

UPPER COLUMBIA RIVER

FINAL **Quality Assurance Project Plan for the** **Phase 3 Sediment Study – Sediment Facies Mapping** **Addendum No. 1**

Prepared for

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SECTION A: PROJECT MANAGEMENT

A1 TITLE AND APPROVAL SHEET

QUALITY ASSURANCE PROJECT PLAN FOR THE
 PHASE 3 SEDIMENT STUDY – SEDIMENT FACIES MAPPING
 ADDENDUM NO. 1

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Elena Wolf		TAI Assistant Project Coordinator	Date	5/1/2026
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Riley Newman		Task Manager	Date	5/1/2026
Kathy Jepson		Task Manager	Date	5/5/26
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ACRONYMS AND ABBREVIATIONS

ADCP	acoustic Doppler current profiler
CSM	conceptual site model
CTD	conductivity, temperature, and depth
DEA	David Evans and Associates, Inc.
DEM	digital elevation model
EPA	U.S. Environmental Protection Agency
ERM	Environmental Resources Management, Inc.
FGDC	Federal Geospatial Data Committee
FSP	field sampling plan
GCP	ground control point
GNSS	global navigation satellite system
IMU	inertial measurement unit
MBES	multibeam echosounder
MKP	model key points
MMU	minimum mapping unit
MRU	motion reference unit
NAVD88	North American Vertical Datum of 1988
OU	operable unit
PPK	postprocessing kinematic
QA	quality assurance
QAPP	quality assurance project plan
QC	quality control
RGB	red/green/blue
RI/FS	remedial investigation and feasibility study
RM	river mile
RMSE _z	root mean square error in the z-direction (vertical)

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
UCR	Upper Columbia River
USACE	U.S. Army Corps of Engineers
USGS	U.S. Geological Survey
UTM	Universal Transverse Mercator

UNITS OF MEASURE

cm	centimeter(s)
ft ³ /s	cubic foot/feet per second
m ³ /s	cubic meter(s) per second
dB	decibel(s)
ft	foot/feet
kHz	kilohertz
m	meter(s)
nm	nanometer(s)
m ²	square meter(s)

A3 DISTRIBUTION LIST

EPA Project Manager	Bonnie Arthur
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TAI Assistant Project Coordinator	Elena Wolf
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A4 INTRODUCTION AND TASK ORGANIZATION (QAPP SECTION A4)

A4.1 Introduction

This addendum outlines proposed additional data collection for the Upper Columbia River (UCR) (hereafter, the Site¹) for the 2018 Phase 3 Sediment Study for sediment facies mapping, as originally described in the UCR quality assurance project plan (QAPP) (TAI 2018) approved by the U.S. Environmental Protection Agency (EPA), and expands the original area covered to also include the 24-mile section of the UCR downstream of Operable Unit (OU) 1 between river mile (RM) 709 and RM 685. The additional work proposed in this addendum (hereafter, “Data Gap Study” or “study”) is intended to address a subset of data gaps identified during sediment transport study scoping meetings conducted with EPA during 2022 and 2023 and further refined by aquatic remedial investigation and feasibility study data gaps scoping between Teck American Incorporated (TAI) and EPA conducted from September through November 2025. The following scoping was conducted to identify potential data gaps and collection approaches:

- TAI prepared a Technical Memorandum dated August 28, 2025, summarizing the need for additional data to inform the aquatic Feasibility Study, specifically to define the volume of media with potentially unacceptable risks associated with the occurrence of contaminants of concern and to complete a sediment transport study.
- TAI and EPA conducted a technical conference on September 17, 2025, to provide an overview of data uses, preliminary data collection approaches, and a proposed TAI-EPA data gap workshop schedule.
- TAI and EPA conducted a technical conference call on October 8, 2025, to review preliminary sample designs to address the bathymetric data (Data Gap 2) and hydrodynamic data (Data Gap 4).
- TAI and EPA conducted a technical conference call on October 22, 2025, to review preliminary sample designs to address the suspended sediment and bedload data gap (Data Gap 3).
- TAI and EPA conducted a technical conference call on November 5, 2025, to review the planning and implementation schedule for Data Gaps 2, 3, and 4; discuss preliminary

¹ As per the June 2, 2006, Settlement Agreement for Implementation of Remedial Investigation and Feasibility Study (RI/FS) at the Upper Columbia River Site (referred to herein as the Site), the Site consists of 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 Grand Coulee Dam, and all suitable areas in proximity to such contamination necessary for implementation of the response actions (RI/FS) described therein.

data quality objectives for the suspended sediment and bedload data gap (Data Gap 3); and review proposed sample equipment and analytical methods.

- TAI and EPA held an in-person workshop in Seattle, Washington, on November 12, 2025, with other project stakeholders to discuss and resolve questions and comments from previous data gap scoping calls.

Through the scoping process described above, EPA and TAI agreed that there are the following data gaps related to the development of a quantitatively supported physical conceptual site model (CSM) of transport and fate of aquatic sediments throughout the Site:

- Data Gap 1 – Nature and Extent of Contamination
- Data Gap 2 – Reach Level Sediment Mass Balance (addressed with this study)
- Data Gap 3 – Suspended and Bedload Sediment Flux
- Data Gap 4 – Hydrodynamic Conditions (addressed with this study).

The primary objective of this study is to collect additional high-resolution topobathymetric and hydrodynamic data to address Data Gaps 2 and 4, while expanding the coverage area of sediment composition maps to include shallow areas that could not be accessed during the 2018 Phase 3 Sediment Study. These data will be acquired using some of the same equipment and collection methods as the 2018 QAPP, with some modifications and additions. TAI will work in consultation with EPA to address Data Gaps 1 and 3 separately in forthcoming standalone QAPPs.

Modifications and additions to the 2018 QAPP, the associated field sampling plan (FSP) (QAPP Appendix A), and relevant standard operating procedures (SOPs) (Attachment A2 of QAPP Appendix A) are included in this addendum. A summary of the primary modifications and additions to the 2018 QAPP (reflected in this addendum) is as follows:

- Main QAPP—survey areas and numbers of transects, specific survey locations and rationale, and sampling schedule
- FSP (QAPP Appendix A)—field survey methods (including continuous, cross-channel acoustic Doppler current profiler (ADCP) profiles, a multibeam echosounder (MBES) bathymetry survey, addition of an aerial lidar topobathymetry survey, and collection of temporal water levels), field equipment, and the timing of surveys
- Modified and additional SOPs (Attachment A2 of QAPP Appendix A)—modifications to SOP-3 (ADCP operation and deployment), addition of SOP-5 (lidar topobathymetry and imagery), and addition of SOP-6 (water level monitoring)

- General site health and safety plan (SHSP) addendum (Attachment A1 of QAPP Appendix A)—health and safety information (Appendix B in this addendum)
- Cultural Resources Coordination Plan (QAPP Appendix B)—amendments to the Cultural Resources Coordination Plan.

All other aspects of the study that are not discussed in this addendum remain unchanged from the QAPP (TAI 2018).

A4.2 Task Organization

This section presents the organizational structure for activities associated with this study, including task management and oversight, field data collection, and data management. While the organizational structure remains unchanged from the QAPP, technical team task members have been updated herein. Contact information for the current technical team task members is provided in Table A4-1.

A4.2.1 EPA Organization and Responsibilities

EPA will oversee TAI activities associated with this study and will coordinate the comments and review completed by the following parties: U.S. Department of the Interior, Washington State Department of Ecology, and local tribes (i.e., the Confederated Tribes of the Colville Reservation 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, Bonnie Arthur, 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 Cindy Fields. The responsibilities of the QA manager or QA designee include review and approval of the QAPP and any subsequent addenda.

A4.2.2 TAI Organization and Responsibilities

Rob Orr 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 (USEPA 2006a). Elena Wolf will serve as TAI’s assistant project coordinator, working closely with Rob to ensure the above.

A4.2.3 Key Task Personnel

TAI technical team task members for this study and their respective responsibilities are identified below. No sediment samples will be collected or analyzed for the Data Gap Study; therefore, no analytical laboratory personnel are included in the project team.

Principal Investigator—Dr. Jennifer Holder (Environmental Resources Management, Inc. [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—Dr. Tim McClinton (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—Riley Newman (DEA) and John Staly (DEA) will lead ADCP and MBES survey data collection, respectively. Kathy Jepson (GeoTerra, Inc.) will lead aerial survey work. 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 Aerial Survey Subcontractor Coordinator—Rob Orr (TAI) will be the acoustic and aerial survey subcontractor coordinator. He 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 aerial survey subcontractor(s) and tracking their progress, verifying that the subcontractors implement the requirements of this QAPP Addendum, 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 subcontractors.

Field Supervisor—The field supervisor, to be determined (TBD), will be 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 this QAPP Addendum are needed, the field supervisor will ensure that proposed changes are coordinated with EPA’s project manager, staff, and 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 (Table A4-1).

Database Administrator—Cristy Kessel (TAI) will be the database administrator and will have primary responsibility for data management and database maintenance and development. Cristy 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.

Cristy will report directly to the TAI project coordinator and will work closely with the task managers and the acoustic and aerial survey subcontractor(s).

A4.2.4 Acoustic and Aerial Survey Subcontractor Managers

Subcontractors will perform the field data collection and post-field data processing. The following responsibilities apply to the project managers and QA managers who will support this project.

Acoustic and Aerial Survey Subcontractor Project Managers—The acoustic and aerial survey subcontractor project managers are responsible for the successful and timely completion of field data collection, management of raw data, data postprocessing, and data compilation and documentation. Subcontractor project manager responsibilities include the following:

- Ensuring that data are collected following the QAPP, QAPP Addendum, and associated appendices and attachments, where applicable
- Apprising the TAI project coordinator of the schedule and status of field mobilization, data collection activities, and demobilization
- Notifying the task managers and TAI acoustic and aerial survey subcontractor coordinator if problems occur during data collection or data postprocessing, such as failure to meet quality control (QC) criteria
- Taking appropriate corrective action as necessary
- Reporting data and supporting QA information as specified in this QAPP Addendum
- Providing geospatial data in a format consistent and compatible with the UCR electronic database.

Acoustic and Aerial Survey Subcontractor QA Managers—The acoustic and aerial survey subcontractor QA managers are responsible for ensuring the quality of the raw data, the postprocessed data, and the final data compilation/documentation prepared for this study. Each subcontractor QA manager is not involved in 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 conform 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 QC issues that affect this task with the task managers and TAI acoustic and aerial survey subcontractor coordinator.

A5 PROJECT DESCRIPTION (QAPP SECTION A6)

This section includes modifications and additions to Section A6 in the main QAPP, including an update to the summary of work to be performed, products to be produced, and schedule for implementation. More detailed descriptions are provided in Section A7 in this addendum.

The goals of this study are to collect topobathymetric data to inform multiple analyses (including bathymetric differencing calculations, reach-level sediment mass balances, sediment composition of shallow shorelines and bars, and refinement of the hydrodynamic model), collect additional hydrodynamic data to provide a greater understanding of the river under high flow conditions (including validation of the hydrodynamic model) and generally inform the sediment transport study and the refined physical CSM presented in the aquatic feasibility study. The following data will be collected with this study:

- Elevation, shallow bathymetry, and return strength (intensity) using aerial lidar and red/green/blue (RGB) imagery
- Bathymetry and acoustic backscatter using an MBES
- 3D flow velocity using an ADCP
- Water level monitoring using pressure transducer data loggers.

The information generated from this study will comprise geospatial data layers, maps, ADCP flow velocity NetCDF files, and CSV data files. The maps and processed data products will include the following:

- Riverbed elevation using the combined, overlapping lidar and MBES data sets
- Sediment composition and geomorphology of shallow nearshore areas and shorelines using the combined, overlapping lidar and MBES data sets along with aerial imagery
- Bathymetric differencing maps depicting areas of erosion and accretion
- ADCP flow velocity data in a format suitable for hydrodynamic modeling use
- Continuous time series water surface elevation data at eight locations in a format suitable for hydrodynamic modeling use.

The 2026 fieldwork schedule is primarily driven by the projected seasonal fluctuation in water surface elevations and flow conditions throughout the Site. Lidar data collection is proposed during low pool (typically mid-March to late May) to ensure maximum overlap with MBES data to be collected during high pool (approximately July through October) (Figure A5-1). The ADCP data collection period will coincide with high flow conditions during the spring freshet, which typically peaks during mid-May to late June (Figure A5-2). Water level monitoring stations will

be installed during low pool prior to the lidar survey and will record water surface elevations from the time of installation through the end of the ADCP survey. Ground control will be installed and surveyed prior to the MBES survey. The lidar survey is expected to take approximately 5 days to complete, the ADCP transects are expected to take approximately 25 days to complete, and the MBES survey is expected to take approximately 60 days to complete.

Data will be collected throughout OU 1 and the upper reaches of OU 2 (the Data Gap Study Area²), as depicted on Map A5-1. The survey limits shown on the map series represent the continuous coverage area of the combined lidar and MBES data sets, which will be used to generate the topobathymetric model. The ADCP data will be collected along transects nominally spaced at 0.5-mile increments throughout the Data Gap Study Area (Map A5-1; Table A5-1), while water surface elevations will be recorded at eight predetermined locations where the river exhibits a steep gradient or significant change in flow (Figure A5-3; Map A5-1; Table A5-2). ADCP transect endpoints presented in Map A5-1 and Table A5-1 are for general reference. The actual endpoints will be determined in the field based on vessel access and instrument limitations within shallow, nearshore areas. Water level monitoring locations presented in Map A5-1 and Table A5-2 are based on observations made during field reconnaissance conducted on March 19, 2026, and may be adjusted in the field depending on conditions during the deployment. Each monitoring location shown on Map A5-1 has a corresponding shaded area where the target location may be relocated in consideration of the study objectives.

A6 DATA QUALITY OBJECTIVES, CRITERIA, AND DESIGN RATIONAL (QAPP SECTION A7)

This section includes modifications and additions to Section A7 in the main QAPP. EPA's seven-step data quality objective process (USEPA 2006b) was used to guide the design rationale for the study. Each step is presented below.

A6.1 Step 1—State the Problem

Topobathymetric data are needed throughout the Data Gap Study Area to inform temporal reach-level mass balance estimates from bathymetric differencing calculations and to extend the coverage area of sediment composition maps to include shallow nearshore areas and shorelines. Additional ADCP data are needed during high flow conditions to validate modeled velocity

² The Data Gap Study Area includes OU 1 from RM 745 to RM 709 and extends beyond the Transitional CSM Unit into the Upper Lacustrine CSM Unit of OU 2 from RM 709 to RM 685.

predictions used to assess location-specific feature stability and inform sediment transport within the study area.

A6.2 Step 2—Identify the Goals of the Study

The goals of this study will be to collect high-resolution data to characterize physical and hydrodynamic conditions within the Data Gap Study Area (i.e., topobathymetry, current velocities, and water surface elevations). Spatial detail regarding topobathymetry and river hydrology at high flow will support the sediment transport study and development of a refined sediment transport CSM. The additional data collection is intended to address data gaps identified during the aquatic remedial investigation as summarized in Section A4.

A6.3 Step 3—Identify Information Inputs

The following information inputs represent data to be acquired that will be processed to support development of a refined sediment transport CSM:

- High-resolution acoustic data collection using an MBES to express bathymetry in terms of sediment bed elevations (tied to known horizontal and vertical elevation benchmarks) to be used to perform bathymetric differencing calculations
- Aerial topobathymetric lidar data from shallow and non-wetted shoreline areas
- Raw MBES and lidar data processed to inform the classification of sediment composition for shallow nearshore areas and shorelines
- ADCP water column velocity profiles and water surface elevation data collected will be used to further validate the hydrodynamic model. The calibrated model will be used to simulate the flow during the time period of the survey(s) for direct comparison with the ADCP data, as was done for the original calibration and validation. If the model validation meets the performance metrics, then the confidence and accuracy of the hydrodynamic model will be validated to perform well during the range of expected current and future flow conditions. If the model validation does not meet performance standards, then the high flow data will be used to recalibrate the hydrodynamic model.

A6.4 Step 4—Define the Boundaries of the Study

A6.4.1 Geographic Boundaries

This study will be performed throughout the Data Gap Study Area. The bathymetric data will be collected over the entire Data Gap Study Area (100 percent coverage), including within nearshore areas, shorelines, and non-wetted areas. ADCP data will be collected at bank-to-bank

transects located throughout the Data Gap Study Area at approximately 0.5-mile intervals and location-specific transects placed at features of interest. The non-invasive remote sensing methods included in this addendum measure the sediment surface only; therefore, the vertical boundary of the study is limited to the river sediment bed surface.

A6.4.2 Temporal Considerations

Single MBES, lidar, and ADCP surveys will be performed. The MBES and lidar survey data will be compared to data collected during 2015 through 2016 and 2018 through 2019 to assess temporal bathymetric changes in the Data Gap Study Area. The ADCP survey will be timed to occur during high flow (typically late April through June) (Figure A5-2). Data collected within areas not previously mapped will be evaluated collaboratively with EPA.

A6.5 Step 5—Define the Analytical Approach

This section describes how the data collection approach in this study differs from the approach used in the QAPP.

- Underwater photographs will not be acquired.
- Aerial topobathymetric lidar of shallow nearshore areas, shorelines, and non-wetted areas will include the collection of RGB imagery to increase the positioning accuracy of the data.
- Water level monitoring during the ADCP data collection will be done at eight locations where the river exhibits a steep gradient or substantial change in flow within the Data Gap Study Area.
- Velocity data collected during high flow will be used to validate flow conditions simulated by the hydrodynamic model during the same time period.

A6.6 Step 6—Specify Performance or Acceptance Criteria

The performance standards for data collection during this study are consistent with the QAPP and applicable for field crews conducting surveys. The horizontal resolution of MBES and lidar data products are expected to be 1 m² or finer, with a root mean square error in the z-direction (RMSE_z) of 10 cm and a vertical accuracy of +/-0.1 m, respectively. If a planned location cannot be surveyed due to physical access or safety constraints, field crews will adjust transects to the nearest location without access or safety constraints. Survey results will be tied to the same elevation and locational benchmarks used in the QAPP to document survey accuracy, precision, and overall quality, with additional benchmarks added downstream of RM 709 to account for the expanded survey area. There are no modifications to the FSP regarding equipment,

methods, or techniques for the MBES. Section A7 in this QAPP Addendum and associated SOPs (Appendix A) provide more detailed information related to performance criteria for specific equipment and procedures.

A6.7 Step 7—Develop the Plan for Collecting Data

A detailed description of the data collection plan for this study is presented in Section A7 in this QAPP Addendum. Bathymetric and acoustic backscatter data will be acquired simultaneously with an MBES instrument, and the data will be processed to produce a digital bathymetric model. Lidar data will then be integrated with the model to produce a seamless topobathymetric model of the riverbed and banks throughout the Data Gap Study Area. The lidar and MBES data sets will overlap to the extent practicable to ensure quality coverage:

- Bathymetric and acoustic backscatter data will be acquired from accessible wetted areas using a boat-mounted MBES system and required hardware and software systems to support data acquisition, including vessel positioning, vessel navigation, and system calibrations. Data will be processed to produce a digital bathymetric model.
- Aerial topobathymetric lidar and RGB imagery acquisition during low pool will be collected over 100 percent of the Data Gap Study Area shoreline.
- Lidar return strength (intensity) and MBES acoustic backscatter data will be evaluated to estimate sediment composition and determine geomorphology for shallow nearshore areas and shorelines.
- ADCP transects will have a nominal spacing of 0.5 mile and be oriented perpendicular to the flow path of the river to the extent practicable. They will be located based on anticipated navigational obstructions within the river, including, but not limited to, submerged bars, benches, and terraces (see Map A5-1).

Final transects and locations along each transect were selected by TAI in collaboration with EPA, based on review of the existing bathymetry of the river and other relevant site information. Transects and survey areas may require adjustment in the field because of physical access constraints (e.g., shoals and other water depth limitations) and safety considerations.

A7 DATA GENERATION AND ACQUISITION (QAPP SECTION B)

This section includes modifications and additions to Section B in the QAPP, including updates to the sample design (Section B1), field data collection methods (Section B2), data postprocessing and analysis (Section B3), and QC (Section B4).

A7.1 Sample Design

The sample design for this study is intended to address Data Gaps 2 and 4 introduced in Section A4, while expanding the coverage area of 2018 sediment composition maps to include shallow shorelines and bars. This study extends the original coverage area to also include the 24-mile section of the UCR downstream of OU 1 between RM 709 and RM 685. Addressing Data Gap 2 requires additional high-resolution bathymetry with which to conduct a bathymetric differencing analysis (and reach-level sediment mass balances) with the 2018 to 2019 bathymetry. Addressing Data Gap 4 requires the collection of additional hydrodynamic data during high flow to refine the hydrodynamic model developed for OU 1. Expanding the sediment composition map coverage areas to include shallow shorelines and bars requires the collection of lidar and MBES data throughout the Data Gap Study Area. Addressing these data gaps is part of a series of studies intended to inform a refined physical sediment transport CSM. To achieve the study objectives, data collection described in the QAPP will be conducted throughout the Data Gap Study Area with the following modifications:

- ADCP data will be collected along preplanned transects while the vessel is underway instead of at discrete locations while the vessel holds position. The change in methodology reflects a change in the intended use of the data and how the data will be processed and analyzed, as described in Section A7.3.
- MBES field data collection will serve the same primary purpose of generating a high-resolution bathymetric model, as described in the QAPP. The collection of acoustic backscatter data will be used to expand the coverage area of sediment composition mapping performed in 2018.

Additional data collection not previously described in the QAPP include the following:

- Aerial topobathymetric lidar and RGB imagery acquisition
- Water level monitoring.

The sample design required to address the data gaps described herein has been developed and refined through a series of scoping calls between TAI and EPA from September through November 2025. High-resolution topobathymetric data following the same data quality objectives described in the QAPP will be needed for estimating reach-level sediment mass balances through the Data Gap Study Area. The additional coverage areas extending into the upper reaches of OU 2 and from the edge of the bathymetric survey limits to the top of the riverbanks using lidar are needed to expand the coverage area of sediment composition maps and accurately simulate the riverbed in the hydrodynamic model domain. Benchmarks occupied

during the 2018 to 2019 surveys will be used along with additional points to establish ground control to ensure the data sets are accurately tied to the same coordinate system vertical datum. Channel-wide ADCP velocity profiles will be used to validate the hydrodynamic model of the Data Gap Study Area, which is used to simulate current velocity under a range of flow conditions. The ADCP data collected during the height of the spring freshet is intended to represent peak conditions, when water flow and sediment transport are likely to be most dynamic and energetic. The spacing of the transects was selected to capture variability in flow at a fine enough resolution to adequately represent river conditions at sufficient scale for representation in the hydrodynamic model. Transects nominally spaced at 0.5-mile increments and oriented perpendicularly to the flow path are expected to provide representative coverage of anticipated geomorphological features. Additional transects have been planned in some areas to better represent flow conditions through complex channel geometries, narrows, and eddies (Map A5-1).

Analysis of the hydrodynamic model outputs suggest that simulated water surface level conditions through several high-gradient sections of the river deviated somewhat from available water surface elevation data. This study includes eight monitoring stations placed throughout the Data Gap Study Area that will log water surface elevation at key locations during the ADCP data collection period (Figure A5-3; Table A5-2). The water level loggers are pressure transducers that precisely record variation in pressure at user-defined time intervals. By surveying the vertical position of the sensor in relation to a baseline water surface elevation and applying a site-specific correction for atmospheric pressure, the fluctuations in pressure are converted to water surface elevations. The water surface elevation data will be included as a hydrodynamic model input, which is expected to improve simulations of water surface elevation by reducing the uncertainty in stream roughness estimates used in the model environment.

A7.2 Field Data Collection Methods

Field data collection will be performed using a combination of the following methods:

- MBES, ADCP, and lidar surveys as documented in the QAPP with modifications included in this QAPP Addendum
- Pressure transducer data loggers included in this QAPP Addendum.

Each of these survey methods employs multiple pieces of equipment. Table A7-1 identifies each survey method, the types of equipment or instrumentation 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 (QAPP Appendix A), with the following additions or modifications included in this QAPP Addendum:

- Field equipment and supplies (Section A8.4)
- Survey methodology (Section A8.5).

SOPs for each survey method are provided in Attachment A2 of the FSP (QAPP Appendix A), with modifications to those SOPs documented in Section A8 in this addendum. Modified and additional SOPs are included in Appendix A of this QAPP Addendum.

If unanticipated or changed circumstances occur in the field, corrective actions will be taken and documented as described in the QAPP.

A7.3 Data Postprocessing and Analysis

Raw data collected in the field will undergo postprocessing to yield the final data deliverables to be included in the data summary report and used to address the data gaps summarized in Section A4. The outputs from data postprocessing to be included in the data summary report are as follows:

- Merged lidar and MBES topobathymetric data as a digital elevation model (DEM) formatted as a raster (GeoTIFF or similar) with elevations tied to North American Vertical Datum of 1988 (NAVD88)
- ADCP flow velocity data in tabular and geospatial formats suitable for GIS display and hydrodynamic modeling use (e.g., TXT, CSV, XLS, SHP, NetCDF)
- Continuous time-series water surface elevation data at eight locations in a format suitable for hydrodynamic modeling use (e.g., CSV files).

