sonar pole and operated from survey software. These surveys will provide two essential datasets for riverbed classification: bathymetry and ABS data from the survey area. Software will be used to collect and process both the MBES and ABS survey data.

Equipment

- Survey vessel appropriate for working in shallow, fast-moving river conditions
- MBES with a transmit frequency between approximately 300 to 450 kHz and integrated sound velocity sensor
- Real-time kinematic (RTK) global navigation satellite system (GNSS) positioning and motion reference unit (MRU) with pitch and roll accuracy of 0.01 degress and heading accuracy of 0.02 degrees or better
- RTK GNSS receiver

- Sound velocity profiler accurate to approximately 0.025 m/s and pressure sensor appropriate for water depths expected (less than 30 m)
- Survey computer with power supply
- Survey software with license key
- Geographic information system (GIS) software
- Survey logbook or digital line log software
- Lead line/bar check.

Positioning and Coordinates

See SOP-4 for vessel positioning procedures.

DATA ACQUISITION

Sonar and Acquisition Software

The MBES will be saved in two formats concurrently during all survey acquisition where possible; both in the native file format of the sonar manufacturer, as well as in the survey navigation and MBES acquisition software.

Initially, the MBES will be controlled by log data in the manufacturer's software. This software allows for the configuration of the sonar properties, as well as logging capabilities of the sonar raw data in the manufacturer's native file format. These files collect all the raw data, including acoustic backscatter. In addition, the start and end times of survey lines, as well as any details relevant to the survey and processing, will be recorded into the field logbook.

Simultaneously, MBES data will be acquired using customized survey and MBES software. This software will collect both navigation and MBES data and log all raw GPS data and MBES sounding data.

Sonar Installation and Static Offsets

The MBES hardware will be mounted and securely fastened to the vessel.

A survey grade positioning and MRU system consisting of an RTK GNSS receiver, heading and motion reference system will be installed on the vessel to report vessel position, heading, pitch, roll and heave to accurately position soundings.

Static offsets will be precisely measured from the vessel reference point (center of gravity) to the reference point of all sensor including: phase center of GNSS antennas, MRU reference point,

sonar acoustic reference point, and any other sensor that requires precise positioning. The offset survey will include surveying all three axis (x,y,z) relative to the vessel reference point to each sensor with redundant observations to determine uncertainty of measurements. Offsets will be applied for each piece of equipment used during survey acquisition. These offsets are to be measured in the project units (i.e., U.S. survey feet) and referenced appropriately.

MRU Installation and Offsets

The MRU is used to record all vessel movements including heave, pitch, and yaw. Additionally, the MRU system is capable of continuous recording due to high accuracy heading information and internal accelerometers, even when GPS reception is lost during short-term outages.

The distance from the primary GPS antenna to the MRU must be measured in all three axes (x,y,z). This information must be input into the MRU configuration set up only, and not into the survey software. Once properly offset, the MRU system will output all position information at the location of the MRU, and not the location of the primary GPS antenna.

MBES Installation and Offsets

Once installed on the vessel, and the sonar and sonar pole are in survey position, the distance from the sonar pole to the reference point (0, 0, 0) must be measured in all three axes. This information must be entered into the positioning software set up file. The draft of the sonar below waterline is input as a positive value downward. A surface sound velocity sensor will be installed at the sonar head and integrated into the sonar for accurate beam forming.

Sound Velocity Profiles

A sound velocity profiler or conductivity, temperature, and depth (CTD) probe will be used to measure the sound velocity depth profiles within the survey area. The probe will measure sound velocity and depth directly or conductivity, temperature and depth to calculate the velocity (speed) of sound. Each sound velocity profile will be recorded with time and position. Sound velocity casts will be used in data processing to accurately correct sonar range and refraction to acoustic beams due to changes in the velocity of sound.

Sound velocity profiles are necessary to properly characterize the variations in sound velocity along depth profiles. This is particularly important if large changes in depth are encountered. Sound velocity changes can occur through thermal layering in pools, rainfall runoff, or confluence with tributaries. Sound velocity casts will be acquired a minimum of hourly, when the sonar surface sound velocity sensor detects more than 2 meters per second change in sound velocity, taken in pools to 90 percent of the depth, or when the hydrographer suspects changes

in the sound velocity profile. Sound velocity measurements at the depth of the sonar will be compared to the surface sound velocity sensor to verify the sensors are working correctly.

Spatial Resolution, Swath Width, and Line Spacing

The MBES survey will consist of contiguous swaths with sufficient overlap to ensure quality coverage (e.g., 50 percent overlap). Line planning must be considered in relation to the survey objectives and the achievable swath width of the sonar. Swath width is impacted by the water depth, bottom geometry (upslope vs. downslope), accurate measurement of sound speed profiles and bottom type. An initial crossline analysis will be conducted to analyze effective swath width for the sonar used for the survey. This will consist of a series of closely spaced main lines filtered to a 45 degree swath and cross lines evaluated at full swath. A histogram of cross line individual sonar beam differences with the main line survey data will determine which beam angles meet project requirements. During survey data acquisition, line spacing will be adjusted as necessary to meet data quality objectives and to help improve data capture in shallow (i.e., nearshore) areas.

Survey Speed

To preserve data quality, sounding frequency will be increased with increased vessel speed to maintain a target minimum density of one sounding per 50 cm. For planning purposes, an optimum survey speed over ground of approximately 4 to 6 knots will be targeted. In some areas, the minimal steerable speed may prevent achieving the target minimum density.

Survey Grid and Data Logging

A matrix file or files will be created for survey data acquisition. Grid cell sizes of approximately 1 m will be considered based on data objectives. A survey matrix will be used to track progress of survey, as well as a first preliminary assessment of bed soundings and river morphology. Data will be logged both in the matrix file and the raw GPS data and MBES sounding data.

Acoustic Backscatter Specifications

The MBES system will also be capable of recording ABS data from each sounding concurrently during the survey. Raw files produced from the MBES system will be controlled using the MBES software. The operator will continually monitor the received sonar pulse intensity and adjust the transmit, gain, and beam width as necessary to focus sonar energy away from surface multipaths and noisy sonar signals. This will enable the survey operator to produce an ABS dataset that can be used to delineate changes in riverbed characteristics.

DATA QA/QC

System Calibration: Patch Testing

A calibration patch test must be performed when sonar configuration has changed. As a best practice, start-of-project and end-of-project patch tests will also be performed. Patch tests determine the misalignment relative to the motion sensor and gyro, as well as the time-offset to the GPS system. Because misalignment erodes accuracy, it is essential to conduct a patch test prior to data acquisition. All patch test data will be postprocessed using software to calculate offset errors.

Latency

To account for errors due to GPS timing, a latency patch test must be performed daily. This is conducted by surveying in a straight line over a bottom feature or slope twice, once at normal survey speed and the second at 1.5x survey speed.

Roll

To correct for errors in vessel and sonar attitude in the lateral directions, a roll patch test must be performed. This is conducted by surveying in a straight line over a relatively flat bottom void of dramatic features or bathymetric relief. A single survey line is run twice at normal survey speed in opposite directions.

Pitch

Patch test data must also be collected to correct for pitch misalignment. This is conducted by surveying in a straight line over a bottom feature or dramatic slope. The same survey line is recorded twice at survey speed in opposite directions.

Yaw

Yaw offsets are calculated from patch test data as well. Yaw corrections are calculated from two survey lines recorded over a bottom feature or dramatic bathymetric slope. Survey lines are recorded in the same direction at survey speed and offset laterally by 0.5 to 1.0 times water depth.

Sound Speed Sensor Calibration

The sound velocity profiler and sound velocity surface sensor will have an annual factory calibration. In addition, the profiler sensor will be compared to surface sensor daily to verify the systems are in agreement.

Crossline Analysis

A crossline analysis will be conducted to evaluate overall system performance and assess survey accuracy against project requirements. Crosslines will be acquired once per day in a relatively flat area avoiding steep slopes. Crosslines will also be acquired after any modification to the survey system that would impact the computation of depth or position.

To assess the precision of the survey, crossline data will be gridded at a 50 cm resolution, consistent with the resolution grid from the main survey lines. A difference analysis will be conducted between the surfaces to evaluate the accuracy by computing the mean difference and compared to project requirements.

In addition, a statistical analysis of the crosslines will be conducted by individual beam number for each junction. Crosslines are gridded at the same resolution as main scheme (primary) lines and analyzed. Ninety-five percent of the data (2 sigma) must meet or exceed the vertical accuracy requirement (10 cm).

Results for both evaluations will be included in the survey report. If the overall analysis using all crosslines does not meet the requirement, the analysis may be run by line to identify the problem area. The deviation from the requirement will be investigated as to why the requirement was not met, identify the source, and will be rerun or discussed in the report if there is no significant impact.

DATA PROCESSING

MBES Depth Soundings

MBES data will be processed using software, incorporating vessel offsets and GNSS positioning and heighting relative to Geoid 12b. A vessel configuration file will be used to manage vessel offsets and changes in sensor bias angles. Patch test data will be analyzed and alignment corrections calculated and applied to the soundings**.** Sound speed profiles will be used to correct multibeam slant range measurements and compensate for refraction in the water column. The profiles will be applied using the closest in distance and time function in the MBES processing software.

Position and sensor data will be examined for data gaps and timing errors. Processed sounding data will be reviewed for anomalous soundings, or "flyers," and these soundings will be manually removed. Acceptability criteria are provided in QAPP Table B4-1, which identifies that 95 percent of the data (2 sigma) must meet or exceed the vertical accuracy requirement (10 cm).

The soundings will be gridded using a swath angle filter to a resolution of one meter and the resulting bathymetry will be exported to a 32-bit floating point GeoTIFF as well as to a .xyz ASCII file. A digital elevation model of the entire Upper Reach OU will then be generated using a GIS platform.

ABS

The backscatter will be processed from the processed depth information as well as the imagery information contained in the raw MBES file. Power, gain, and beam pattern corrections will be made during processing and river conditions will be accounted for. A mosaic will then be generated at the desired resolution (e.g., 12 cm) and exported to a 32-bit floating point GeoTIFF format. The GeoTIFF can then be imported as a raster into a GIS platform for the delineation and classification of the riverbed.

Reporting

During survey activities, a brief summary report will be completed at the end of each day and submitted electronically to the TAI field supervisor. Progress reports will include information on survey activities, deviations, and any issues encountered with instrumentation.

The field logbook will include start and stop of each transect and will be maintained by the TAI field supervisor. Calibration sheets (if used) will also be scanned and/or entered electronically and submitted to the TAI field supervisor.

STANDARD OPERATING PROCEDURE SOP-2

DROP CAMERA SURVEYS

Scope and Application

This standard operating procedure (SOP) is specific to the sediment facies mapping element of the Phase 3 Sediment Study (hereinafter "the study") being conducted for Teck American Incorporated (TAI) in the Upper Reach Operable Unit (OU) of the Upper Columbia River (UCR). The purpose of this SOP is to describe the procedures in surveying and image processing involved in classifying riverbed sediments with the use of a drop camera and video imaging system. Imaging surveys will be completed concurrently and co-located with velocity profile measurements performed using an acoustic Doppler current profiler (ADCP). ADCP measurements are described in SOP-3.

Summary of Method

Imaging surveys will be conducted from a vessel at predefined transects locations. The imaging surveys will be performed by lowering a submersible camera system equipped with a digital high definition (HD) video camera and single-lens reflex (SLR) camera to collect observational data at locations along transects. The vessel will be equipped with the necessary equipment including a real-time kinematic global positioning system (RTK GPS), A-frame, and winch to complete the required tasks. Additionally, the proper vessel will be selected for stations in shallow areas, which may preclude larger vessels due to draft limitations, the minimum depth a vessel can safely navigate. The images collected during the drop camera survey will be used in riverbed sediment classification. The images will be used to identify the smaller scale sediment types and will be used to confirm findings from the sonar riverbed mapping surveys.

Equipment

A drop camera unit designed specifically for seafloor surveys including both an HD video camera and a still-frame digital single-lens reflex (DSLR) camera will be used to collect images. The camera to be used should have a wide-angle lens and be adjustable for taking high resolution images in low light conditions. All images collected will be recorded on a secure digital (SD) card. In addition, the drop camera system will incorporate high-power scaling lasers set at a known separation distance (e.g., 102 mm or 4 in.), LED lights, and an altimeter for monitoring descent. The drop camera system is housed in a rugged frame winch that can be deployed in fast-moving rivers.

The following equipment is necessary for the imaging surveys:

- Drop camera unit
- Winch with sufficient line to deploy and retrieve the instrument from the river bottom
- A-frame to safely deploy camera over bow of vessel
- RTK GPS for accurate station positioning
- Altimeter
- Field notebook
- Laptop for navigation and electronic tablet for viewing images
- Survey navigation software for logging individual drop points
- HD recorder.

Positioning and Coordinates

The drop camera system will be deployed at preidentified locations along transects. Transect and image survey locations are identified in the Field Sampling Plan (FSP). Transects or survey locations may be adjusted during the survey due to access restrictions from shoals or other depth limitations. Image survey locations along transects may also be added in the field at the time of data collection based on field data.

A RTK GPS will be used aboard the vessel for accurate station positioning (see SOP-4). Once the vessel is on station, the actual position will be recorded for each drop camera image taken and/or attempted. The vessel will stay within 3 m of station during measurements. Water depths will be recorded from the vessel sonar or using a lead line.

Camera Calibration and Scaling

The drop camera will be calibrated on a daily basis. Because the frame holds the camera at a known distance above the riverbed, the scaling lasers can be quickly adjusted on the vessel deck. To adjust laser scale, a calibration picture will be taken daily with the SLR camera showing the lasers and a ruler. Camera focus will also be set daily using a calibration card on the deck. Finally, the SLR camera time stamp will be synchronized with vessel computer time. After scale, time, and focus parameters have been verified, the system will be ready for deployment.

Drop Camera Deployment and Retrieval

Once the vessel has navigated to each transect position, the drop camera will be deployed over the bow of the vessel.

Deployment checks:

- Ensure the camera is tested prior to submersion by taking a surface picture and reviewing clarity and quality
- Check resolution and exposure settings on camera
- Test connection with the camera
- Test lights and laser scales, confirm offsets and positioning of lasers
- Inspect all bolts for tightness
- Ensure winch connection is secure.

Prior to deployment of the drop camera, a card with the name of each transect point will be recorded at the surface of the transect. The video camera recording will remain on until the SLR camera is back on deck. The drop camera will then be lowered to 1 m above the riverbed as verified with the altimeter, at which point the lasers will be turned on and the winch speed will be slowed until the camera is settled on the riverbed. The camera frame is designed to position on the substrate surface and provide an image covering an area of 1 m^2. To ensure that the HD SLR image of the riverbed is not disturbed, the live view camera will verify the frame and that sediments are settled before taking a still image with the SLR camera. All care will be taken to lower the frame to the seabed slowly to ensure no sediments are disturbed. The frame is 1.5 m^2 and is therefore outside of the imaging area. Immediately upon capture of this image, a survey navigation point will be collected (using survey-grade software). The camera will then be returned to the deck and prepared for the next transect location.

Video and Image Recording and Reporting

All images and video will be recorded using an HD recording system and digitally stamped with date and time. Both HD video and DSLR live-view images will be viewed on the vessel. One image will be captured on the riverbed and video will be recorded continuously from vessel deployment to retrieval with each camera deployment. Video will be used as a backup image analysis in the event that the still image captured from the SLR camera was blurry, improperly exposed, or the resolution quality was insufficient for postprocessing and analysis. Images will be observed and assessed in real-time at each of the drop locations. If clearly defined geomorphological features are observed from the live feed or based on a review of bathymetry or acoustic backscatter data, additional images may be collected along transects to help ensure that images are collected to represent the full range representative geomorphic features.

To assess the precision and variability of image collection and anlysis, duplicate images will be collected at 5 percent of the stations. Duplicate images will be collected by leaving the camera

frame on the seafloor for at least 5 minutes prior to collecting a second SLR image. This approach will capture temporal variability (lighting, suspended solids in the water column, sediment bed disturbance) and variability in image interpretation without effects from small-scale spatial sediment bed heterogeneity, which would confound comparison of duplicate photographs if not collected from the same location. Variability and precision between the primary and duplicate image analyses would be reported as the percent of sediment less than 2 mm for each photograph and the associated RPD.

Field notes will be taken during all survey activities in a field notebook, which will be kept with the field supervisor. The field notes will include the following information:

- Names of persons obtaining and reviewing images/video
- Names of persons operating vessel and/or equipment
- Weather conditions (and/or any changes in weather)
- Water depth
- Date and time of the start and end of each transect
- Brief description of observations
- Any deviations from the approved QAPP or FSP.

Following each day of surveying, a daily summary report will be completed and sent electronically to the TAI field supervisor. The report will include a summary of the number of transects and locations completed, the number of supplemental locations added (if any), and a summary of any issues and associated corrective actions.

Image Processing and Analysis

Automated and/or manual image analysis will be performed to provide sediment composition (grain size fraction) data to help guide interpretation of acoustic backscatter data. Automated analysis of video and still images will be performed using software. Typical steps for automated image analysis include: 1) correcting image for the lens; 2) adjusting for exposure, contrast, and clarity; and 3) performing granulometry analysis to classify surface sediments in the field of view for percent grain size fractions. Steps 1 and 2 will be conducted prior to camera deployment, but if an image is captured with poor exposure, focus, or contrast, a still from the video image may be used as a contingency.

The following sediment grain size fractions will be used for automated and manual analyses:

- Bedrock
- Boulders and cobble (> 64 mm)

- Gravels (> 2 to 64 mm)
- Sands (0.063 to 2 mm)
- Mud (< 0.063 mm; includes silts and clays).

As a quality control (QC) check for automated analyses, 10 percent of images will be manually interpreted to verify the sediment classifications obtained via automated analysis. If sediment classifications do not agree between manual and automated analyses, then the sensitivity algorithm for the automated analysis will be adjusted.

Duplicate images that are collected at 5 percent of stations will be analyzed independently of primary images, and the total percent of sediment less than 2 mm will be calculated from the primary and duplicate image analyses. Variability and precision between the primary and duplicate image analyses will be reported as the percent of sediment less than 2 mm for each photograph and the associated relative percent difference (RPD) between measurements:

$$RPD = \frac{|C_1 - C_2|}{(C_1 + C_2)/2} \times 100$$

Where: RPD = relative percent difference

C_1 = percent sediment less than 2 mm from primary image

C_2 = percent sediment less than 2 mm from duplicate image

Interpreted image results will be output in ESRI shapefile format, with Federal Geographic Data Committee (FGDC) metadata included. Each image location will be a point feature including the location identifier from the FSP and attributes including, but not limited to, date imagery collected, percent composition of each sediment grain size class, location (X-Y coordinates), and identifier for mixed sediments to differentiate between primarily sand areas and areas of sand mixed with gravels, cobbles, and/or boulders.

STANDARD OPERATING PROCEDURE SOP-3

ACOUSTIC DOPPLER CURRENT PROFILER OPERATION AND DEPLOYMENT

Scope and Application

This standard operating procedure (SOP) is specific to the sediment facies mapping element of the Phase 3 Sediment Study (hereinafter "the study") being conducted for Teck American Incorporated (TAI) in the Upper Reach Operable Unit (OU) of the Upper Columbia River (UCR). The purpose of this SOP is to describe the procedures for collecting velocity profile measurements using an acoustic Doppler current profiler (ADCP) to characterize riverbed sediments within the Upper Reach OU. ADCP surveys will be completed concurrently and co-located with video imaging surveys. Video imaging surveys are described in SOP-2.

This document describes procedures for calibrating, preparing, and deploying vessel-mounted ADCPs for the purpose of using mean velocity profiles at a point to infer flow resistance characteristics (i.e., bottom coefficient of friction and apparent roughness height). ADCP current meters measure water velocity throughout the water column with a high degree of accuracy and can be used to calculate near-bed shear stresses in aquatic environments.

The ADCP operates by transmitting bursts of sound called pings at fixed intervals and frequency into the water column. These pings are reflected from suspended particles in the water and the echoes produced from these reflections are received by the ADCP (RD Instruments 1996). As the particles move with the water current, the echoes produce a Doppler shift or a change in the frequency between the transmitted sound and the sound reflected back to the ADCP. It is the Doppler shift, along with the timing of the returned echoes, from which the ADCP calculates water velocity, current direction, and the depth within the water column the velocity occurred (RD Instruments 1996). The ADCP also produces a longer-pulsed ping which is used to track the seafloor or riverbed in the case of downward pointed vessel-mounted applications. This is used to determine the overall depth of the water column and to determine the relative speed and direction of the ADCP as it moves along a transect.