The procedures for data postprocessing and interpretation to generate the data products listed above are described in the SOPs provided in Attachment A2 of the FSP (QAPP Appendix A) and in the modified and additional SOPs included in Appendix A of this QAPP Addendum. Modifications and additions to the SOPs are documented in Section A8. Raw data will be archived and can be made available if different postprocessing methods are identified for its subsequent use.

A7.4 QC

The QC procedures described in QAPP Section B4 will be followed during this study, with modifications or additions as described in the SOPs included in Appendix A of this addendum. QC activities for ADCP and MBES surveys are based on the same U.S. Geological Survey (USGS) and U.S. Army Corp of Engineers guidelines referenced in the QAPP. Additional QC

activities as well as standards and specifications unique to the lidar survey are based on the USGS National Geospatial Program guidance, Lidar Base Specification 2025, Rev. A (USGS 2025), and American Society of Photogrammetry and Remote Sensing Positional Accuracy Standards for Digital Geospatial Data, Edition 2, Version 2 (2024) (ASPRS 2024).

The measurement quality objectives presented in Table A7-2 are the target performance criteria for data to be collected in this study. Where possible, the performance criteria identified in Table A7-2 are related to the planned utility of each data type for supporting the ultimate data use for addressing the data gaps summarized in Section A4. All survey results will be tied to known elevation and locational benchmarks to document survey accuracy, precision, and overall quality.

A8 FSP (QAPP APPENDIX A)

This section describes modifications and additions to Section 2 and Attachment A2 (SOPs) in QAPP Appendix A. It includes information specific to the procedures and methods that will be used during this study to conduct a lidar and RGB imagery survey and an MBES survey as well as collect ADCP velocity profiles and monitor water levels.

All procedures will be conducted in accordance with the SOPs provided in Attachment A2 of QAPP Appendix A, with modifications or additions as presented in this QAPP Addendum. Modified and additional SOPs have also been included in Appendix A of this QAPP Addendum.

Depending on field conditions, procedures specified in the referenced SOPs may be modified, if necessary, in consultation with EPA and documented in a Protocol Modification Form or Change Request Form (Attachment A3 of QAPP Appendix A).

A8.1 Survey Areas (FSP Section 2.1)

Data will be collected throughout the Data Gap Study Area, as depicted on Map A5-1. The survey limits shown on the map series represent the continuous coverage area of the combined lidar and MBES data sets, which will be used to generate the topobathymetric model and to aid in classifying sediment composition for inundated areas that were not surveyed in 2018. The ADCP data will be collected along transects nominally spaced at 0.5-mile increments throughout the Data Gap Study Area (Table A5-1), while water surface elevations will be recorded at eight predetermined locations where the river exhibits a steep gradient or substantial change in flow (Figure A5-3; Table A5-2). ADCP transect endpoints presented in Map A5-1 and Table A5-1 are for general reference. The actual endpoints will be determined in the field based on vessel access and instrument limitations within shallow, nearshore areas. Water level monitoring locations presented in Map A5-1 and Table A5-2 are based on observations made during field reconnaissance conducted on March 19, 2026, and may be

adjusted in the field depending on conditions during the deployment. Each monitoring location shown on Map A5-1 has a corresponding shaded area where the target location may be relocated in consideration of the study objectives.

A8.2 Survey Protocols (FSP Section 2.2)

It is anticipated that multiple mobilizations will occur in succession by separate field teams with primary responsibilities unique to each survey or field event. The first mobilization will be a four-person boat-based team to install and survey water level monitoring equipment at predetermined locations throughout the Data Gap Study Area. The second mobilization will be a three- to four-person land-based team to access and survey ground control points. The third mobilization will involve a three-person team to conduct the aerial lidar survey from a manned fixed-wing aircraft. The fourth mobilization will involve a two- to three-person boat-based team to acquire the ADCP data. The fifth mobilization will involve two separate two- to three-person boat-based teams to conduct the MBES survey. Mobilization of personnel and equipment for each survey or field event will be to various boat launches located throughout the Data Gap Study Area, depending on the specific area to be surveyed. An additional vessel with a two-person health and safety crew will accompany all boat-based surveys.

A8.3 Task Schedule (FSP Section 2.3)

The 2026 fieldwork schedule is primarily driven by the projected seasonal fluctuation in water surface elevations and flow conditions throughout the Data Gap Study Area. Lidar data collection is proposed during low pool (typically mid-March to late May) to ensure maximum overlap with MBES data to be collected during high pool (approximately July through October) (Figure A5-1). The ADCP data collection period will coincide with high flow conditions during the spring freshet, which typically peaks during mid-May to late June. Water level monitoring stations will be installed during low pool prior to the lidar survey and will record water surface elevations from the time of installation through the end of the ADCP survey. Ground control will be surveyed prior to the MBES survey. The lidar survey is expected to take approximately 5 days to complete, the ADCP transects are expected to take approximately 25 days to complete, and the MBES survey is expected to take approximately 60 days to complete.

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

A8.4 Field Equipment and Supplies (FSP Section 2.4)

Field equipment and supplies anticipated for this study are detailed in each of the task SOPs and include a research vessel, an ADCP, an MBES, a lidar with RGB imagery sensor, pressure

transducers for monitoring water levels, and field logbooks (or electronic tablets). The specific SOPs for this study include a detailed list of equipment required to perform each survey. These SOPs are included in Attachment A2 of the FSP or in Appendix A of this QAPP Addendum, as indicated below.

Relevant SOPs included in Attachment A2 of the FSP with minor modifications detailed in Section A8.5 include the following:

- SOP-1 Multibeam Echosounder and Acoustic Backscatter Survey for Riverbed Classification
- SOP-4 Vessel Positioning.³

Modified or additional SOPs included in Appendix A of this QAPP Addendum are as follows:

- SOP-3 Acoustic Doppler Current Profiler Operation and Deployment (modified)
- SOP-5 Lidar Topobathymetry and Imagery (additional)
- SOP-6 Water Level Monitoring (additional).

A8.5 Survey Methodology (FSP Section 2.5)

This section includes modifications and additions to FSP Section 2.5, which describes the survey methods that will be used during the implementation of this QAPP Addendum. Minor modifications to SOPs that were originally included in Attachment A2 of the FSP are presented here, in the appropriate subsection. SOPs that were substantially modified and additional SOPs for this study that were not included as part of the FSP are provided in Appendix A of this QAPP Addendum and summarized in the appropriate subsection. Operation and procedures related to vessel positioning (SOP-4 in Attachment A2 of the FSP) have not been modified and are not discussed in this section.

A8.5.1 MBES

In addition to daily position checks to quantify horizontal and vertical positioning accuracy and independent depth verification methods, as described in the 2018 QAPP, an additional weekly independent depth verification method will include a topo shot (independent global navigation satellite system [GNSS] measurement of elevation) of a flat surface (i.e., boat ramp) directly beneath the MBES transducers. This technique will provide an additional independent depth verification method to supplement existing methods. The only other addition is the inclusion of a second shallow-draft survey vessel, which will work alongside a primary conventional survey

³ SOP-4 Vessel Positioning will remain unmodified for the purpose of this study.

vessel. Both vessels will have identical survey instrumentation and configuration. The vessels will work in tandem to acquire deep and shallow bathymetric data safely and efficiently.

A8.5.2 ADCP

There are no modifications to the FSP regarding equipment, vessel-mounted deployment, or fundamental principles of data collection for the ADCP. The modifications to SOP-3 relate to use of the ADCP for measuring mean flow velocity profiles across the entire UCR channel rather than for time-averaged profiles at a single location. For the objectives of this study, ADCP data will be collected along a minimum of two bank-to-bank profiles in reciprocal directions at each proposed transect location. The channel-wide velocity data will be averaged at a spatial scale suitable for representing flow dynamics within the hydrodynamic model. The modified SOP-3 is included in Appendix A of this addendum.

A8.5.3 Aerial Topobathymetric Lidar with RGB Imagery

Lidar topobathymetry, echo intensity, and RGB imagery will be acquired from a manned fixed-wing aircraft. The lidar system will be a hydrographic laser system, which includes a green (532 nm wavelength) laser for penetrating the water surface and acquiring riverbed elevations in shallow nearshore areas where depths prohibit vessel-based bathymetric data collection. It is anticipated that the lidar system will acquire bathymetric data to approximately 1.5 times Secchi depth (the depth beyond which a submerged disk with a high-contrast pattern is no longer visible from the surface). The lidar system will also acquire elevation data for non-wetted areas within the Data Gap Study Area to a maximum elevation of 1,500 ft NAVD88. A ground control survey will be conducted to acquire calibration points and independent ground control points (GCPs) using real-time kinematic (RTK) GNSS survey techniques. Based on the size of the project area, a minimum of 30 GCPs will be acquired. In addition, color aerial imagery will be acquired with a large format digital camera to produce high-resolution color orthophotography. Lidar-derived topobathymetric data will be integrated with MBES bathymetric data to produce a seamless DEM. Processed lidar intensity will be integrated with MBES acoustic backscatter data to expand the coverage area of sediment composition maps to include shallow nearshore areas, shorelines, and inundated areas within the Data Gap Study Area that were not surveyed in 2018.

A8.5.4 Water Level Monitoring

Continuous water level monitoring data collection will be conducted using non-vented pressure transducers installed inside stilling wells anchored along stable riverbank sections at eight deployment sites. Stilling wells are used to dampen short-term fluctuations and protect the pressure transducers from debris and will incorporate integrated staff gages for manual

verification. A traditional stilling well may not be feasible at several locations because of the large range in water level anticipated between May and July or a lack of suitable structures and/or substrate to anchor the wells along the shoreline. For these locations, the transducer will be housed inside a 2-ft section of perforated pipe mounted to a concrete block below the waterline. The concrete block will be leveled and staked to the riverbank during low water. Each pressure transducer records absolute pressure at programmed intervals during the deployment period, with barometric pressure corrections applied using either on-site sensors or nearby weather station data. Elevation surveys are conducted during installation to reference water levels to fixed benchmarks using standard leveling formulas, including sensor face correction. Sensor data are stored internally and will be manually downloaded during site visits, which will also include visual checks, staff gage readings, and redeployment in calibrated positions.

A8.5.5 Control Network

All control points in the existing control network will be recovered and reoccupied with static GNSS observations. Additional control points and check points will be installed south of the existing network to support the expanded survey area. All new control and check points will be documented with new static GNSS observations.

A8.6 SHSP (Attachment A1 of QAPP Appendix A)

This section includes modifications and additions to the SHSP (Attachment A1 of QAPP Appendix A). Minor modifications to the text and tables have been incorporated into the SHSP included as Appendix B of this addendum. Emergency contact information and regional hospital information have been verified and updated accordingly.

A9 CULTURAL RESOURCES COORDINATION PLAN (FSP SECTION 2.8 AND QAPP APPENDIX B)

The data collection activities presented in this addendum have been developed in communication with EPA and the Cultural Resources Working Group as they relate to potential impacts to cultural resources. The Cultural Resources Coordination Plan presented in QAPP Appendix B does not require additions and/or modifications beyond expanding the original footprint of sampling activities to cover the Data Gap Study Area. Field teams will have a copy of the Cultural Resources Coordination Plan on hand while conducting any field-related activities.

A10 REFERENCES (QAPP SECTION E)

- ASPRS (American Society of Photogrammetry and Remote Sensing). 2024. ASPRS Positional Accuracy Standards for Digital Geospatial Data. Edition 2, Version 2 (2024). ASPRS, Baton Rouge, LA. <https://asprs.org/Main/Main/Standards/Positional-Accuracy-Standards.aspx>.
- TAI (Teck American Incorporated). 2018. Final Quality Assurance Project Plan for the Phase 3 Sediment Study – Sediment Facies Mapping. Prepared for TAI by ERM in association and consultation with HDR, David Evans and Associates, Inc., Windward Environmental LLC, Gravity Consulting LLC, and Parametrix, Inc.
- U.S. Army Corps of Engineers. 2013. Hydrographic Surveying. Engineer Manual EM 1110-2-1003. Washington, DC.
https://www.publications.usace.army.mil/Portals/76/Publications/EngineerManuals/EM_1110-2-1003.pdf.
- USEPA (U.S. Environmental Protection Agency). 2006a. Settlement Agreement for Implementation of Remedial Investigation and Feasibility Study at the Upper Columbia River Site. U.S. Environmental Protection Agency, Washington, DC.
- 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, DC.
- USGS (U.S. Geological Survey). 2025. Lidar Base Specifications 2025, Rev. A (June 11, 2025).
<https://www.usgs.gov/media/files/lidar-base-specification-2025-rev-a>.

FIGURES

M:\US\Projects\SI\UTeck\0493466 Teck Upper Columbia River\Maps\Data Gaps 2-4 QAPP\Figure A5-1 Topobathy Conceptual.vsd

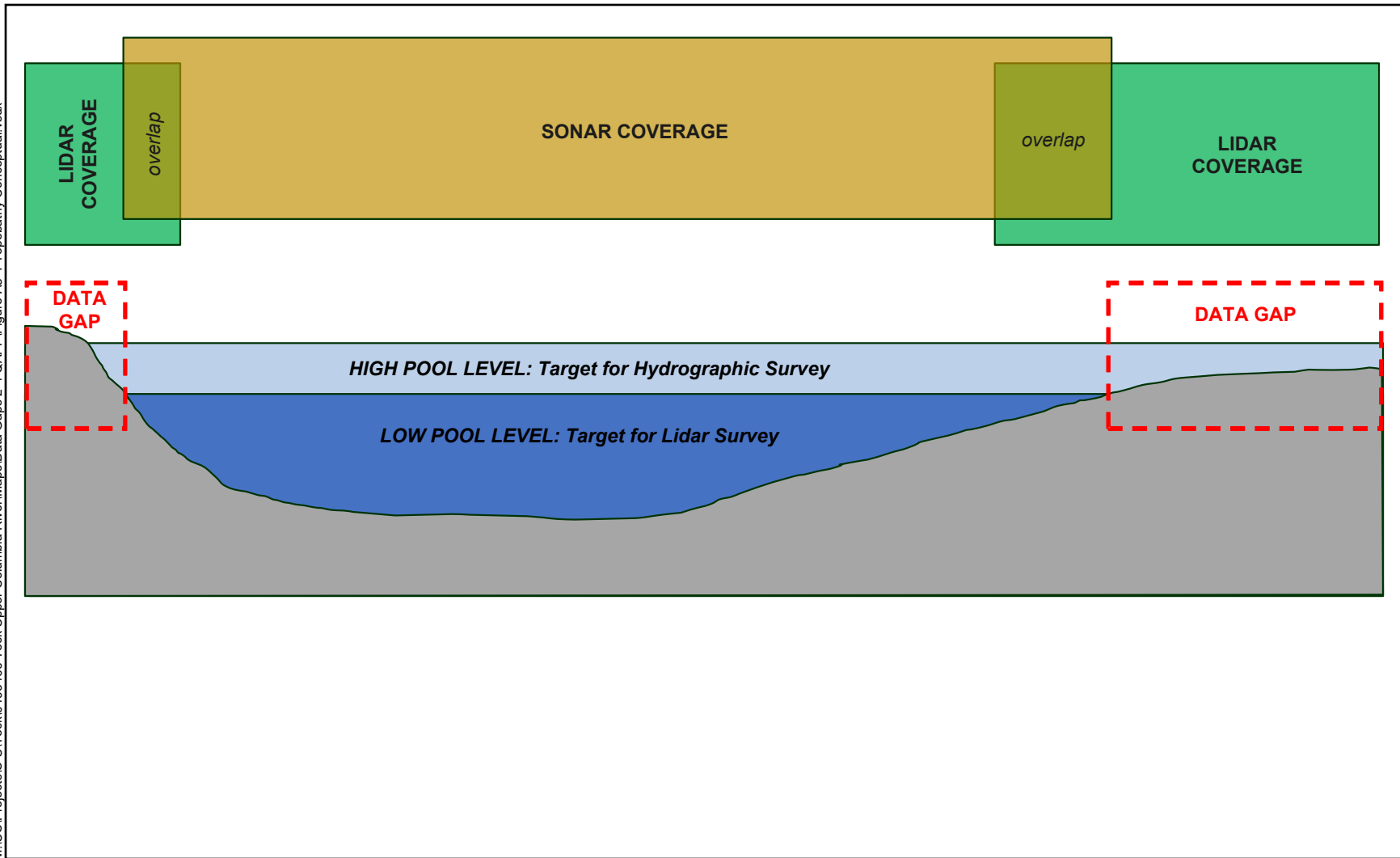


Figure A5-1. Topobathymetry Conceptual Study Design
Phase 3 Sediment Study – Sediment Facies Mapping QAPP Addendum No. 1
Upper Columbia River, Washington

M:\US\Projects\S-U\Teck\0493466 Teck Upper Columbia River\Maps\Data Gaps 2-4 QAPP\Figure A5-2_YearlyVariation.vsd

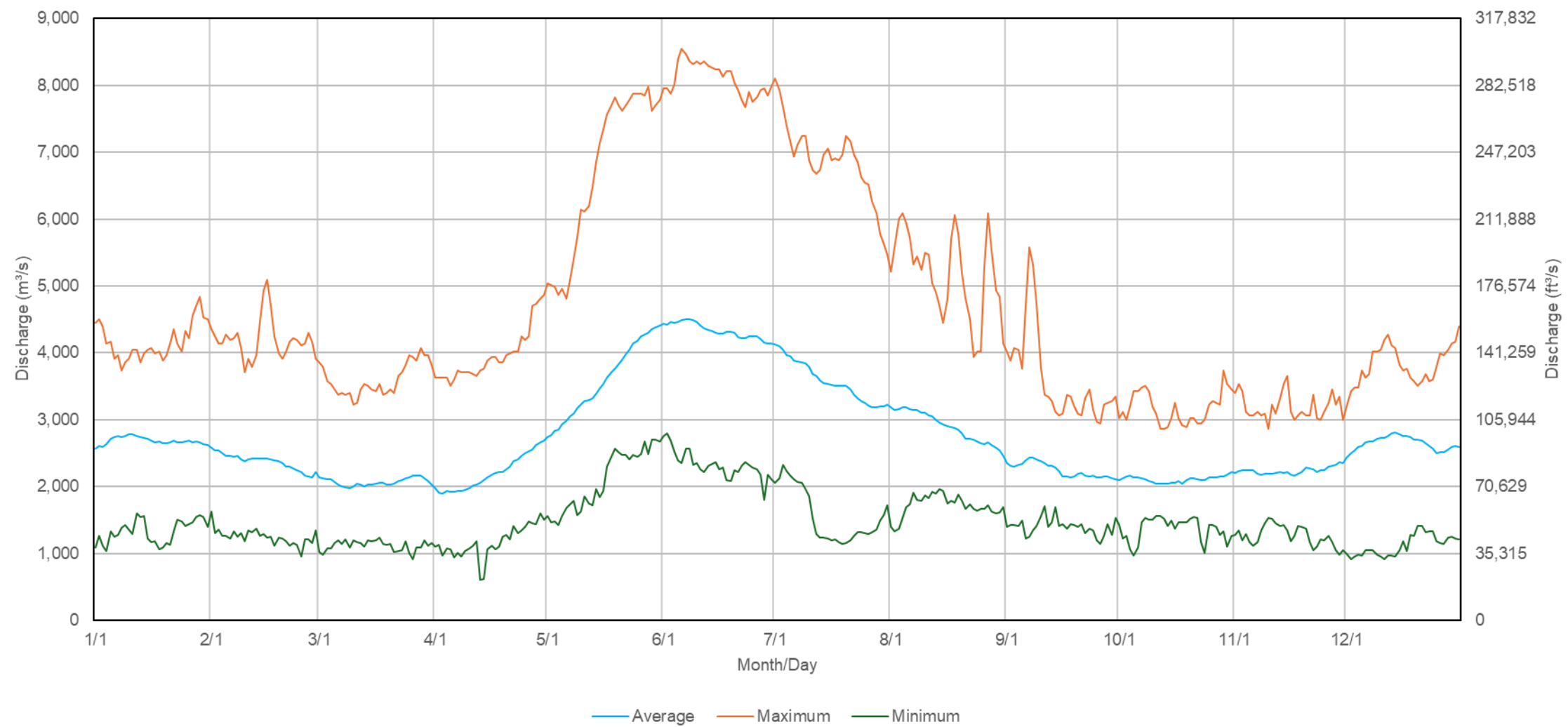
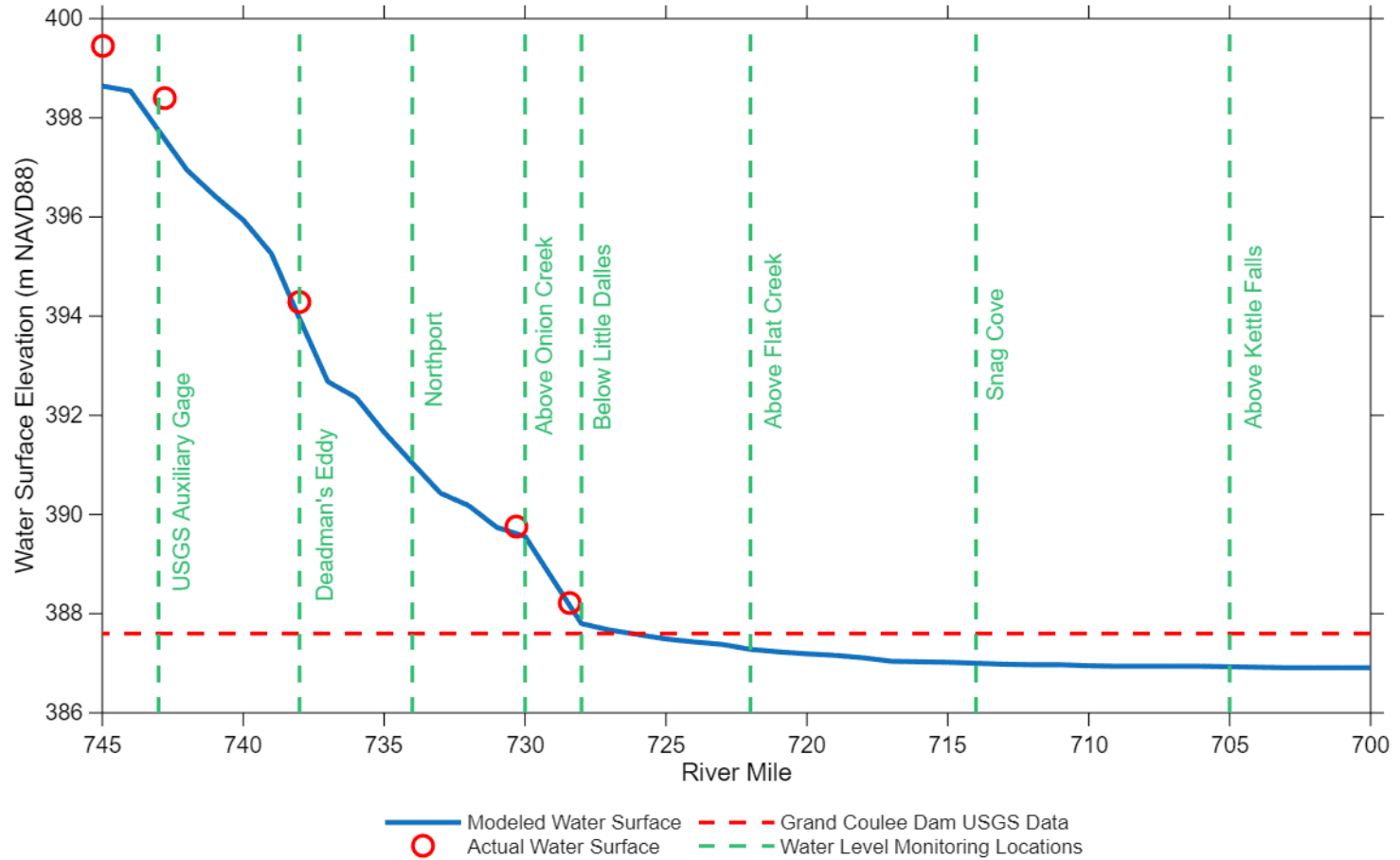


Figure A5-2. Typical Yearly Variation of Daily Discharge at the U.S.-Canada Border for 1973-2025
Phase 3 Sediment Study – Sediment Facies Mapping QAPP Addendum No. 1
Upper Columbia River, Washington