All of these data are calculated and recorded within the ADCP itself or transmitted via cable connected to a laptop computer. The data are stored in files and can be replayed and post-processed, allowing the user to refine the data after collection.

Vessel-mounted ADCP surveys are covered by this SOP. This SOP should be followed for calibrating, preparing, deploying, and recovering ADCPs utilized in riverine monitoring of near-bed shear stress. It includes the approved methods for all of the following:

- Preparation for deployment with ADCP software so that battery life and data storage issues are properly addressed.
- Calibration to remove one- and two-cycle magnetic deviations from the internal magnetic fluxgate compass after adding a new battery. The ADCP has no moving parts, but it contains internal sensors that are sensitive to magnetic metals and electromagnetic fields.
- Deployment using an adjustable pole mount to attach the ADCP to a vessel.
- ADCP configuration for high-resolution water profiling.
- Data processing and analysis overview.

Summary of Method

A vessel-mounted ADCP is any application consisting of an ADCP that is attached to a moving platform (i.e., a boat). The package consists of four Doppler transducers (send and receive)—three for measuring velocity (u, v, and w) and one for error checking—a temperature cell, a tilt sensor, and a fluxgate compass. The ADCP should have bottom-tracking engaged. The ADCP is secured to a mounting pole and a back-up safety lanyard. An on-board laptop computer records results from the ADCP via a powered cable.

Procedures

This type of field servicing typically requires two technicians to safely perform the survey, in addition to the boat operator.

Training in the use of ADCP equipment and software as well as experience with water sampling are required. Personnel will have adequate experience using ADCPs.

Equipment

For vessel-mounted deployments the following equipment is necessary:

- ADCP and packer box with tools
- Dedicated laptop computer equipped with ADCP software
- ADCP communication cables, power cord
- Real-time kinematic (RTK) global navigation satellite system (GNSS) and interface
- Motion reference unit (MRU)
- Field logbook
- Adjustable pole mount.

Positioning and Coordinates

A RTK GNSS will be used aboard the vessel for accurate station positioning (see SOP-4). Once the vessel is on station, the actual position will be recorded for each velocity profile taken and/or attempted. The vessel will stay within 3 m of station during measurements (see Data QA/QC below). Water depths will be recorded in meters from the vessel sonar or using a lead line.

Motion Reference System

An accurate heading sensor is required from a motion reference unit (MRU) or other motion reference system (e.g., dual GNSS). The MRU system will be installed on the vessel to report vessel heading, pitch, roll, and heave. The heading values obtained by the MRU will replace the values from the internal ADCP compass and will be used to translate the GNSS position to the ADCP in order to apply the correct speed over ground of the ADCP as the vessel turns during maneuvering on station.

Equipment Calibration

Typically, the ADCP should only need to be calibrated when battery packs are being exchanged. Calibration commands should be conducted using specific manufacturer software and commands. ADCP calibration will be performed away from stray magnetic fields.

ADCP Configuration

- Acoustic frequency appropriate for water depth
- Bottom tracking
- High-resolution profiling mode
- RTK GNSS and heading
- Approximate 1 ping per second sampling frequency
- Collect every ping for later averaging
- Set an appropriate blanking distance (waiting period) to exclude data influenced by echo from bottom.

ADCP Preparation and Deployment

ADCP preparation procedures:

- Before mounting the ADCP attach the safety lanyard
- Bolt the ADCP to the mounting plate at the end of the pole such that Beam 3 is pointing towards the bow (front) when the ADCP is in the water
- Secure the pole and ADCP to the side of the vessel (out of the water) before long transits and when operating in very shallow water

- When the ADCP is out of the water, cover the head to protect transducers from sun exposure to prevent damage
- When preparing for measurements, remove extra restraints and transducer head cover
- Rotate the pole until the ADCP is in the water, taking care to minimize the angle of tilt.

Pre-measurement field procedures:

- Instrument diagnostic checks should be performed according to manufacturer recommendations and the results electronically stored on the field computer for later inclusion in the ADCP field logbooks
- A compass calibration verification should be performed according to manufacturer recommendations and the results electronically stored on the field computer for later inclusion in the ADCP field logbooks.

Measurement procedure:

- Secure vessel position at each station
- If the water depth exceeds the ADCP range, lower the mounting pole so that the full range of the ADCP covers the entire water column, or adjust the profiling mode
- Collect and save approximately 300 ensembles (roughly 3 to 5 minutes of pings) at regular, consistently sized bin intervals (e.g., 1 m), which will be averaged into one mean velocity profile during data analysis.

Data Acquisition and Logging

ADCP measurements are averaged internally during acquisition into discrete segments of the vertical water column referred to as "bins." Multiple pings are grouped together temporally (usually by averaging) into "ensembles," providing a more precise value than an individual ping. Data will be recorded using the manufacturer's software (e.g., WinADCP, WinRiverII, etc.), which will provide real-time data visualization and quality control. Data will be monitored by field personnel to verify that the ADCP instrument is reporting correct date and times, and that the values seem reasonable given the observed weather conditions and environment of deployment, and the field monitoring observations will be recorded in the field logbook.

Raw data from the instrument will be processed using this software, which will convert the data to metrics such as current speed, direction, and depth. Processed data files will be saved as ASCII files for each specific location. File naming convention will include data type, monitoring location, and date of data recovery. The data filename will follow this format:

"LOCATION ID_INSTRUMENT_RECOVERYDATE (DDMMYYY).xlsx"

For example, data from a bottom-mounted ADCP at Station "B04" on July 4, 2018, would be saved as "B04_ADCP_04072018.xlsx". When possible, data will be uploaded daily via the internet to the

TAI field supervisor on shore. Data will be backed up on a removable thumb-drive and transferred with crew shifts.

All gear will be hosed down with fresh water, decontaminated, and dried prior to storage. Biofouling may need to be scrubbed or even scraped off, taking care not to damage the ADCP, especially the beam heads.

Data QA/QC

The fourth transducer head on the ADCP provides a built-in error estimate of the errors in measuring the three dimensions of water velocity: *u*, *v*, and *w*. The differences in these measurements between each beam are captured as the error velocity, which is a measure of the uncertainty of each component. The ADCP acquisition software will screen each ping for noise and anisotropy, and error velocity values exceeding the threshold defined by the user will result in the ping being marked as bad data. It is important to note that because the geometry of the transducer heads is fixed (e.g., 20-degree rotation out of the horizontal plane) the uncertainty estimates of the upwelling/downwelling term, *w*, will be larger than for the horizontal components, *u* (east-west) and *v* (north-south). The ADCP software will also measure correlation, or the measurement of how much the particle distribution has changed between the outgoing and reflected signal, and is a measure of the signal-to-noise ratio. A low change in distribution will result in a high correlation, with an acceptable value of strong correlation being greater than 128 counts. As an additional QA check, only pings with strong correlations between the outgoing and reflected signals will be retained.

Boat captains will maintain vessel position as close to the target location as possible given the river current and wind conditions. Only pings collected within 3 m of the target station will be accepted for use in calculating flow resistance characteristics at a given station. Data collected outside of 3 m will be excluded from processing but still recorded and archived.

To assess the precision and variability of sediment bed reoughness parameters derived from ADCP measurements, sequential duplicate 300-ensemble samples will be collected at 5 percent of the measurement locations, using the same anchored station points between measurements. The roughness length and coefficient of friction will be calculated from each duplicate measurement set and compared to the calculated values from the station data.

DATA PROCESSING AND ANALYSIS

Theoretical Background

In steady open-channel flow, the mean velocity profile near a boundary takes on a logarithmic shape, because the turbulence near the boundary is a function only of the distance from that boundary (i.e., "law of the wall"). Thus, in a river, near-bed shear is calculated as:

$$(1)\ u(z) = \frac{u_*}{\kappa}\ln\left(\frac{z}{z_0}\right)$$

Where u is the mean velocity as a function of z, height above the bed, von Karman's constant, κ, is roughly 0.41, z_0 is the apparent roughness length, and u_* is the shear velocity (Julien 1998). A linear regression of the near-bed average velocity, u, against the natural log of height above the bed, z, will yield a slope and y-intercept that are related to shear velocity and apparent hydraulic roughness as follows:

$$(2)\ z_0 = e^{y-intercept}$$

$$(3)\ u_* = \frac{\kappa}{slope}$$

And the bottom coefficient of friction, C, which is generally independent of flow conditions, is related to the ratio of shear velocity to depth averaged velocity, U:

$$(4)\ C = \frac{u_*}{U}$$

Data Processing Procedure

Each station will consist of roughly 300 raw velocity profiles or ensembles collected within 3 m of the station location. These ensembles will be averaged together to produce one mean velocity profile. The lower 10 to 20 percent of the profile will be linearly regressed to extract an estimate of bed stress and roughness length. Correlation coefficients and 95-percent confidence intervals will be reported for each linear regression. The following criteria will be used to determine whether a given mean velocity profile is appropriate for further analysis:

- Log-fit correlation coefficient greater than 0.8
- Adequate number of data points to calculate shear stress (>3 data points)
- Lower bound of 95 percent confidence interval is non-negative
- Number of recorded ensembles is greater than 50
- Boundary Reynolds number (inertial forces/viscous forces) is greater than 3.5 (ensures turbulent boundary layer condition necessary for log-profile relation)
- Duplicate measurements of roughness height and coefficient of friction provide overlapping confidence bounds.

In using the log-fit method, care must be taken to use only the portion of the mean velocity profile that is influenced by the bottom of the riverbed. Upper portions of the water column are easily contaminated by other sources of shear such as wind and boat wakes. Studies have shown that the logarithmic region (or boundary layer) extends to approximately 20 percent of the water depth above the bed (Westenbroek 2006; Biron et al. 1998). In the presence of bedforms, only the portion 10 to 20 percent of the flow depth should be used (Westenbroek 2006).

Duplicate measurements that are collected at 5 percent of stations will be analyzed independently of primary measurements, yielding paired values from primary and duplicate measurements for apparent roughness height and coefficient of friction. Variability and precision between the primary and duplicate measurements will be reported as the paired values and the associated calculated relative percent difference (RPD):

$$RPD = \frac{|C_1 - C_2|}{(C_1 + C_2)/2} \times 100$$

Where: RPD = relative percent difference

C_1 = value derived from primary measurement

C_2 = value derived from duplicate measurement

Reporting

During ADCP survey activities, a brief daily summary report will be completed at the end of each day and submitted electronically to the field supervisor. These reports will include information on survey activities, locations of deployed/recovered ADCPs, locations of vessel mounted ADCP survey transects, and any issues encountered with survey progress or instrumentation.

When possible, a brief overview of the data logged will be included in the summary reports. Information such as average velocity direction, magnitude, and any other notable observations will be included.

At the completion of the survey, a final data summary report will be provided. This will be comprised of ASCII text files of position (*x*, *y*, *x)*; time; velocity (*u*, *v*, *w*); apparent roughness height; and coefficient of friction. Velocity data (*u*, *v*, *w*) will be available as raw data, as well as temporally and spatially averaged. Depth-averaged velocity, coefficient of friction, and apparent roughness heights will also be provided as point (.shp) files.

REFERENCES

Biron, P., S. Lane, A. Roy, K. Bradbrook, and K. Richards. 1998. Sensitivity of bed shear stress estimated from vertical velocity profiles—The problem of sampling resolution: Earth surface processes and landforms. Volume 23, p. 133–139.

Julien, P.Y. 1998. Erosion and sedimentation. Cambridge University Press, Cambridge, England. 280 pp.

RD Instruments. 1996. Acoustic Doppler current pro-filer—principles of operation, a practical primer (2nd ed. for broadband ADCPs): RD Instruments, San Diego, California, P/N 951-6069-00. 52 pp.

Westenbroek, S. 2006. Estimates of shear stress and measurements of water levels in the Lower Fox River near Green Bay, Wisconsin. USGS Scientific Investigations Report 2006-5226. https://pubs.usgs.gov/sir/2006/5226.

STANDARD OPERATING PROCEDURE SOP-4

VESSEL POSITIONING

Scope and Application

This standard operating procedure (SOP) is specific to the sediment facies mapping element of the Phase 3 Sediment Study (hereinafter "the study") being conducted for Teck American Incorporated (TAI) in the Upper Reach Operable Unit (OU) of the Upper Columbia River (UCR). The purpose of this SOP is to describe the procedures for collecting and processing positioning data for riverbed bathymetry and surface sediment composition (grain size) studies.

This SOP details the operation and procedures associated with collecting vertical and horizontal positioning data. The following procedures provide an explanation for how these datasets will be used to support acoustic Doppler current profiler (ADCP), multi-beam echo-sounder (MBES) and drop camera studies to classify riverbed sediments.

Project Horizontal and Vertical Datums

Datums for this project will conform to the National Geodetic Survey (NGS) National Spatial Reference System, National Adjustment of 2011.

Horizontal datum, projection and units for the project are as follows:

- Datum—North American Datum of 1983, 2011 realization (NAD83 [2011]) epoch 2010.00
- Ellipsoid—Geodetic Reference System of 1980 (GRS80)
- Projection—Washington State Plane Coordinate System
- Zone—WA-4601 Washington North
- Coordinate units—U.S. survey feet.

Vertical datum and units for the project are as follows:

- Datum—North American Vertical Datum of 1988 (NAVD88)
- Geoid model—Geoid12b
- Elevation units—U.S. survey feet.

Equipment and Materials

The positioning equipment will consist of the following:

- Global navigation satellite system (GNSS) dual frequency receivers with suitable memory for logging raw observables for multiple days. The system will require two receivers:
  - GNSS rover
  - GNSS base station
- GNSS positioning and motion reference unit (MRU)[1]
- Vessel navigation and acquisition software
- Base station radio broadcasting equipment capable of broadcasting at 5 watts or 25 watts with a joint FCC and Canadian license
- Cellular modem suitable for receiving satellite correctors via Networked Transport of Radio Technical Commission for Maritime Services (RTCM) via Internet Protocol (NTRIP) and transferring correctors to GNSS receivers
- Rover receiver radio equipment that is compatible with GNSS receivers and FCC licensed.

POSITIONING CONTROL

All position information will be acquired such that postprocess kinematic corrections using a 13 degree elevation mask can be performed relative to the Washington State Reference Network (WSRN).

Primary Positioning Control

The primary control network for the project will be the WSRN. In areas of good cellular coverage, real-time kinematic (RTK) satellite signal correctors will be acquired from the WRSN real-time broadcast and applied to GNSS receivers for precise positioning. All GNSS equipment will log raw satellite observables to allow for a postprocessed solution from the WSRN archived reference stations using a smart base solution.

[1] MRU is required for MBES. For ADCP, an accurate heading sensor is required from a MRU or other system (e.g., dual GNSS).

Radio Broadcast

Due to the poor cellular coverage in some remote areas of the project, RTK corrections will be sent to the vessel GNSS receiver system via radio broadcast when cellular service is not available or limited. With an FCC license and programmed to FCC protocols, an RTK base station radio will be used that can broadcast at a power level of 5 watts (or 25 watts with a joint FCC and Canadian license). In some areas, the cellular modem may be used to receive corrections and rebroadcast the WSRN correctors to the survey vessel GNSS receivers. Given the terrain of the survey area and the quality of the signal required, it is anticipated that additional base stations may be required. Control point locations for GNSS base station sites will be selected with open sky access and on high ground to maximize both satellite coverage and radio broadcast range. Sites will be selected on land that is publicly owned, has access agreements, or on dry banks accessible by land or vessel.

Control Network

To provide control points for GNSS base station occupation, a control network will be established under the direction of a Washington-licensed land surveyor. In addition to base station control, the network will include control points suitably located for conducting position checks from the survey vessel for each base station deployment. The network may include a combination of current published monuments as well as new control points installed by the survey team. New, permanenet monuments (e.g., iron rod) will be set with control caps. Permanent markers will include a magnetic signature, for ease of recovery during follow-on survey efforts. All monuments will be surveyed with a minimum 4-hour GNSS observation. Postprocessing of the control points will use the NGS Online Positioning User Service (OPUS) using Rapid Orbits to determine positions and elevations. The WSRN is aligned with NGS Continuous Operating Reference Stations (CORS) used in OPUS. To validate alignment, the NGS OPUS solution will be checked against the prototype on line positioning service provided by WSRN. The WSRN is aligned with the NGS CORS used in OPUS, with OPUS providing a more robust solution but there may be some stations in Canada used by the WSRN that are not used in OPUS.

Vessel Configuration and Survey Methodology

To accurately translate position and height data to sensors, precise offsets between the GNSS antenna phase center, reference point for the MRU, and all sensor reference points (multibeam sonar, ADCP, etc.) will be surveyed and documented. Redundant observations shall be conducted such that a measurement uncertainty can be computed.

The onboard GNSS rover receiver and MRU will receive RTK corrections via radio broadcast, or other suitable transmission, to be applied in real-time. Computed geographic position and ellipsoid height data, along with position quality data, will be sent to the navigation and acquisition computer to be time tagged and logged with sensor data. Timing messages from the MRU or GNSS receiver will be used for precise timing of all data. Position quality data shall be monitored and logged during the survey.

In the event of radio outages, the base station receiver, rover receiver and MRU will be configured to log raw GNSS observables such that postprocessing of position and height data can be computed and applied to sensor data postsurvey.

DATA QA/QC

OPUS Position Report

To document a valid position was obtained from NGS OPUS for each control monument, an NGS OPUS Solution Report will be included in the final survey report, which includes: observation time, orbit type, latitude root-mean square (RMS), longitude RMS, ellipsoid height RMS, and other quality indicators. These reports will be reviewed by a Washington-licensed land surveyor and approved or rejected based on minimum quality parameters established by NGS.

Horizontal and Vertical Position Checks

Horizontal and vertical accuracies will be checked daily, or whenever the base station is moved, to ensure the reference GNSS base station height and position was entered correctly and the navigation and acquisition software is using the correct geodetic parameters. Checks will be conducted by placing the vessel receiver on a survey pole over the check monument and recording data. Recorded data will be used to validate the position and height relative to the established control list. Acceptable horizontal and vertical accuracies shall be within 5 cm. A mobile GNSS receiver system will be used if a check monument cannot be reached by the survey vessel. The mobile GNSS system will then be used to check the vessel position.

ATTACHMENT A3

EXAMPLES OF VARIOUS FIELD FORMS

CHANGE REQUEST FORM
Upper Columbia River Phase 3 Sediment Facies Mapping

Page: _____ of _____ Change No: _____

CHANGE REQUEST

Applicable Reference:

Description of Change:

Reason for Change:

Impact on Present and Completed Work:

Requested By: _____ Date: _____
(Field Supervisor)

Acknowledged By: _____ Date: _____
(Teck Project Manager)

APPROVAL

Senior Technical Advisor _____ Date: _____

Teck Project Coordinator: _____ Date: _____

EPA Project Manager: _____ Date: _____

PROTOCOL MODIFCATION FORM
Upper Columbia River Phase 3 Sediment Facies Mapping

Page: _____ of _____ Field Modification No: _____

Survey Type (MBES, ADCP, Video):

Standard Procedure for Field Data Collection or Data Processing (cite reference):

Reason for Change in Field Survey Procedure or Data Processing:

Variation from Field Survey or Data Processing Procedure:

Special Equipment, Materials or Personnel Required:

APPROVAL

Initiated by _____ Date: _____

Project Manager: _____ Date: _____

Task Manager: _____ Date: _____

PHOTO LOG

Project Name: Upper Columbia River Phase 3 Sediment Facies Mapping ***Field Crew Initials:***

Comments:

Collection Date	Collection Time	Location ID	Photo ID	Photo Direction	Photo Notes	Comments

APPENDIX B

CULTURAL RESOURCES COORDINATION PLAN

CONTENTS

LIST OF MAPS

LIST OF TABLES

ACRONYMS AND ABBREVIATIONS

ACHP	Advisory Council on Historic Preservation
APE	area of potential effects
ARPA	Archaeological Resources Protection Act of 1979
CCT	Confederated Tribes of the Colville Reservation
CERCLA	Comprehensive Environmental Response, Compensation and Liability Act
CFR	Code of Federal Regulations
CRCP	cultural resources coordination plan
EPA	U.S. Environmental Protection Agency
Lake Roosevelt	Franklin D. Roosevelt Lake
MOA	Memorandum of Agreement
NAGPRA	Native American Graves Protection and Repatriation Act
National Register	National Register of Historic Places
NHPA	National Historic Preservation Act
NPS	National Park Service
OU	Operable Unit
QAPP	quality assurance project plan
RCW	Revised Code of Washington
RI/FS	remedial investigation and feasibility study
RM	river mile
SHPO	State Historic Preservation Officer
Site	Upper Columbia River site
STI	Spokane Tribe of Indians
TAI	Teck American Incorporated
THPO	Tribal Historic Preservation Officer
UCR	Upper Columbia River
USBR	U.S. Bureau of Reclamation
USC	United States Code
WAC	Washington Administrative Code

UNITS OF MEASURE

ft	foot/feet
m	meter(s)

1 INTRODUCTION

This document presents the cultural resources coordination plan (CRCP) for the Upper Columbia River (UCR) site (herein the 'Site') remedial investigation and feasibility study (RI/FS) with emphasis placed on field activities associated with the Sediment Facies Mapping element of the Phase 3 sediment study. Data collection to support sediment facies mapping will include geophysical acoustic measurements (collectively referred to herein as bathymetry data collection) and underwater video and photographs of the sediment bed in the river.

1.1 BACKGROUND

As specified in the Statement of Work associated with the June 2, 2006 Settlement Agreement (USEPA 2006), "For all RI/FS activities at the Site involving sediment collection or ground penetration/disturbance, the Company shall work with the potentially affected parties to assess the effects of the planned work and seek ways to avoid, minimize or mitigate any adverse effects on historic properties." The purpose of this CRCP is to describe known or likely physical impacts of proposed bathymetry data and underwater imagery collection activities, provide relevant background information, define measures for protecting resources, and define procedures for consulting with the appropriate state, federal, and tribal parties with interests in the cultural resources of the Site.

The Site is located wholly within the state of Washington and includes approximately 150 river miles of the Columbia River extending from the U.S.-Canada border to the Grand Coulee Dam, as well as areas in proximity to contamination necessary for implementation of the response actions described in the 2006 Settlement Agreement. The Colville Indian Reservation borders the UCR from approximately river mile (RM) 690 to the Grand Coulee Dam. The Spokane Indian Reservation borders the UCR to the east from approximately RM 650 to RM 640. Franklin D. Roosevelt Lake (Lake Roosevelt) and associated lands are administered by the U.S. Bureau of Reclamation (USBR) and the National Park Service (NPS) of the U.S. Department of the Interior.

The U.S. Environmental Protection Agency (EPA) has responsibilities under the National Historic Preservation Act (NHPA) to consider how its undertakings would affect historic properties. As defined in the NHPA, "historic properties" include archaeological resources, historic-period buildings and structures, and traditional cultural places listed in or determined eligible for listing in the National Register of Historic Places (National Register).

To meet the NHPA requirements, EPA must ensure that sampling and other activities would avoid, minimize, or mitigate any adverse effects to any historic properties.

The CRCP is organized into six sections, as follows: 1) this introductory section, which includes summary information on the archaeology, prehistory, Native peoples, and Euroamerican historical development of the project area; 2) an overview of the relevant federal, state, and tribal laws and regulations, and other appropriate procedures and requirements; 3) a description of the proposed sampling program and its potential physical effects; 4) a plan for coordination and consultation with all affected parties to address known and likely impacts to cultural resources in implementing the proposed work; 5) a list of references; and 6) a glossary of terms.

1.2 CULTURAL SETTING

The broader context of the cultural development of the upper Columbia region[1] provides the critical framework for understanding the importance of the cultural resources in the area. Archaeological and historical resources reflect broad patterns of cultural use and development, just as ongoing traditional use of areas and natural resources represents cultural continuity that can be important to individual and social identities. This section of the CRCP serves as a brief introduction to the cultural history of the upper Columbia region. The primary source of information on the prehistory of the area is Goodal et al. (2004); for Native peoples, the source is Kennedy and Bouchard (1998); and for Euroamerican history, McKay and Renk (2002).

Archaeological research contributes significantly to our understanding of the prehistoric past. In the upper Columbia region, systematic archaeological research began in the late 1930s and has continued to the present. Almost 500 archaeological resources have been recorded in and along Lake Roosevelt, representing prehistoric, protohistoric, ethnohistoric, and historic-period human use and occupation. Research at some of these resources has provided the outlines of prehistoric cultural development in the upper Columbia region. Human presence in the region extends back at least 11,000 years. These first humans lived in small groups and were mobile foragers, hunting and gathering plants. The presence of the Columbia River led

[1] The phrase "upper Columbia region" herein refers to the drainage of the upper Columbia River from around Grand Coulee to the Arrow Lakes area in British Columbia. The upper Columbia region includes, but is not limited to, the Site as defined in the Settlement Agreement. This distinction is important because general patterns of cultural development in the upper Columbia region as a whole provide the framework for addressing the significance of the cultural resources within the Site boundaries.

to an early focus on the abundance of riverine resources. Beginning about 8,000 years ago, populations appear to have increased and led to a gradual trend to less mobility and more permanent settlements. The growing population also led to use of a greater diversity of resources and increasing reliance on fish.

Permanent settlements increased in size and became concentrated in the river valleys beginning about 6,000 years ago, probably in response to continued population growth. Use of resources in upland areas expanded to meet the needs of the burgeoning populations and settlements. These trends continued until about 1,000 years ago, when there is evidence for a decline in population size. There were fewer settlements, villages were smaller, and there was less use of upland areas.

Cultural patterns of the late prehistoric period were reflected in the lives of the Native peoples at the time of Euroamerican contact. At the time of contact, the UCR was the homeland of the Lakes, Colville, Spokane, and Sanpoil peoples. The Lakes people occupied the Columbia River valley from the vicinity of modern Northport, Washington, north into the Arrow Lakes area of modern British Columbia. The Colville lived along the river downstream of the Lakes as far as around the mouth of the Spokane River. Downriver of the Colville were the Spokane, in the Spokane River drainage, and the Sanpoil, who lived along the Columbia River from around the mouth of the Spokane River to near the modern location of the Grand Coulee Dam.

All of these groups spoke Interior Salish languages and shared many cultural features. Their cultural differences largely reflected differences in the local environments in which they lived. The social, political, and economic foundation of these groups was historically the winter village. The villages were concentrated in the river valleys, and each village was politically independent. Residents of the villages relied on provisions gathered, dried, and stored during the summer to survive through the winter. With the coming of spring, families began moving out of the winter village and shifting among the warm-season camps near resource locations. Gathering of plants and hunting game in upland areas were important subsistence activities during this season, but salmon constituted the most important food staple. Kettle Falls was a major aboriginal fishery, attracting people from throughout the region.

Native life began to change with the introduction of elements of Euroamerican culture. Horses reached the region in the 1700s and significantly changed Native travel and transportation. European diseases such as smallpox appeared in the late 1700s and had disastrous consequences for Native groups. Populations may have declined as much as 80

percent between the 1780s and 1840s. Direct contact with Euroamericans came in the early 1800s, when fur-trade posts were established on the Spokane River and at Kettle Falls.

When American settlement began in the 1840s, it bypassed the upper Columbia region. The discovery of gold in the region in the 1850s led to a major influx of Americans and growing conflict between the new settlers and Indian groups. A series of treaties with Indian groups was signed in 1855 but did not include the peoples of the upper Columbia region. As American settlement continued, the federal government responded by Presidential Executive Order creating the Colville Reservation in 1872 for the Colville, Spokane, Methow, Okanogan, Sanpoil, Lakes, Calispel, Coeur d'Alene, and scattering bands. Separate reservations were later set aside for the Spokane, Calispel, and Coeur d'Alene tribes. The Colville and Spokane reservations have subsequently lost lands to the allotment process in the late 1800s and early 1900s as well as inundation from the waters of Lake Roosevelt. The Colville Reservation is now the home of the 12 tribes that comprise the Confederated Tribes of the Colville Reservation (CCT); the Spokane Reservation is the home of the Spokane Tribe of Indians (STI).

As noted above, the direct Euroamerican presence in the upper Columbia region began with the establishment of fur-trade posts on the Spokane River and at Kettle Falls. These posts were constructed between 1810 and 1825. The fur traders were followed by Christian missionaries in the 1830s and 1840s. A more substantial Euroamerican presence in the region developed in the 1850s, with the discovery of gold near Fort Colville. Conflicts between miners and Indians led to a military campaign in the Spokane River valley in 1858 and the establishment of an army post (Fort Colville) near Kettle Falls in 1859.

American settlement in the upper Columbia River drainage accelerated in the 1860s, initially spurred by mining. Farmers eventually followed the miners, but agricultural activity was limited until the construction of the Spokane Falls and Northern Railway through the region in 1890. With improved access to markets, farming—especially orchard crops—developed as one of the economic mainstays of the area, although mining has continued to play an important role.

The growing demands for agriculture led to plans to construct a dam at Grand Coulee. The dam would provide water for irrigation and inexpensive hydroelectric power. Construction of the dam began in 1934 and was completed in 1942. More than 82,000 acres above the dam were flooded, resulting in the relocation of 11 towns and about 3,000 residents. Since its creation, Lake Roosevelt has provided a growing number of recreational and tourist activities, which have become increasingly important to local economies.

2 OVERVIEW OF LAWS AND REGULATIONS

Implementation of the RI/FS would occur primarily on federal and tribal lands. Federal and tribal laws and regulations addressing cultural resources will therefore provide the primary legal framework for this coordination plan. It is possible, however, that implementation of the RI/FS may require activities on private or non-federal, non-tribal public lands. This overview therefore includes a brief description of relevant state laws and executive orders. Ferry, Lincoln, and Stevens counties, which border the UCR, do not appear to have any ordinances addressing cultural resources that would be relevant to the Site RI/FS.

Relevant federal, tribal, and state laws and regulations directly addressing cultural resources are briefly outlined below, as well as pertinent executive orders issued by the President of the United States and the Governor of Washington.

2.1 FEDERAL LEGISLATION AND REGULATIONS

An overview of federal legislation and regulations is provided below. There are three key laws relevant to Site RI/FS activities. The NHPA guides all federal agency actions that could affect cultural resources. Implementation of the RI/FS constitutes an "undertaking" as defined in the NHPA; therefore, complying with the NHPA requirements is the responsibility of EPA. The Archaeological Resources Protection Act of 1979 (ARPA) and the Native American Graves Protection and Repatriation Act (NAGPRA) apply to activities that could affect archaeological resources and Indian burials on federal and tribal lands. These laws and their implementing regulations would therefore apply to RI/FS activities conducted on federal and tribal lands.

2.1.1 National Historic Preservation Act of 1966, as Amended through 1992 (16 USC 470-470w)

The NHPA is the centerpiece of federal legislation protecting cultural resources. In the Act, Congress states that the federal government will "provide leadership in the preservation of the prehistoric and historic resources of the United States," including resources that are federally owned, administered, or controlled. For federal agencies, Sections 106 and 110 of the Act provide the foundation for how federal agencies are to manage cultural resources, but other sections provide further guidance. The implementing regulations for the NHPA are in 36 Code of Federal Regulations (CFR) Part 800. These regulations are summarized below.

2.1.1.1 Section 106

Similar to the National Environmental Policy Act of 1969, Section 106 of the NHPA requires federal agencies to take into account the effects of their actions or programs specifically on historic and archaeological properties, prior to implementation. This is accomplished through consultation with the State Historic Preservation Officer (SHPO) and/or the Advisory Council on Historic Preservation (ACHP). On lands held by a tribe with a Tribal Historic Preservation Officer (THPO), the THPO has the same duties and responsibilities as the SHPO. If an undertaking on federal lands may affect properties having historic value to a federally recognized Indian tribe, such tribe shall be afforded the opportunity to participate as interested persons during the consultation process defined in 36 CFR 800. Compliance can also be accomplished using agreed-upon streamlined methods and agreement documents such as programmatic agreements.

The Section 106 process is designed to identify possible conflicts between historic preservation objectives and the proposed activity, and to resolve those conflicts in the public's interest through consultation. Neither the NHPA nor the ACHP regulations require that all historic properties be preserved. Rather, they only require the agency proposing the undertaking to consider the effects of the proposed undertaking prior to implementation.

Failure to take into account the effects of an undertaking on historic or cultural properties can result in formal notification from the ACHP to the head of the federal agency for foreclosure of the ACHP's opportunity to comment on the undertaking pursuant to NHPA. A notice of foreclosure can be used by litigants against the federal agency in a manner that can halt or delay critical activities or programs.

The process for compliance with Section 106 consists of the following steps:

1. **Identification of Historic Properties**—Identification of historic properties located within the area of potential effects (APE) is accomplished through review of existing documentation and/or field surveys.
2. **Property Evaluation**—Evaluation of the identified historic properties is accomplished using National Register of Historic Places criteria (36 CFR Part 63) in consultation with the SHPO and, if necessary, the ACHP. Properties that meet the criteria will be considered "Eligible" for listing in the National Register, and will be subject to further review under Section 106. Properties that do not meet the criteria will be considered "Not Eligible" for listing in the National Register, and will not be subject to further Section 106 review.

3. **Determination of Effect**—An assessment is made of the effects of the proposed project on properties that were determined to meet the National Register criteria, in consultation with the SHPO and, if necessary, the ACHP. One of the following effect findings will be made:

    - No Historic Properties Affected—If no historic properties are found or no effects on historic properties are found, the agency official provides appropriate documentation to the SHPO/THPO and notifies consulting parties. However, the federal agency must proceed to the assessment of adverse effects when it finds that historic properties may be affected or the SHPO/THPO or ACHP objects to a "No Historic Properties Affected" finding. The agency must notify all consulting parties and invite their views.
    - No Historic Properties Adversely Affected—When the Criteria of Adverse Effect are applied (36 CFR 800.5(a)), and it is found that historic properties will not be adversely affected by the undertaking, the agency may make a finding of "No Historic Properties Adversely Affected." This finding is submitted to the SHPO for concurrence. Typically, the ACHP will not review "No Adverse Effect" determinations. However, the ACHP will intervene and review "No Historic Properties Adversely Affected" determinations if it deems it appropriate, or if the SHPO/THPO or another consulting party and the federal agency disagree on the finding and the agency cannot resolve the disagreement. If Indian tribes disagree with the finding, they can request the ACHP's review directly, but this must be done within the 30-day review period. Agencies must retain records of their findings of "No Historic Properties Adversely Affected" and make them available to the public. The public should be given access to the information when they so request, subject to Freedom of Information Act and other statutory limits on disclosure, including the confidentiality provisions in Section 304 of the NHPA. Failure of the agency to carry out the undertaking in accordance with the finding requires the agency official to reopen the Section 106 process and determine whether the altered course of action constitutes an adverse effect.
    - Historic Properties Adversely Affected—Adverse effects occur when an undertaking may directly or indirectly alter characteristics of a historic property that qualify it for inclusion in the National Register. Reasonably foreseeable effects caused by the undertaking that may occur later in time, be farther removed in distance, or be cumulative also need to be considered. The finding of "Historic Properties Adversely Affected" is submitted to the SHPO for concurrence. The SHPO/THPO may suggest changes in a project or impose conditions so that adverse effects can be avoided and thus result in a "No Historic Properties Adversely Affected" determination.

4. **Resolution of Adverse Effects/Mitigation**—When adverse effects are found, the consultation must continue among the federal agency, SHPO/THPO, and consulting parties to attempt to resolve them. The agency official must notify the ACHP when adverse effects are found, and should invite the ACHP to participate in the consultation when circumstances exist, as outlined in 36 CFR 800.6(a)(1)(i)(A)-(C). A consulting party may also request the ACHP to join the consultation.

   When resolving adverse effects without the ACHP, the agency official consults with the SHPO/THPO and other consulting parties to develop a Memorandum of Agreement (MOA). The MOA will outline the steps or actions to be taken prior to implementation of the project, in order to mitigate the adverse effects on the historic property. Stipulations included in an MOA may include (but are not limited to) documentation, modification of the project to lessen the adverse effects on the property, efforts to sell or relocate the resource, or step-by-step consultation with interested parties throughout the process to ensure it is carried out according to plan.

   The MOA is executed between the agency official and the SHPO/THPO and filed with required documentation with the ACHP. This filing is the formal conclusion of the Section 106 process and must occur before the undertaking is approved.

In some cases, streamlining of the Section 106 process can be accomplished through the use of programmatic agreements. The ACHP and the agency official may negotiate a programmatic agreement to govern the implementation of a particular program or the resolution of effects from complex projects or multiple undertakings. Programmatic agreements are particularly useful when programs or projects affecting historic properties are similar and repetitive, and have known effects, such as routine maintenance or a series of similar rehabilitation projects.

2.1.1.2 Section 101(d)(2)

This section of the NHPA provides for the assumption by federally recognized Indian tribes of all or any part of the functions of a SHPO with respect to tribal lands (e.g., all lands within the exterior boundaries of any Indian reservation and all dependent Indian communities). Section 101(d)(2) requires federal agencies, in carrying out their Section 106 responsibilities, to consult with federally recognized Indian tribes that attach religious or cultural significance to a historic property. The agency will consult with federally recognized Indian tribes in the Section 106 process to identify, evaluate, and treat historic properties that have religious or cultural importance to those groups.

2.1.1.3 Section 110

Section 110 of the NHPA is intended to ensure that historic preservation is integrated into the ongoing programs of federal agencies. This section of the Act requires agencies to identify, evaluate, and nominate for listing in the National Register, historic properties owned or controlled by the agency; use historic properties to the maximum extent feasible; ensure documentation of historic properties that are to be altered or damaged; carry out programs and projects that further the purpose of the Act; and undertake such planning and actions as may be necessary to minimize harm to any formally designated National Historic Landmark properties.

2.1.1.4 Section 111

Section 111 of the NHPA requires agency officials, to the extent practicable, to establish and implement alternatives for historic properties, including adaptive use, that are not needed for current or projected agency uses or requirements. Further, Section 111 allows the proceeds from any lease to be retained by the agency to defray the cost of administration, maintenance, repair, and related expenses of historic properties.

2.1.1.5 Section 112

Section 112 of the NHPA requires that agency officials who are responsible for protection of historic properties pursuant to the NHPA ensure that all actions taken by employees or contractors meet professional historic preservation standards established by the Secretary of the Interior (Professional Qualifications Standards of the Secretary of the Interior's Standards and Guidelines in Archaeology and Historic Preservation [NPS 1983]).

2.1.1.6 Section 304

Section 304 of the NHPA requires that information about the location, character, or ownership of a historic property be withheld from public disclosure when the federal agency head or other public official determines that disclosure may cause a significant invasion of privacy, risk, and/or harm to the historic property, or impede the use of a traditional religious site by practitioners.

2.1.1.7 Comprehensive Environmental Response, Compensation and Liability Act and the National Historic Preservation Act

EPA's Comprehensive Environmental Response, Compensation and Liability Act (CERCLA) manual, CERCLA Compliance with Other Laws Manual: Part II. Clean Air Act

and Other Environmental Statutes and State Requirements (USEPA 1989), outlines how "substantive compliance" with the NHPA is to be achieved in CERCLA actions.[2] The initial step is determining if cultural resources are known or are likely to be present "in or near the area under study in the RI." This step may require conducting a survey of the location of the proposed remedial action and any associated actions that would occur off site. The CERCLA manual referenced above defines three stages of a survey: Stage IA, literature search and sensitivity study; Stage IB, field investigation; and Stage II, site definition and evaluation. All studies should include Stage IA but implementation of Stage IB is contingent on the results of Stage IA, and the need for Stage II is contingent on the results of Stage IB. If results of the survey identify significant cultural resources (i.e., resources listed or considered eligible for listing in the National Register), effects of the proposed remedial action and associated actions to the significant resources must be evaluated. Adverse effects to significant resources must be either avoided or mitigated. Any proposed mitigation measures must be incorporated into the remedial design process.

2.1.2 Archaeological Resources Protection Act of 1979 (16 USC 470aa-470ll)

ARPA is essentially an update to the 1906 Antiquities Act. It expands and strengthens the activities prohibited under the Antiquities Act, increases the criminal penalties for violation, establishes civil penalties, and provides further guidelines for the issuance of permits. This Act continues to apply only to federal and Indian lands (the definition of "Indian lands" in ARPA differs very slightly from the definition of "Tribal lands" in the NHPA). Most archaeological excavations and collection of artifacts on these lands are allowed only with an ARPA permit. Trafficking in illegally obtained archaeological resources from federal and Indian lands is also prohibited. Individuals convicted of violating the Act are liable for the value of the archaeological resource itself, and the cost of restoration or repair of the damage caused by illegal excavation or collection.