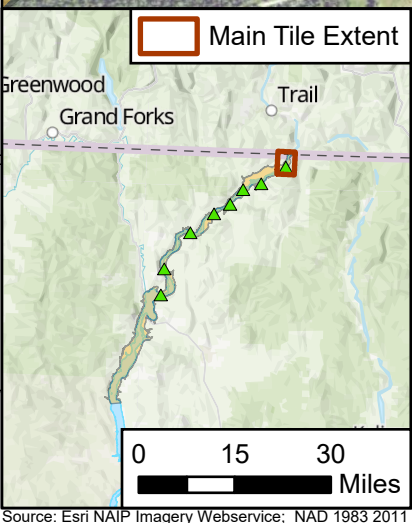
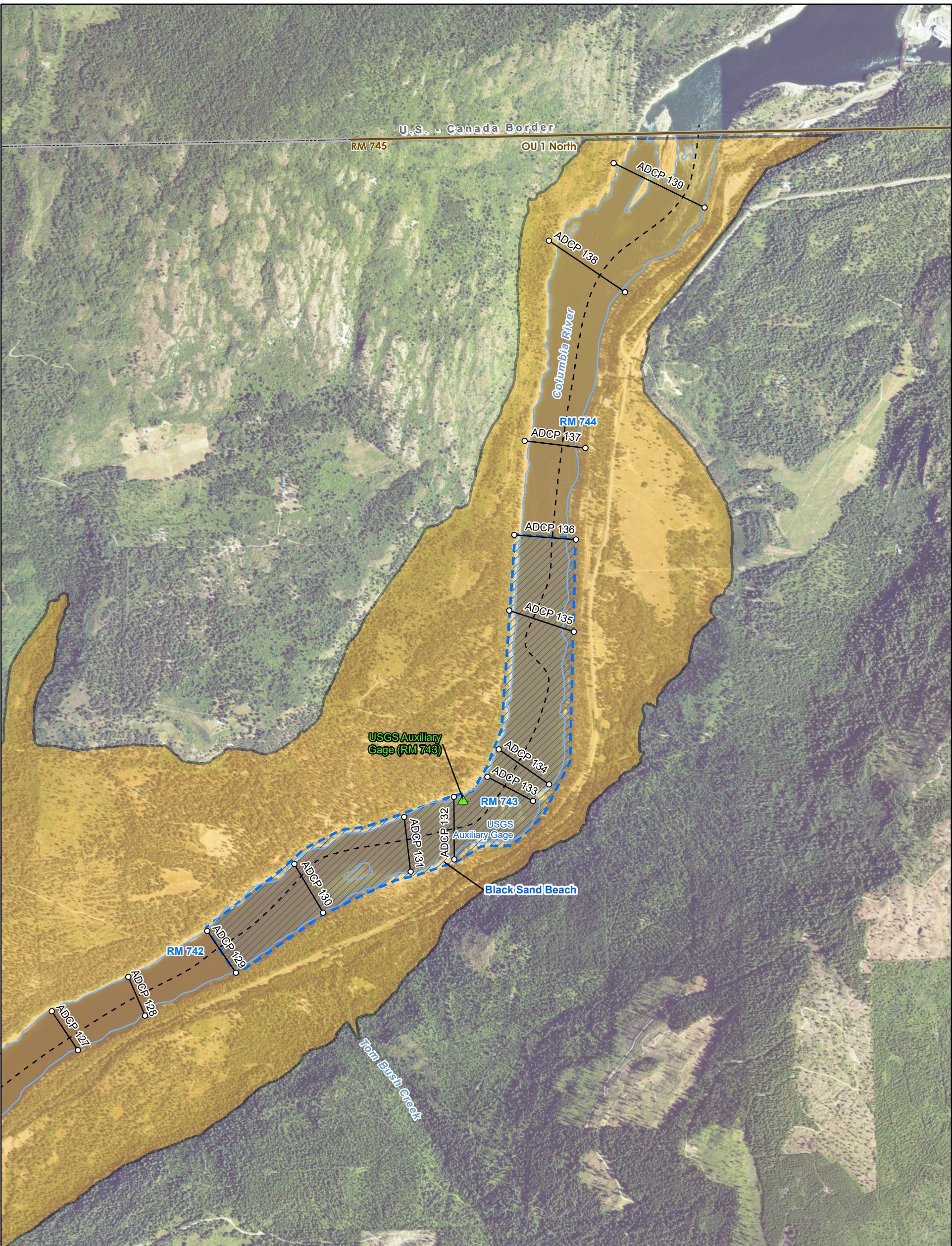


Note: Modeled water surface elevation and actual measurements are from May 25, 2016.

Figure A5-3. Water Surface Elevation Monitoring Locations
Phase 3 Sediment Study – Sediment Facies Mapping QAPP Addendum No. 1
Upper Columbia River, Washington

MAPS

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Legend

- ▲ Water Level Monitoring Station
- ADCP Transects
- - - Thalweg
- Columbia River Shoreline
- Water Level Monitoring Area
- Estimated Topobathymetry Extent (Lidar plus MBES)

Note: Transect endpoint locations are approximate. Actual locations will be determined by vessel access to shallow, nearshore areas during the survey.

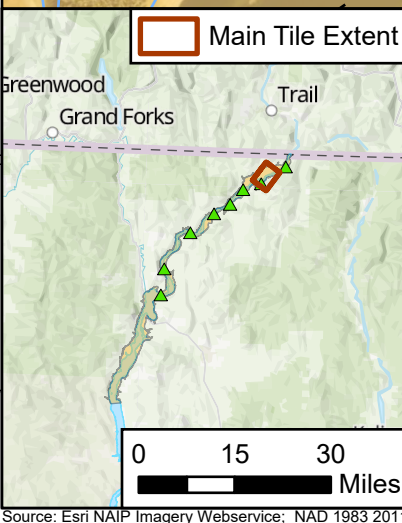
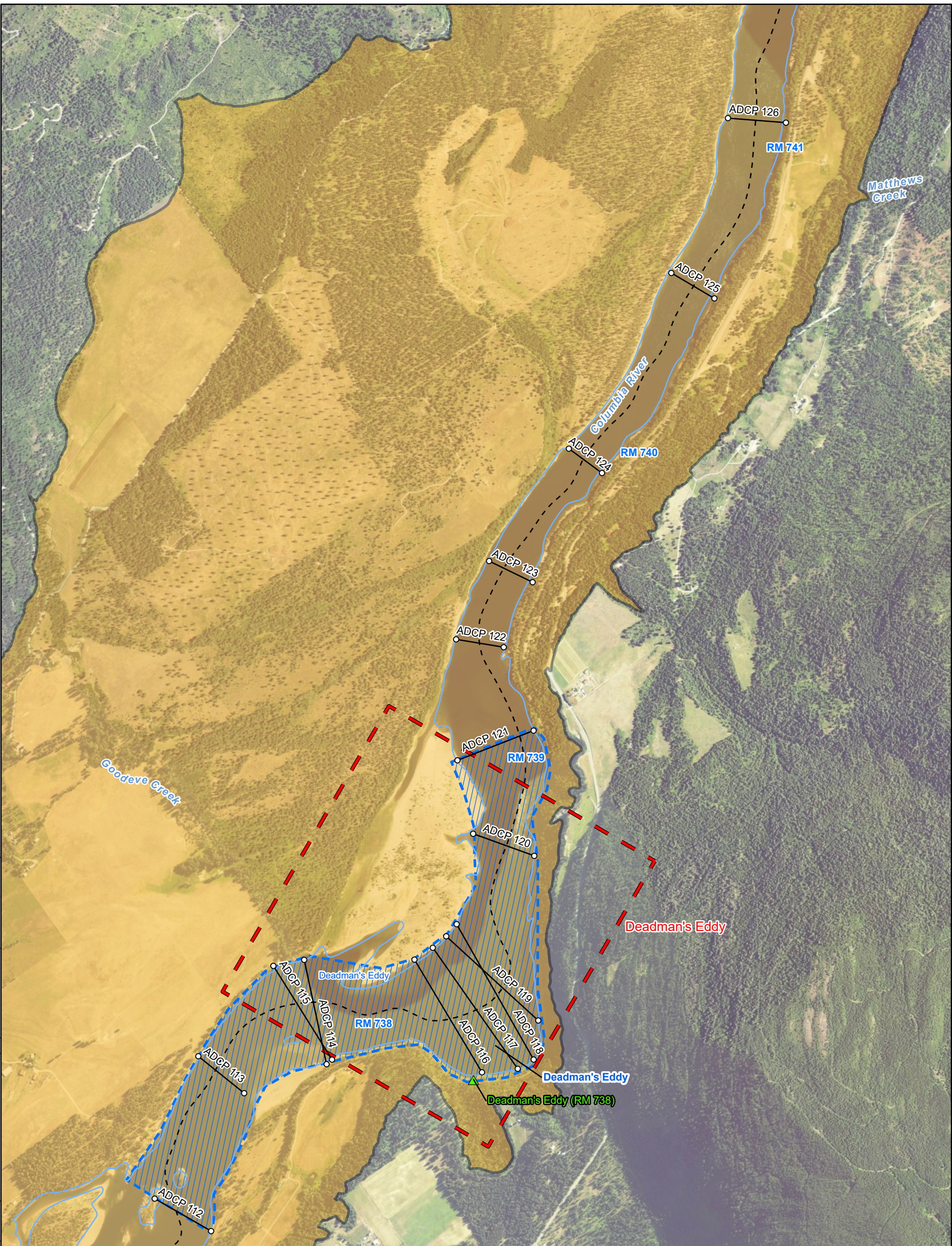
0 650 1,300 2,600 Feet

Map A5-1 Tile 1.
ADCP Transect Locations
 Phase 3 Sediment Study – Sediment Facies Mapping QAPP Addendum No. 1
 Upper Columbia River, Washington


ERM

Source: Esri NAIP Imagery Webservice; NAD 1983 2011 StatePlane Washington North FIPS 4601 Ft US

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Legend

- ▲ Water Level Monitoring Station
- ADCP Transects
- - - Thalweg
- Columbia River Shoreline
- Water Level Monitoring Area
- Deadman's Eddy Area of Interest
- Estimated Topobathymetry Extent (Lidar plus MBES)

Note: Transect endpoint locations are approximate. Actual locations will be determined by vessel access to shallow, nearshore areas during the survey.

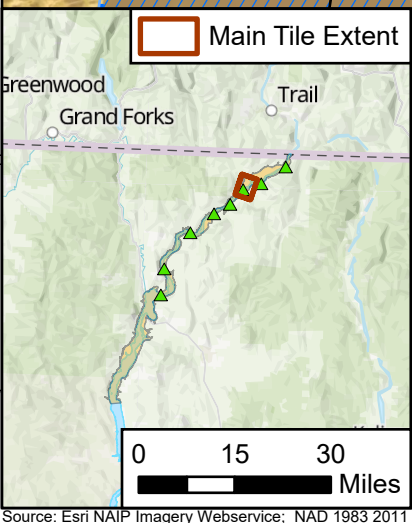
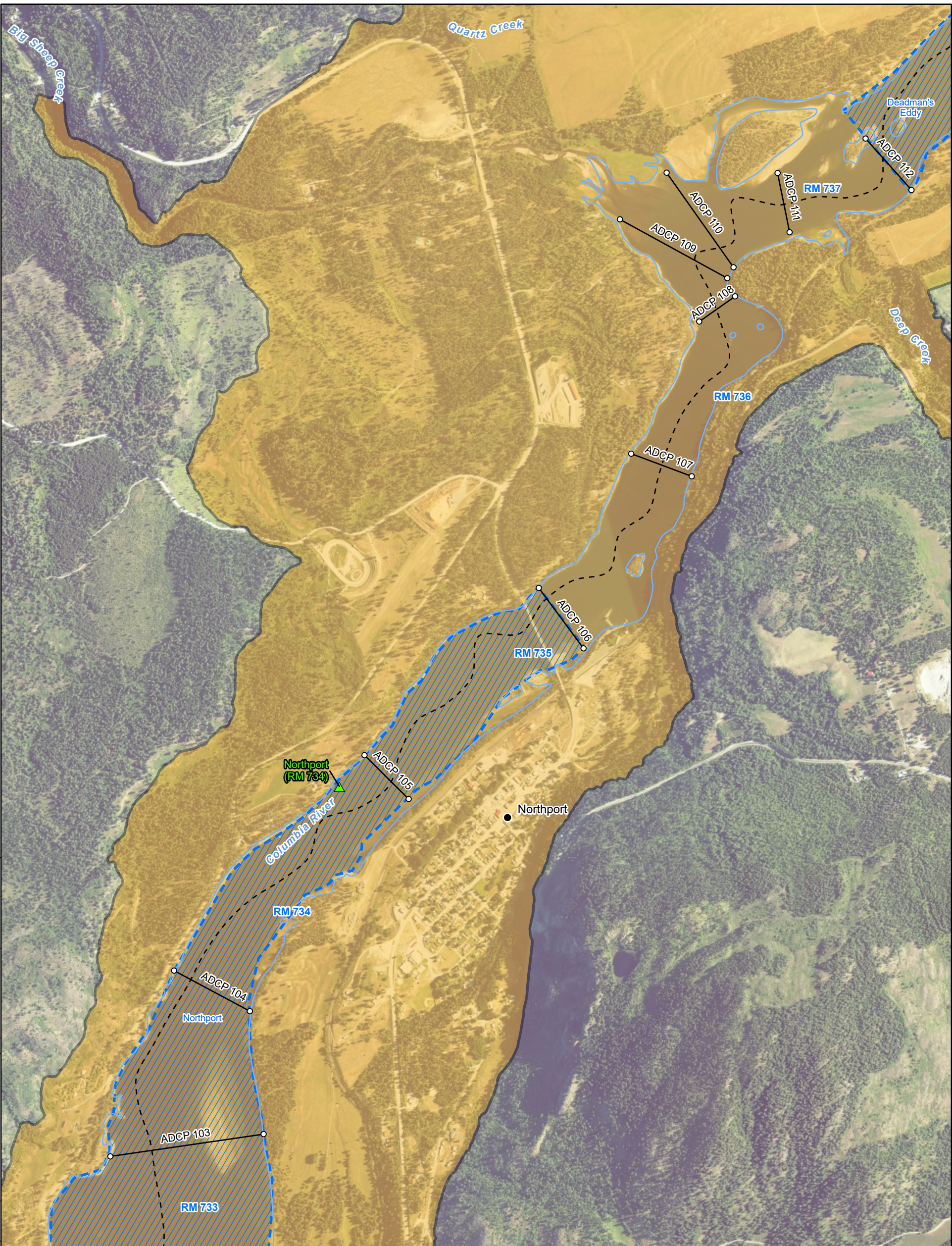
0 650 1,300 2,600 Feet

Map A5-1 Tile 2.
ADCP Transect Locations
 Phase 3 Sediment Study – Sediment Facies
 Mapping QAPP Addendum No. 1
 Upper Columbia River, Washington


ERM

Source: Esri NAIP Imagery Webservice; NAD 1983 2011 StatePlane Washington North FIPS 4601 Ft US

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Legend


- ▲ Water Level Monitoring Station
- City/Town
- ADCP Transects
- - - Thalweg
- Columbia River Shoreline
- Water Level Monitoring Area
- Estimated Topobathymetry Extent (Lidar plus MBES)

Note: Transect endpoint locations are approximate. Actual locations will be determined by vessel access to shallow, nearshore areas during the survey.

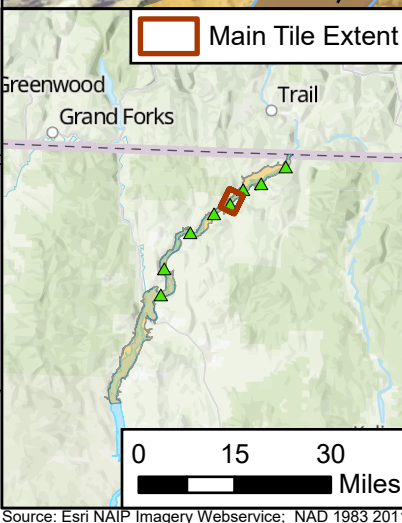
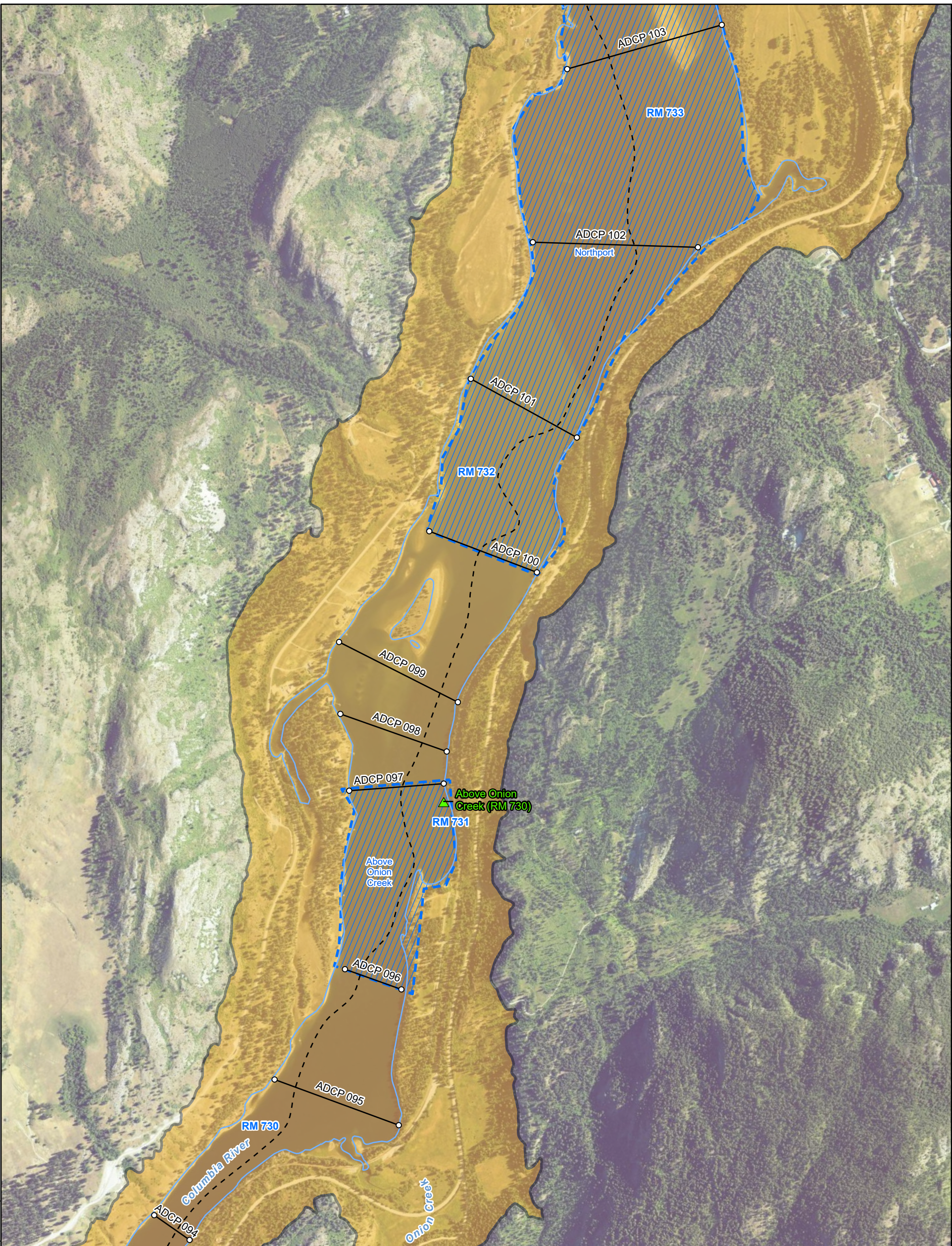
0 625 1,250 2,500 Feet

Map A5-1 Tile 3.
ADCP Transect Locations
 Phase 3 Sediment Study – Sediment Facies Mapping QAPP Addendum No. 1
 Upper Columbia River, Washington





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Legend

- ▲ Water Level Monitoring Station
- ADCP Transects
- - - Thalweg
- Columbia River Shoreline
- Water Level Monitoring Area
- Estimated Topobathymetry Extent (Lidar plus MBES)

Note: Transect endpoint locations are approximate. Actual locations will be determined by vessel access to shallow, nearshore areas during the survey.

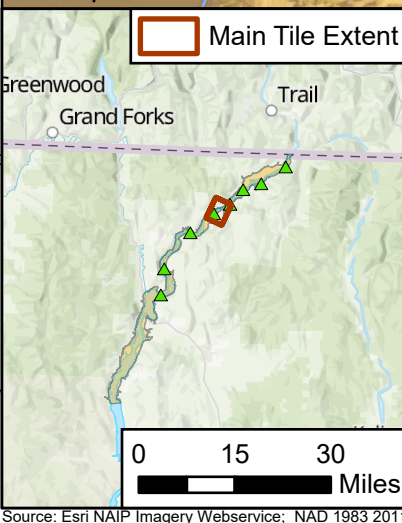
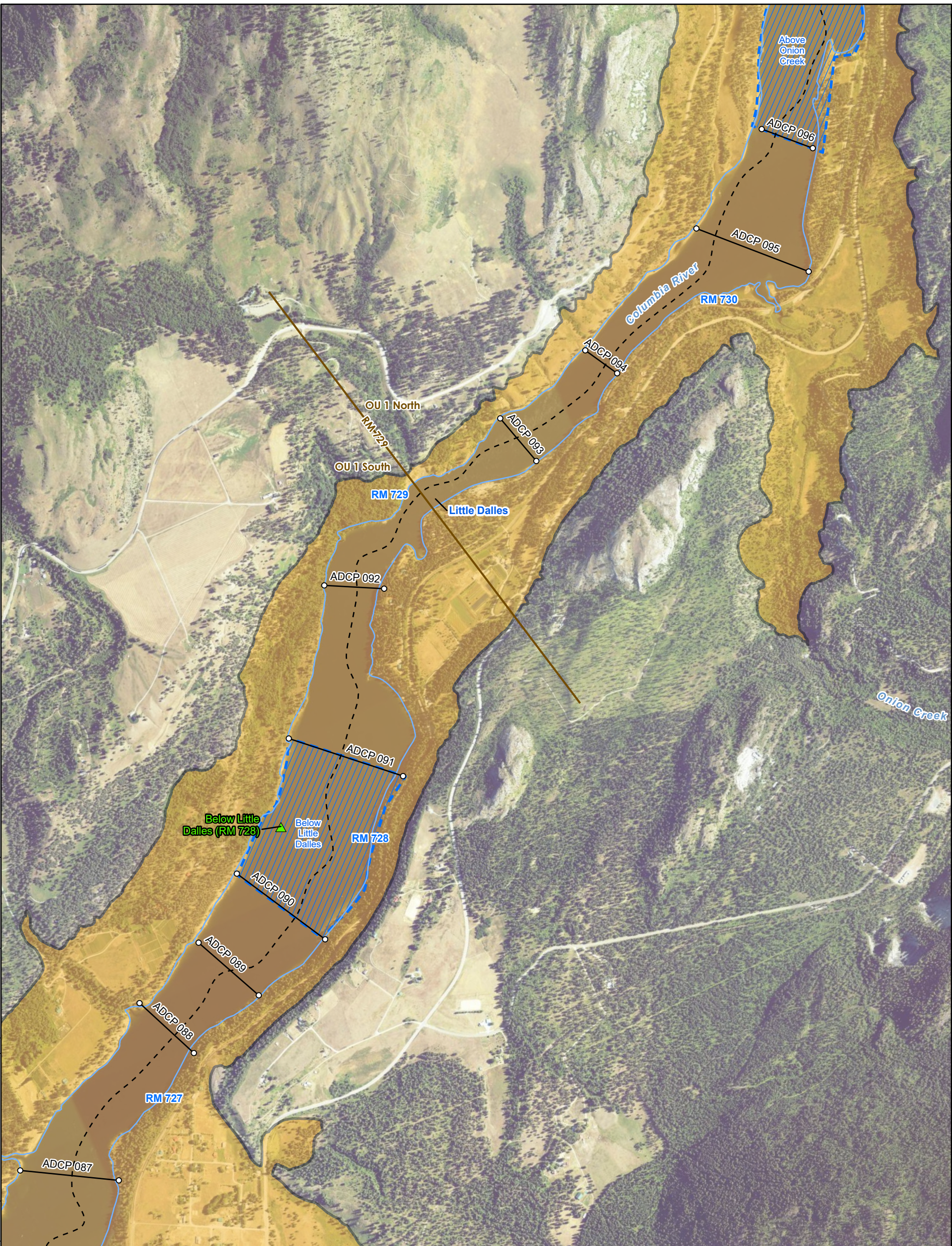
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Map A5-1 Tile 4.
ADCP Transect Locations
 Phase 3 Sediment Study – Sediment Facies
 Mapping QAPP Addendum No. 1
 Upper Columbia River, Washington


ERM

Source: Esri NAIP Imagery Webservice; NAD 1983 2011 StatePlane Washington North FIPS 4601 Ft US

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Legend

- ▲ Water Level Monitoring Station
- ADCP Transects
- - - Thalweg
- Columbia River Shoreline
- Water Level Monitoring Area
- Estimated Topobathymetry Extent (Lidar plus MBES)

Note: Transect endpoint locations are approximate. Actual locations will be determined by vessel access to shallow, nearshore areas during the survey.