The implementing regulations are 43 CFR Part 7 (U.S. Department of the Interior), which applies to federal lands that are not within military reservations or national forests. The regulations include detailed definitions of "archaeological resource" and "Indian lands"

[2] As stated in the June 2, 2006 Settlement Agreement (USEPA 2006), "The Parties intend that this RI/FS, while not being carried out under an administrative order or judicial order issued pursuant to the provisions of the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA), will be consistent with the National Contingency Plan ('NCP'), 40 CFR Part 300."

(lands held in trust by the United States on behalf of a federally recognized tribe or individual members of a federally recognized tribe).

2.1.3 Native American Graves Protection and Repatriation Act (25 USC 3001-3013)

NAGPRA establishes that Native American human remains and associated funerary objects found on federal or tribal lands belong to the lineal descendants of the Native American. When the lineal descendants cannot be determined, the remains belong to the tribe on whose land the remains were found (when found on tribal lands), or to the Indian tribe with the "closest cultural affiliation."[3] This latter rule also applies to unassociated funerary objects, sacred objects, and objects of cultural patrimony (all defined in the Act). NAGPRA applies to both human remains intentionally excavated (which would require an ARPA permit) and those accidentally discovered.

NAGPRA also requires all federal agencies and museums to inventory their holdings of Native American human remains and funerary objects. Once the inventories are completed, the agencies and museums are to notify the appropriate tribes of the remains and other objects in their collections. The remains and associated funerary objects are to be returned (repatriated) at the request of the lineal descendants or tribe. The same requirement applies to unassociated funerary objects, sacred objects, and objects of cultural patrimony for which a cultural affiliation can be demonstrated. Exceptions to the repatriation requirement are objects that are "indispensable for completion of a specific scientific study, the outcome of which would be of major benefit to the United States."

The implementing regulations are 43 CFR Part 10, which largely expand on the elements of the statute. The regulations detail 1) the process of consultation with Indian tribes to address either intentional excavation of human remains or inadvertent discovery of human remains; 2) how agencies and museums are to inventory their collections; and 3) the repatriation process. When human remains, funerary objects, sacred objects, and objects of cultural patrimony are inadvertently discovered on federal lands, the following steps are to be followed: 1) ongoing activity in the area of the find must cease and a reasonable effort made to protect the find; and 2) the federal land agency (i.e., the federal agency on whose lands the remains or objects have been found) must be immediately notified by telephone, with written confirmation. The federal land agency must then notify the appropriate tribe(s) and

[3] Cultural affiliation is defined in the implementing regulations, 43 CFR 10.2(e), and refers to a relationship of shared group identity, which can be reasonably traced historically or prehistorically between a present-day Indian tribe or Native Hawaiian organization and an identifiable earlier group.

further secure and protect the discovery. The activity may be halted for up to 30 days while an appropriate response to the find is negotiated by the federal agency and the appropriate tribe(s).

2.1.4 American Indian Religious Freedom Act (42 USC 1996)

This Act states that it is the policy of the United States to protect and preserve the rights of American Indians to practice traditional religions. That policy includes rights of access to sacred sites and to the use and possession of sacred objects. There are no implementing regulations.

2.2 PRESIDENTIAL EXECUTIVE ORDERS

Presidential executive orders define policies and procedures for federal agencies to facilitate their execution of laws passed by the U.S. Congress or clarify how specific laws are to be implemented. Presidential executive orders can be considered instructions or directives from the President to federal agencies on how to carry out specific laws. The executive orders listed below are either directly related to cultural resources or define relationships between federal agencies and tribes.

2.2.1 Executive Order 11593. Protection and Enhancement of the Cultural Environment

Issued in 1971, Executive Order 11593 states that the federal government would provide leadership in "preserving, restoring, and maintaining the historic and cultural environment of the Nation." Federal agencies were directed to inventory cultural resources under their jurisdiction and nominate National Register-eligible properties to the National Register. Properties that have been determined eligible are not to be transferred, sold, demolished, or altered without providing the ACHP with an opportunity to comment. Properties to be demolished or substantially altered were to be documented prior to demolition or alteration. National Register properties or National Register-eligible properties under federal control were to be maintained following standards set by the Secretary of the Interior. Executive Order 11593 also assigns specific responsibilities to the Secretary of the Interior, including managing the National Register of Historic Places and assisting and advising other federal agencies in the management of cultural resources.

2.2.2 Executive Order 13007. Indian Sacred Sites

Issued in 1996, Executive Order 13007 directs federal agencies to provide access and ceremonial use of Indian sacred sites, where practicable, legal, and not inconsistent with essential agency functions. Agencies are also directed to avoid adversely affecting sacred sites and maintain the confidentiality of such sites. A "sacred site" as defined by this executive order is a specific location that is sacred because of its religious significance to or ceremonial use in an Indian religion.

2.2.3 Executive Order 13175. Consultation and Coordination with Indian Tribal Governments

Issued in 2000, Executive Order 13175 directs federal agencies to consult with tribal officials in the development of policies and regulations that have "tribal implications" or that preempt tribal law. Executive Order 13175 also emphasizes the importance of government-to-government relationships between the U.S. Government and tribes. Agencies must designate an official responsible for implementing the Executive Order and must document tribal consultation in the development of the relevant policies and regulations.

2.3 TRIBAL LEGISLATION AND REGULATIONS

Tribal laws and regulations addressing cultural resources would apply to lands on the reservations and off-reservation trust lands. The CCT and the STI are the two tribes whose laws and regulations would be potentially applicable to the Site. The legal code of the CCT addresses cultural resources, as summarized below. This code applies to both on-reservation actions and off-reservation actions by federal agencies that could affect cultural resources. STI does not currently have laws that specifically address cultural resources. Both tribes have THPOs, who have the same authority and responsibilities as the SHPO on their respective reservations and on off-reservation trust lands.

2.3.1 Confederated Tribes of the Colville Reservation. Colville Tribal Law and Order Code Chapter 4-4, Cultural Resources Protection

This Colville Tribal Code establishes the Colville Cultural Resources Board, which has the responsibility of developing policies and procedures to protect cultural resources of interest and concern to the Colville Tribes, both on and off the Colville Reservation. The Board reviews proposed federal agency actions off the reservation and is responsible for reviewing all proposed on-reservation actions that could affect significant cultural resources. The code

also establishes a Colville Register of Historic and Archaeological Properties for listing of historic properties on the Colville Reservation.

This code defines the roles and responsibilities of the Colville History and Archaeology Department, which include identifying significant cultural resources on the reservation, nominating properties to the National Register and the Colville Register, and promoting efforts to protect cultural resources on the reservation.

Chapter 4-4 of the Colville Tribal Code prohibits the excavation, disturbance, or other adverse effects to archaeological resources and historic properties on the reservation without a permit issued by the Colville History and Archaeology Department. The code defines the procedure for the issuance of permits and the responsibilities of permittees.

2.4 STATE LEGISLATION AND REGULATIONS

Washington State laws and regulations regarding archaeological and historical resources, as well as the law protecting Indian graves, are not applicable on federal lands or on tribal trust lands. These laws would apply, however, to any RI/FS-related activities that would affect private lands or non-federal or non-tribal public lands.

2.4.1 Revised Code of Washington (RCW) Chapter 27.44, Indian Graves and Records

This legislation prohibits the removal or other disturbance of Indian burials, cairns, and "glyptic or painted records." "Burials" and "graves" are not defined in the statute. Excavation or removal of burials is permitted only under provisions of a permit issued by the Washington Department of Archaeology and Historic Preservation. Procedures for obtaining permits are defined in Washington Administrative Code (WAC) Chapter 25-48.

2.4.2 RCW Chapter 27.53, Archaeological Sites and Resources

This legislation prohibits the excavation or disturbance of archaeological sites on public and private lands in Washington except under provisions of a permit issued by the Washington Department of Archaeology and Historic Preservation. Procedures for obtaining permits are defined in WAC Chapter 25-48.

2.4.3 RCW Chapter 68.60, Abandoned and Historic Cemeteries and Historic Graves

This legislation prohibits the destruction, alteration, or other disturbance of historical and abandoned cemeteries and historic graves (Indian graves and burials are protected in RCW Chapter 27.44). A historic cemetery is defined in the statute as one established before November 1889. A historic grave is a grave or graves outside of a cemetery placed prior to June 1990.

2.4.4 RCW Chapter 43.21C, State Environmental Policy Act

This legislation directs state and local agencies in Washington to address environmental impacts of proposed projects. The implementing rules (WAC Chapter 197-11) require that impacts to historic and cultural resources are to be addressed in the State Environmental Policy Act process.

3 PROPOSED SAMPLING PROGRAM

A detailed description of collection techniques and associated equipment is provided in this quality assurance project plan (QAPP). As indicated in the QAPP, bathymetry data and underwater imagery will be collected throughout the Upper Reach Operable Unit (OU), which encompasses the UCR river channel from the U.S.-Canada border to an area just north of Marcus Flats within the Site (Map B1). Sediment bed elevation and acoustic backscatter data will be collected continuously throughout the Upper Reach OU. Water velocity profiles and underwater imagery will be co-located and collected at point locations along transects throughout the Upper Reach OU. A summary of proposed velocity profile/underwater imagery point locations is provided in Table B1. Detailed data collection methods and maps of each area of interest are provided in the field sampling plan (Appendix A of this QAPP).

4 COORDINATION PLAN

The objective of the CRCP is to ensure that implementation of the RI/FS and associated sampling activities does not adversely affect any cultural resources. The plan therefore defines a general process and more specific procedures to meet this objective.

The two main challenges in meeting this objective are 1) the iterative process of remedial investigations; and 2) the high density of cultural resources in the study area. The iterative process is a challenge because there are likely to be several rounds of sampling (and associated actions) that extend over several years. Coordination and consultation must therefore also be an iterative process as methods and locations are defined for each round of sampling.

The high density of cultural resources is a challenge because it is highly likely that every round of intrusive sampling will occur at the identified location of one or more cultural resources. At the same time, the high density is potentially misleading by suggesting that all cultural resources in the UCR have been identified. Most—if not all—of the Lake Roosevelt lands have been surveyed for cultural resources in the past. Few of the surveys conducted prior to about 1975 are likely to have met current regulatory and professional standards. In addition, many of the previous surveys focused on archaeological resources to the exclusion of other types of cultural resources (and older archaeological surveys documented only evidence of prehistoric use or occupation). Finally, it is likely that there are some locations previously surveyed at which burials or buried archaeological resources are present but not evident and therefore not recorded at the time of the survey (many surveys both in the past and in the present rely entirely or primarily on surface evidence of archaeological resources or burials).

This plan therefore defines procedures that address sampling at known locations of cultural resources and locations where no cultural resources are currently recorded.

4.1 GENERAL CONSULTATION FRAMEWORK

Implementation of the RI/FS constitutes an "undertaking" as defined in the NHPA; therefore, complying with the NHPA requirements is the responsibility of EPA. EPA is the lead federal agency for cultural resources consultation and coordination for the Site. Any issues or concerns related to cultural resources during the planning and/or implementation of Site work shall be brought to the attention of EPA for consultation with the UCR Cultural Resources Working Group, as appropriate. Successful implementation of the RI/FS and of this

CRCP, given the issues defined above, will require ongoing consultation and coordination with the UCR Cultural Resources Working Group consisting of the NPS, USBR, CCT, STI, and the Washington SHPO (i.e., the consulting parties). Other consulting parties (as defined in 36 CFR 800.2(c)) may be recognized in the future, whose participation would be important for general consultation or coordination in the RI/FS process or for specific sampling locations. For the purposes of cultural resources coordination activities, the "consulting parties" referred to in this plan are distinguished from other "participating parties" to the RI/FS process.

4.2 CULTURAL RESOURCE PROCEDURES IN THE SAMPLING PROCESS

This section defines general procedures to be followed in the sampling process to minimize the potential for inadvertent disturbance of cultural resources. More specific protocols to respond to discoveries are defined in the following subsections.

In addition, the UCR Cultural Resources Working Group recommended to Teck American Incorporated (TAI) that it provide cultural awareness, avoidance, and sensitivity training/refresher to field personnel, as appropriate, prior to the commencement of field activities.

4.2.1 Archaeological Monitoring in the Sampling Program

To ensure compliance with the NHPA and the applicable requirements, procedures, and standards of the NPS, USBR, CCT, and STI, the following procedures have been developed to address potential discoveries, including inadvertent discoveries, of cultural materials and deposits (including sacred objects, funerary objects, and objects of cultural patrimony as defined in NAGPRA), including Indian burials and human remains (as defined in NAGPRA), during bathymetry data and underwater imagery collection and associated activities.

4.2.1.1 Notification of Planned Bathymetry Data and Underwater Imagery Collection Activity

TAI shall notify EPA at least 15 days in advance of any sample collection activity, unless shorter notice is agreed to by EPA. Notification to EPA may be provided by e-mail or by letter. As for all RI/FS activities at the Site involving ground penetration and disturbance, TAI shall work with potentially affected parties to assess the effects of the planned work and seek ways to avoid, minimize, or mitigate any adverse effects on historic properties. Further,

bathymetry data and underwater imagery collection activity cannot be performed at the Site without 1) clearance of proposed locations by tribal and federal/state cultural resources coordinators; 2) a cultural monitor present on site with each field crew conducting bathymetry data and underwater imagery collection activities unless otherwise indicated by the UCR Cultural Resources Working Group; and 3) approval by EPA.

The names and contact information for potentially affected parties (i.e., representatives of the federal land-managing agencies and tribes) are provided in Attachment B1 of this CRCP. TAI will work with EPA to establish a procedure for timely notification of these parties.

4.2.1.2 Professional Archaeologist and/or Tribal Cultural Monitor On Site

The bathymetry data collection and underwater imagery equipment is non-invasive and will not result in ground disturbance. Therefore, the UCR Cultural Resources Working Group is not requiring a professional archaeologist or tribal representative for this sediment facies mapping study, although a monitor may opt to participate at any time.

4.2.1.3 Discoveries—Archaeological Monitor Not Present

In the event that suspected or evident artifacts or other archaeological deposits are encountered when an archaeological monitor or tribal representative is not present, the immediate vicinity of the discovery will be secured. Notification of any archaeological discoveries must be provided to EPA for further coordination with consulting parties within 24 hours of the discovery. All telephone notification of discoveries must be promptly followed by notification in writing (via e-mail or conventional mail).

The discovery will be mapped and photographed in place but will be otherwise left as found (other than appropriate measures to secure the find and maintain security). In consultation with the land-managing agency or appropriate tribe, as well as other interested parties, TAI will arrange for the location of the discovery to be examined by a professional archaeologist and tribal representative in a timely manner. If the archaeologist/tribal representative confirms the presence of artifacts or other archaeological deposits, the procedures defined above for discoveries made during ground-disturbing activity monitored by an archaeologist will be implemented. The archaeologist/tribal representative will prepare appropriate State of Washington archaeological forms to document the find.

To ensure proper recognition of artifacts and other cultural items or deposits, all TAI field personnel will be provided with training in recognizing these materials by a professional archaeologist prior to the initiation of any sediment and soil sampling.

4.2.1.4 Discovery of Human Remains

Native peoples in the study area consider the graves of their ancestors to be important in both their cultural identity and in defining their relationship with the land. These graves are therefore considered sacred and should be left undisturbed. Should inadvertent disturbance occur, the remains and associated materials (funerary objects) must be treated with respect and honor. All appropriate federal, tribal, and state laws, regulations, and procedures regarding burials should be rigorously enforced.

In the event that likely or confirmed human remains are encountered, all further sampling or other ground-disturbing activity will cease immediately. To comply with 43 CFR 10.4(b), any discoveries of human remains must be reported to the NPS and USBR immediately by telephone, followed by written notification. Any discoveries within the boundaries of the CCT or the STI reservations must also be reported immediately to the respective tribe.

TAI will notify EPA for further coordination with consulting parties (consisting minimally of the NPS, USBR, CCT, STI, and the Washington SHPO). The TAI technical team will assist the archaeological monitor and tribal representative in securing the location of the discovery.

If no archaeological monitor or tribal representative is present, the TAI technical team will secure the location of the discovery in such a manner that both maintains the physical integrity of the remains and any associated objects and precludes further disturbance, or a member of the TAI technical team will remain on site until an archaeologist or tribal representative can arrive to assess the find.

Other conditions for responses to discoveries of archaeological materials may be defined in the permits issued for the sampling program. Responses to any discoveries of burials must comply with provisions of NAGPRA and its implementing regulations (in addition to those referenced above), as well as the existing protocols of the NPS, USBR, CCT, and STI (copies of these protocols are provided in Attachment B1).

4.2.2 Curation

Artifacts and other cultural materials that may be recovered during the sampling program (with the exception of human remains and associated items subject to NAGPRA) will be curated at a facility that meets the standards of 36 CFR 79. The appropriate facility or facilities will be designated by the NPS and USBR in consultation with the tribes for items recovered from federal lands. The appropriate tribe will designate the curation facility for cultural materials recovered from tribal lands.

4.2.3 Reporting

Within 150 days of completion of each sampling activity that is covered under the QAPP,[4] if a discovery is made, a professional archaeologist will prepare a confidential[5] written report that presents the results of responses to any discoveries of archaeological resources or burials. The report will include 1) copies of field notes, descriptions, and maps of all locations at which sampling-related archaeological monitoring was conducted; 2) descriptions of any discoveries made and the outcome of the discoveries (including the rationale for the decisions for the disposition of any finds); and 3) recommendations for any changes in the monitoring protocol or coordination plan that may be appropriate to address results of the monitoring or how well existing coordination procedures worked. A standardized archaeological monitoring form may be substituted for the field notes referenced above.

The draft report will be provided to EPA for review and dissemination to the consulting parties for review and comment.

4.3 CONFIDENTIALITY

TAI shall make its best efforts, in accordance with state and federal law, to ensure that its employees and contractors keep the discovery of any found or suspected human remains, other cultural items, and potential historic properties confidential. Pertinent TAI employees and contractors will be required to read and sign a confidentiality statement that specifies procedures to be followed in response to media and public contacts regarding archaeological and other cultural resources. To the extent permitted by law, prior to any release of information, EPA, TAI, and the other consulting parties shall concur on the amount of information, if any, to be released to the public, any third party, and the media, and the procedures for such a release.

[4] Sampling or other RI/FS activities that do not require coordination under the QAPP will not result in generation of this reporting requirement.

[5] Refer to Section 4.3, Confidentiality.

5 REFERENCES

Goodal, N.B., W.C. Prentiss, and I. Krujit. 2004. Cultural complexity: A new chronology of the Upper Columbia drainage. In: Complex Hunter-Gatherers: Evolution and Organization of Prehistoric Communities on the Plateau of Northwestern North America, edited by William C. Prentiss and Ian Krujit. pp. 36-48. University of Utah Press, Salt Lake City, UT.

McKay, K.L., and N.F. Renk. 2002. Currents and under currents: An administrative history of Lake Roosevelt National Recreation Area.

NPS (National Park Service). 1983 (with updates). Archeology and historic preservation: Secretary of the Interior's standards and guidelines (as amended and annotated). National Park Service, Department of the Interior. Available at: http://www.nps.gov/history/local-law/arch_stnds_9.htm.

USEPA (U.S. Environmental Protection Agency). 1989. CERCLA compliance with other laws manual: Part II. Clean Air Act and other environmental statutes and state requirements. U.S. Environmental Protection Agency, Region 10, Seattle, WA.

USEPA. 2006. Settlement agreement for implementation of remedial investigation and feasibility study at the Upper Columbia River Site. June 2, 2006. U.S. Environmental Protection Agency, Region 10, Seattle, WA.

6 GLOSSARY OF TERMS

Burial—A burial is defined in NAGPRA as "[a]ny natural or prepared physical location, whether originally below, on, or above the surface of the earth, into which as part of the death rite or ceremony of a culture, individual human remains are deposited."

Curation—Long-term storage and preservation of archaeological collections. Archaeological collections from federal lands must be curated at facilities that meet the standards of 36 CFR 79.

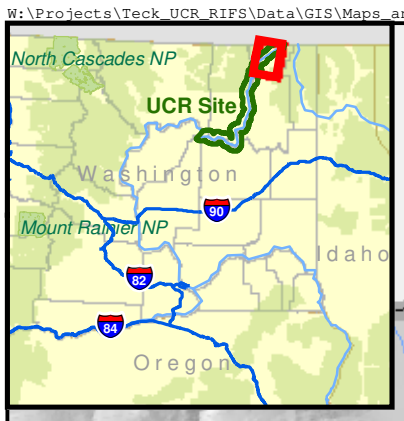
Ethnohistoric—Information on Native peoples gathered from historical accounts.

Historic, historic-period, historical—The NHPA uses the term "historic" to refer to properties that are listed or have been determined eligible for listing on the National Register of Historic Places. To avoid confusion with this definition of "historic," "historic-period" or "historical" are used to reference resources, places, events, and people associated with the period since the appearance of Euroamericans and the beginning of written accounts (ca. 1780–1810 in the Pacific Northwest).

Protohistoric—The period of time transitional from prehistory to history. In the Pacific Northwest, protohistoric can be generally defined as from the late 1600s until late 1700s.

Map

W:\Projects\Teck_UCR_RIFS\Data\GIS\Maps_and_Analyses\Sediment DQOs and QAPP\Sediment Facies Mapping QAPP\Field Sampling Plan\Map B1. Bathy and Underwater Imagery Collection Area.mxd @ 08/27/2018



U.S. - Canada Border

RM 744

RM 740

Big Sheep Creek

Deadman's Eddy

251

North Fork Deep Creek

Northport

RM 730

Deep Creek

25

China Bend

RM 720

South Fork Deep Creek

Cable Ferry Landing

Bossburg Flat Beach

Evans Campground

South Fork Deep Creek

Legend

- Photo Location
- Photo Transect
- Bathymetry Data Collection Area
- Upper Columbia River
- Stream
- Populated Places
- State Highway
- Railroad
- River Mile (USGS)

Windward environmental LLC

Km 0 2 4

Miles 0 1 2

N

Map B1. **Proposed Bathymetry Data and Underwater Imagery Collection Areas**
Upper Columbia River, WA

TABLE

Table B1. Velocity Profile and Underwater Imagery Point Locations

Transect No.	Station No.	Station ID	WA StatePlane N X (ft)	WA StatePlane N Y (ft)	UTM 11N X (m)	UTM 11N Y (m)	River Segment	Approximate River Mile
1	1	001-01	2406994	743988	453210	5427193	Upstream of DME	744.5
1	2	001-02	2407157	743878	453258	5427157	Upstream of DME	744.5
1	3	001-03	2407320	743768	453306	5427121	Upstream of DME	744.5
1	4	001-04	2407483	743658	453354	5427085	Upstream of DME	744.5
1	5	001-05	2407646	743548	453402	5427049	Upstream of DME	744.4
2	1	002-01	2406601	741115	453047	5426324	Upstream of DME	743.9
2	2	002-02	2406727	741102	453085	5426319	Upstream of DME	743.9
2	3	002-03	2406854	741090	453123	5426313	Upstream of DME	743.9
2	4	002-04	2406981	741077	453162	5426307	Upstream of DME	743.9
2	5	002-05	2407108	741065	453200	5426301	Upstream of DME	743.9
3	1	003-01	2406439	738536	452958	5425542	Upstream of DME	743.5
3	2	003-02	2406574	738493	452999	5425527	Upstream of DME	743.4
3	3	003-03	2406709	738451	453039	5425512	Upstream of DME	743.4
3	4	003-04	2406844	738409	453079	5425497	Upstream of DME	743.4
3	5	003-05	2406978	738367	453120	5425482	Upstream of DME	743.4
4	1	004-01	2406130	736194	452829	5424834	Upstream of DME	743.0
4	2	004-02	2406240	736129	452861	5424813	Upstream of DME	743.0
4	3	004-03	2406350	736063	452893	5424791	Upstream of DME	743.0
4	4	004-04	2406460	735998	452926	5424769	Upstream of DME	743.0
4	5	004-05	2406570	735933	452958	5424748	Upstream of DME	743.0
5	1	005-01	2404053	735061	452179	5424521	Upstream of DME	742.5
5	2	005-02	2404076	734945	452185	5424485	Upstream of DME	742.5
5	3	005-03	2404100	734829	452190	5424450	Upstream of DME	742.5
5	4	005-04	2404172	734470	452207	5424339	Upstream of DME	742.4
5	5	005-05	2404184	734408	452209	5424320	Upstream of DME	742.4
6	1	006-01	2401893	733587	451500	5424105	Upstream of DME	742.0
6	2	006-02	2401963	733483	451519	5424073	Upstream of DME	742.0
6	3	006-03	2402033	733379	451539	5424040	Upstream of DME	742.0
6	4	006-04	2402102	733276	451559	5424007	Upstream of DME	742.0
6	5	006-05	2402172	733172	451578	5423975	Upstream of DME	742.0
7	1	007-01	2399564	732316	450772	5423754	Upstream of DME	741.5
7	2	007-02	2399632	732220	450791	5423724	Upstream of DME	741.5
7	3	007-03	2399699	732124	450810	5423693	Upstream of DME	741.5
7	4	007-04	2399767	732028	450829	5423663	Upstream of DME	741.5
7	5	007-05	2399835	731932	450848	5423633	Upstream of DME	741.5
8	1	008-01	2397615	730444	450150	5423214	Upstream of DME	741.0
8	2	008-02	2397727	730360	450183	5423187	Upstream of DME	741.0
8	3	008-03	2397838	730276	450215	5423159	Upstream of DME	741.0
8	4	008-04	2397949	730191	450248	5423132	Upstream of DME	741.0
8	5	008-05	2398061	730107	450281	5423105	Upstream of DME	741.0
9	1	009-01	2395655	728986	449531	5422800	Upstream of DME	740.5
9	2	009-02	2395707	728879	449546	5422767	Upstream of DME	740.5
9	3	009-03	2395758	728771	449560	5422733	Upstream of DME	740.5
9	4	009-04	2395810	728663	449574	5422699	Upstream of DME	740.5
9	5	009-05	2395862	728555	449588	5422666	Upstream of DME	740.5
10	1	010-01	2393403	727704	448827	5422444	Upstream of DME	740.0
10	2	010-02	2393424	727607	448832	5422415	Upstream of DME	740.0
10	3	010-03	2393446	727511	448837	5422385	Upstream of DME	740.0
10	4	010-04	2393468	727415	448842	5422355	Upstream of DME	740.0
10	5	010-05	2393489	727319	448847	5422326	Upstream of DME	740.0
11	1	011-01	2390909	726774	448054	5422199	Upstream of DME	739.5
11	2	011-02	2390964	726674	448069	5422168	Upstream of DME	739.5
11	3	011-03	2391019	726574	448084	5422137	Upstream of DME	739.5
11	4	011-04	2391075	726474	448100	5422105	Upstream of DME	739.5
11	5	011-05	2391130	726374	448115	5422074	Upstream of DME	739.5
12	1	012-01	2389050	724698	447457	5421596	Upstream of DME	739.0
12	2	012-02	2389257	724645	447519	5421576	Upstream of DME	739.0
12	3	012-03	2389464	724591	447581	5421557	Upstream of DME	739.0
12	4	012-04	2389670	724538	447643	5421538	Upstream of DME	739.0
12	5	012-05	2389877	724485	447705	5421518	Upstream of DME	739.0
13	1	013-01	2389044	723868	447442	5421343	DME	738.8
13	2	013-02	2389087	723824	447454	5421329	DME	738.8
13	3	013-03	2389129	723780	447467	5421315	DME	738.8
13	4	013-04	2389172	723736	447479	5421301	DME	738.8
13	5	013-05	2389215	723692	447491	5421287	DME	738.8
13	6	013-06	2389258	723648	447504	5421273	DME	738.8
13	7	013-07	2389300	723604	447516	5421259	DME	738.8
13	8	013-08	2389343	723560	447528	5421245	DME	738.8
13	9	013-09	2389386	723516	447541	5421231	DME	738.8
13	10	013-10	2389429	723472	447553	5421217	DME	738.8
14	1	014-01	2388378	723077	447227	5421113	DME	738.6
14	2	014-02	2388420	723021	447239	5421095	DME	738.6
14	3	014-03	2388461	722965	447251	5421077	DME	738.6
14	4	014-04	2388503	722909	447263	5421060	DME	738.6
14	5	014-05	2388544	722853	447275	5421042	DME	738.6
14	6	014-06	2388586	722797	447286	5421024	DME	738.6
14	7	014-07	2388628	722742	447298	5421007	DME	738.6
14	8	014-08	2388669	722686	447310	5420989	DME	738.6
14	9	014-09	2388711	722630	447322	5420972	DME	738.6
14	10	014-10	2388753	722574	447334	5420954	DME	738.6
15	1	015-01	2387541	722453	446963	5420936	DME	738.5
15	2	015-02	2387616	722381	446985	5420912	DME	738.5
15	3	015-03	2387690	722308	447006	5420889	DME	738.5
15	4	015-04	2387765	722236	447028	5420866	DME	738.5
15	5	015-05	2387840	722163	447050	5420843	DME	738.5
15	6	015-06	2387915	722090	447072	5420819	DME	738.5
15	7	015-07	2387990	722018	447093	5420796	DME	738.5

Table B1. Velocity Profile and Underwater Imagery Point Locations

Transect No.	Station No.	Station ID	WA StatePlane N X (ft)	WA StatePlane N Y (ft)	UTM 11N X (m)	UTM 11N Y (m)	River Segment	Approximate River Mile
15	8	015-08	2388065	721945	447115	5420773	DME	738.5
15	9	015-09	2388140	721872	447137	5420750	DME	738.5
15	10	015-10	2388215	721800	447158	5420726	DME	738.5
16	1	016-01	2387397	722288	446917	5420888	DME	738.4
16	2	016-02	2387385	722077	446910	5420824	DME	738.4
16	3	016-03	2387373	721866	446903	5420760	DME	738.4
16	4	016-04	2387361	721655	446896	5420695	DME	738.3
16	5	016-05	2387349	721444	446889	5420631	DME	738.3
16	6	016-06	2387337	721233	446882	5420567	DME	738.3
16	7	016-07	2387325	721021	446876	5420503	DME	738.3
16	8	016-08	2387313	720810	446869	5420439	DME	738.3
16	9	016-09	2387301	720599	446862	5420375	DME	738.3
16	10	016-10	2387289	720388	446855	5420311	DME	738.3
17	1	017-01	2387199	722280	446856	5420888	DME	738.4
17	2	017-02	2387124	722100	446831	5420835	DME	738.3
17	3	017-03	2387050	721921	446806	5420781	DME	738.3
17	4	017-04	2386976	721741	446780	5420728	DME	738.3
17	5	017-05	2386901	721562	446755	5420674	DME	738.3
17	6	017-06	2386827	721382	446730	5420621	DME	738.2
17	7	017-07	2386753	721203	446704	5420567	DME	738.2
17	8	017-08	2386678	721023	446679	5420514	DME	738.2
17	9	017-09	2386604	720844	446654	5420460	DME	738.2
17	10	017-10	2386530	720664	446628	5420407	DME	738.2
18	1	018-01	2386560	722266	446662	5420893	DME	738.1
18	2	018-02	2386520	722150	446648	5420859	DME	738.1
18	3	018-03	2386482	722039	446635	5420826	DME	738.1
18	4	018-04	2386447	721936	446622	5420795	DME	738.1
18	5	018-05	2386419	721854	446613	5420770	DME	738.2
18	6	018-06	2386367	721703	446595	5420725	DME	738.2
18	7	018-07	2386332	721601	446582	5420694	DME	738.2
18	8	018-08	2386292	721484	446568	5420660	DME	738.2
18	9	018-09	2386251	721366	446554	5420624	DME	738.2
18	10	018-10	2386210	721245	446540	5420588	DME	738.2
19	1	019-01	2385915	723067	446478	5421147	DME	738.0
19	2	019-02	2385871	722933	446462	5421107	DME	738.0
19	3	019-03	2385718	722460	446409	5420965	DME	738.0
19	4	019-04	2385680	722342	446395	5420930	DME	738.0
19	5	019-05	2385616	722146	446373	5420871	DME	738.0
19	6	019-06	2385576	722021	446359	5420834	DME	738.0
19	7	019-07	2385530	721882	446343	5420792	DME	738.0
19	8	019-08	2385492	721763	446329	5420757	DME	738.0
20	1	020-01	2384952	723390	446190	5421260	DME	737.8
20	2	020-02	2384936	723245	446183	5421216	DME	737.8
20	3	020-03	2384914	723041	446173	5421154	DME	737.8
20	4	020-04	2384898	722894	446166	5421110	DME	737.8
20	5	020-05	2384885	722767	446160	5421072	DME	737.8
20	6	020-06	2384870	722627	446153	5421029	DME	737.8
20	7	020-07	2384855	722490	446146	5420988	DME	737.9
20	8	020-08	2384841	722360	446140	5420948	DME	737.9
20	9	020-09	2384827	722231	446134	5420909	DME	737.9
20	10	020-10	2384795	721939	446120	5420821	DME	737.9
21	1	021-01	2384239	723250	445970	5421228	Between DME and CB	737.7
21	2	021-02	2384242	723079	445969	5421176	Between DME and CB	737.7
21	3	021-03	2384245	722909	445967	5421124	Between DME and CB	737.7
21	4	021-04	2384248	722738	445965	5421072	Between DME and CB	737.7
21	5	021-05	2384251	722567	445964	5421020	Between DME and CB	737.8
22	1	022-01	2381769	722060	445201	5420904	Between DME and CB	737.3
22	2	022-02	2381901	721901	445239	5420853	Between DME and CB	737.3
22	3	022-03	2382033	721742	445276	5420803	Between DME and CB	737.3
22	4	022-04	2382165	721583	445314	5420753	Between DME and CB	737.3
22	5	022-05	2382298	721424	445352	5420702	Between DME and CB	737.3
23	1	023-01	2379990	721241	444647	5420681	Between DME and CB	736.9
23	2	023-02	2379985	721081	444643	5420633	Between DME and CB	736.9
23	3	023-03	2379979	720921	444639	5420584	Between DME and CB	736.9
23	4	023-04	2379973	720761	444634	5420536	Between DME and CB	736.9
23	5	023-05	2379967	720601	444630	5420487	Between DME and CB	736.9
24	1	024-01	2378510	719707	444173	5420237	Between DME and CB	736.3
24	2	024-02	2378640	719718	444213	5420239	Between DME and CB	736.3
24	3	024-03	2378771	719729	444253	5420240	Between DME and CB	736.3
24	4	024-04	2378902	719740	444293	5420241	Between DME and CB	736.3
24	5	024-05	2379032	719751	444333	5420243	Between DME and CB	736.3
25	1	025-01	2377126	717876	443724	5419701	Between DME and CB	735.7
25	2	025-02	2377251	717797	443761	5419675	Between DME and CB	735.7
25	3	025-03	2377377	717718	443798	5419649	Between DME and CB	735.7
25	4	025-04	2377503	717639	443835	5419623	Between DME and CB	735.7
25	5	025-05	2377629	717560	443873	5419597	Between DME and CB	735.7
26	1	026-01	2375388	716370	443173	5419269	Between DME and CB	735.1
26	2	026-02	2375451	716210	443189	5419220	Between DME and CB	735.1
26	3	026-03	2375515	716050	443206	5419170	Between DME and CB	735.1
26	4	026-04	2375578	715889	443223	5419120	Between DME and CB	735.1
26	5	026-05	2375642	715729	443240	5419070	Between DME and CB	735.1
27	1	027-01	2373268	715427	442513	5419014	Between DME and CB	734.7
27	2	027-02	2373322	715236	442527	5418956	Between DME and CB	734.7
27	3	027-03	2373375	715046	442540	5418897	Between DME and CB	734.6
27	4	027-04	2373429	714856	442553	5418838	Between DME and CB	734.6
27	5	027-05	2373482	714666	442567	5418780	Between DME and CB	734.6
28	1	028-01	2371033	713981	441811	5418608	Between DME and CB	734.1

Table B1. Velocity Profile and Underwater Imagery Point Locations

Transect No.	Station No.	Station ID	WA StatePlane N X (ft)	WA StatePlane N Y (ft)	UTM 11N X (m)	UTM 11N Y (m)	River Segment	Approximate River Mile
28	2	028-02	2371214	713858	441864	5418568	Between DME and CB	734.1
28	3	028-03	2371396	713736	441918	5418528	Between DME and CB	734.2
28	4	028-04	2371577	713613	441971	5418488	Between DME and CB	734.2
28	5	028-05	2371758	713491	442024	5418448	Between DME and CB	734.2
29	1	029-01	2369090	712432	441196	5418167	Between DME and CB	733.6
29	2	029-02	2369242	712296	441240	5418123	Between DME and CB	733.6
29	3	029-03	2369394	712160	441285	5418079	Between DME and CB	733.6
29	4	029-04	2369546	712024	441329	5418036	Between DME and CB	733.6
29	5	029-05	2369699	711889	441373	5417992	Between DME and CB	733.6
30	1	030-01	2367756	710217	440757	5417513	Between DME and CB	733.1
30	2	030-02	2368097	710179	440860	5417496	Between DME and CB	733.1
30	3	030-03	2368437	710142	440963	5417480	Between DME and CB	733.1
30	4	030-04	2369292	710048	441221	5417438	Between DME and CB	733.1
30	5	030-05	2369447	710031	441268	5417431	Between DME and CB	733.1
31	1	031-01	2366408	708094	440314	5416887	Between DME and CB	732.5
31	2	031-02	2366756	707940	440418	5416835	Between DME and CB	732.5
31	3	031-03	2367105	707785	440521	5416783	Between DME and CB	732.5
31	4	031-04	2367454	707631	440625	5416731	Between DME and CB	732.6
31	5	031-05	2367802	707477	440729	5416679	Between DME and CB	732.6
32	1	032-01	2364818	706688	439809	5416484	Between DME and CB	732.1
32	2	032-02	2364992	706476	439859	5416417	Between DME and CB	732.1
32	3	032-03	2365167	706263	439909	5416349	Between DME and CB	732.1
32	4	032-04	2365342	706051	439959	5416282	Between DME and CB	732.1
32	5	032-05	2365517	705838	440009	5416215	Between DME and CB	732.1
33	1	033-01	2363353	704856	439335	5415949	Between DME and CB	731.7
33	2	033-02	2363571	704693	439399	5415896	Between DME and CB	731.7
33	3	033-03	2363789	704531	439463	5415843	Between DME and CB	731.7
33	4	033-04	2364007	704368	439527	5415790	Between DME and CB	731.7
33	5	033-05	2364225	704206	439591	5415738	Between DME and CB	731.7
34	1	034-01	2361365	703200	438705	5415475	Between DME and CB	731.2
34	2	034-02	2361568	703012	438764	5415415	Between DME and CB	731.2
34	3	034-03	2361771	702824	438823	5415354	Between DME and CB	731.2
34	4	034-04	2361973	702635	438882	5415294	Between DME and CB	731.2
34	5	034-05	2362176	702447	438940	5415234	Between DME and CB	731.2
35	1	035-01	2360331	700700	438352	5414730	Between DME and CB	730.6
35	2	035-02	2360451	700604	438387	5414699	Between DME and CB	730.6
35	3	035-03	2360571	700508	438423	5414668	Between DME and CB	730.6
35	4	035-04	2360691	700412	438458	5414637	Between DME and CB	730.6
35	5	035-05	2360812	700317	438493	5414606	Between DME and CB	730.6
36	1	036-01	2358713	698774	437831	5414168	Between DME and CB	730.1
36	2	036-02	2358935	698572	437895	5414104	Between DME and CB	730.1
36	3	036-03	2359157	698370	437960	5414039	Between DME and CB	730.1
36	4	036-04	2359379	698168	438024	5413974	Between DME and CB	730.1
36	5	036-05	2359601	697966	438089	5413909	Between DME and CB	730.1
37	1	037-01	2356294	697790	437080	5413906	Between DME and CB	729.6
37	2	037-02	2356352	697707	437096	5413880	Between DME and CB	729.6
37	3	037-03	2356411	697624	437113	5413854	Between DME and CB	729.6
37	4	037-04	2356470	697541	437129	5413827	Between DME and CB	729.6
37	5	037-05	2356529	697458	437146	5413801	Between DME and CB	729.6
38	1	038-01	2353960	696877	436355	5413663	Between DME and CB	729.1
38	2	038-02	2353987	696818	436363	5413645	Between DME and CB	729.1
38	3	038-03	2354015	696760	436370	5413627	Between DME and CB	729.1
38	4	038-04	2354043	696701	436378	5413609	Between DME and CB	729.1
38	5	038-05	2354070	696643	436386	5413591	Between DME and CB	729.1
39	1	039-01	2351440	695965	435575	5413424	Between DME and CB	728.6
39	2	039-02	2351564	695910	435612	5413406	Between DME and CB	728.6
39	3	039-03	2351688	695855	435648	5413387	Between DME and CB	728.6
39	4	039-04	2351812	695800	435685	5413368	Between DME and CB	728.6
39	5	039-05	2351936	695744	435722	5413350	Between DME and CB	728.6
40	1	040-01	2350199	693847	435165	5412799	Between DME and CB	728.2
40	2	040-02	2350421	693670	435230	5412741	Between DME and CB	728.2
40	3	040-03	2350644	693493	435295	5412684	Between DME and CB	728.1
40	4	040-04	2350867	693317	435360	5412627	Between DME and CB	728.1
40	5	040-05	2351089	693140	435425	5412570	Between DME and CB	728.1
41	1	041-01	2348645	692229	434667	5412330	Between DME and CB	727.7
41	2	041-02	2348785	692002	434706	5412259	Between DME and CB	727.7
41	3	041-03	2348924	691775	434745	5412187	Between DME and CB	727.7
41	4	041-04	2349063	691548	434784	5412116	Between DME and CB	727.6
41	5	041-05	2349203	691321	434823	5412045	Between DME and CB	727.6
42	1	042-01	2346532	690955	434005	5411974	Between DME and CB	727.2
42	2	042-02	2346603	690809	434024	5411929	Between DME and CB	727.2
42	3	042-03	2346674	690664	434044	5411884	Between DME and CB	727.2
42	4	042-04	2346745	690518	434063	5411838	Between DME and CB	727.2
42	5	042-05	2346816	690373	434083	5411793	Between DME and CB	727.2
43	1	043-01	2344078	689405	433235	5411540	Between DME and CB	726.7
43	2	043-02	2344286	689295	433296	5411503	Between DME and CB	726.7
43	3	043-03	2344493	689185	433358	5411467	Between DME and CB	726.7
43	4	043-04	2344701	689075	433419	5411430	Between DME and CB	726.7
43	5	043-05	2344908	688964	433481	5411393	Between DME and CB	726.6
44	1	044-01	2342755	688269	432815	5411214	Between DME and CB	726.3
44	2	044-02	2342825	688027	432832	5411140	Between DME and CB	726.3
44	3	044-03	2342894	687786	432850	5411065	Between DME and CB	726.2
44	4	044-04	2342964	687544	432867	5410991	Between DME and CB	726.2
44	5	044-05	2343034	687303	432885	5410916	Between DME and CB	726.2
45	1	045-01	2340849	686072	432201	5410575	Between DME and CB	725.8
45	2	045-02	2341021	686001	432252	5410551	Between DME and CB	725.8
45	3	045-03	2341192	685931	432304	5410527	Between DME and CB	725.8