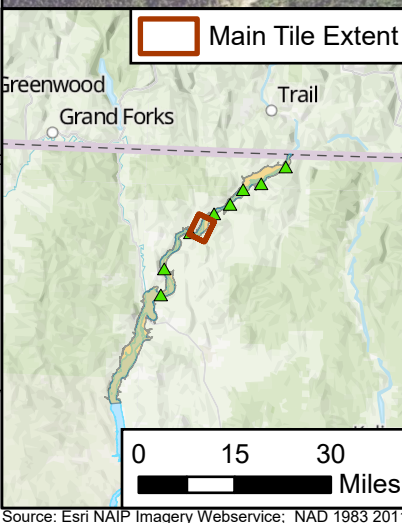
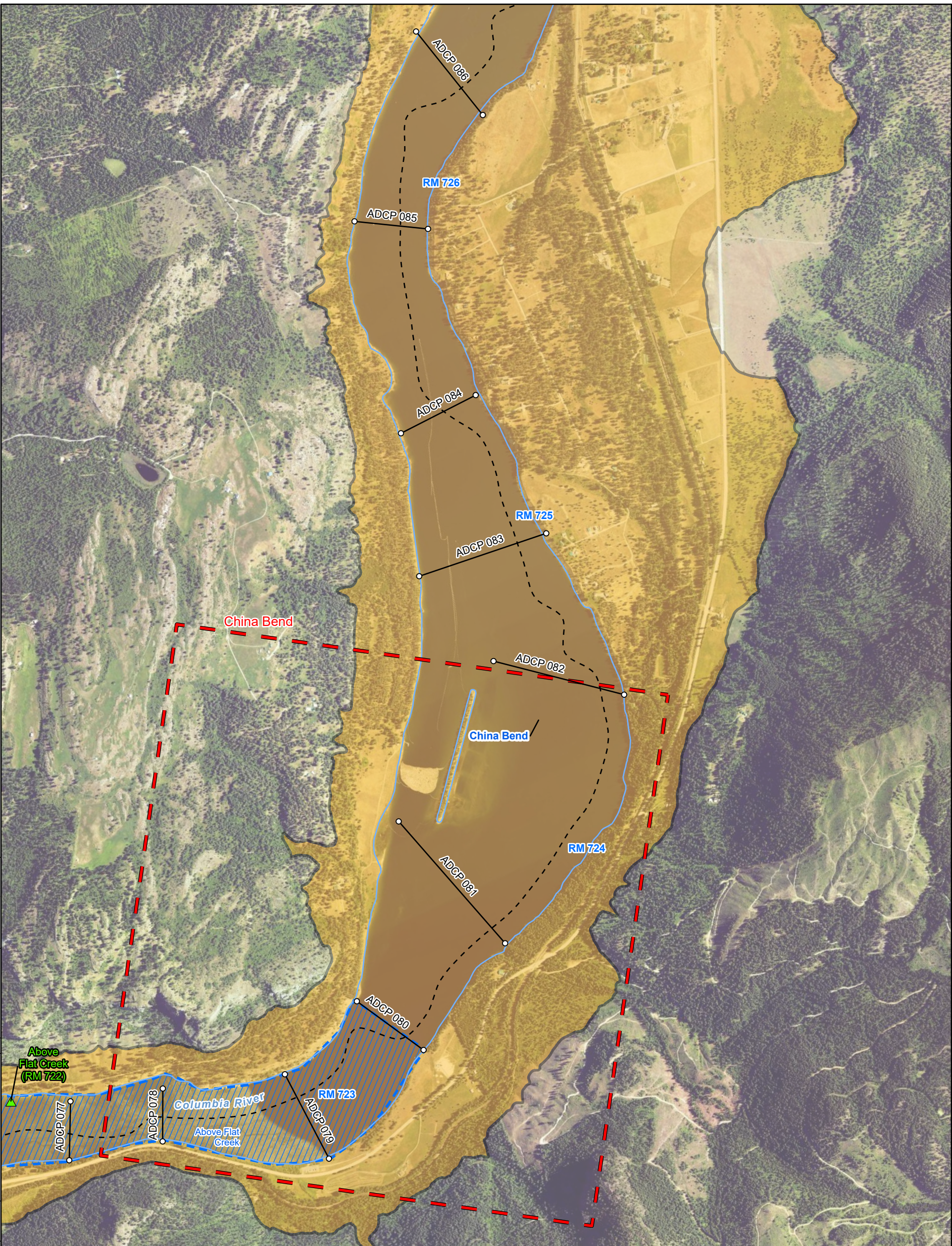
0 650 1,300 2,600 Feet

Map A5-1 Tile 5.
ADCP Transect Locations
 Phase 3 Sediment Study – Sediment Facies Mapping QAPP Addendum No. 1
 Upper Columbia River, Washington


ERM

Source: Esri NAIP Imagery Webservice; NAD 1983 2011 StatePlane Washington North FIPS 4601 Ft US

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Legend

- ▲ Water Level Monitoring Station
- ADCP Transects
- - - Thalweg
- Columbia River Shoreline
- Water Level Monitoring Area
- China Bend Area of Interest
- Estimated Topobathymetry Extent (Lidar plus MBES)

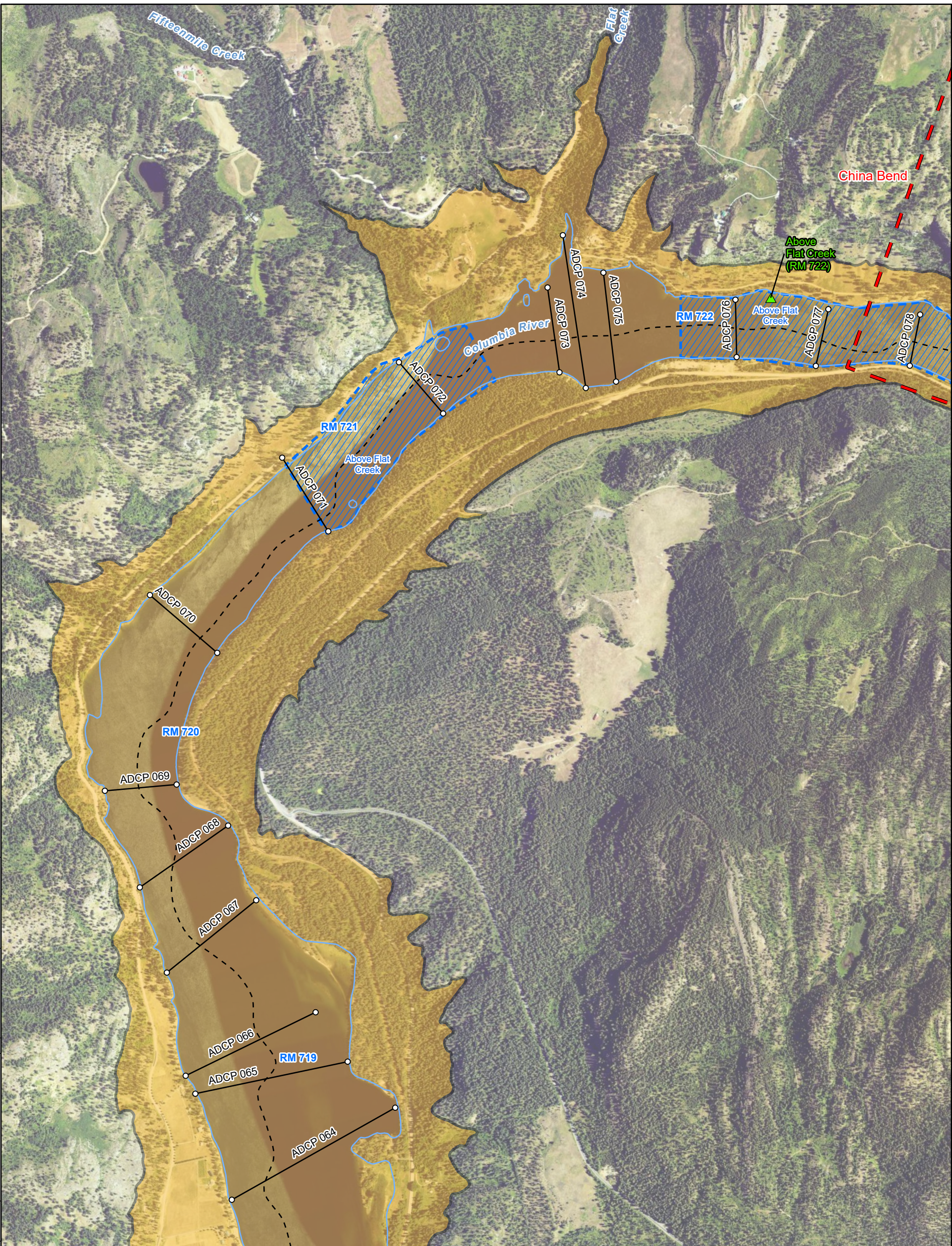
Note: Transect endpoint locations are approximate. Actual locations will be determined by vessel access to shallow, nearshore areas during the survey.

0 650 1,300 2,600 Feet

Map A5-1 Tile 6.
ADCP Transect Locations
 Phase 3 Sediment Study – Sediment Facies
 Mapping QAPP Addendum No. 1
 Upper Columbia River, Washington


ERM

Source: Esri NAIP Imagery Webservice; NAD 1983 2011 StatePlane Washington North FIPS 4601 Ft US

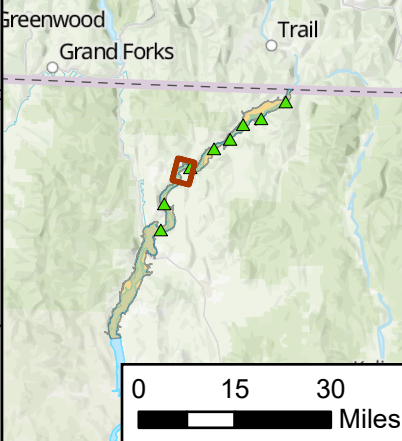


Main Tile Extent

Legend

- Water Level Monitoring Station
- ADCP Transects
- Thalweg
- Columbia River Shoreline
- Water Level Monitoring Area
- China Bend Area of Interest
- Estimated Topobathymetry Extent (Lidar plus MBES)

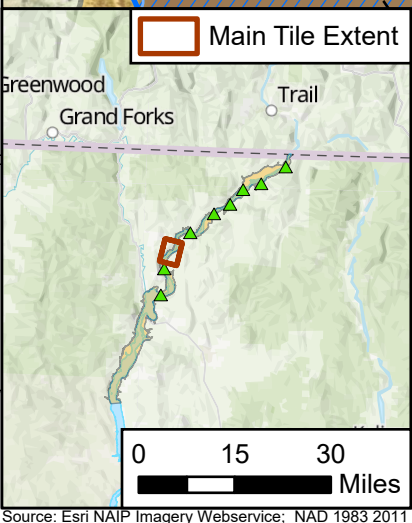
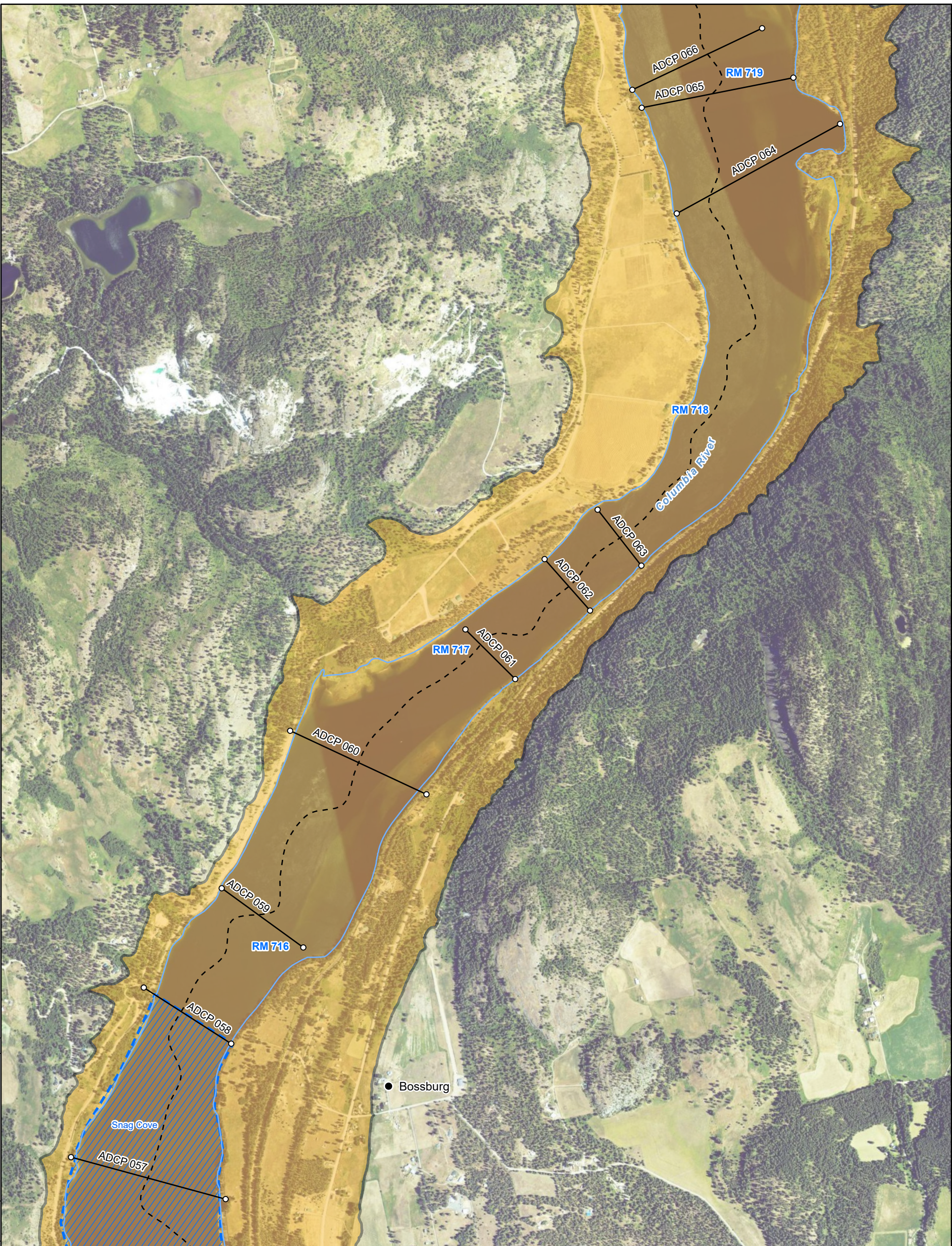
Note: Transect endpoint locations are approximate. Actual locations will be determined by vessel access to shallow, nearshore areas during the survey.



Map A5-1 Tile 7.
ADCP Transect Locations
 Phase 3 Sediment Study – Sediment Facies Mapping QAPP Addendum No. 1
 Upper Columbia River, Washington



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 FILE: M:\US\Projects\5-UT\Tech\0499466_Teck_Upper Columbia River\Maps\Data Gaps 2-4_QAPP.aprx | REVISED: 09/27/2026 | SCALE: 1:17,920 when printed at 11x17




Legend

- City/Town
- ADCP Transects
- - - Thalweg
- Columbia River Shoreline
- ▨ Water Level Monitoring Area
- ▭ Estimated Topobathymetry Extent (Lidar plus MBES)

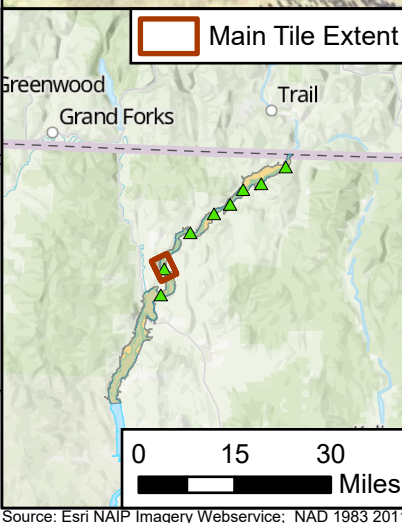
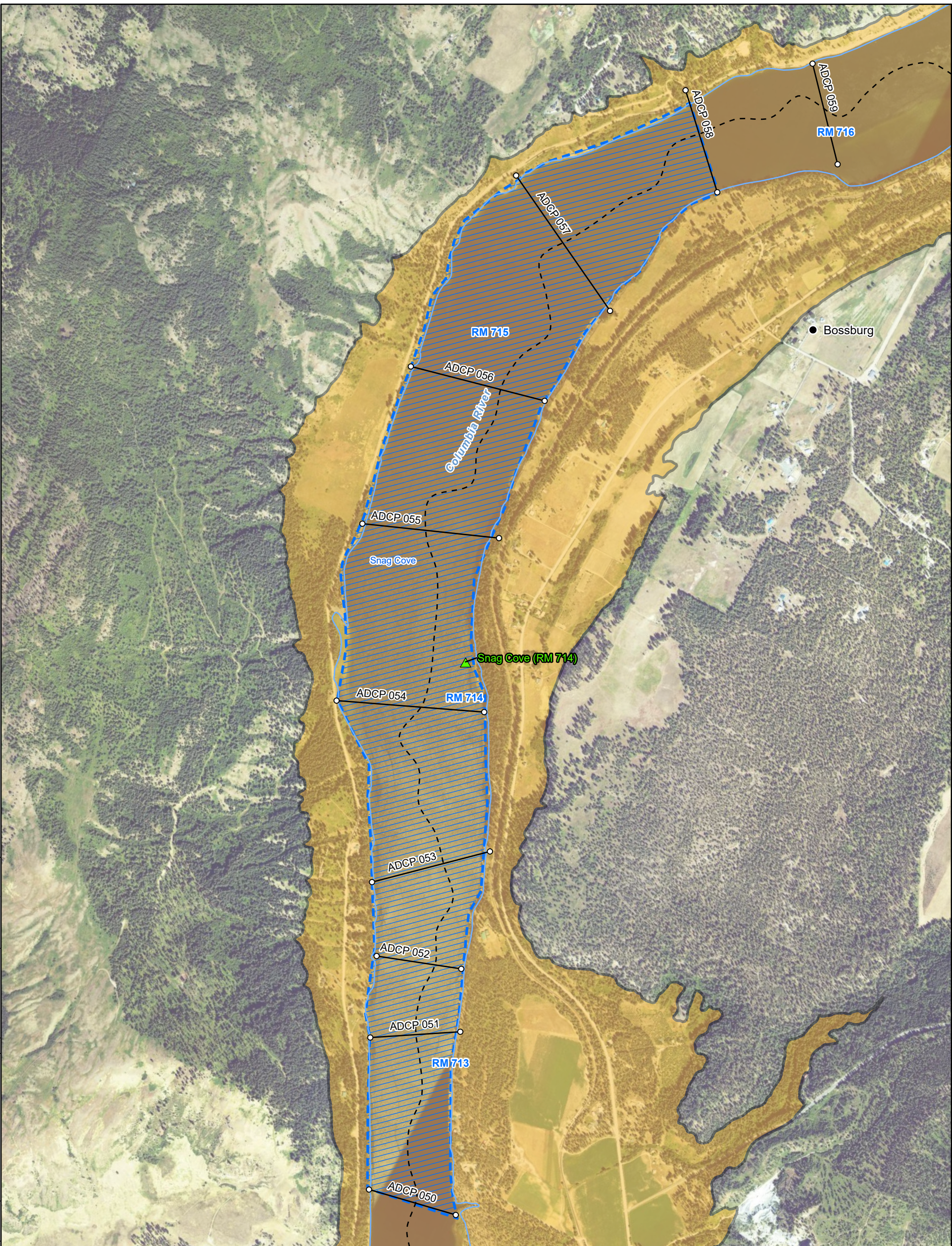
Note: Transect endpoint locations are approximate. Actual locations will be determined by vessel access to shallow, nearshore areas during the survey.

0 650 1,300 2,600 Feet

Map A5-1 Tile 8.
ADCP Transect Locations
 Phase 3 Sediment Study – Sediment Facies
 Mapping QAPP Addendum No. 1
 Upper Columbia River, Washington

 **ERM**

DRAWN BY: David Evans & Assoc
 FILE: M:\US\Projects\5-UT\Tech\0499466_Teck_Upper Columbia River\Maps\Data Gaps 2-4_QAPP.aprx | REVISED: 09/27/2026 | SCALE: 1:17,040 when printed at 11x17




Legend

- ▲ Water Level Monitoring Station
- City/Town
- ADCP Transects
- - - Thalweg
- Columbia River Shoreline
- Water Level Monitoring Area
- Estimated Topobathymetry Extent (Lidar plus MBES)

Note: Transect endpoint locations are approximate. Actual locations will be determined by vessel access to shallow, nearshore areas during the survey.

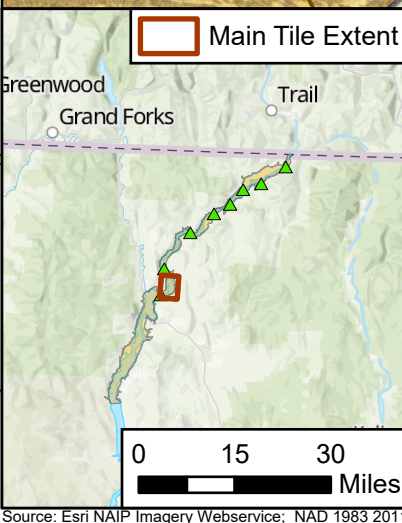
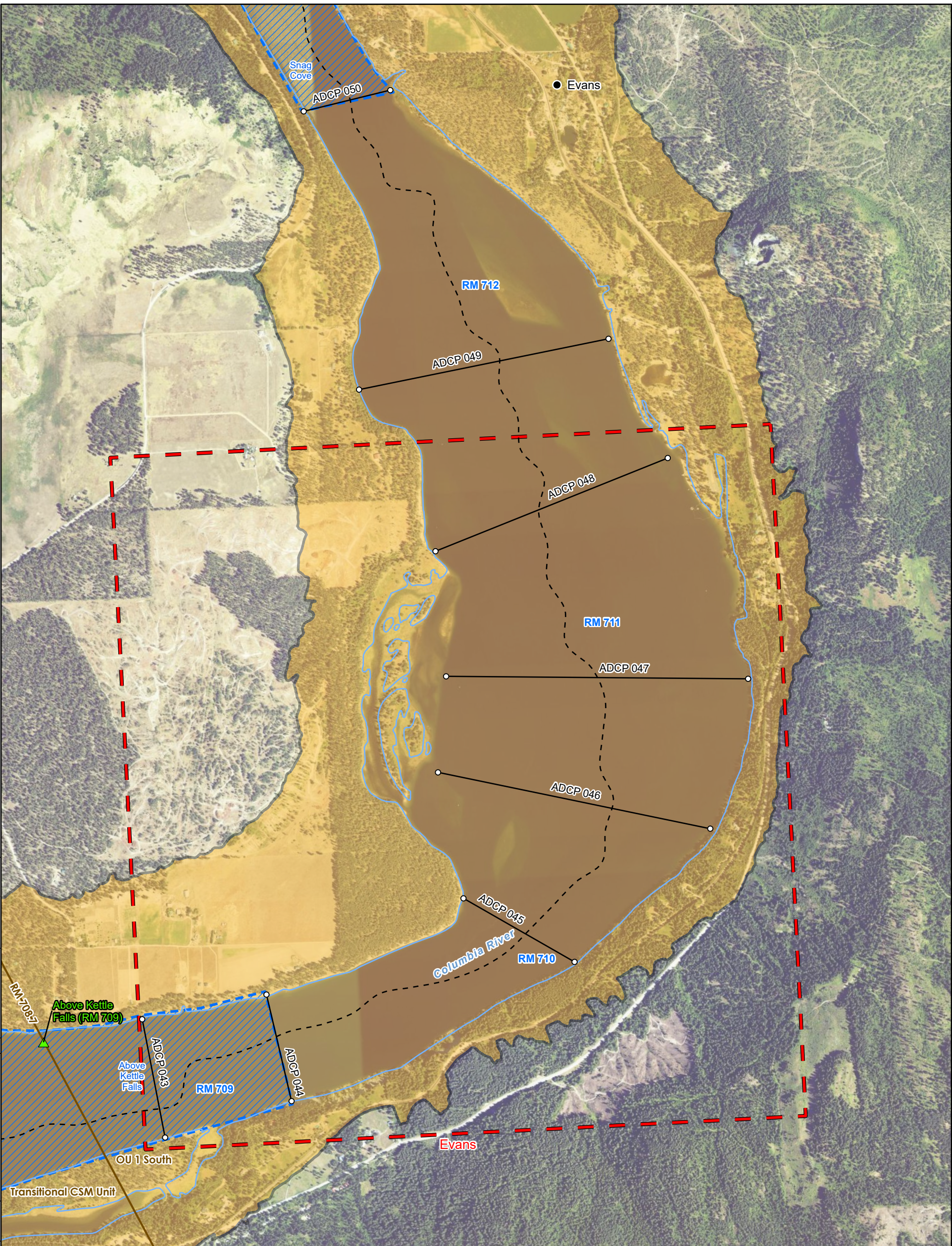
0 650 1,300 2,600 Feet

Map A5-1 Tile 9.
ADCP Transect Locations
 Phase 3 Sediment Study – Sediment Facies Mapping QAPP Addendum No. 1
 Upper Columbia River, Washington


ERM

Source: Esri NAIP Imagery Webservice; NAD 1983 2011 StatePlane Washington North FIPS 4601 Ft US

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Legend

- ▲ Water Level Monitoring Station
- City/Town
- ADCP Transects
- - - Thalweg
- Columbia River Shoreline
- Water Level Monitoring Area
- Evans Area of Interest
- Estimated Topobathymetry Extent (Lidar plus MBES)

Note: Transect endpoint locations are approximate. Actual locations will be determined by vessel access to shallow, nearshore areas during the survey.

0 15 30
Miles

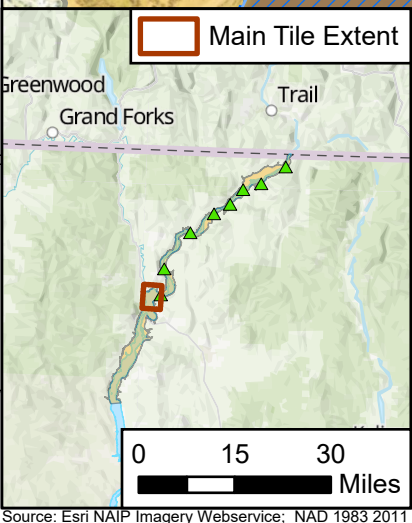
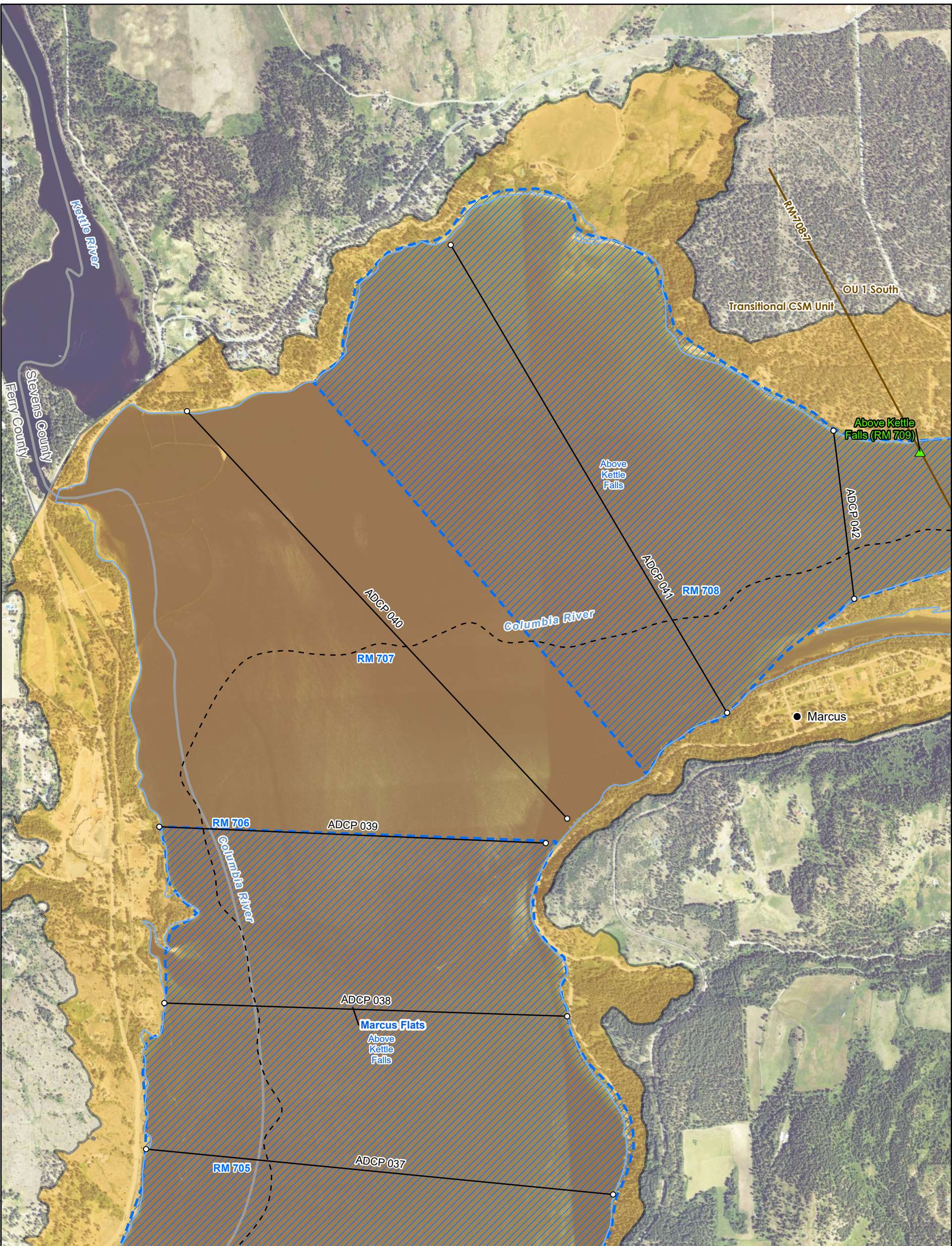
0 650 1,300 2,600
Feet

N

Map A5-1 Tile 10.
ADCP Transect Locations
 Phase 3 Sediment Study – Sediment Facies
 Mapping QAPP Addendum No. 1
 Upper Columbia River, Washington

Source: Esri NAIP Imagery Webservice; NAD 1983 2011 StatePlane Washington North FIPS 4601 Ft US

DRAWN BY: David Evans & Assoc
 FILE: M:\US\Projects\S-UIT\Tech\0499466_Teck_Upper_Columbia_River\Maps\Data_Gaps_2-4_QAPP\UCR_AQ_RI_DG_2-4_QAPP.aprx | REVISED: 09/27/2026 | SCALE: 1:18,120 when printed at 11x17



Legend

- ▲ Water Level Monitoring Station
- City/Town
- ADCP Transects
- - - Thalweg
- Columbia River Shoreline
- County Boundary
- Water Level Monitoring Area
- Estimated Topobathymetry Extent (Lidar plus MBES)

Note: Transect endpoint locations are approximate. Actual locations will be determined by vessel access to shallow, nearshore areas during the survey.

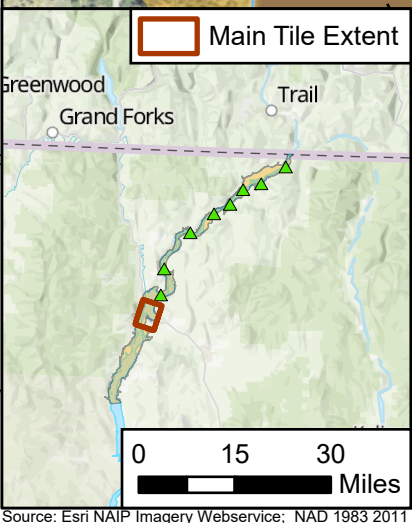
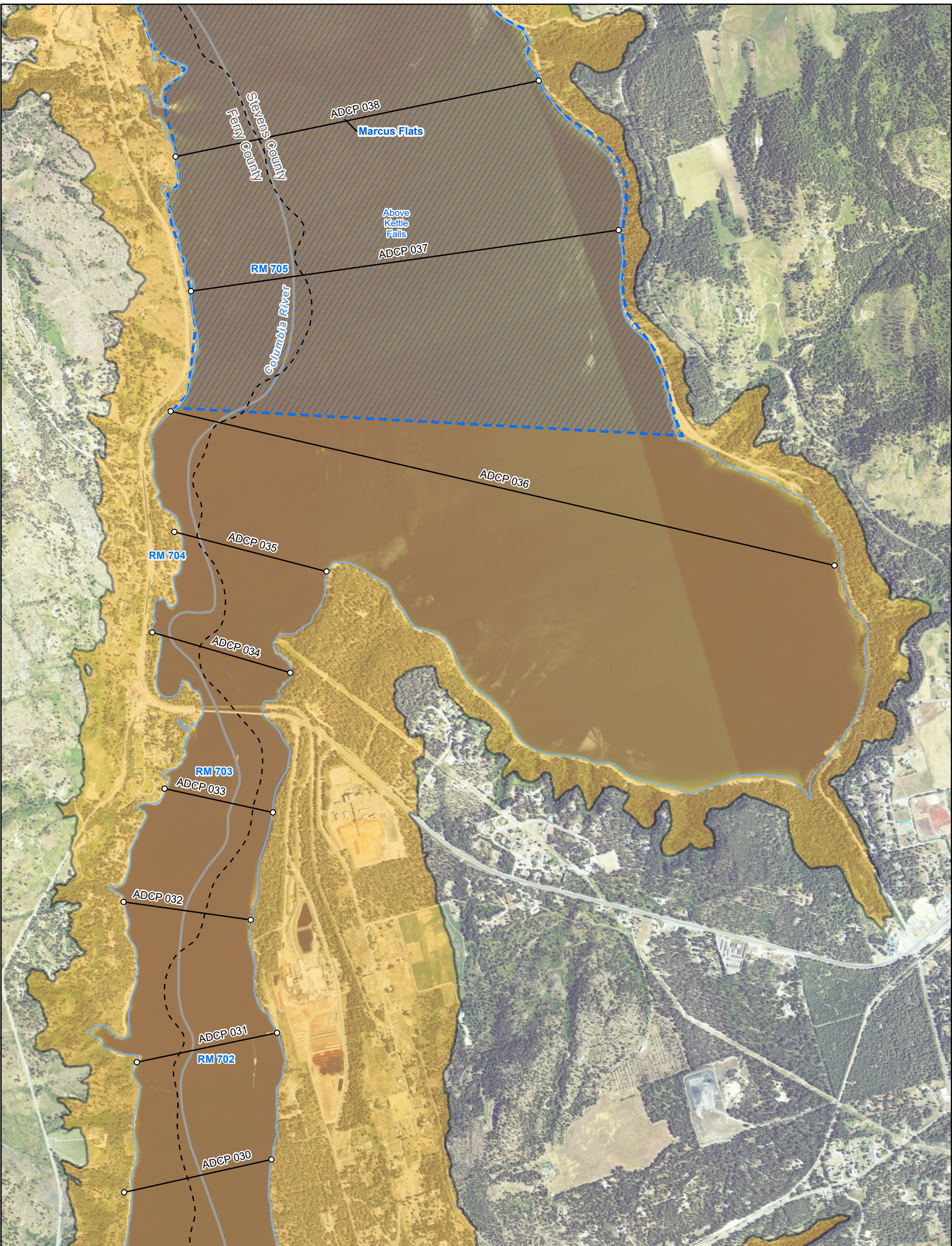
0 700 1,400 2,800

Feet

N

Map A5-1 Tile 11.
ADCP Transect Locations
 Phase 3 Sediment Study – Sediment Facies Mapping QAPP Addendum No. 1
 Upper Columbia River, Washington

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 FILE: M:\US\Projects\5-UT\Tech\0499466_Teck_Upper Columbia River\Maps\Data Gaps 2-4_QAPP\CR AQ RI DG 2-4_QAPP.aprx | REVISED: 09/27/2026 | SCALE: 1:19,680 when printed at 11x17



Legend

- ADCP Transects
- Thalweg
- Columbia River Shoreline
- County Boundary
- Water Level Monitoring Area
- Estimated Topobathymetry Extent (Lidar plus MBES)

Note: Transect endpoint locations are approximate. Actual locations will be determined by vessel access to shallow, nearshore areas during the survey.

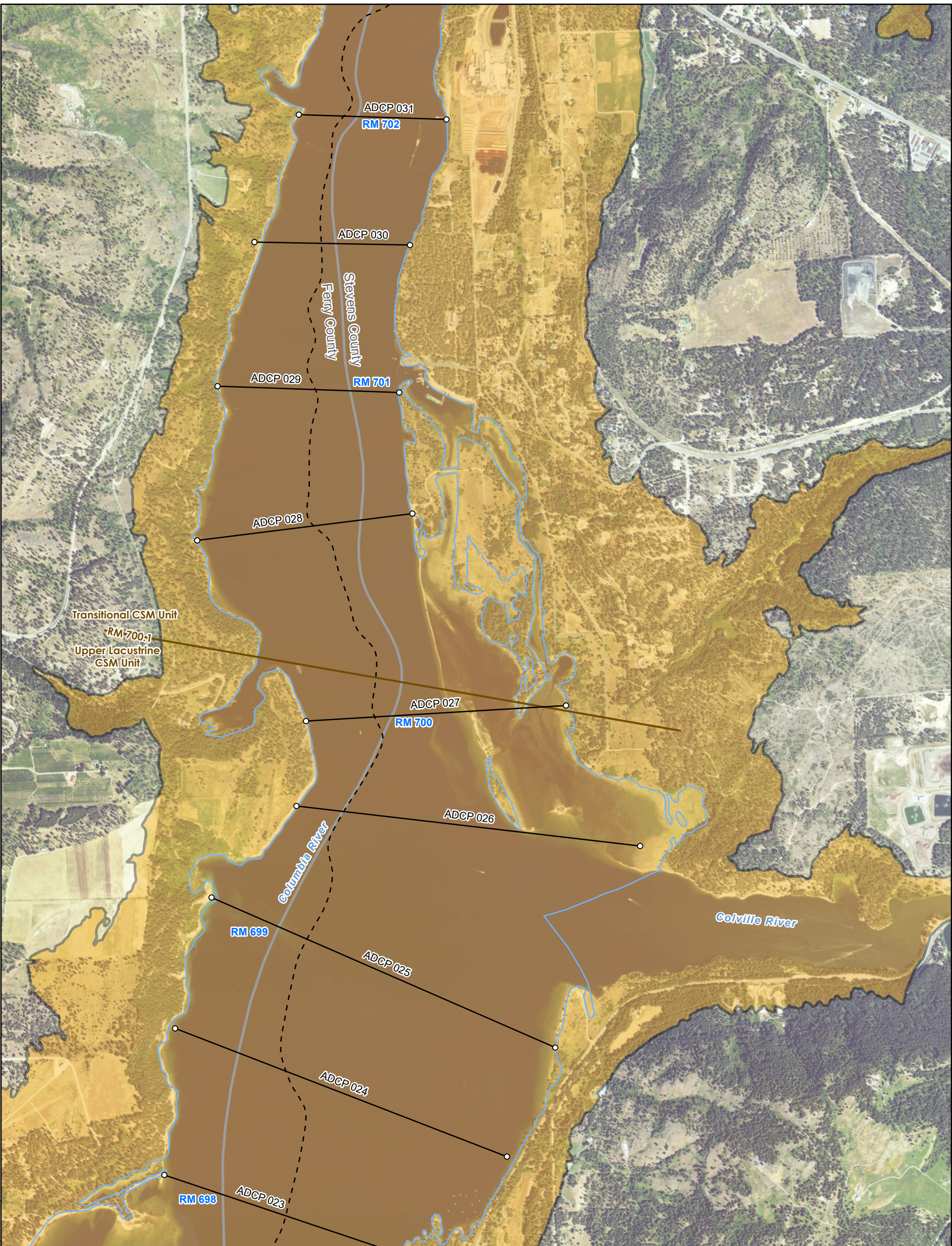
0 750 1,500 3,000 Feet

Map A5-1 Tile 12.
ADCP Transect Locations
 Phase 3 Sediment Study – Sediment Facies
 Mapping QAPP Addendum No. 1
 Upper Columbia River, Washington

ERM

Source: Esri NAIP Imagery Webservice; NAD 1983 2011 StatePlane Washington North FIPS 4601 Ft US

DRAWN BY: David Evans & Assoc
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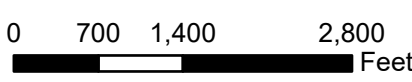
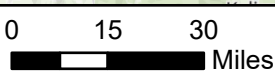
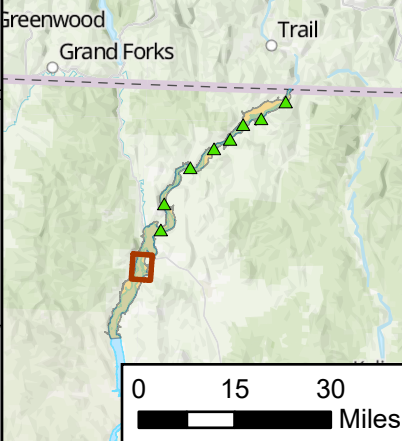


Main Tile Extent

Legend

- ADCP Transects
- Thalweg
- Columbia River Shoreline
- County Boundary
- Estimated Topobathymetry Extent (Lidar plus MBES)

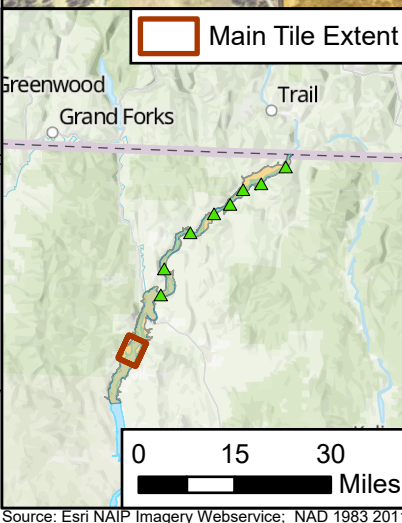
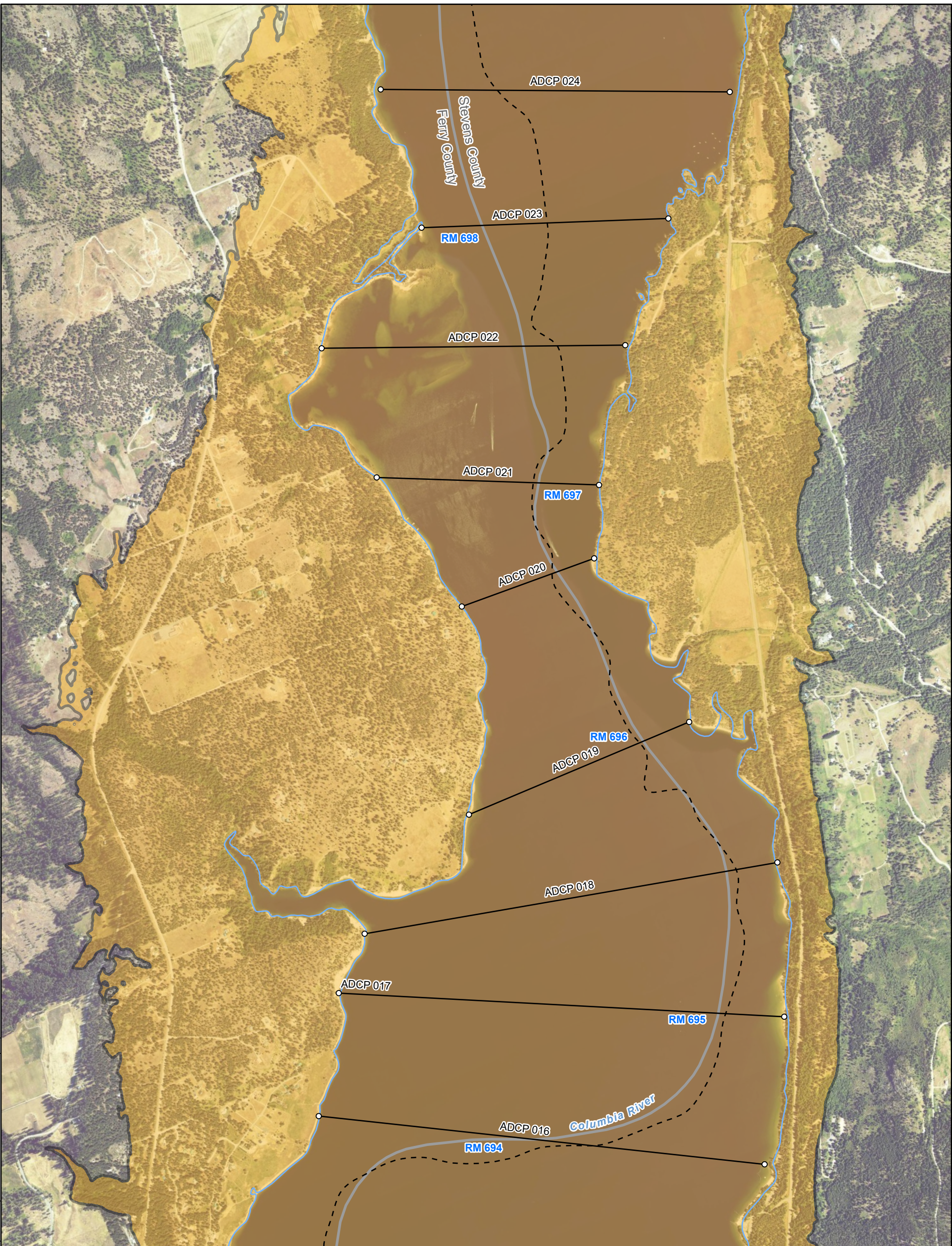
Note: Transect endpoint locations are approximate. Actual locations will be determined by vessel access to shallow, nearshore areas during the survey.



Map A5-1 Tile 13.
ADCP Transect Locations
 Phase 3 Sediment Study – Sediment Facies
 Mapping QAPP Addendum No. 1
 Upper Columbia River, Washington



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Legend

- ADCP Transects
- Thalweg
- Columbia River Shoreline
- County Boundary
- Estimated Topobathymetry Extent (Lidar plus MBES)

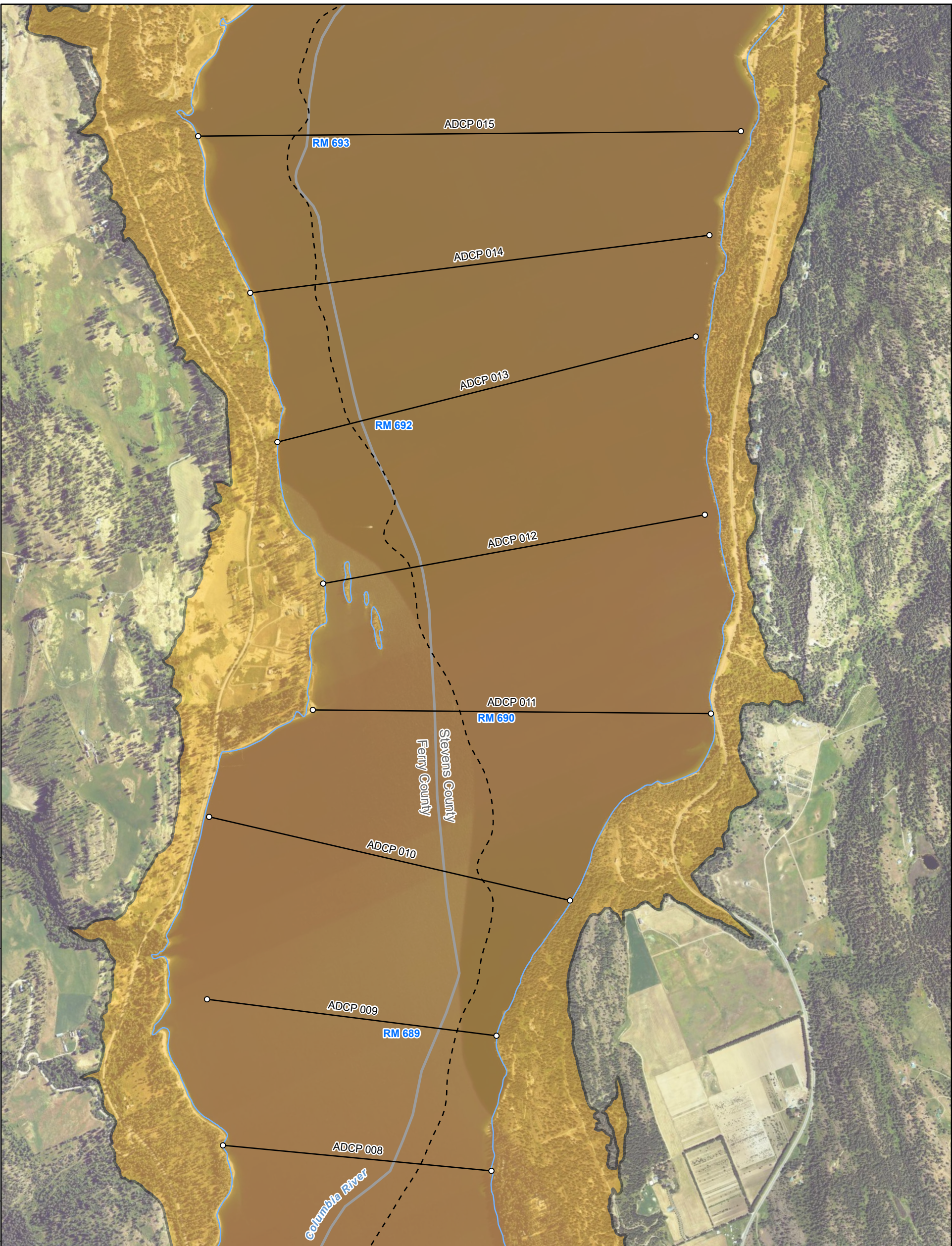
Note: Transect endpoint locations are approximate. Actual locations will be determined by vessel access to shallow, nearshore areas during the survey.