Table B1. Velocity Profile and Underwater Imagery Point Locations

Transect No.	Station No.	Station ID	WA StatePlane N X (ft)	WA StatePlane N Y (ft)	UTM 11N X (m)	UTM 11N Y (m)	River Segment	Approximate River Mile
45	4	045-04	2341364	685860	432355	5410503	Between DME and CB	725.8
45	5	045-05	2341536	685790	432406	5410478	Between DME and CB	725.8
46	1	046-01	2340420	683144	432026	5409690	Between DME and CB	725.3
46	2	046-02	2340648	683256	432097	5409721	Between DME and CB	725.3
46	3	046-03	2340877	683369	432169	5409752	Between DME and CB	725.3
46	4	046-04	2341105	683481	432240	5409783	Between DME and CB	725.4
46	5	046-05	2341334	683594	432311	5409813	Between DME and CB	725.4
47	1	047-01	2339969	680913	431855	5409018	Between DME and CB	724.9
47	2	047-02	2340294	680891	431954	5409007	Between DME and CB	724.9
47	3	047-03	2340619	680870	432052	5408995	Between DME and CB	724.9
47	4	047-04	2340944	680848	432151	5408984	Between DME and CB	724.9
47	5	047-05	2341269	680827	432249	5408972	Between DME and CB	724.9
48	1	048-01	2340408	679180	431962	5408484	CB	724.6
48	2	048-02	2340583	679048	432013	5408441	CB	724.5
48	3	048-03	2340715	678948	432052	5408409	CB	724.5
48	4	048-04	2340887	678818	432103	5408367	CB	724.5
48	5	048-05	2341145	678624	432178	5408304	CB	724.5
48	6	048-06	2341360	678461	432241	5408251	CB	724.4
48	7	048-07	2341524	678337	432289	5408211	CB	724.4
48	8	048-08	2341630	678257	432320	5408185	CB	724.4
48	9	048-09	2341684	678217	432336	5408172	CB	724.4
48	10	048-10	2341748	678169	432355	5408156	CB	724.4
49	1	049-01	2340080	678185	431847	5408186	CB	724.4
49	2	049-02	2340223	678085	431889	5408154	CB	724.3
49	3	049-03	2340367	677986	431932	5408121	CB	724.3
49	4	049-04	2340532	677870	431980	5408084	CB	724.3
49	5	049-05	2340653	677787	432016	5408057	CB	724.2
49	6	049-06	2340754	677717	432045	5408034	CB	724.2
49	7	049-07	2340940	677587	432100	5407992	CB	724.2
49	8	049-08	2341083	677488	432142	5407959	CB	724.2
49	9	049-09	2341239	677380	432188	5407924	CB	724.2
49	10	049-10	2341439	677241	432246	5407879	CB	724.2
50	1	050-01	2339828	677712	431763	5408046	CB	724.0
50	2	050-02	2339916	677570	431788	5408002	CB	724.0
50	3	050-03	2340004	677429	431813	5407958	CB	724.0
50	4	050-04	2340092	677287	431837	5407913	CB	724.0
50	5	050-05	2340158	677182	431856	5407880	CB	724.0
50	6	050-06	2340262	677015	431885	5407828	CB	724.0
50	7	050-07	2340346	676881	431908	5407786	CB	724.0
50	8	050-08	2340445	676721	431936	5407735	CB	724.0
50	9	050-09	2340533	676580	431961	5407691	CB	724.0
50	10	050-10	2340653	676388	431994	5407631	CB	724.0
51	1	051-01	2338948	677122	431487	5407880	CB	723.8
51	2	051-02	2339038	676978	431512	5407835	CB	723.8
51	3	051-03	2339157	676788	431545	5407775	CB	723.8
51	4	051-04	2339239	676658	431568	5407735	CB	723.8
51	5	051-05	2339321	676528	431591	5407694	CB	723.8
51	6	051-06	2339425	676363	431620	5407642	CB	723.8
51	7	051-07	2339485	676267	431637	5407612	CB	723.8
51	8	051-08	2339566	676137	431660	5407571	CB	723.8
51	9	051-09	2339648	676007	431683	5407530	CB	723.8
51	10	051-10	2339760	675828	431714	5407474	CB	723.8
52	1	052-01	2337947	677733	431191	5408082	CB	723.7
52	2	052-02	2338067	677378	431222	5407972	CB	723.7
52	3	052-03	2338145	677147	431243	5407900	CB	723.7
52	4	052-04	2338253	676829	431271	5407802	CB	723.7
52	5	052-05	2338321	676626	431288	5407739	CB	723.7
52	6	052-06	2338389	676424	431306	5407676	CB	723.7
52	7	052-07	2338457	676224	431324	5407614	CB	723.7
52	8	052-08	2338535	675993	431344	5407543	CB	723.7
52	9	052-09	2338613	675762	431364	5407471	CB	723.7
52	10	052-10	2338741	675384	431397	5407355	CB	723.7
53	1	053-01	2337122	676282	430918	5407652	CB	723.5
53	2	053-02	2337197	676140	430939	5407608	CB	723.5
53	3	053-03	2337303	675940	430968	5407546	CB	723.5
53	4	053-04	2337366	675819	430986	5407508	CB	723.5
53	5	053-05	2337422	675714	431001	5407475	CB	723.5
53	6	053-06	2337497	675572	431022	5407430	CB	723.5
53	7	053-07	2337572	675430	431042	5407386	CB	723.5
53	8	053-08	2337647	675288	431063	5407342	CB	723.5
53	9	053-09	2337722	675146	431084	5407297	CB	723.5
53	10	053-10	2337831	674939	431114	5407233	CB	723.5
54	1	054-01	2336566	675488	430737	5407419	CB	723.3
54	2	054-02	2336603	675396	430747	5407391	CB	723.3
54	3	054-03	2336638	675311	430756	5407364	CB	723.3
54	4	054-04	2336658	675261	430762	5407349	CB	723.3
54	5	054-05	2336681	675206	430768	5407332	CB	723.3
54	6	054-06	2336716	675117	430777	5407304	CB	723.3
54	7	054-07	2336785	674948	430795	5407251	CB	723.3
54	8	054-08	2336850	674787	430813	5407201	CB	723.3
54	9	054-09	2336957	674522	430841	5407119	CB	723.3
54	10	054-10	2337003	674408	430854	5407084	CB	723.3
55	1	055-01	2335871	674887	430516	5407247	CB	723.1
55	2	055-02	2335916	674845	430529	5407233	CB	723.1
55	3	055-03	2335981	674784	430548	5407214	CB	723.1
55	4	055-04	2336020	674747	430560	5407202	CB	723.1
55	5	055-05	2336073	674698	430575	5407186	CB	723.1

Table B1. Velocity Profile and Underwater Imagery Point Locations

Transect No.	Station No.	Station ID	WA StatePlane N X (ft)	WA StatePlane N Y (ft)	UTM 11N X (m)	UTM 11N Y (m)	River Segment	Approximate River Mile
55	6	055-06	2336137	674638	430594	5407167	CB	723.1
55	7	055-07	2336263	674520	430630	5407129	CB	723.2
55	8	055-08	2336439	674355	430681	5407076	CB	723.2
55	9	055-09	2336555	674247	430715	5407042	CB	723.2
55	10	055-10	2336639	674169	430739	5407017	CB	723.2
56	1	056-01	2335502	674697	430401	5407195	CB	723.0
56	2	056-02	2335542	674581	430412	5407159	CB	723.0
56	3	056-03	2335583	674466	430422	5407123	CB	723.0
56	4	056-04	2335623	674351	430433	5407087	CB	723.0
56	5	056-05	2335663	674235	430443	5407052	CB	723.0
56	6	056-06	2335703	674120	430454	5407016	CB	723.0
56	7	056-07	2335753	673978	430467	5406972	CB	723.0
56	8	056-08	2335811	673812	430482	5406921	CB	723.0
56	9	056-09	2335838	673736	430489	5406897	CB	723.0
56	10	056-10	2335865	673659	430496	5406873	CB	723.0
57	1	057-01	2334955	674644	430234	5407187	CB	722.9
57	2	057-02	2334972	674503	430237	5407144	CB	722.9
57	3	057-03	2334985	674397	430239	5407111	CB	722.9
57	4	057-04	2334999	674287	430242	5407078	CB	722.9
57	5	057-05	2335013	674173	430244	5407043	CB	722.9
57	6	057-06	2335033	674007	430248	5406992	CB	722.9
57	7	057-07	2335055	673830	430252	5406938	CB	722.9
57	8	057-08	2335071	673693	430255	5406896	CB	722.9
57	9	057-09	2335086	673572	430258	5406859	CB	722.9
57	10	057-10	2335102	673443	430260	5406819	CB	722.9
58	1	058-01	2334108	674766	429978	5407237	CB	722.8
58	2	058-02	2334075	674641	429966	5407199	CB	722.8
58	3	058-03	2334059	674579	429960	5407181	CB	722.8
58	4	058-04	2334034	674485	429951	5407153	CB	722.7
58	5	058-05	2334016	674416	429945	5407132	CB	722.7
58	6	058-06	2333985	674298	429934	5407096	CB	722.7
58	7	058-07	2333961	674204	429925	5407068	CB	722.7
58	8	058-08	2333936	674111	429916	5407040	CB	722.7
58	9	058-09	2333912	674017	429907	5407012	CB	722.7
58	10	058-10	2333887	673923	429898	5406984	CB	722.7
59	1	059-01	2333242	675365	429723	5407432	CB	722.6
59	2	059-02	2333209	675277	429712	5407406	CB	722.6
59	3	059-03	2333176	675189	429701	5407380	CB	722.6
59	4	059-04	2333132	675072	429686	5407345	CB	722.6
59	5	059-05	2333094	674969	429672	5407314	CB	722.6
59	6	059-06	2333064	674889	429662	5407290	CB	722.6
59	7	059-07	2333037	674817	429653	5407269	CB	722.6
59	8	059-08	2333001	674722	429641	5407240	CB	722.6
59	9	059-09	2332979	674661	429633	5407222	CB	722.6
59	10	059-10	2332946	674573	429621	5407196	CB	722.6
60	1	060-01	2332485	675424	429494	5407462	CB	722.4
60	2	060-02	2332478	675343	429491	5407437	CB	722.4
60	3	060-03	2332471	675263	429487	5407413	CB	722.4
60	4	060-04	2332464	675182	429484	5407388	CB	722.4
60	5	060-05	2332457	675101	429481	5407364	CB	722.4
60	6	060-06	2332450	675021	429477	5407340	CB	722.4
60	7	060-07	2332443	674940	429474	5407315	CB	722.4
60	8	060-08	2332436	674860	429471	5407291	CB	722.4
60	9	060-09	2332429	674779	429467	5407266	CB	722.4
60	10	060-10	2332422	674698	429464	5407242	CB	722.4
61	1	061-01	2330618	675851	428932	5407620	Between CB and UMF	722.1
61	2	061-02	2330595	675693	428923	5407572	Between CB and UMF	722.1
61	3	061-03	2330572	675534	428914	5407524	Between CB and UMF	722.1
61	4	061-04	2330549	675375	428904	5407476	Between CB and UMF	722.1
61	5	061-05	2330526	675217	428895	5407428	Between CB and UMF	722.1
62	1	062-01	2328024	676963	428160	5407998	Between CB and UMF	721.6
62	2	062-02	2328005	676596	428149	5407887	Between CB and UMF	721.6
62	3	062-03	2327986	676228	428137	5407775	Between CB and UMF	721.6
62	4	062-04	2327967	675861	428126	5407663	Between CB and UMF	721.6
62	5	062-05	2327948	675493	428115	5407552	Between CB and UMF	721.6
63	1	063-01	2325330	675838	427323	5407697	Between CB and UMF	721.1
63	2	063-02	2325418	675690	427348	5407650	Between CB and UMF	721.1
63	3	063-03	2325506	675542	427372	5407604	Between CB and UMF	721.1
63	4	063-04	2325594	675393	427397	5407557	Between CB and UMF	721.1
63	5	063-05	2325682	675245	427421	5407511	Between CB and UMF	721.1
64	1	064-01	2323335	674560	426697	5407338	Between CB and UMF	720.7
64	2	064-02	2323411	674378	426717	5407281	Between CB and UMF	720.7
64	3	064-03	2323487	674196	426737	5407225	Between CB and UMF	720.7
64	4	064-04	2323563	674014	426758	5407168	Between CB and UMF	720.7
64	5	064-05	2323639	673831	426778	5407112	Between CB and UMF	720.7
65	1	065-01	2320998	673010	425962	5406902	Between CB and UMF	720.2
65	2	065-02	2321133	672831	426000	5406845	Between CB and UMF	720.2
65	3	065-03	2321268	672652	426039	5406789	Between CB and UMF	720.2
65	4	065-04	2321404	672473	426077	5406732	Between CB and UMF	720.2
65	5	065-05	2321539	672294	426115	5406676	Between CB and UMF	720.2
66	1	066-01	2319795	670252	425554	5406081	Between CB and UMF	719.8
66	2	066-02	2319985	670241	425611	5406075	Between CB and UMF	719.7
66	3	066-03	2320175	670231	425669	5406069	Between CB and UMF	719.7
66	4	066-04	2320365	670220	425727	5406063	Between CB and UMF	719.7
66	5	066-05	2320555	670210	425784	5406056	Between CB and UMF	719.7
67	1	067-01	2320280	667614	425661	5405271	Between CB and UMF	719.3
67	2	067-02	2320542	667752	425743	5405309	Between CB and UMF	719.3