0 750 1,500 3,000 Feet

Map A5-1 Tile 14.
ADCP Transect Locations
 Phase 3 Sediment Study – Sediment Facies
 Mapping QAPP Addendum No. 1
 Upper Columbia River, Washington



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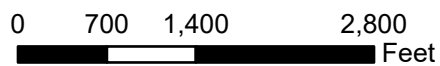
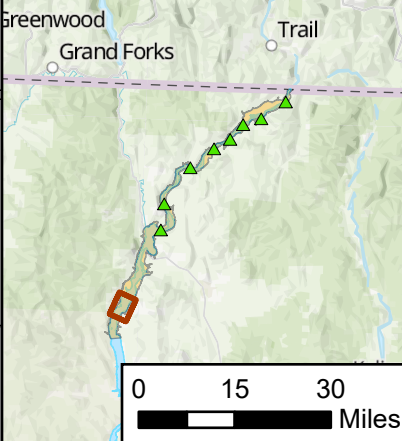


Main Tile Extent

Legend

- ADCP Transects
- Thalweg
- Columbia River Shoreline
- County Boundary
- Estimated Topobathymetry Extent (Lidar plus MBES)

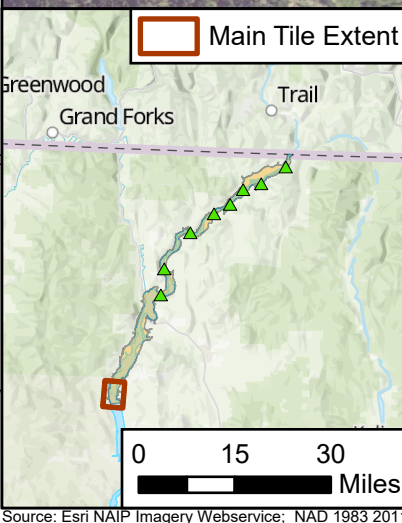
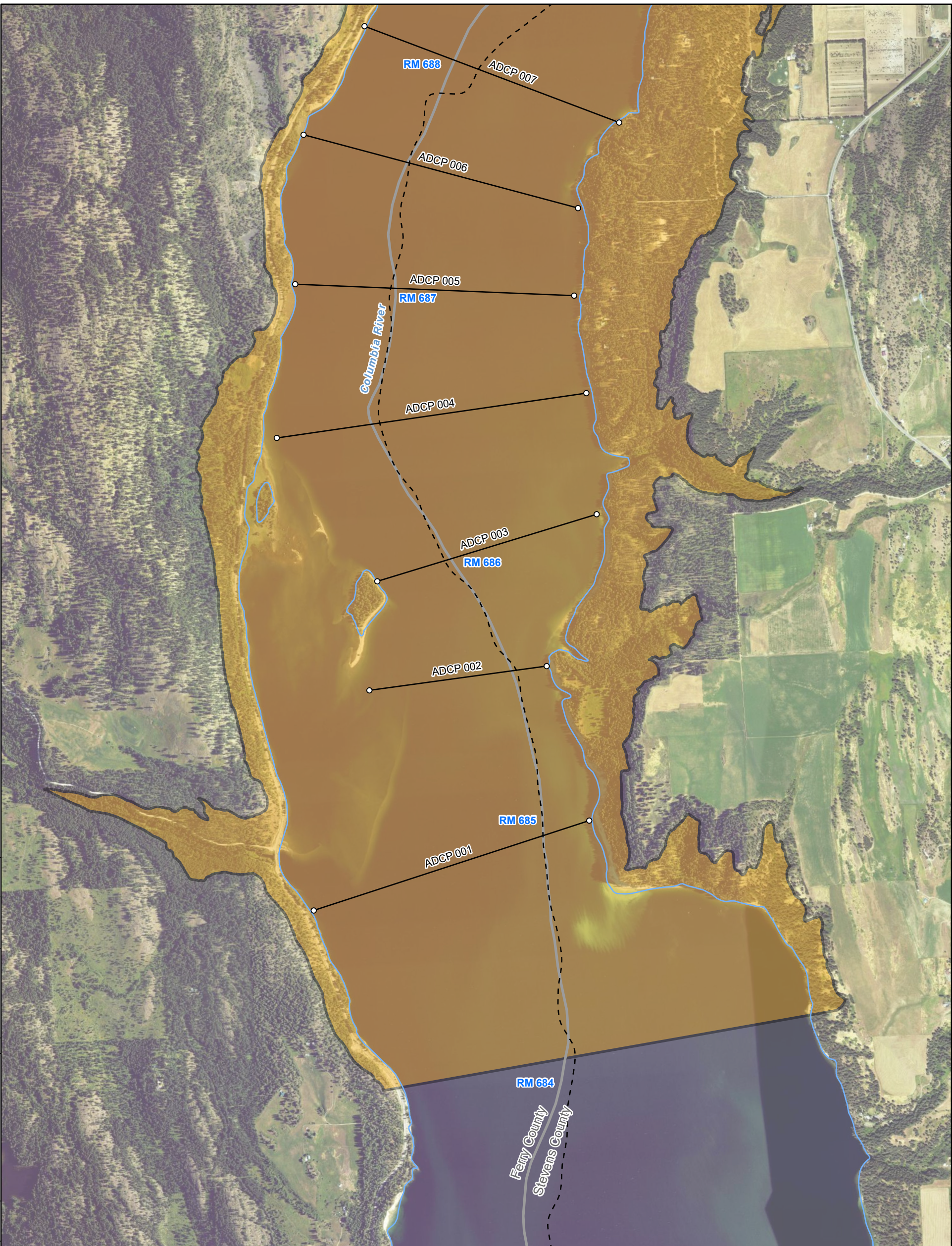
Note: Transect endpoint locations are approximate. Actual locations will be determined by vessel access to shallow, nearshore areas during the survey.



Map A5-1 Tile 15.
ADCP Transect Locations
 Phase 3 Sediment Study – Sediment Facies
 Mapping QAPP Addendum No. 1
 Upper Columbia River, Washington



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Legend

- ADCP Transects
- Thalweg
- Columbia River Shoreline
- County Boundary
- Estimated Topobathymetry Extent (Lidar plus MBES)

Note: Transect endpoint locations are approximate. Actual locations will be determined by vessel access to shallow, nearshore areas during the survey.

0 750 1,500 3,000 Feet

Map A5-1 Tile 16.
ADCP Transect Locations
 Phase 3 Sediment Study – Sediment Facies Mapping QAPP Addendum No. 1
 Upper Columbia River, Washington


ERM

Source: Esri NAIP Imagery Webservice; NAD 1983 2011 StatePlane Washington North FIPS 4601 Ft US

TABLES

Table A4-1. Technical Team Task Member Information

Name	Task Role	Phone Number	Email Address
EPA			
Bonnie Arthur	EPA Project Manager	(206) 553-4072	arthur.bonnie@epa.gov
Cindy Fields	EPA Region 10 QA Manager	(206) 553-1893	fields.cindy@epa.gov
TAI			
Rob Orr	TAI Project Coordinator, Subcontractor Coordinator	(509) 623-4551	rob.orr@teck.com
Elena Wolf	TAI Assistant Project Coordinator	(509) 623-4524	elena.wolf@teck.com
Cristy Kessel	Database Administrator	(509) 496-1160	cristy.kessel@teck.com
Consultant Team			
Jennifer Holder	Principal Investigator	(805) 680-8484	jennifer.holder@erm.com
Tim McClinton	Senior Technical Advisor	(843) 475-4394	tim.mcclinton@deainc.com
John Staly	Task Manager	(360) 314-3216	jxst@deainc.com
Riley Newman	Task Manager	(907) 982-4073	rsn@deainc.com
Kathy Jepson	Task Manager	(541) 343-8877	kjepson@geoterra.us
TBD	Field Supervisor	TBD	TBD
Acoustic and Aerial Survey Subcontractors			
Tim McClinton	Acoustic Subcontractor Project Manager	(843) 475-4394	tim.mcclinton@deainc.com
Riley Newman	Acoustic Subcontractor QA Manager	(907) 982-4073	rsn@deainc.com
Brad Hille	Aerial Survey Subcontractor Project Manager	(503) 239-6010	bhille@geoterra.us
Bret Hazell	Aerial Survey Subcontractor QA Manager	(541) 343-8877	bhazell@geoterra.us

Notes:

QA - quality assurance

TBD - to be determined

Table A5-1. ADCP Transect Endpoint Locations

ADCP Transect Number	Endpoint Position	Washington State Plane North Zone ^a		UTM Zone 11 North ^a		Approximate River Mile	Map A5-1 Tile(s)
		X-Coordinate (ft)	Y-Coordinate (ft)	X-Coordinate (m)	Y-Coordinate (m)		
139	right bank	2,407,657	745,356	453,433	5,427,599	744.9	Tile 1
139	left bank	2,409,040	744,720	453,844	5,427,384	744.9	Tile 1
138	right bank	2,406,711	744,168	453,127	5,427,252	744.5	Tile 1
138	left bank	2,407,873	743,419	453,469	5,427,006	744.5	Tile 1
137	right bank	2,406,414	741,149	452,990	5,426,338	744.0	Tile 1
137	left bank	2,407,330	741,062	453,268	5,426,297	744.0	Tile 1
136	right bank	2,406,290	739,732	452,931	5,425,908	743.7	Tile 1
136	left bank	2,407,218	739,683	453,213	5,425,879	743.7	Tile 1
135	right bank	2,406,241	738,594	452,899	5,425,563	743.5	Tile 1
135	left bank	2,407,218	738,297	453,192	5,425,457	743.5	Tile 1
134	left bank	2,406,899	735,993	453,059	5,424,761	743.1	Tile 1
134	right bank	2,406,129	736,502	452,833	5,424,928	743.1	Tile 1
133	left bank	2,406,663	735,738	452,984	5,424,687	743.0	Tile 1
133	right bank	2,405,968	736,085	452,778	5,424,804	743.0	Tile 1
132	left bank	2,405,499	734,832	452,616	5,424,429	742.8	Tile 1
132	right bank	2,405,471	735,773	452,622	5,424,716	742.8	Tile 1
131	left bank	2,404,846	734,633	452,414	5,424,379	742.7	Tile 1
131	right bank	2,404,730	735,453	452,391	5,424,630	742.7	Tile 1
130	left bank	2,403,544	733,986	452,008	5,424,202	742.3	Tile 1
130	right bank	2,403,094	734,710	451,882	5,424,429	742.3	Tile 1
129	left bank	2,402,251	733,054	451,601	5,423,938	742.0	Tile 1
129	right bank	2,401,806	733,673	451,475	5,424,133	742.0	Tile 1
128	left bank	2,400,900	732,379	451,179	5,423,753	741.8	Tile 1
128	right bank	2,400,635	732,955	451,107	5,423,932	741.8	Tile 1
127	left bank	2,399,903	731,836	450,867	5,423,603	741.5	Tile 1
127	right bank	2,399,496	732,412	450,752	5,423,784	741.5	Tile 1
126	left bank	2,398,184	729,984	450,316	5,423,065	741.0	Tile 2
126	right bank	2,397,489	730,516	450,113	5,423,238	741.0	Tile 2
125	left bank	2,395,845	728,350	449,580	5,422,604	740.5	Tile 2
125	right bank	2,395,509	729,023	449,488	5,422,814	740.5	Tile 2
124	left bank	2,392,999	727,064	448,694	5,422,256	739.9	Tile 2
124	right bank	2,392,779	727,642	448,636	5,422,435	739.9	Tile 2
123	left bank	2,391,231	726,252	448,144	5,422,035	739.5	Tile 2
123	right bank	2,390,854	726,874	448,039	5,422,231	739.5	Tile 2
122	right bank	2,389,797	726,155	447,706	5,422,028	739.3	Tile 2
122	left bank	2,390,334	725,667	447,862	5,421,871	739.3	Tile 2
121	left bank	2,390,030	724,370	447,750	5,421,481	739.0	Tile 2
121	right bank	2,388,826	724,617	447,387	5,421,574	739.0	Tile 2
120	right bank	2,388,424	723,561	447,249	5,421,259	738.7	Tile 2
120	left bank	2,389,016	722,783	447,417	5,421,013	738.7	Tile 2
119	left bank	2,387,721	720,672	446,991	5,420,391	738.4	Tile 2
119	right bank	2,387,247	722,487	446,874	5,420,950	738.4	Tile 2
118	left bank	2,387,344	720,216	446,869	5,420,258	738.4	Tile 2
118	right bank	2,387,477	722,555	446,945	5,420,967	738.4	Tile 2
117	left bank	2,387,067	720,230	446,785	5,420,266	738.3	Tile 2
117	right bank	2,386,983	722,452	446,793	5,420,944	738.3	Tile 2
116	left bank	2,386,587	720,476	446,643	5,420,349	738.3	Tile 2
116	right bank	2,386,655	722,452	446,694	5,420,949	738.3	Tile 2
115	left bank	2,384,796	721,863	446,119	5,420,798	737.9	Tile 2
115	right bank	2,384,822	723,525	446,152	5,421,303	737.9	Tile 2
114	left bank	2,384,691	721,849	446,087	5,420,795	737.9	Tile 2

Table A5-1. ADCP Transect Endpoint Locations

ADCP Transect Number	Endpoint Position	Washington State Plane North Zone ^a		UTM Zone 11 North ^a		Approximate River Mile	Map A5-1 Tile(s)
		X-Coordinate (ft)	Y-Coordinate (ft)	X-Coordinate (m)	Y-Coordinate (m)		
114	right bank	2,385,260	723,350	446,283	5,421,243	737.9	Tile 2
113	left bank	2,383,412	722,157	445,702	5,420,908	737.6	Tile 2
113	right bank	2,383,135	722,998	445,631	5,421,168	737.6	Tile 2
112	left bank	2,381,869	720,685	445,210	5,420,484	737.3	Tile 2, Tile 3
112	right bank	2,381,421	721,556	445,087	5,420,756	737.3	Tile 2, Tile 3
111	left bank	2,380,043	720,539	444,652	5,420,467	737.0	Tile 3
111	right bank	2,380,089	721,396	444,679	5,420,727	737.0	Tile 3
110	left bank	2,379,147	720,257	444,376	5,420,395	736.7	Tile 3
110	right bank	2,378,564	721,795	444,221	5,420,872	736.7	Tile 3
109	left bank	2,379,022	720,129	444,336	5,420,358	736.5	Tile 3
109	right bank	2,377,755	721,320	443,968	5,420,740	736.5	Tile 3
108	right bank	2,378,483	719,633	444,164	5,420,215	736.4	Tile 3
108	left bank	2,379,066	719,852	444,345	5,420,273	736.4	Tile 3
107	right bank	2,377,077	718,059	443,712	5,419,758	735.8	Tile 3
107	left bank	2,377,829	717,533	443,933	5,419,586	735.8	Tile 3
106	right bank	2,375,329	716,543	443,157	5,419,323	735.2	Tile 3
106	left bank	2,375,729	715,552	443,264	5,419,015	735.2	Tile 3
105	right bank	2,372,338	714,864	442,221	5,418,857	734.5	Tile 3
105	left bank	2,372,789	714,104	442,347	5,418,619	734.5	Tile 3
104	right bank	2,368,953	712,581	441,157	5,418,214	733.7	Tile 3
104	left bank	2,369,851	711,753	441,417	5,417,949	733.7	Tile 3
103	right bank	2,367,416	710,254	440,654	5,417,529	733.2	Tile 3, Tile 4
103	left bank	2,369,603	710,014	441,315	5,417,423	733.2	Tile 3, Tile 4
102	right bank	2,366,086	708,240	440,218	5,416,937	732.7	Tile 4
102	left bank	2,368,151	707,323	440,833	5,416,626	732.7	Tile 4
101	right bank	2,364,596	706,831	439,743	5,416,531	732.2	Tile 4
101	left bank	2,365,635	705,540	440,040	5,416,122	732.2	Tile 4
100	left bank	2,364,433	704,040	439,651	5,415,684	731.8	Tile 4
100	right bank	2,363,282	705,116	439,318	5,416,029	731.8	Tile 4
099	left bank	2,362,762	702,805	439,124	5,415,333	731.4	Tile 4
099	right bank	2,361,568	704,180	438,782	5,415,770	731.4	Tile 4
098	left bank	2,362,366	702,238	438,995	5,415,167	731.2	Tile 4
098	right bank	2,361,212	703,263	438,660	5,415,497	731.2	Tile 4
097	left bank	2,362,162	701,847	438,927	5,415,051	731.1	Tile 4
097	right bank	2,360,927	702,246	438,557	5,415,191	731.1	Tile 4
096	left bank	2,360,563	699,461	438,404	5,414,349	730.5	Tile 4, Tile 5
096	right bank	2,359,952	700,008	438,227	5,414,525	730.5	Tile 4, Tile 5
095	left bank	2,359,828	697,755	438,154	5,413,841	730.2	Tile 4, Tile 5
095	right bank	2,358,491	698,976	437,766	5,414,233	730.2	Tile 4, Tile 5
094	left bank	2,356,586	697,384	437,162	5,413,778	729.6	Tile 4, Tile 5
094	right bank	2,356,266	697,880	437,072	5,413,934	729.6	Tile 4, Tile 5
093	left bank	2,354,972	696,600	436,659	5,413,564	729.3	Tile 5
093	right bank	2,354,701	697,395	436,589	5,413,810	729.3	Tile 5
092	right bank	2,351,319	696,023	435,539	5,413,444	728.7	Tile 5
092	left bank	2,352,140	695,649	435,783	5,413,317	728.7	Tile 5
091	right bank	2,349,981	694,075	435,102	5,412,871	728.2	Tile 5
091	left bank	2,351,375	692,920	435,509	5,412,499	728.2	Tile 5
090	left bank	2,349,388	691,063	434,876	5,411,964	727.7	Tile 5
090	right bank	2,348,512	692,468	434,631	5,412,405	727.7	Tile 5
089	left bank	2,348,151	690,644	434,493	5,411,855	727.5	Tile 5
089	right bank	2,347,597	691,711	434,341	5,412,188	727.5	Tile 5

Table A5-1. ADCP Transect Endpoint Locations

ADCP Transect Number	Endpoint Position	Washington State Plane North Zone ^a		UTM Zone 11 North ^a		Approximate River Mile	Map A5-1 Tile(s)
		X-Coordinate (ft)	Y-Coordinate (ft)	X-Coordinate (m)	Y-Coordinate (m)		
088	left bank	2,346,925	690,192	434,113	5,411,736	727.2	Tile 5
088	right bank	2,346,438	691,190	433,980	5,412,047	727.2	Tile 5
087	left bank	2,345,175	688,822	433,560	5,411,346	726.7	Tile 5
087	right bank	2,343,848	689,503	433,166	5,411,573	726.7	Tile 5
086	left bank	2,343,120	687,012	432,907	5,410,827	726.3	Tile 5
086	right bank	2,342,656	688,553	432,789	5,411,302	726.3	Tile 5
085	left bank	2,341,716	685,731	432,460	5,410,458	725.8	Tile 6
085	right bank	2,340,732	686,249	432,168	5,410,630	725.8	Tile 6
084	right bank	2,340,191	683,031	431,955	5,409,659	725.3	Tile 6
084	left bank	2,341,449	683,144	432,339	5,409,675	725.3	Tile 6
083	right bank	2,339,644	680,934	431,757	5,409,030	724.9	Tile 6
083	left bank	2,341,658	680,820	432,368	5,408,964	724.9	Tile 6
082	right bank	2,340,205	679,333	431,903	5,408,534	724.5	Tile 6
082	left bank	2,341,841	678,131	432,382	5,408,143	724.5	Tile 6
081	right bank	2,337,983	677,628	431,201	5,408,049	723.7	Tile 6
081	left bank	2,338,785	675,330	431,410	5,407,337	723.7	Tile 6
080	left bank	2,337,048	674,298	430,865	5,407,050	723.3	Tile 6
080	right bank	2,336,390	675,353	430,681	5,407,381	723.3	Tile 6
079	left bank	2,335,118	673,313	430,263	5,406,779	723.0	Tile 6
079	right bank	2,334,976	674,738	430,242	5,407,215	723.0	Tile 6
078	left bank	2,332,892	674,487	429,604	5,407,170	722.6	Tile 6, Tile 7
078	right bank	2,333,192	675,224	429,706	5,407,390	722.6	Tile 6, Tile 7
077	left bank	2,331,483	674,748	429,179	5,407,271	722.4	Tile 6, Tile 7
077	right bank	2,331,831	675,563	429,297	5,407,514	722.4	Tile 6, Tile 7
076	left bank	2,330,321	675,103	428,831	5,407,397	722.1	Tile 7
076	right bank	2,330,464	675,966	428,887	5,407,658	722.1	Tile 7
075	left bank	2,328,444	675,075	428,259	5,407,417	721.8	Tile 7
075	right bank	2,328,561	676,743	428,320	5,407,923	721.8	Tile 7
074	left bank	2,327,972	675,064	428,115	5,407,421	721.7	Tile 7
074	right bank	2,328,058	677,419	428,177	5,408,136	721.7	Tile 7
073	left bank	2,327,622	675,373	428,013	5,407,520	721.6	Tile 7
073	right bank	2,327,681	676,678	428,051	5,407,917	721.6	Tile 7
072	left bank	2,325,762	675,084	427,443	5,407,461	721.2	Tile 7
072	right bank	2,325,243	675,976	427,299	5,407,740	721.2	Tile 7
071	right bank	2,323,224	674,874	426,668	5,407,435	720.7	Tile 7
071	left bank	2,323,708	673,641	426,796	5,407,053	720.7	Tile 7
070	right bank	2,320,855	673,188	425,921	5,406,958	720.3	Tile 7
070	left bank	2,321,701	672,132	426,162	5,406,624	720.3	Tile 7
069	right bank	2,319,628	670,381	425,505	5,406,123	719.8	Tile 7
069	left bank	2,320,722	670,272	425,836	5,406,073	719.8	Tile 7
068	left bank	2,321,378	669,512	426,024	5,405,832	719.6	Tile 7
068	right bank	2,319,881	668,834	425,558	5,405,648	719.6	Tile 7
067	right bank	2,320,046	667,481	425,588	5,405,234	719.3	Tile 7
067	left bank	2,321,590	668,314	426,070	5,405,464	719.3	Tile 7
066	right bank	2,320,038	665,882	425,561	5,404,747	719.0	Tile 7, Tile 8
066	left bank	2,322,165	666,468	426,217	5,404,893	719.0	Tile 7, Tile 8
065	right bank	2,320,133	665,586	425,585	5,404,656	718.9	Tile 7, Tile 8
065	left bank	2,322,507	665,638	426,309	5,404,636	718.9	Tile 7, Tile 8
064	right bank	2,320,381	663,894	425,635	5,404,137	718.7	Tile 7, Tile 8
064	left bank	2,323,090	664,814	426,474	5,404,376	718.7	Tile 7, Tile 8
063	left bank	2,318,910	658,662	425,108	5,402,567	717.5	Tile 8

Table A5-1. ADCP Transect Endpoint Locations

ADCP Transect Number	Endpoint Position	Washington State Plane North Zone ^a		UTM Zone 11 North ^a		Approximate River Mile	Map A5-1 Tile(s)
		X-Coordinate (ft)	Y-Coordinate (ft)	X-Coordinate (m)	Y-Coordinate (m)		
063	right bank	2,318,397	659,625	424,967	5,402,868	717.5	Tile 8
062	left bank	2,318,014	658,120	424,827	5,402,416	717.3	Tile 8
062	right bank	2,317,463	659,018	424,673	5,402,698	717.3	Tile 8
061	left bank	2,316,700	657,282	424,415	5,402,181	717.0	Tile 8
061	right bank	2,316,079	658,166	424,239	5,402,459	717.0	Tile 8
060	left bank	2,315,051	655,775	423,890	5,401,748	716.6	Tile 8
060	right bank	2,313,158	657,099	423,334	5,402,179	716.6	Tile 8
059	right bank	2,311,704	654,900	422,858	5,401,532	716.1	Tile 8, Tile 9
059	left bank	2,312,781	653,787	423,169	5,401,177	716.1	Tile 8, Tile 9
058	right bank	2,310,261	653,605	422,399	5,401,160	715.7	Tile 8, Tile 9
058	left bank	2,311,435	652,524	422,740	5,400,813	715.7	Tile 8, Tile 9
057	right bank	2,308,709	651,234	421,891	5,400,462	715.3	Tile 8, Tile 9
057	left bank	2,310,937	650,188	422,553	5,400,110	715.3	Tile 8, Tile 9
056	right bank	2,308,778	647,978	421,862	5,399,470	714.8	Tile 9
056	left bank	2,310,766	648,535	422,476	5,399,610	714.8	Tile 9
055	right bank	2,309,329	645,583	421,993	5,398,733	714.4	Tile 9
055	left bank	2,311,203	646,420	422,576	5,398,959	714.4	Tile 9
054	right bank	2,310,319	643,104	422,257	5,397,963	714.0	Tile 9
054	left bank	2,312,314	644,062	422,879	5,398,225	714.0	Tile 9
053	right bank	2,312,137	641,024	422,778	5,397,303	713.5	Tile 9
053	left bank	2,313,432	642,304	423,192	5,397,673	713.5	Tile 9
052	right bank	2,312,750	640,104	422,951	5,397,013	713.2	Tile 9
052	left bank	2,313,941	640,572	423,321	5,397,138	713.2	Tile 9
051	right bank	2,313,278	639,003	423,095	5,396,670	713.0	Tile 9
051	left bank	2,314,399	639,752	423,448	5,396,881	713.0	Tile 9
050	right bank	2,314,400	637,029	423,406	5,396,053	712.6	Tile 9, Tile 10
050	left bank	2,315,712	637,351	423,811	5,396,131	712.6	Tile 9, Tile 10
049	right bank	2,315,238	632,815	423,598	5,394,758	711.8	Tile 10
049	left bank	2,319,018	633,585	424,760	5,394,934	711.8	Tile 10
048	right bank	2,316,396	630,368	423,913	5,393,995	711.3	Tile 10
048	left bank	2,319,915	631,779	425,005	5,394,371	711.3	Tile 10
047	right bank	2,316,557	628,473	423,933	5,393,416	710.8	Tile 10
047	left bank	2,321,133	628,436	425,325	5,393,335	710.8	Tile 10
046	left bank	2,320,559	626,166	425,116	5,392,653	710.5	Tile 10
046	right bank	2,316,434	627,018	423,873	5,392,975	710.5	Tile 10
045	left bank	2,318,503	624,148	424,459	5,392,070	710.0	Tile 10
045	right bank	2,316,820	625,111	423,962	5,392,389	710.0	Tile 10
044	left bank	2,314,216	622,040	423,123	5,391,494	709.3	Tile 10
044	right bank	2,313,836	623,653	423,031	5,391,991	709.3	Tile 10
043	left bank	2,312,301	621,489	422,531	5,391,355	708.9	Tile 10
043	right bank	2,311,953	623,279	422,453	5,391,906	708.9	Tile 10
042	left bank	2,309,416	620,593	421,640	5,391,126	708.4	Tile 10
042	right bank	2,309,086	623,263	421,580	5,391,944	708.4	Tile 10
041	left bank	2,307,396	618,783	420,997	5,390,606	707.9	Tile 11
041	right bank	2,303,006	626,213	419,774	5,392,934	707.9	Tile 11
040	left bank	2,304,856	617,103	420,199	5,390,134	707.1	Tile 11
040	right bank	2,298,816	623,573	418,459	5,392,195	707.1	Tile 11
039	right bank	2,298,376	616,973	418,225	5,390,193	706.0	Tile 11
039	left bank	2,304,516	616,713	420,089	5,390,020	706.0	Tile 11
038	right bank	2,298,456	614,172	418,207	5,389,339	705.5	Tile 11, Tile 12
038	left bank	2,304,856	613,963	420,151	5,389,178	705.5	Tile 11, Tile 12

Table A5-1. ADCP Transect Endpoint Locations

ADCP Transect Number	Endpoint Position	Washington State Plane North Zone ^a		UTM Zone 11 North ^a		Approximate River Mile	Map A5-1 Tile(s)
		X-Coordinate (ft)	Y-Coordinate (ft)	X-Coordinate (m)	Y-Coordinate (m)		
037	right bank	2,298,166	611,853	418,083	5,388,638	705.0	Tile 11, Tile 12
037	left bank	2,305,586	611,133	420,330	5,388,306	705.0	Tile 11, Tile 12
036	right bank	2,297,336	609,923	417,801	5,388,063	704.4	Tile 12
036	left bank	2,307,836	604,633	420,916	5,386,293	704.4	Tile 12
035	right bank	2,296,905	607,888	417,639	5,387,450	704.0	Tile 12
035	left bank	2,299,296	606,603	418,347	5,387,023	704.0	Tile 12
034	left bank	2,298,276	605,053	418,013	5,386,567	703.5	Tile 12
034	right bank	2,296,126	606,293	417,378	5,386,977	703.5	Tile 12
033	right bank	2,295,696	603,623	417,206	5,386,171	702.9	Tile 12
033	left bank	2,297,416	602,783	417,717	5,385,889	702.9	Tile 12
032	left bank	2,296,606	601,073	417,444	5,385,381	702.5	Tile 12
032	right bank	2,294,546	601,893	416,830	5,385,662	702.5	Tile 12
031	right bank	2,294,116	599,153	416,657	5,384,834	702.0	Tile 12, Tile 13
031	left bank	2,296,586	599,073	417,408	5,384,772	702.0	Tile 12, Tile 13
030	right bank	2,293,373	597,023	416,399	5,384,197	701.5	Tile 12, Tile 13
030	left bank	2,295,976	596,973	417,190	5,384,143	701.5	Tile 12, Tile 13
029	right bank	2,292,756	594,613	416,174	5,383,473	701.0	Tile 13
029	left bank	2,295,796	594,508	417,098	5,383,395	701.0	Tile 13
028	right bank	2,292,416	592,033	416,032	5,382,693	700.6	Tile 13
028	left bank	2,296,016	592,483	417,134	5,382,776	700.6	Tile 13
027	right bank	2,294,236	589,013	416,540	5,381,747	700.0	Tile 13
027	left bank	2,298,586	589,273	417,868	5,381,760	700.0	Tile 13
026	right bank	2,294,076	587,593	416,469	5,381,317	699.5	Tile 13
026	left bank	2,299,826	586,923	418,209	5,381,026	699.5	Tile 13
025	right bank	2,292,656	586,063	416,014	5,380,873	699.0	Tile 13
025	left bank	2,298,406	583,553	417,726	5,380,022	699.0	Tile 13
024	right bank	2,292,046	583,873	415,795	5,380,216	698.5	Tile 13, Tile 14
024	left bank	2,297,597	581,729	417,452	5,379,479	698.5	Tile 13, Tile 14
023	right bank	2,291,866	581,423	415,703	5,379,473	698.0	Tile 13, Tile 14
023	left bank	2,295,856	580,083	416,897	5,379,004	698.0	Tile 13, Tile 14
022	left bank	2,294,406	578,323	416,429	5,378,491	697.5	Tile 14
022	right bank	2,289,546	580,103	414,977	5,379,106	697.5	Tile 14
021	left bank	2,293,146	576,253	416,014	5,377,880	697.0	Tile 14
021	right bank	2,289,646	577,713	414,971	5,378,377	697.0	Tile 14
020	left bank	2,292,626	575,113	415,838	5,377,541	696.7	Tile 14
020	right bank	2,290,226	575,143	415,108	5,377,586	696.7	Tile 14
019	right bank	2,289,086	571,783	414,710	5,376,581	696.0	Tile 14
019	left bank	2,293,156	571,933	415,951	5,376,565	696.0	Tile 14
018	left bank	2,293,716	569,163	416,080	5,375,713	695.5	Tile 14
018	right bank	2,286,706	570,513	413,967	5,376,231	695.5	Tile 14
017	left bank	2,292,896	566,663	415,792	5,374,965	695.0	Tile 14
017	right bank	2,285,936	569,723	413,720	5,376,002	695.0	Tile 14
016	left bank	2,291,694	564,428	415,393	5,374,303	694.1	Tile 14
016	right bank	2,284,876	567,883	413,370	5,375,458	694.1	Tile 14
015	right bank	2,282,376	565,523	412,573	5,374,778	693.0	Tile 15
015	left bank	2,290,476	562,563	414,993	5,373,754	693.0	Tile 15
014	right bank	2,282,276	562,903	412,503	5,373,982	692.5	Tile 15
014	left bank	2,289,426	561,193	414,653	5,373,353	692.5	Tile 15
013	right bank	2,281,846	560,533	412,336	5,373,267	692.0	Tile 15
013	left bank	2,288,656	559,763	414,397	5,372,930	692.0	Tile 15
012	right bank	2,281,736	558,173	412,267	5,372,551	690.5	Tile 15

Table A5-1. ADCP Transect Endpoint Locations

ADCP Transect Number	Endpoint Position	Washington State Plane North Zone ^a		UTM Zone 11 North ^a		Approximate River Mile	Map A5-1 Tile(s)
		X-Coordinate (ft)	Y-Coordinate (ft)	X-Coordinate (m)	Y-Coordinate (m)		
012	left bank	2,287,796	557,063	414,094	5,372,121	690.5	Tile 15
011	right bank	2,280,876	556,353	411,977	5,372,010	690.0	Tile 15
011	left bank	2,286,776	554,073	413,738	5,371,227	690.0	Tile 15
010	left bank	2,283,636	552,083	412,752	5,370,669	689.5	Tile 15
010	right bank	2,278,736	555,343	411,311	5,371,735	689.5	Tile 15
009	left bank	2,281,786	550,483	412,165	5,370,210	689.0	Tile 15
009	right bank	2,277,686	552,643	410,950	5,370,929	689.0	Tile 15
008	left bank	2,280,956	548,503	411,882	5,369,620	688.6	Tile 15
008	right bank	2,277,106	550,383	410,739	5,370,250	688.6	Tile 15
007	left bank	2,280,336	546,353	411,661	5,368,975	688.0	Tile 16
007	right bank	2,275,956	548,053	410,354	5,369,559	688.0	Tile 16
006	right bank	2,274,888	546,190	410,001	5,369,008	687.5	Tile 16
006	left bank	2,279,612	544,884	411,418	5,368,539	687.5	Tile 16
005	left bank	2,279,532	543,374	411,371	5,368,081	687.0	Tile 16
005	right bank	2,274,721	543,614	409,911	5,368,227	687.0	Tile 16
004	right bank	2,274,380	540,965	409,767	5,367,426	686.5	Tile 16
004	left bank	2,279,728	541,691	411,405	5,367,565	686.5	Tile 16
003	right bank	2,276,092	538,476	410,250	5,366,642	686.0	Tile 16
003	left bank	2,279,887	539,601	411,422	5,366,927	686.0	Tile 16
002	right bank	2,275,940	536,597	410,175	5,366,073	685.5	Tile 16
002	left bank	2,279,002	536,989	411,113	5,366,145	685.5	Tile 16
001	right bank	2,274,946	532,809	409,815	5,364,935	684.9	Tile 16
001	left bank	2,279,713	534,318	411,289	5,365,322	684.9	Tile 16

Notes:

^a Transect endpoint locations are approximate. Actual locations will be determined by vessel access to shallow, nearshore areas during the survey.

ADCP - acoustic Doppler current profiler

UTM - Universal Transverse Mercator

Table A5-2. Water Level Monitoring Locations

Location	Washington State Plane North Zone		UTM Zone 11 North		Approximate River Mile	Map A5-1 Tile(s)
	X-Coordinate (ft)	Y-Coordinate (ft)	X-Coordinate (m)	Y-Coordinate (m)		
USGS Auxiliary Gage	2,405,607	735,746	452,663	5,424,706	742.9	Tile 1
Deadman's Eddy	2,386,422	720,457	446,592	5,420,345	738.3	Tile 2
Northport	2,371,881	714,525	442,077	5,418,761	734.4	Tile 3
Above Onion Creek	2,362,068	701,621	438,895	5,414,984	731.1	Tile 4
Below Little Dalles	2,349,388	692,886	434,903	5,412,519	727.9	Tile 5
Above Flat Creek	2,331,002	675,903	429,050	5,407,630	722.2	Tile 6, Tile 7
Snag Cove	2,311,697	644,571	422,699	5,398,389	714.2	Tile 9
Above Kettle Falls	2,310,460	622,939	421,993	5,391,825	708.7	Tile 10, Tile 11

Notes:

USGS - U.S. Geological Survey

UTM - Universal Transverse Mercator

Table A7-1. Data Acquisition Equipment and Operation

Survey Method	Data Type	Equipment or Instrumentation	Operation and/or Configuration	Applicable SOP
MBES bathymetry and acoustic backscatter	bottom soundings	MBES with integrated sound velocity sensor	300–450 kHz acoustic swath	SOP-1
	acoustic backscatter	MBES configured for normalized time-series data collection		
	sound velocity profiles	CTD probe	configured to measure conductivity, temperature, depth	
	positioning	survey grade RTK GNSS and MRU	NA	
Water level and river stage	absolute pressure converted to water level	non-vented submersible pressure transducer	configured to make high frequency pressure measurements in water, calibrated to a fixed reference point	SOP-6
	barometric pressure	barometers and/or regional weather stations	NA	
Topobathymetric lidar with RGB imagery	return strength (intensity), distance range, point cloud	lidar pulsed laser and scanner	laser echo, GPS, and IMU	SOP-5
	geographic position	specialized GPS receiver		
ADCP velocity profiles	velocity profiles	ADCP	600 or 1,200 kHz and appropriate water mode for depth, sensor, conditions	SOP-3
	bottom soundings	single beam sonar	200 kHz single beam echo returns	
	positioning	survey grade RTK GNSS and MRU	NA	SOP-4

Notes:

Standard operating procedures (SOPs) SOP-1 and SOP-4 are in Attachment A2 of Appendix A (field sampling plan) to the quality assurance project plan (QAPP) (TAI 2018).

Modified SOP-3 and new SOP-5 and SOP-6 are in Appendix A of this QAPP Addendum.

ADCP - acoustic Doppler current profiler

CTD - conductivity, temperature, and depth

GNSS - global navigation satellite system

IMU - inertial measurement unit

MBES - multibeam echosounder

MRU - motion reference unit

NA - not applicable

RGB – red/green/blue

RTK - real-time kinematic

Table A7-2. Measurement Quality Objectives

Data Deliverable	Utility for the Data Gap Study	Data Quality Requirements (Drivers for Specifications)	Performance Criteria (Specifications)
Multibeam Bathymetry			
Bathymetric surface <i>Format: DEM in one of several formats (e.g., GeoTIFF) with FGDC metadata included</i>	riverbed elevation and geomorphology bathymetric differencing	full bathymetric coverage throughout the Data Gap Study Area (i.e., no data gaps filled by interpolation in postprocessing)	100% quality bathymetric coverage to water depth supported by MBES instrumentation (expected 2 to 3 m minimum depth contour)
Raw multibeam data files ^a		spatial resolution compatible with project MMU of 1 x 1 m	spatial resolution to support MMU: 1 x 1 m MMU = 50 x 50 cm bathymetric data resolution
Ancillary data (sound velocity profiles, GPS files, etc.) ^a		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; target accuracy is +/- 0.1 m at a 95% confidence level (2 times sigma)

Table A7-2. Measurement Quality Objectives

Data Deliverable	Utility for the Data Gap Study	Data Quality Requirements (Drivers for Specifications)	Performance Criteria (Specifications)
Acoustic Backscatter			
Normalized/calibrated acoustic backscatter image (time series) <i>Format: GeoTIFF with FGDC metadata included</i>	riverbed texture and roughness	full coverage throughout Data Gap Study Area and spatially coincident with multibeam bathymetry	simultaneous acquisition with multibeam bathymetry for native coregistration of bathymetry and acoustic backscatter
Raw multibeam data files ^b	quantitative data for substrate characterization (return is primarily related to sediment grain size and bottom texture)	normalized/calibrated backscatter intensity with units in absolute dB	spatial resolution to support MMU: 1 x 1 m MMU = 50 x 50 cm bathymetric data resolution
Ancillary data (sound velocity profiles, GPS files, etc.) ^b		inter- and intra-sonar calibration for consistency and repeatability	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 of QAPP Appendix A)
		spatial resolution to support project MMU of 1 x 1 m	
Water Level Monitoring (Pressure Transducers)			
ASCII text files with water surface elevation (NAVD88) and date/time	used to validate the hydrodynamic model under measured high flow conditions; potential recalibration of model (primarily via roughness coefficients) if needed	water level monitoring data quality drivers based on the accuracy needs of the model eight locations that capture the anticipated steep water level gradients temporal resolution of the data should be at a finer scale than the model time step; sensors planned to log at 1-minute intervals	approximately +/- 0.1 m accuracy with 0.05 m precision; accuracy will be evaluated by comparison to visual markings on stilling well, USGS auxiliary gage measurements, and/or water level survey shots

Table A7-2. Measurement Quality Objectives

Data Deliverable	Utility for the Data Gap Study	Data Quality Requirements (Drivers for Specifications)	Performance Criteria (Specifications)
Aerial Lidar			
Topobathymetric surface <i>Format: DEM in one of several formats (e.g. GeoTIFF) with FGDC metadata included</i>	riverbed, shoreline, and upland elevation and geomorphology	full coverage throughout the Data Gap Study Area (i.e., no data gaps filled by interpolation in postprocessing)	100% quality coverage throughout the Data Gap Study Area to an elevation of 1,500 ft NAVD88
Raw data files ^a	bathymetric differencing	spatial resolution compatible with project MMU of 1 x 1 m	hydrographic depth range: ≥ 1.5 x Secchi depth
Ancillary data (flight lines, exposures, tiles, boundaries, GPS files, etc.) ^a		high horizontal/vertical accuracy and precision with position checks relative to the Washington State Reference Network	topographic point cloud meeting USGS Quality Level1 standards for accuracy and density
<i>Phase 1</i>			spatial resolution to support MMU: 1 x 1 m MMU = 50 x 50 cm bathymetric data resolution
<i>Topo/bathy lidar - all points with ground/non-ground/water classifications in v1.4 LAS/LAZ format</i>			
<i>Topo/bathy lidar - ground points only (merged ground classifications) in v1.4 LAS/LAZ format</i>			
<i>0.40-ft 3-band natural color orthophoto tiles in uncompressed TIF/TFW format</i>			RTK GPS positioning with position checks relative to the Washington State Reference Network
<i>0.40-ft 3-band natural color orthophoto tiles and mosaic in 20:1 compressed SID/SDW format</i>			
<i>Phase 2</i>			10-cm RMSEz lidar survey meeting or exceeding the applicable standards and data quality levels established by the USGS Lidar Base Specification 2025, Rev. A (USGS 2025)
<i>Integrated - lidar ground MKP/hydrographic breaklines/bathymetric multibeam in GIS (geodatabase) format</i>			
<i>Integrated - bare earth raster DEM at 3-ft resolution in GeoTIFF format</i>			
<i>Integrated - intensity images raster DEM at 1.5-ft resolution in GeoTIFF format</i>			

Table A7-2. Measurement Quality Objectives

Data Deliverable	Utility for the Data Gap Study	Data Quality Requirements (Drivers for Specifications)	Performance Criteria (Specifications)
ADCP			
Raw transect data ^c <i>Format: ASCII text file with x, y, z, time, u, v, w</i>	quantitative data for future hydrodynamic and/or sediment transport modeling	0.01 to 0.5 m depth averaging, as deemed appropriate by water depth, designated survey design, hardware specifications	RTK GPS positioning
Raw ADCP data files ^c			average vessel speed less than or equal to the average current velocity
			minimum of two transects in reciprocal directions at each location
			Corrections and/or calibrations (i.e., compass calibration, moving-bed tests) to USGS suggestions for accuracy and precision (see SOP-3 in Appendix A)

Notes:

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

Raw data files for GPS and multibeam echosounder (MBES) will include time stamps to allow postprocessing kinematic (PPK) corrections if necessary.

^a 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.

^b Raw data and ancillary data files will be archived in a separate database from the acoustic backscatter image GeoTIFF and not posted on the project database web tool. These data will be available upon request.

^c Raw acoustic Doppler current profiler (ADCP) data files will be archived in a separate database from spatially averaged data and not posted on the project database web tool. These data will be available upon request.

MKP - model key points

MMU - minimum mapping unit

NAVD88 - North American Vertical Datum of 1988

QAPP - quality assurance project plan

RMSEz - root mean square error in the z-direction

RTK - real-time kinematic

SOP - standard operating procedure

USACE - U.S. Army Corps of Engineers

USGS - U.S. Geological Survey

APPENDIX A

MODIFIED AND ADDITIONAL STANDARD OPERATING
PROCEDURES FOR PHASE 3 SEDIMENT STUDY – SEDIMENT
FACIES MAPPING QAPP ADDENDUM No. 1

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 “this study”) being conducted for Teck American Incorporated (TAI) in Operable Units (OU 1 and OU 2) 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 flow conditions within OU 1 and the upper reaches of OU 2.

This document describes procedures for calibrating, preparing, and deploying vessel-mounted ADCPs for the purpose of acquiring moving boat current velocity measurements and producing mean velocity profiles.

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 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 postprocessed, 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 measuring flow velocity and discharge. 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 (e.g., 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 backup safety lanyard. An on-board laptop computer records results from the ADCP via a powered cable. Information presented in this SOP is consistent with U.S. Geological Survey standard practices for collecting ADCP data from a moving vessel (Mueller et al. 2013).

Procedures

This type of field servicing typically requires one technician 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

An RTK GNSS will be used aboard the vessel for accurate station positioning (see SOP-4 in Attachment A2 of Appendix A to the quality assurance project plan [QAPP] [TAI 2018]). RTK GNSS positioning, rather than positioning based on detected bottom (bottom tracking), will eliminate the requirement for moving bed tests. Vessel position checks will be conducted at the start of each survey day. Once the vessel is on the station, the actual position will be recorded for each velocity profile taken and/or attempted. Water depths will be recorded in meters from the vessel sonar. GNSS observables (raw, primary data) will be logged at all times.

Motion Reference System

An accurate heading sensor is required from an 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

The ADCP settings that control instrument operation, logging, and reporting are typically configured by the user for different applications. For this study, the ADCP should be configured as follows:

- Acoustic frequency appropriate for water depth
- Bottom tracking
- High-resolution profiling mode
- RTK GNSS and heading
- Approximately one 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 are as follows:

- Before mounting the ADCP, attach the safety lanyard.
- Bolt the ADCP to the mounting plate at the end of the pole so that Beam 3 is pointing toward 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.

Premeasurement field procedures are as follows:

- 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 procedures are as follows:

- Navigate the vessel to the station and begin recording vessel position.
- 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.
- Record continuous ensembles (defined in the next section) along a transect between station end points. Upon completion, record continuous ensembles along a reciprocal transect (opposite direction) between station end points. Monitor data acquisition display for real-time data visualization and quality control (QC). Ensembles from reciprocal transects will be averaged into one mean velocity profile per station 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, WinRiver II), which will provide real-time data visualization and QC. Data will be monitored by field personnel to verify that the ADCP instrument is reporting the date and time correctly, the values seem reasonable given the observed weather conditions and environment of deployment, and the field monitoring observations are 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 file name will follow this format:

“LOCATION ID_INSTRUMENT_COLLECTIONDATE (DDMMYYYY).xlsx.”

For example, data from a vessel-mounted ADCP recording along Transect “100” on May 4, 2028, would be saved as “100_ADCP_05042028.” Data will be recorded internally and routinely backed up on an external hard drive. At the end of each survey day, data will be duplicated to maintain multiple copies. If possible, data will be uploaded to secure file storage.

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. A low change in distribution will result in a high correlation. As

an additional QA check, only pings with strong correlations between the outgoing and reflected signals will be retained.

Vessel operators will navigate reciprocal transects as straight as possible given the river current and/or wind conditions. ADCP data will be monitored in real time via multiple displays at the data acquisition station aboard the ADCP survey vessel. Transects will be flagged for rerun if quality flags in ADCP data acquisition software indicate poor data due to out of range values in vessel speed, water current, water depth, positioning, heading, and/or other factors. If river current and/or wind conditions pose a significant challenge to vessel navigation, transects may be manually flagged for rerun, repositioning, or removal upon consultation with the TAI field supervisor.

Each log sheet that is entered into the database by one of the field staff will be rechecked for errors by other staff after entry. The name of the technician who entered the data and the date the entry is made will be written on the log sheet for reference. Log sheets will be retained according to Section 3 in the field sampling plan (QAPP Appendix A).

DATA PROCESSING AND ANALYSIS

Data Processing Procedure

Each station will comprise continuous raw velocity profiles or ensembles collected along at least two reciprocal transects between defined station end points. These ensembles will be averaged together to produce one mean velocity profile. Raw files (*.mmt format and associated files) will be generated and processed with the WinRiver II software to generate the mean transect profile at each station from all usable transect profiles at approximately 1-m intervals.

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. The final data summary report will comprise ASCII text files of position (x, y, z), time, and velocity (u, v, w). Velocity data (u, v, w) will be available as raw data, as well as temporally and spatially averaged. Depth-averaged velocity will also be provided in a geospatial database format (e.g., GDB, SHP).

REFERENCES

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- TAI (Teck American Incorporated). 2018. Final Quality Assurance Project Plan for the Phase 3 Sediment Study – Sediment Facies Mapping. Prepared for TAI by ERM in association and consultation with HDR, David Evans and Associates, Inc., Windward Environmental LLC, Gravity Consulting LLC, and Parametrix, Inc.