Table B1. Velocity Profile and Underwater Imagery Point Locations

Transect No.	Station No.	Station ID	WA StatePlane N X (ft)	WA StatePlane N Y (ft)	UTM 11N X (m)	UTM 11N Y (m)	River Segment	Approximate River Mile
67	3	067-03	2320804	667890	425825	5405347	Between CB and UMF	719.3
67	4	067-04	2321066	668029	425907	5405385	Between CB and UMF	719.3
67	5	067-05	2321327	668167	425988	5405423	Between CB and UMF	719.3
68	1	068-01	2320536	665561	425708	5404642	Between CB and UMF	718.8
68	2	068-02	2320939	665536	425830	5404628	Between CB and UMF	718.9
68	3	068-03	2321343	665511	425953	5404615	Between CB and UMF	718.9
68	4	068-04	2321746	665486	426075	5404601	Between CB and UMF	718.9
68	5	068-05	2322150	665461	426197	5404587	Between CB and UMF	718.9
69	1	069-01	2320833	662976	425759	5403851	Between CB and UMF	718.4
69	2	069-02	2321181	663010	425865	5403856	Between CB and UMF	718.4
69	3	069-03	2321529	663045	425972	5403861	Between CB and UMF	718.4
69	4	069-04	2321877	663080	426078	5403867	Between CB and UMF	718.4
69	5	069-05	2322225	663114	426185	5403872	Between CB and UMF	718.4
70	1	070-01	2320266	660878	425554	5403221	Between CB and UMF	718.0
70	2	070-02	2320402	660706	425593	5403167	Between CB and UMF	717.9
70	3	070-03	2320538	660535	425632	5403113	Between CB and UMF	717.9
70	4	070-04	2320675	660363	425671	5403058	Between CB and UMF	717.9
70	5	070-05	2320811	660192	425710	5403004	Between CB and UMF	717.9
71	1	071-01	2318304	659435	424935	5402812	Between CB and UMF	717.4
71	2	071-02	2318388	659254	424958	5402756	Between CB and UMF	717.4
71	3	071-03	2318473	659074	424981	5402699	Between CB and UMF	717.4
71	4	071-04	2318557	658893	425004	5402643	Between CB and UMF	717.4
71	5	071-05	2318641	658712	425027	5402587	Between CB and UMF	717.4
72	1	072-01	2316119	658122	424250	5402446	Between CB and UMF	717.0
72	2	072-02	2316235	657954	424283	5402393	Between CB and UMF	717.0
72	3	072-03	2316351	657786	424316	5402340	Between CB and UMF	717.0
72	4	072-04	2316468	657618	424349	5402287	Between CB and UMF	717.0
72	5	072-05	2316584	657450	424382	5402234	Between CB and UMF	717.0
73	1	073-01	2313514	656870	423439	5402104	Between CB and UMF	716.5
73	2	073-02	2313805	656663	423524	5402037	Between CB and UMF	716.5
73	3	073-03	2314096	656456	423610	5401969	Between CB and UMF	716.5
73	4	073-04	2314388	656249	423695	5401902	Between CB and UMF	716.5
73	5	073-05	2314679	656043	423781	5401835	Between CB and UMF	716.6
74	1	074-01	2311997	654766	422945	5401487	Between CB and UMF	716.0
74	2	074-02	2312352	654670	423052	5401452	Between CB and UMF	716.1
74	3	074-03	2312707	654574	423158	5401418	Between CB and UMF	716.1
74	4	074-04	2313061	654478	423265	5401383	Between CB and UMF	716.1
74	5	074-05	2313416	654382	423371	5401348	Between CB and UMF	716.2
75	1	075-01	2310536	653199	422477	5401032	Between CB and UMF	715.7
75	2	075-02	2310714	653064	422529	5400989	Between CB and UMF	715.7
75	3	075-03	2310892	652929	422581	5400945	Between CB and UMF	715.7
75	4	075-04	2311070	652793	422633	5400901	Between CB and UMF	715.6
75	5	075-05	2311248	652658	422685	5400857	Between CB and UMF	715.6
76	1	076-01	2309132	651036	422016	5400395	Between CB and UMF	715.2
76	2	076-02	2309477	650863	422119	5400337	Between CB and UMF	715.2
76	3	076-03	2309822	650689	422221	5400279	Between CB and UMF	715.2
76	4	076-04	2310166	650516	422323	5400221	Between CB and UMF	715.2
76	5	076-05	2310511	650342	422426	5400163	Between CB and UMF	715.2
77	1	077-01	2309115	648043	421966	5399485	Between CB and UMF	714.8
77	2	077-02	2309443	648145	422067	5399511	Between CB and UMF	714.8
77	3	077-03	2309771	648248	422168	5399537	Between CB and UMF	714.8
77	4	077-04	2310099	648351	422270	5399564	Between CB and UMF	714.8
77	5	077-05	2310427	648454	422371	5399590	Between CB and UMF	714.8
78	1	078-01	2309628	645693	422086	5398762	Between CB and UMF	714.4
78	2	078-02	2309913	645828	422175	5398799	Between CB and UMF	714.4
78	3	078-03	2310198	645964	422264	5398836	Between CB and UMF	714.4
78	4	078-04	2310483	646099	422353	5398873	Between CB and UMF	714.4
78	5	078-05	2310768	646235	422441	5398909	Between CB and UMF	714.4
79	1	079-01	2310649	643297	422360	5398017	Between CB and UMF	713.9
79	2	079-02	2310977	643455	422463	5398060	Between CB and UMF	713.9
79	3	079-03	2311306	643614	422565	5398104	Between CB and UMF	713.9
79	4	079-04	2311635	643772	422668	5398147	Between CB and UMF	713.9
79	5	079-05	2311963	643930	422770	5398190	Between CB and UMF	713.9
80	1	080-01	2312351	641244	422847	5397366	Between CB and UMF	713.4
80	2	080-02	2312552	641442	422911	5397424	Between CB and UMF	713.4
80	3	080-03	2312752	641640	422975	5397481	Between CB and UMF	713.4
80	4	080-04	2312952	641839	423039	5397538	Between CB and UMF	713.5
80	5	080-05	2313152	642037	423103	5397596	Between CB and UMF	713.5
81	1	081-01	2313415	639122	423139	5396704	Between CB and UMF	713.0
81	2	081-02	2313588	639254	423193	5396742	Between CB and UMF	713.0
81	3	081-03	2313762	639387	423248	5396780	Between CB and UMF	713.0
81	4	081-04	2313935	639520	423303	5396818	Between CB and UMF	713.0
81	5	081-05	2314108	639653	423358	5396856	Between CB and UMF	713.0
82	1	082-01	2314613	637075	423472	5396063	Between CB and UMF	712.6
82	2	082-02	2314832	637127	423540	5396076	Between CB and UMF	712.5
82	3	082-03	2315052	637179	423607	5396088	Between CB and UMF	712.5
82	4	082-04	2315271	637231	423675	5396101	Between CB and UMF	712.5
82	5	082-05	2315490	637283	423742	5396113	Between CB and UMF	712.5
83	1	083-01	2315858	635207	423823	5395476	Between CB and UMF	712.1
83	2	083-02	2316325	635215	423965	5395471	Between CB and UMF	712.1
83	3	083-03	2316792	635223	424107	5395467	Between CB and UMF	712.1
83	4	083-04	2317260	635230	424249	5395462	Between CB and UMF	712.0
83	5	083-05	2317727	635238	424392	5395457	Between CB and UMF	712.0
84	1	084-01	2315873	632813	423791	5394747	Between CB and UMF	711.7
84	2	084-02	2316548	632847	423997	5394747	Between CB and UMF	711.7
84	3	084-03	2317223	632881	424202	5394747	Between CB and UMF	711.7
84	4	084-04	2317898	632915	424408	5394747	Between CB and UMF	711.6

Table B1. Velocity Profile and Underwater Imagery Point Locations

Transect No.	Station No.	Station ID	WA StatePlane N X (ft)	WA StatePlane N Y (ft)	UTM 11N X (m)	UTM 11N Y (m)	River Segment	Approximate River Mile
84	5	084-05	2318572	632948	424614	5394747	Between CB and UMF	711.6
85	1	085-01	2316458	631540	423949	5394351	UMF	711.5
85	2	085-02	2316758	631631	424042	5394374	UMF	711.5
85	3	085-03	2317170	631755	424169	5394405	UMF	711.5
85	4	085-04	2317483	631849	424266	5394429	UMF	711.5
85	5	085-05	2317660	631902	424321	5394443	UMF	711.5
85	6	085-06	2317900	631974	424395	5394461	UMF	711.5
85	7	085-07	2318261	632083	424506	5394489	UMF	711.5
85	8	085-08	2318562	632173	424599	5394512	UMF	711.4
85	9	085-09	2318863	632264	424692	5394535	UMF	711.4
85	10	085-10	2319163	632354	424785	5394557	UMF	711.4
86	1	086-01	2316568	630654	423969	5394080	UMF	711.3
86	2	086-02	2316928	630742	424080	5394101	UMF	711.3
86	3	086-03	2317232	630816	424174	5394119	UMF	711.3
86	4	086-04	2317876	630974	424372	5394157	UMF	711.3
86	5	086-05	2318006	631006	424412	5394165	UMF	711.3
86	6	086-06	2318157	631043	424459	5394174	UMF	711.3
86	7	086-07	2318725	631182	424634	5394207	UMF	711.3
86	8	086-08	2319085	631270	424745	5394229	UMF	711.3
86	9	086-09	2319444	631358	424855	5394250	UMF	711.3
86	10	086-10	2319804	631446	424966	5394271	UMF	711.2
87	1	087-01	2317299	629956	424181	5393856	UMF	711.1
87	2	087-02	2317732	629953	424313	5393849	UMF	711.1
87	3	087-03	2318114	629951	424429	5393842	UMF	711.1
87	4	087-04	2318350	629949	424501	5393838	UMF	711.1
87	5	087-05	2318601	629948	424577	5393834	UMF	711.1
87	6	087-06	2319324	629943	424797	5393821	UMF	711.0
87	7	087-07	2320103	629938	425034	5393808	UMF	711.0
87	8	087-08	2319884	629940	424968	5393812	UMF	711.0
87	9	087-09	2320267	629937	425084	5393805	UMF	711.0
87	10	087-10	2320651	629935	425201	5393799	UMF	711.0
88	1	088-01	2317015	628919	424079	5393545	UMF	711.0
88	2	088-02	2317308	628930	424168	5393544	UMF	710.9
88	3	088-03	2317797	628947	424317	5393541	UMF	710.9
88	4	088-04	2318371	628968	424492	5393539	UMF	710.9
88	5	088-05	2318533	628973	424542	5393538	UMF	710.9
88	6	088-06	2318753	628981	424609	5393537	UMF	710.9
88	7	088-07	2319360	629003	424794	5393535	UMF	710.9
88	8	088-08	2319750	629017	424913	5393533	UMF	710.8
88	9	088-09	2320141	629031	425032	5393531	UMF	710.8
88	10	088-10	2320532	629044	425151	5393529	UMF	710.8
89	1	089-01	2317062	628291	424084	5393353	UMF	710.8
89	2	089-02	2317444	628362	424201	5393369	UMF	710.8
89	3	089-03	2317956	628458	424358	5393390	UMF	710.8
89	4	089-04	2318491	628558	424523	5393413	UMF	710.8
89	5	089-05	2318678	628593	424580	5393420	UMF	710.8
89	6	089-06	2318811	628618	424621	5393426	UMF	710.8
89	7	089-07	2319315	628713	424776	5393447	UMF	710.8
89	8	089-08	2319719	628788	424900	5393464	UMF	710.8
89	9	089-09	2320122	628864	425024	5393481	UMF	710.8
89	10	089-10	2320525	628939	425148	5393498	UMF	710.8
90	1	090-01	2316861	627744	424014	5393190	UMF	710.7
90	2	090-02	2317285	627714	424143	5393174	UMF	710.7
90	3	090-03	2317710	627684	424272	5393158	UMF	710.7
90	4	090-04	2318321	627640	424457	5393136	UMF	710.7
90	5	090-05	2318832	627604	424612	5393117	UMF	710.6
90	6	090-06	2318983	627593	424658	5393111	UMF	710.6
90	7	090-07	2319099	627585	424693	5393107	UMF	710.6
90	8	090-08	2319832	627533	424915	5393080	UMF	710.6
90	9	090-09	2320256	627503	425044	5393065	UMF	710.6
90	10	090-10	2320854	627460	425225	5393043	UMF	710.5
91	1	091-01	2316816	627169	423992	5393015	UMF	710.6
91	2	091-02	2317578	626972	424221	5392944	UMF	710.6
91	3	091-03	2317960	626874	424335	5392908	UMF	710.6
91	4	091-04	2318341	626776	424450	5392872	UMF	710.5
91	5	091-05	2318654	626695	424544	5392843	UMF	710.5
91	6	091-06	2319046	626594	424662	5392806	UMF	710.5
91	7	091-07	2319177	626560	424701	5392794	UMF	710.4
91	8	091-08	2319457	626488	424785	5392768	UMF	710.4
91	9	091-09	2319867	626382	424908	5392730	UMF	710.4
91	10	091-10	2320248	626284	425023	5392694	UMF	710.4
92	1	092-01	2316340	626346	423834	5392772	UMF	709.9
92	7	092-02	2319005	626067	424641	5392646	UMF	710.4
92	2	092-03	2316955	626281	424021	5392743	UMF	710.0
92	3	092-04	2317651	626209	424231	5392710	UMF	710.2
92	4	092-05	2317958	626176	424324	5392696	UMF	710.2
92	5	092-06	2318492	626120	424486	5392671	UMF	710.4
92	6	092-07	2318820	626086	424585	5392655	UMF	710.4
92	8	092-08	2319171	626049	424692	5392639	UMF	710.4
92	9	092-09	2319424	626023	424768	5392627	UMF	710.3
92	10	092-10	2319980	625964	424936	5392601	UMF	710.3
93	1	093-01	2316712	626884	423956	5392930	UMF	710.6
93	2	093-02	2317112	626503	424072	5392808	UMF	710.5
93	3	093-03	2317512	626123	424188	5392686	UMF	710.1
93	4	093-04	2317879	625774	424294	5392575	UMF	710.1
93	5	093-05	2318113	625552	424362	5392503	UMF	710.1
93	6	093-06	2318346	625330	424429	5392432	UMF	710.1

Table B1. Velocity Profile and Underwater Imagery Point Locations

Transect No.	Station No.	Station ID	WA StatePlane N X (ft)	WA StatePlane N Y (ft)	UTM 11N X (m)	UTM 11N Y (m)	River Segment	Approximate River Mile
93	7	093-07	2318464	625218	424464	5392396	UMF	710.1
93	8	093-08	2318579	625108	424497	5392361	UMF	710.1
93	9	093-09	2318693	625000	424530	5392327	UMF	710.1
93	10	093-10	2318813	624886	424565	5392290	UMF	710.2
94	1	094-01	2316906	624883	423985	5392318	UMF	709.9
94	2	094-02	2317092	624790	424040	5392287	UMF	709.9
94	3	094-03	2317233	624719	424081	5392263	UMF	709.9
94	4	094-04	2317360	624655	424119	5392242	UMF	709.9
94	5	094-05	2317464	624602	424150	5392224	UMF	709.9
94	6	094-06	2317596	624536	424189	5392202	UMF	709.9
94	7	094-07	2317706	624481	424222	5392184	UMF	710.0
94	8	094-08	2317867	624400	424270	5392157	UMF	710.0
94	9	094-09	2318042	624311	424322	5392127	UMF	710.0
94	10	094-10	2318306	624179	424400	5392083	UMF	710.0
95	1	095-01	2316442	624454	423837	5392195	UMF	709.7
95	2	095-02	2316424	624338	423829	5392160	UMF	709.7
95	3	095-03	2316402	624201	423821	5392118	UMF	709.7
95	4	095-04	2316378	624047	423811	5392072	UMF	709.7
95	5	095-05	2316359	623930	423804	5392037	UMF	709.7
95	6	095-06	2316332	623753	423792	5391983	UMF	709.7
95	7	095-07	2316299	623543	423779	5391920	UMF	709.6
95	8	095-08	2316272	623372	423768	5391868	UMF	709.6
95	9	095-09	2316239	623164	423755	5391805	UMF	709.6
95	10	095-10	2316205	622951	423742	5391741	UMF	709.6
96	1	096-01	2315325	623943	423489	5392056	UMF	709.5
96	2	096-02	2315471	623891	423533	5392038	UMF	709.5
96	3	096-03	2315613	623840	423575	5392021	UMF	709.5
96	4	096-04	2315796	623775	423630	5391998	UMF	709.6
96	5	096-05	2315983	623709	423686	5391975	UMF	709.6
96	6	096-06	2316125	623659	423728	5391958	UMF	709.6
96	7	096-07	2316333	623585	423790	5391932	UMF	709.7
96	8	096-08	2316421	623554	423817	5391921	UMF	709.7
96	9	096-09	2316560	623505	423858	5391904	UMF	709.7
96	10	096-10	2316847	623403	423944	5391869	UMF	709.7
97	1	097-01	2314661	623752	423284	5392008	UMF	709.4
97	2	097-02	2314712	623610	423297	5391964	UMF	709.4
97	3	097-03	2314762	623469	423310	5391920	UMF	709.4
97	4	097-04	2314813	623327	423324	5391876	UMF	709.4
97	5	097-05	2314863	623185	423337	5391833	UMF	709.4
97	6	097-06	2314914	623044	423350	5391789	UMF	709.4
97	7	097-07	2314965	622902	423363	5391745	UMF	709.4
97	8	097-08	2315015	622760	423377	5391701	UMF	709.4
97	9	097-09	2315066	622619	423390	5391657	UMF	709.4
97	10	097-10	2315116	622477	423403	5391613	UMF	709.4
98	1	098-01	2313604	623463	422958	5391936	UMF	709.2
98	2	098-02	2313666	623322	422975	5391892	UMF	709.2
98	3	098-03	2313728	623181	422992	5391849	UMF	709.2
98	4	098-04	2313791	623041	423008	5391805	UMF	709.2
98	5	098-05	2313853	622900	423025	5391761	UMF	709.2
98	6	098-06	2313916	622759	423042	5391717	UMF	709.2
98	7	098-07	2313978	622619	423059	5391674	UMF	709.2
98	8	098-08	2314040	622478	423076	5391630	UMF	709.2
98	9	098-09	2314103	622337	423093	5391586	UMF	709.2
98	10	098-10	2314165	622197	423109	5391542	UMF	709.2
99	1	099-01	2312699	623243	422679	5391883	UMF	709.0
99	2	099-02	2312732	623085	422687	5391835	UMF	709.0
99	3	099-03	2312765	622928	422695	5391786	UMF	709.0
99	4	099-04	2312798	622770	422702	5391738	UMF	709.0
99	5	099-05	2312832	622612	422710	5391689	UMF	709.0
99	6	099-06	2312865	622454	422718	5391640	UMF	709.0
99	7	099-07	2312898	622296	422725	5391592	UMF	709.0
99	8	099-08	2312931	622139	422733	5391543	UMF	709.0
99	9	099-09	2312964	621981	422741	5391495	UMF	709.0
99	10	099-10	2312997	621823	422748	5391446	UMF	709.0
100	1	100-01	2311954	623169	422451	5391872	UMF	708.9
100	2	100-02	2311989	623003	422460	5391821	UMF	708.9
100	3	100-03	2312025	622837	422468	5391770	UMF	708.9
100	4	100-04	2312060	622671	422476	5391719	UMF	708.9
100	5	100-05	2312096	622505	422484	5391668	UMF	708.9
100	6	100-06	2312131	622338	422493	5391616	UMF	708.8
100	7	100-07	2312167	622172	422501	5391565	UMF	708.8
100	8	100-08	2312202	622006	422509	5391514	UMF	708.8
100	9	100-09	2312238	621840	422518	5391463	UMF	708.8
100	10	100-10	2312273	621674	422526	5391412	UMF	708.8

Notes:
ADCP – Acoustic Doppler Current Profiler
CB – China Bend
DME – Deadman's Eddy
UMF – Upstream of Marcus Flats
UTM – Universal Transvers Mercator

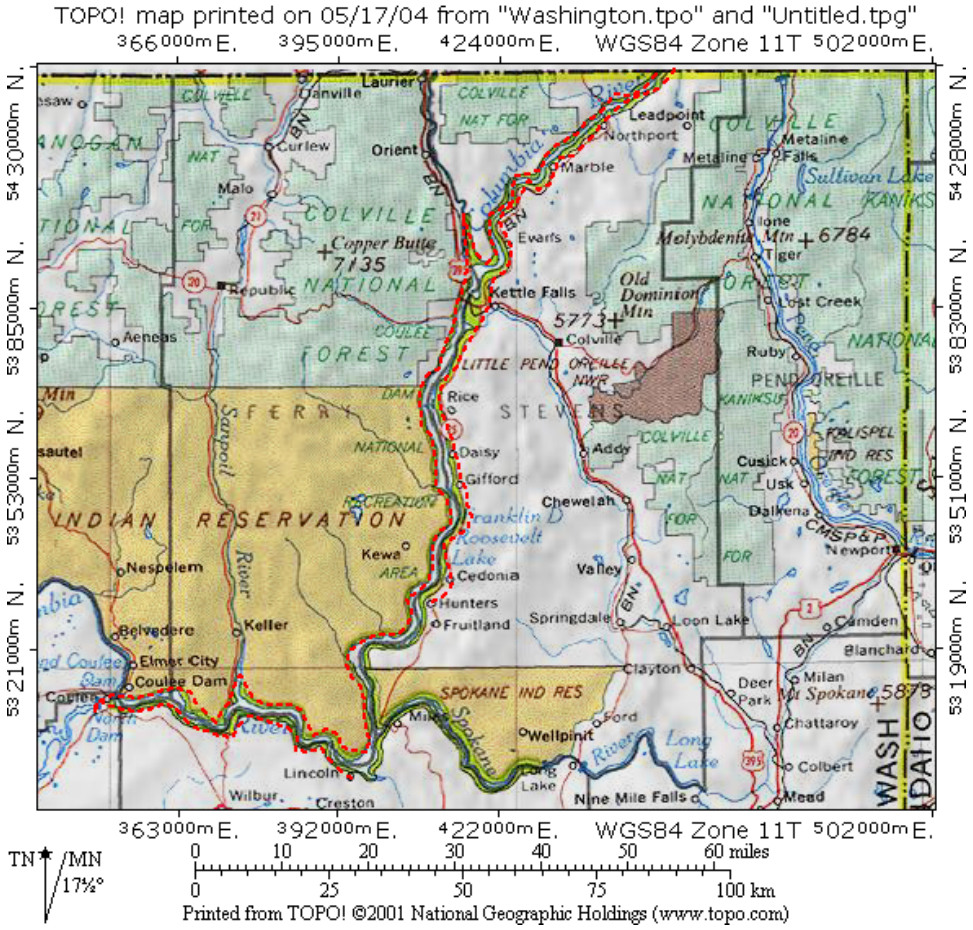
ATTACHMENT B1

PROTOCOLS FOR INADVERTENT DISCOVERIES

NAGPRA Inadvertent Discoveries or Intentional Excavations: Confederated Tribes of the Colville Reservation, National Park Service, and the Bureau of Reclamation

Lake Roosevelt Protocols for Native American Graves Protection and Repatriation Act (NAGPRA) Inadvertent Discoveries or Intentional Excavations: Confederated Tribes of the Colville Reservation, National Park Service, and the Bureau of Reclamation

This protocol is intended to cover NAGPRA items exposed by inadvertent discoveries or intentional excavations within the boundaries of lands managed by the National Park Service (NPS)/Lake Roosevelt National Recreation Area. The term "NAGPRA items" in this document refers to human NAGPRA items, associated funerary objects, and objects of cultural patrimony as they are defined in 25 USC 3001. This document does not address inadvertent discoveries on lands within reservation boundaries or trust land outside of the reservation boundaries of the Confederated Tribes of the Colville Reservation (CCT). Funding of actions is not covered under this protocol.



Map of Lake Roosevelt National Recreation Area

This protocol covers those areas highlighted in red within the recreation area, which is the yellow highlighted portion of the Lake Roosevelt shoreline.

1. If NAGPRA items that are potentially human are encountered, any activity in the vicinity of the discovery shall cease and all reasonable efforts shall be made to protect the NAGPRA items and all appropriate effort shall be made to determine if the NAGPRA items are human. The activity shall resume only when clearance to proceed is received by the CCT Tribal Historic Preservation Officer and the National Park Service's designated official.

2. If the NAGPRA items are determined to be human, the burial or location shall not be disturbed in any way. Any discovered human NAGPRA items and associated artifacts will be treated in a respectful manner.

3. In cases where a potential crime scene exists, *personnel except those necessary to protect the location will leave the immediate vicinity in order to prevent unintentional destruction of crime scene information.* A National Park Service law enforcement officer will be immediately notified.

4. The Colville Tribal Historic Preservation Officer and the archaeologists working for the Colville Tribes and the Park Service (numbers listed below) will also be contacted immediately after law enforcement. For NAGPRA discoveries associated with the Lake Roosevelt shoreline, the Reclamation archaeologist must also be contacted. Live phone contact is required; backup staff are identified if the primary contacts are unavailable. Phone contact will be followed up by written confirmation, e-mail is acceptable. E-mail should not include detailed (site specific information) for security reasons.

5. A professional archaeologist will assist law enforcement in determining if the NAGPRA items are archaeological in origin. If the crime scene is ARPA-related (i.e., there is evidence for intentional disturbance or looting of archaeological materials), an archaeologist shall assist law enforcement as needed in the collection of archeological data to support the ARPA case.

6. Guy Moura, CCT THPO and Program Manager of the CCT History/Archaeology Program is the primary contact for the CCT. Mr. Moura's phone number at the Program is (509) 634-2695 and email is guy.moura@colvilletribes.com. After hours, Mr. Moura can be contacted at (509) 631-1705 (cell). If Mr. Moura cannot be reached, then Brenda Convington, Senior Archaeologist is the alternate contact at (509) 634-2699 (office) or (509) 634-1737 (cell) and at brenda.covington@colvilletribes.com. In the event that neither Mr. Moura or Ms. Covington cannot be contacted, then Arrow Coyote, CCT Senior Archaeologist will be contacted at (509) 634-2736 (office) or (509) 634-1280 (cell) and at arrow.coyote@colvilletribes.com. Ms. Covington or Ms. Coyote shall participate in the NAGPRA consultation process on Mr. Moura's behalf until his return. Jackie Cook, Repatriation Specialist, will also participate in the NAGPRA consultation process. Ms. Cook's contact information is (509) 634-2635 (office) or (509) 631-1176 (cell) and jackie.cook@colvilletribes.com. The CCT shall maintain a presence at the

location of the discovery as needed until all contacts have been made and appropriate treatment of the NAGPRA items has been conducted.

Keith Holliday, NPS Project Manager for the Lake Roosevelt National Recreation Area, is the primary contact for the NPS. Mr. Holliday's phone number is (509) 754-7858, FAX is (509) 738-3108, and e-mail address is keith_holliday@nps.gov.

Justin Eichelberger, NPS Archaeologist, is also a contact person for the NPS. Mr. Eichelberger's phone number is (509) 754-7860 or (509) 631-4191 (cell), and e-mail address is Justin_eichelberger@nps.gov.

Derek Beery, Power Office Archaeologist, is Reclamation's contact. His phone numbers are (509) 633-9233 [desk] and (509) 237-4477 [cell phone], his FAX number is (509) 633-9138, and e-mail address is dbeery@usbr.gov. If Derek Beery is not available, contact Sean Hess, Regional Archaeologist, at (208) 378-5316, FAX (208) 378-5305, or at e-mail address shess@usbr.gov.

7. As soon as the NAGPRA items have been determined to be human, then all effort shall be made in the field to determine whether human NAGPRA items are Native American. If yes, skip steps 8 and 9 below and proceed to step 10.

8. If the NAGPRA items are determined not to be Native American, then Washington State laws apply and shall be followed (Title 68, Chapter 68.50 RCW HUMAN NAGPRA ITEMS).

9. If the NAGPRA items' affiliation cannot be determined in the field, further non-destructive analysis of human NAGPRA items and/or associated cultural materials may be required. The CCT, NPS, and Reclamation shall coordinate regarding the types of non-destructive analysis to be conducted.

10. Provenience information will be collected as specified by the written plan of action. The Reclamation contract language for burials recovered in the shoreline of the National Recreation Area will also apply and should agree with the written plan of action and these protocols.

11. Recording of provenience may include any or all of the following: documenting the location of the burial or scattered NAGPRA items and general site conditions on a site form or on an addendum to an existing form; describing the surface visible NAGPRA items to the degree that can be accomplished without causing additional disturbance to the grave; documenting the location of the burial on a USGS 7.5' topographic sheet and with a GPS unit.

12. If it is possible to rebury or cap the NAGPRA items in place, then that decision shall be documented in the written plan of action (see below).

13. If NAGPRA items must be excavated or removed, procedures will be specified by the written plan of action. The Reclamation contract language for burials recovered in the shoreline of the NRA will also apply and should agree with the written plan of action and these protocols. If NAGPRA items are to be excavated or removed by personnel other than those employed by the CCT or the U.S. government, an ARPA permit will be required from the NPS.

14. Excavation or removal procedures may include any or all of the following: NAGPRA items will be removed using standard professional archaeological practices in a culturally sensitive manner at the direction of a CCT History/Archaeology Department representative. Such practices may include collection of horizontal provenience data referenced to a site datum point; if excavation is required, vertical provenience data shall be tracked through the use of controlled 10-cm levels within a standard grid unit, screening of all excavated fill through 1/8-inch screen mesh, and photographic and to-scale plan map documentation of excavated features. All recovered items shall be listed in the field during collection to minimize handling after recovery.

15. Inadvertent discoveries that result from activities requiring easements or other non-ARPA permits (such as access, construction, etc.) shall be dealt with by the permitting agencies, which may be Reclamation or the NPS. This protocol document will be included with documents issued to permittees.

16. The written plans of action for individual discoveries will detail exact procedures for further implementation of NAGPRA. A sample written plan of action is attached.

Template NAGPRA Plan of Action for Lake Roosevelt

This plan of action shall comply with the requirements of the Native American Graves Protection and Repatriation Act (NAGPRA) (25 USC 3001 et seq.), its implementing regulations (43 CFR Part 10) and the Archaeological Resources Protection Act (ARPA) (16 USC 470 et seq.) with its implementing regulations (43 CFR Part 7).

1. The kinds of objects to be considered as cultural items as defined in Sec. 10.2 (b):
   - ✓ Human remains
   - ✓ Associated funerary objects
   - ✓ Unassociated funerary objects
   - ✓ Objects of cultural patrimony
   - ✓ Sacred objects

   These objects are cultural objects as defined under NAGPRA 43CFR Part 10.2 (d)

2. The specific information used to determine custody pursuant to Sec. 10.6:
   - ✓ Traditional association (this is where tribe's area of interest is cited with reference to Lake Roosevelt)
   - ✓ Cultural affiliation
   - ✓ Evidence: Geographical, archaeological, linguistic, folklore, oral tradition, historical

3. The planned treatment, care, and handling of human remains and other objects as defined in NAGPRA

4. The planned archaeological recording of the human remains and other objects as defined in NAGPRA

5. The kinds of analysis planned for each kind of object

6. Any steps to be followed to contact Indian tribe officials at the time of intentional excavation or inadvertent discovery of specific human remains and other objects as defined in NAGPRA

7. The kind of traditional treatment, if any, to be afforded the human remains and other objects as defined in NAGPRA by members of the Indian tribe

8. The nature of reports to be prepared

9. The planned disposition of human remains, and other objects as defined in NAGPRA.

NAGPRA Inadvertent Discoveries and Intentional Excavations on the Lake Roosevelt National Recreation Area: Spokane Tribe of Indians, National Park Service, and Bureau of Reclamation

Protocols for NAGPRA Inadvertent Discoveries and Intentional Excavations on the Lake Roosevelt National Recreation Area: Spokane Tribe of Indians, National Park Service, and Bureau of Reclamation

This protocol is intended to cover NAGPRA items exposed by inadvertent discoveries and intentional excavations within the boundaries of lands managed by the National Park Service/Lake Roosevelt National Recreation Area (Figure 1), excluding inadvertent discoveries on lands within reservation boundaries of the Spokane Tribe of Indians (STI) (Figure 2). For procedures within STI reservation boundaries (as shown in Figure 2 along the left bank [east side of the Columbia River], from the mouth of the Spokane River and north to the Spokane Reservation boundary) please see the Spokane Tribe's *Procedure for the Inadvertent Disturbance or Discovery of Spokane Human Remains and Cultural Resources*. Funding of actions is not covered under this protocol.

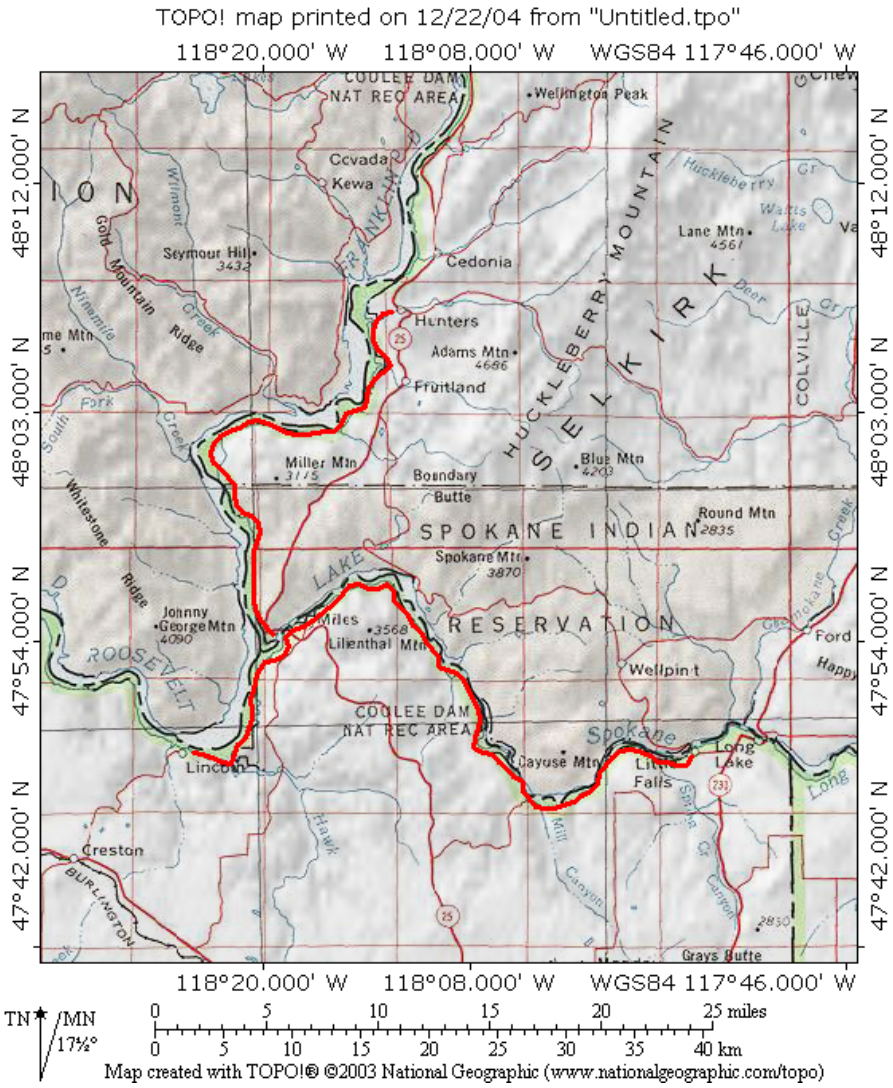


Figure 1. Lake Roosevelt National Recreation Area Shoreline Areas Managed by the National Park Service and Bureau of Reclamation

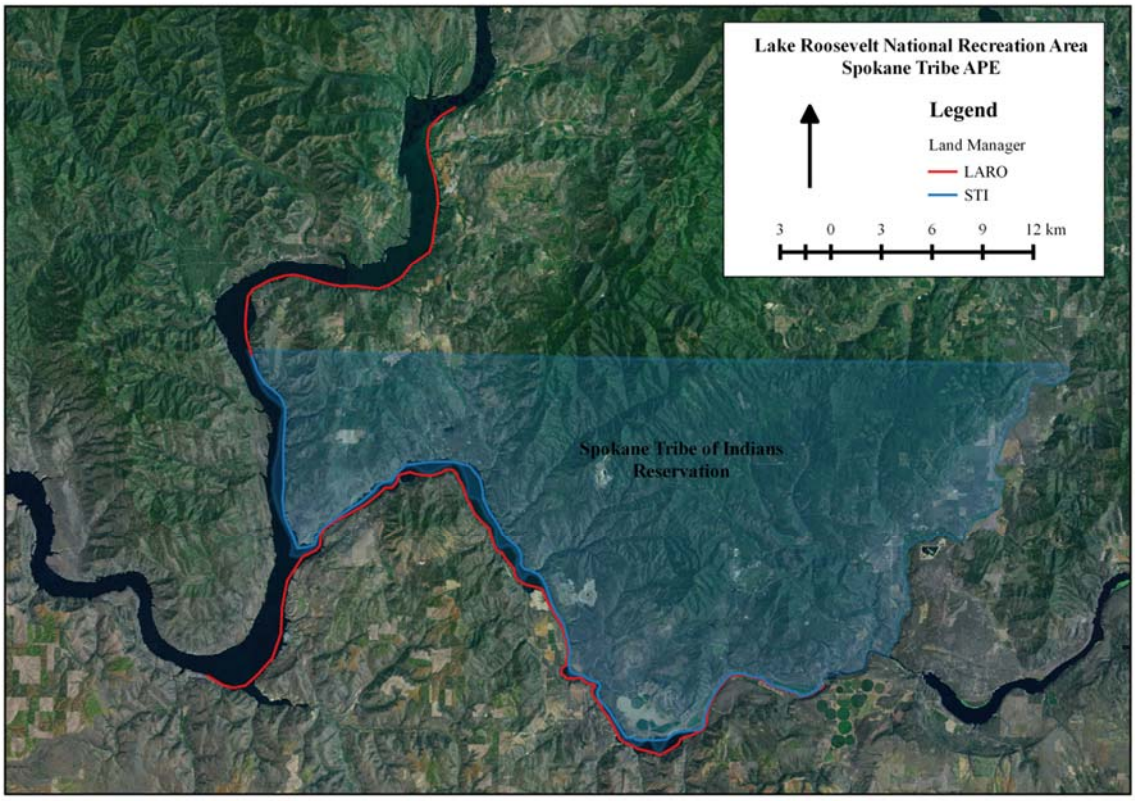


Figure 2. Spokane Tribe of Indians Reservation Land Not Covered by NPS Protocol

1. If remains that are potentially human are encountered, any activity in the vicinity of the discovery shall cease and all appropriate effort shall be made to determine if the remains are human. NAGPRA dictates that the 'stop work' order shall be for 30 days, but this period can be shortened in consultation between affected parties.

2. If the remains are determined to be human, the burial or location shall not be disturbed in any way. Any discovered human remains and associated artifacts will be treated in a respectful manner.

3. The person(s) making the discovery shall immediately notify NPS law enforcement. In cases where a potential crime scene exists, *personnel except those necessary to protect the location will leave the immediate vicinity in order to prevent unintentional destruction of crime scene information.*

4. The person(s) making the discovery shall immediately notify the Spokane Tribal Historic Preservation Officer (STI THPO), the Park Service archaeologist, and the Reclamation archaeologist (numbers are listed below) immediately after law enforcement.

   Live phone contact is required; backup staff are identified if the primary contacts are unavailable. Phone contact will be followed up by written confirmation, e-mail is acceptable.

5. **Notifications:**

   - Randy Abrahamson, STI THPO, is the primary contact for the STI. Mr. Abrahamson's phone number at the Department is (509) 258-4315, FAX (509) 258-6965, and his e-mail address is randya@spokanetribe.com. After work hours, Mr. Abrahamson can generally be reached at (509) 951-0524 (cell). If Mr. Abrahamson cannot be reached, John Matt (Preservation Department Director), James Harrison (Principal Investigator), Jackie Corley(Tribal Archaeologist), Laura McCullough (Project Archaeologist), or Chris Casserino (Project Archaeologist) shall be contacted at (509) 258-4060. If none of the above people can be reached, then the on-site STI crew leader shall be presumed delegated as the primary STI representative and shall participate in the NAGPRA consultation process until Mr. Abrahamson's return. The STI shall maintain a presence at the location of the discovery as needed until all contacts have been made and appropriate treatment of the remains has been conducted.

   - Derek Beery, Power Office Archaeologist, is Reclamation's contact. His phone number is (509) 237-4477 [cell phone], (509) 633-9233 [desk] FAX 633-9138, and e-mail address is "dbeery@usbr.gov." If Derek Beery is not available, contact Sean Hess, Regional Archaeologist (208) 378-5316, FAX (208) 378-5305, and e-mail address is shess@usbr.gov.

   - Keith Holliday, NPS Project Manager for the Lake Roosevelt National Recreation Area, is the primary contact for the NPS. Mr. Holliday's phone number is (509) 754-7858 or (509) 631-0306, and his FAX is (509) 738-3108, and e-mail address is keith_holliday@nps.gov. .

   - Spokane Tribal Law Enforcement can be reached at 1-888-258-6899 and/or 258-7766, and at (509) 633-9441, ext. 123. If Tribal Law Enforcement is not available, the North District Ranger number is (509) 738-6266 ext. 162 or cell (509) 631-4722.

6. A professional archaeologist will assist law enforcement in determining if the remains are archaeological in origin. If the discovery is determined to be a recent crime scene, field personnel shall follow direction from law enforcement officers.

7. If the discovery is determined to be an ARPA crime scene (i.e., there is evidence for intentional disturbance or looting of archaeological materials), an archaeologist shall assist law enforcement as needed in the collection of archeological data to support the ARPA case.

8. If the discovery is determined not to be a crime scene, an attempt will be made to determine whether the remains are human remains.

9. Documentation: If the remains are human, the location of the burial or scattered remains and general site conditions shall be documented. Documentation will include locating the burial on a USGS 7.5' topographic sheet and with a GPS unit, and recording the location on a site form or on an addendum to an existing form. Surface visible remains will be described to the degree that can be accomplished without causing any additional disturbance.

   If NAGPRA applies to the remains, a written plan of action will be drafted by the NPS and Reclamation archaeologists in coordination with the STI THPO. The party responsible for making the NAGPRA determination must document in writing the basis of that determination. Documentation methods will be described in the written plan of action for each discovery.

10. If possible and if agreed upon by all parties, human remains and associated objects shall be protected in place. If it is possible to rebury or cap the remains in place, then further actions under NAGPRA are not required. If the tribe prefers, protective actions can be conducted after locational information is collected.

11. If it is not possible to protect the remains in place, all efforts shall be made to determine in the field whether NAGPRA applies to the human remains. If NAGPRA does not pertain to the discovered remains, then WA state laws apply and shall be followed (Chapter 27.44 RCW: INDIAN GRAVES AND RECORDS, at http://www.oahp.wa.gov/rcw2744.htm).

12. Recovery: Remains or associated items that cannot be protected in place shall be recovered in a culturally sensitive manner according to the written plan of action developed by the STI, the NPS, and Reclamation. If remains are threatened and must be recovered before a written plan of action can be completed, the steps identified below shall be followed, at minimum:

    Collection of horizontal provenience data referenced to a site datum point; if excavation is required, vertical provenience data shall be tracked through the use of controlled 10-cm levels within a standard grid unit, screening of all excavated fill through 1/4-inch screen mesh (1/8-inch if sediments are sand), and (No photography, etc. if NAGPRA) of excavated features. Methods employed shall be designed to document information about burial practices and to recover any associated grave goods.

13. The NPS shall publish Notices of Intent to Make Disposition in local newspapers. The newspapers shall be named in the Written Plan of Action for each discovery.

14. After recovery and during the 30-day waiting period after newspaper notices are published by the NPS, NAGPRA items shall be stored and protected by the STI.

15. The written plans of action for individual discoveries within the Lake Roosevelt National Recreation Area will detail exact procedures for further implementation of NAGPRA.