STANDARD OPERATING PROCEDURE SOP-5

LIDAR TOPOBATHYMETRY AND IMAGERY

Scope and Application

This standard operating procedure (SOP) is specific to Addendum No. 1 to the quality assurance project plan (QAPP) (TAI 2018) for the sediment facies mapping element of the Phase 3 Sediment Study being conducted for Teck American Incorporated (TAI) in the Upper Columbia River (UCR). The purpose of this SOP is to describe the procedures for collecting lidar topobathymetric data and imagery from a manned fixed-wing aircraft for bathymetric and topographic mapping of riverbed, shallow nearshore areas, and upland areas for characterization of Operable Unit (OU) 1 and the upper reaches of OU 2 of the UCR.

This SOP details the operation and procedures associated with acquiring and processing lidar-derived topobathymetric and imagery data. The following procedures provide an explanation for how these data sets will be used for the purpose of riverbed, shoreline, and upland mapping.

Summary of Method

The lidar topobathymetry will be conducted in a single survey. Topobathymetric lidar data will be acquired using an airborne hydrographic laser system. The survey will cover the entire survey area in contiguous swaths with minimum 50 percent overlap to ensure quality coverage, minimize laser shadowing, and improve relative accuracy. A boresight-calibrated laser sensor mounted in a fixed-wing aircraft will be used for lidar data acquisition. Aerial imagery will be acquired with a large format direct digital mapping camera. Timing of lidar and aerial imagery flights will be subject to availability of contractor equipment. Aerial data sets will conform to American Society for Photogrammetry and Remote Sensing (ASPRS) “Produced to Meet” accuracy standards.

Equipment

For lidar data and imagery collection, the following equipment is necessary:

- Fixed-wing aircraft
- Airborne hydrographic laser system with integrated inertial measurement unit (IMU)
- Large format direct digital mapping camera
- Airborne real-time kinematic (RTK) global navigation satellite system (GNSS)

- Survey computer with power supply
- Survey software with license key
- Survey logbook or digital logging software.

Positioning and Coordinates

See SOP-4 in Attachment A2 of QAPP Appendix A for positioning procedures.

DATA ACQUISITION

Lidar and Acquisition Software

The lidar data will be saved in two formats concurrently during all survey acquisition where possible, both in the native file format of the lidar manufacturer and in the survey navigation and lidar acquisition software.

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

Simultaneously, lidar data will be acquired using customized survey and lidar software. This software will collect both navigation and lidar data and log all raw GNSS data and lidar data.

Lidar coverage will be monitored in real time via multiple data acquisition displays aboard the acquisition aircraft. Any coverage gaps will be identified and filled as needed to minimize the likelihood of additional flight operations.

Equipment Installation and Static Offsets

The lidar and camera hardware will be mounted and securely fastened to the aircraft. A survey-grade positioning and IMU system, consisting of an RTK GNSS receiver, heading, and motion reference system, will be installed on the aircraft to report position and attitude to accurately position survey measurements.

Static offsets will be precisely measured from the aircraft reference point (center of gravity) to the reference point of all sensors, including the phase center of GNSS antennas, motion reference unit reference point, lidar reference point, camera reference point, and any other sensor that requires precise positioning. The offset survey will include surveying all three axes (x,y,z) relative to the aircraft 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 ft) and referenced appropriately.

IMU Installation and Offsets

The IMU is used to record all aircraft movements, including heave, pitch, and yaw. Additionally, the IMU 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 IMU will be measured in all three axes (x,y,z). This information will be input into the IMU configuration setup only and not into the survey software. Once properly offset, the IMU system will output all position information at the location of the IMU and not the location of the primary GPS antenna.

Lidar Survey Specifications

The following are the anticipated specifications for the lidar survey:

- Altitude—500 to 1,000 m above ground level
- Laser wavelength—532 nm
- Multi-swath pulse density—minimum 8 pulses per square meter
- Lateral swath overlap—minimum 50 percent.

The aerial topobathymetric lidar system will enable acquisition of shallow bathymetric data as well as topographic data. It is anticipated that bathymetric data will be acquired to at least 1.5 times Secchi depth (the depth beyond which a submerged disk with a high-contrast pattern is no longer visible from the surface). Above-water lidar point cloud data will meet U.S. Geological Survey Quality Level 1 standards (USGS 2025) for accuracy and density. Lidar data sets will conform to ASPRS “Produced to Meet” accuracy standards (ASPRS 2024).

A ground control survey will acquire calibration points and independent ground control points (GCPs) for assessing horizontal and vertical accuracy. Points will be acquired using RTK GNSS survey techniques. Based on the size of the project area, a minimum of 30 independent GCPs will be acquired (ASPRS 2024; USGS 2025). The techniques for establishing all GCPs will be documented, including the identity, locations, and position residuals of all GCPs used to evaluate survey accuracy. All survey control and accuracy will be validated and certified by a registered land surveyor for Washington State. Secchi depth measurements will be taken at suitable locations as close to acquisition time as possible.

Imagery Specifications

Color 3-band (red, green, blue), 8-bit-per-band aerial imagery will be acquired with a calibrated and certified large-format direct digital mapping camera at 12 cm ground sample distance (GSD). The acquired imagery and resulting delivery products will meet the American Society for Photogrammetry and Remote Sensing Map Accuracy Standard of ± 1.0 ft root mean square error (RMSE_{x,y}). The mission will acquire exposures at 60 percent endlap and at least 30 percent sidelap for a block aerial triangulation solution and complete stereo coverage. Imagery coverage will be monitored in real time via data acquisition displays aboard the acquisition aircraft. Any coverage gaps will be identified and filled as needed to minimize the likelihood of additional flight operations. Ground control will provide an absolute adjustment of the imagery to the surveyed ground coordinates. Requirements for sun angle and atmospheric conditions will be evaluated and provided by contractor(s).

DATA QA/QC

System Calibration: Patch Testing

An aerial lidar patch test, also known as a boresight calibration or swath alignment, is a systematic field procedure used to determine and correct for the precise angular misalignments (roll, pitch, and yaw) and latency between the lidar sensor and the aircraft's IMU. This is a crucial step to ensure accurate and consistent data acquisition across overlapping flight lines. A patch test must be performed when lidar and/or IMU configuration has changed. The patch test typically involves flying specific flight patterns over a designated calibration area that includes features useful for detecting errors, such as flat surfaces, sloping features, and vertical features. As a best practice, start-of-project and end-of-project patch tests will also be performed. All patch test data will be postprocessed using software to calculate offset errors.

Yaw and Latency

To account for errors due to GPS timing, a latency patch test will be performed. This is conducted by flying parallel lines with significant overlap over areas with distinct linear features or vertical structures.

Roll

To correct for errors in aircraft attitude in the lateral directions, a roll patch test must be performed. This is conducted by flying over a flat area in opposite directions. Roll misalignments are evident as a vertical step between the two opposing flight lines.

Pitch

Patch test data must also be collected to correct for pitch misalignment. This is conducted by flying in opposite directions along a slope. Pitch misalignments are evident as a vertical offset at nadir when comparing the data from the two lines.

DATA PROCESSING

Lidar processing tasks will include echo extraction, calculations of laser point position, flight line calibration, water surface extraction, refraction correction, point classification, and accuracy assessments. The lidar point cloud will be finalized for positional and classification accuracy. A lidar-derived digital elevation model (DEM) will be developed. Lidar intensity imagery will also be processed and delivered as tiled images and as a single image mosaic. A table of intended lidar classifications is provided below and will be provided by the contractor(s).

Table 1. Intended Lidar Classifications

Classification Number	Classification Name
1	Default/Unclassified
2	Ground
8	Model Key Points
20	Ignored Ground
40	Bathymetric Bottom
41	Water Surface
425	Synthetic Water Surface
45	Water Column
48	Bathymetric Model Key Point

High-resolution color orthophotography will be generated from the aerial imagery, rectified to the new lidar-based DEM and delivered in compressed and uncompressed formats in a logical tiling scheme. The orthophoto imagery will be color balanced and tone matched to merge all exposures into a seamless orthorectified image mosaic. In addition to the tiled orthophotos, a single image mosaic of the entire mapped area will be developed.

After the bathymetric survey is complete, bathymetric data will be integrated with lidar-derived topobathymetric data to create a seamless topobathymetric DEM. Bathymetric survey data acquired with MBES will be held constant and the lidar topobathymetric data will augment the MBES bathymetry coverage in shallow nearshore and shoreline areas up to the 1,500 ft NAVD88 elevation contour. The shoreline overlap region of both data sets will be reviewed using a high resolution dZ (elevation difference) raster to delineate a line of best vertical data coincidence between the two data sets. The resulting delineation will be used to clip each data set along the

length of both shores and surrounding all islands, then both clipped data sets will be merged into a single edge-matched terrain points data set. The integrated data will be finalized for positional and classification accuracy using bare-earth and shallow-water checkpoints collected during the bathymetric survey. The integrated data will then undergo a final review to ensure seamless integration without any overlaps or gaps throughout the survey area.

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STANDARD OPERATING PROCEDURE SOP-6

WATER LEVEL MONITORING

Scope and Application

This standard operating procedure (SOP) is specific to Addendum No. 1 to the quality assurance project plan (QAPP) (TAI 2018) for the sediment facies mapping element of the Phase 3 Sediment Study (hereinafter “the study”) being conducted for Teck American Incorporated (TAI) in the Upper Columbia River (UCR). The purpose of this SOP is to describe the procedures for collecting water level (stage) data at multiple monitoring sites for hydrologic characterization of Operable Unit (OU) 1 and the upper reaches of OU 2 of the UCR.

This SOP details the operation and procedures associated with acquiring stage data using in situ pressure transducers installed in stilling wells. Pressure transducers record absolute pressure (air pressure plus water pressure), from which air pressure must be subtracted to yield water pressure. Water pressure can then be converted to water level relative to a fixed reference point using the density of water. Because atmospheric pressure changes with weather and altitude, compensating for barometric variations is necessary (USEPA 2014).

Summary of Method

Water level is measured continuously using submerged non-vented pressure transducers installed at predetermined, hydrologically representative locations along the UCR. Pressure transducers are housed in temporary stilling wells anchored to the riverbank or riverbed to dampen transient water fluctuations and protect the transducers from sediment and other debris.

Each pressure transducer will record absolute pressure (air pressure plus water pressure) at a programmed logging interval for a deployment period of approximately 2 months.

Barometric pressure is measured either by a dedicated topside barometric sensor or obtained from nearby weather stations and will be used to correct absolute pressure recorded by the in situ pressure transducers.

At each monitoring site, water level logger data will be referenced to an absolute elevation by surveying the water surface elevation in the immediate vicinity of the recording logger. For installations where a traditional stilling well is appropriate, a locally referenced staff gage will be incorporated directly onto each stilling well so that visual observations of the water level can be directly related to a surveyed reference point at the top of the well. For locations with a traditional stilling well, stage readings will be collected from the staff gage during installation,

periodic site visits, and recovery to verify the transducer operation. For locations where the stilling well must remain completely submerged, water surface elevations will be surveyed after installation and before recovery. Data are stored internally on each pressure transducer and will be manually downloaded during site visits and/or at the end of the deployment period. Atmospheric pressure observations recorded by nearby loggers and/or weather stations will be incorporated during post-processing to translate the absolute pressure data to real-world elevations.

Equipment

For continuous water level monitoring the following equipment is suggested:

- Non-vented pressure transducer(s)
 - Self-logging, non-vented submersible pressure transducer with internal memory and battery
 - Manufacturer interface cable and software for sensor configuration and data download
 - Non-stretch suspension cable or wire
 - Wire rope clamps and other cable hardware for strain relief as needed
 - Eyebolt, D-ring, or other anchoring hardware for cable mounting to well cap as needed
 - Spare batteries
 - Replacement pressure transducers as needed
- Barometric pressure measurements
 - Self-logging topside barometric pressure sensor(s) for selected sites
 - Weather-resistant housing and mounting hardware for on-site barometric sensors
 - Manufacturer interface cable, telemetry equipment, or software for configuration and data download
- Traditional stilling well with integrated staff gage
 - Galvanized steel or PVC pipe (site-specific lengths) with appropriate perforation or slots
 - Durable integrated staff gage markings (painted graduations, affixed staff plate, or adhesive scale)
 - Galvanized or stainless-steel fasteners and brackets
 - Anchoring materials such as concrete anchors, rebar, brackets, and/or ecology blocks
 - Locking well caps compatible with stilling wells and suspension systems

- Rotary drill, drill, and drill bits
- Other hardware and hand tools as necessary
- Fully submerged stilling well
 - Galvanized steel pipe, 1- to 2-ft vertical section with appropriate perforation or slots
 - Galvanized or stainless-steel flange attached to a weight or base plate (e.g., concrete block)
 - Materials to anchor the base plate to the riverbed (e.g., rebar, fence post, or stakes)
 - Location and recovery rope
 - Floating buoy or aid to navigation as required by federal regulations
- Land surveying and referencing
 - Professional land-survey services (licensed subcontractor)
 - Auto level or laser level
 - Tripod
 - Stadia rod
 - Survey paint
 - Additional surveying equipment as specified by subcontractor
- Data collection
 - Laptop or ruggedized mobile device with manufacturer software
 - Interface cables for data download
 - Field notebook
 - Field logs and datasheets
 - Camera
 - Pens, permanent markers, and waterproof labels for equipment, notetaking, and site identification

Traditional Stilling Well with Integrated Staff Gage Installation

A stilling well with integrated staff gage installation is appropriate for sites where an existing permanent structure, such as a dock or piling, is already in place or the configuration of the shoreline allows a vertical pipe to be anchored to the shore while the base of the pipe remains submerged throughout the deployment period. The anticipated range in water level over the deployment period should be less than 10 ft to avoid challenges with sensor deployment, recovery, and elevation surveying during low water.

The stilling well consists of a pre-cut length of steel or PVC pipe mounted vertically along a permanent structure or stable section of the riverbank. The well should be securely anchored using the most suitable site-specific method, such as driven rebar fastened to an ecology block, drilled into bedrock, or anchored to existing infrastructure. The lower portion of the well should be slotted or perforated to allow free water exchange while dampening turbulence and protecting from debris and sediment. The well should be deep enough to account for all expected water level ranges. The well will be positioned so that it is not easily impacted by vessels, passing debris, or bank sloughing and can be safely accessed for servicing.

Each stilling well will incorporate an integrated staff gage so that all routine visual water level observations are made directly on the well assembly and limits number of parts. The staff gage will be referenced to a fixed reference point on each well, not a real-world elevation datum. The staff gage may consist of the following:

- Permanent graduations marked directly onto the exterior of the steel pipe
- A factory or custom adhesive scale affixed securely to the pipe
- Another robust or permanent measurement reference integrated into the stilling well.

The integrated staff gage markings will be installed so that they are clearly visible from a safe distance during typical river levels. These markings should also be labeled sufficiently long to cover the anticipated range of stage observations at each monitoring site.

A locking well cap will be installed at the top of each stilling well to secure the pressure transducer as well as prevent damage or unauthorized access. The cap will be compatible with the pressure transducer cable/wire system, weather-resistant, and fitted with a lock as appropriate. Cap type and lock information will be documented in site records so that authorized personnel can safely open and secure the well during site visits.

Fully Submerged Stilling Well Installation

A fully submerged stilling well is appropriate for sites where the anticipated range in water level during the deployment exceeds 10 ft or there is a lack of suitable structures and/or substrate to feasibly anchor a vertical well along the shoreline.

A fully submerged stilling well consists of a 1- to 2-ft length of steel pipe mounted vertically to a weighted base resting on the riverbed. Depending on site-specific conditions, such as substrate and anticipated flows, the base may be secured to the riverbed using a shallow anchoring system including temporary stakes or posts. The lower portion of the pipe should be slotted or perforated to allow free water exchange while dampening turbulence and protecting from debris and sediment. The submerged stilling well should be placed deep enough to account for

all expected water level ranges and may require a buoy or other signaling device to comply with U.S. Army Corps of Engineers or U.S. Coast Guard regulations. A weighted recovery line will be tethered from the immediate shoreline to the stilling well base using a 4-point harness for recovery using a vessel-mounted davit or winch at the end of the deployment period.

Pressure Transducer Installation

The pressure transducers used in this procedure are non-vented, autonomous sensors that record absolute pressure at programmed intervals. Prior to deployment, each logger will be configured (e.g., sampling interval, start time) and calibrated in accordance with the manufacturer's guidelines.

At each monitoring site, the pressure transducer will be installed inside the stilling well described in the “Stilling Well Installation” section above. The transducer will be suspended from the top of the stilling well or well cap using a corrosion-resistant, non-stretch cable, wire, or clamp system that allows for the following:

- Positioning below the minimum expected water level and above the riverbed to avoid sedimentation
- Remaining within the perforated portion of the stilling well to ensure free water flow
- Easy retrieval by reeling the sensor up inside the well for maintenance, data download, and consistent redeployment.

The vertical position of the transducer will be set so that the full anticipated stage range is captured while maintaining sufficient submergence at low water. The exact deployment depth at each monitoring site will be selected based on location-specific bathymetry, hydraulic conditions, and access considerations. Once the transducer is installed, the cable will be secured to the stilling well or adjacent secure structure with strain relief to prevent movement or damage.

If applicable, topside barometric sensors will be installed at select sites for air pressure readings. These sensors will be mounted above anticipated flood levels in protective housing and configured according to manufacturer's guidelines.

Elevation Survey and Georeferencing

Refer to SOP-4 for procedures associated with collecting vertical and horizontal positioning data at the water level monitoring sites. Stilling well locations must be georeferenced and documented to enable field personnel to relocate the sensor during subsequent visits. Additionally, an elevation survey must be conducted to establish a reference point for the pressure transducer and local staff gage, if used. This allows for monitoring changes at the location of the transducer, which could affect the stage data and corrections.

Ideally, the elevation survey will be performed on the day when the stilling well, integrated staff gage (if used), and pressure transducer are installed. Due to practical considerations in coordinating with land-based crews engaged in survey activities across the UCR Site, the elevation survey may follow the installation of stilling wells, provided the locations have been georeferenced using a combination of GPS and visual markers. If the surveyed water surface elevation is the only available reference point for the pressure transducer, such as for the submerged stilling well installation option, the sensors must be logging at the time of the elevation survey.

Real-Time Kinematic Global Navigation Satellite System Survey

The primary method of surveying the stilling wells will be the use of real-time kinematic global navigation satellite system rovers, as described in SOP-4. For stilling wells with an integrated staff gage, an etched “X” or similar marking will be incorporated into the construction of the well such that the vertical sensor position relative to the mark is precisely known. Following installation at the water level monitoring location, the mark will be surveyed to determine its real-world elevation in the project datum. The water surface elevation will then be determined by adding the atmospheric pressure-compensated depth measured by the logger to the real-world elevation of the sensor. Centimeter-scale markings on the outside of the pipe will be used by field crews to record the distance between the water surface and the reference mark to verify logger readings during periodic downloads and maintenance checks.

For fully submerged stilling wells, the water surface elevation in the immediate vicinity of the data logger will be surveyed to reference the atmospheric pressure-compensated depth recorded by the data logger to the project datum.

Water levels will be surveyed at the beginning and end of the deployment at each water level monitoring location regardless of the well installation type. The approximately 2-month period shall be considered the minimum frequency necessary for measurement verification.

Differential Leveling Technique

The traditional differential leveling technique is provided as a backup means of vertical positioning for stilling wells that have an integrated staff gage. If required, this procedure would be carried out by a professional licensed surveyor using standard land surveying practices appropriate for the objectives of this study. The following procedure may be modified at the discretion of the surveyor.

Using a stadia rod, identify and mark a benchmark and at least one backup reliable marker on stable structures (e.g., bridge components) to detect future movement. Assign relative elevations to these points (e.g., 100 ft) and calculate elevations using standard leveling formulas.

$$\text{Height of Instrument (H.I.)} = \text{Backsite (B.S.)} + \text{Elevation of benchmark (B.M.)}$$

$$\text{Elevation of survey point} = \text{H.I.} - \text{Foresite (F.S.)}$$

where:

- H.I. = the height of the instrument at the measurement window
- B.S. = the height of the stadia rod at the benchmark
- F.S. = the height of the stadia rod at each survey point (e.g., permanent marker, top of gage, transducer housing)
- B.M. = the relative elevation (e.g., 100 ft).

To calculate the actual elevation of the transducer, subtract the distance from the transducer housing (at the point where the stadia rod was placed) to the sensor face from the elevation of the transducer housing.

After elevations of all survey points are calculated, compare beginning and end H.I. to ensure that there is no movement of the auto level during the survey. Next, compare the elevation of all survey points to previously surveyed elevations to determine whether movement occurred. For further information on surveying technique, see Harrelson et al. (1994) and USEPA (2014).

Data Acquisition and Logging

Data acquisition is designed to provide continuous, high-resolution data of river stage over an approximate 2-month deployment. Data acquired using a stilling well with integrated staff gage will be supplemented with periodic site visits for data download, maintenance, and sensor verification.

During initial deployment, the configuration information (e.g., logging interval, start time, serial number, firmware) will be documented for each monitoring site. This will be recorded in standardized field logs. Loggers will then be installed as described above in the “Pressure

Transducer Installation” section. Once deployed, each logger will operate continuously, recording water level data at programmed intervals of high temporal resolution (i.e., every 15 minutes). There is no telemetry, so all data will be stored internally on each logger, requiring manual data download following manufacturer specifications and required software.

To verify logger operation and maintain a reliable record, site visits will occur monthly to complete the following:

- Document the physical condition of the stilling well and transducer installation.
- Record integrated staff gage readings to verify sensor data.
- Retrieve and download data from the sensor.
- Redeploy the sensor in the same, calibrated configuration.

During installation, site visits, and retrieval, field personnel will collect observations from the integrated staff gage. For each reading, the date, time, site ID, and water level will be recorded. Field conditions, equipment status, and/or damage will be recorded and photographed during each site visit. Staff gage readings will be compared to sensor data logged at the same date and time to verify the reported water levels.

Fully submerged stilling wells will not be accessible for download or visual verification while deployed. These sites will be checked regularly for signs of disturbance while remaining in place throughout the deployment period. The pressure loggers that will be used for this study are capable of multi-month deployment without the need for maintenance, download, or battery replacement. Water level surveys in the immediate vicinity of the instrument after deployment and before recovery will serve to verify the stability of the pressure loggers over the 2-month deployment period.

Because the transducers are non-vented, their absolute pressure readings will be corrected for barometric pressure during data processing. Barometric pressure will be obtained from one of the following:

1. Topside barometric sensors installed at the monitoring sites following the manufacturers recommendations (e.g., tethered inside the stilling well above anticipated flood levels, or mounted in a separate ventilated housing away from direct sunlight)
2. Nearby weather stations (within approximately 10 miles) that provide reliable, continuous barometric data for the region
3. A combination of options 1 and 2 above, where topside barometric sensors are placed at selected monitoring sites that can be used to interpolate air pressure across the entire study region and correct for neighboring sites in conjunction with local weather data. This is the most likely option.

Data QA/QC

General quality assurance/quality control (QA/QC) procedures will include pre-deployment checks and calibration verification of each pressure transducer following manufacturer recommendations, along with confirmation of correct logger configuration. As stated earlier, integrated staff gage manual readings on the stilling well will be used as routine consistency checks against in situ transducer-derived water levels. Any notable discrepancies or monitoring site changes will be documented. Surveyed water surface elevation in the immediate vicinity of the pressure transducer will also be recorded at the beginning and end of the deployment period. These measurements will serve as an absolute elevation reference for the fully submerged stilling well installations and will be used as an independent verification for the stilling wells with integrated staff gages.

Time-series data will be reviewed after every data download for anomalies and compared to expected river stages and seasonal patterns. Throughout the deployment, rigorous note-keeping and documentation (e.g., field logs, site descriptions, photographs) will be maintained to support data analysis, interpretation, and traceability. Any data gaps, nonoperational periods, or corrections applied will be clearly noted for data users to be aware of limitations and QA/QC actions.

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APPENDIX B

GENERAL SITE HEALTH AND SAFETY PLAN ADDENDUM FOR
PHASE 3 SEDIMENT STUDY – SEDIMENT FACIES MAPPING
QAPP ADDENDUM No. 1

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ACRONYMS AND ABBREVIATIONS

DEET	N,N-diethyl-m-toluamide
ERM	Environmental Resources Management
HAZWOPER	hazardous waste operations and emergency response
OSHA	Occupational Safety and Health Administration
OU	operable unit
PFD	personal flotation device
PPE	personal protective equipment
QAPP	quality assurance project plan
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

ERM 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
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_____ 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 UCR site (Site) information and health and safety provisions to protect workers from potential hazards during hydrographic and lidar data 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 the policy of Environmental Resources Management (ERM) to provide a safe and healthy 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 Teck American Incorporated (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 modifications will be presented to the on-site team during a safety briefing and will be recorded in the field notebook.

1.1 ORGANIZATION

Task-specific safety procedures associated with water level sensor installation and hydroacoustic and lidar data collection activities are presented in this addendum to the general SHSP. In addition, this addendum provides a field study area and hospital location map, 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

Hydroacoustic and lidar data collection activities will be conducted by TAI field contractors during the spring of 2026. As indicated in the Quality Assurance Project Plan (QAPP) Addendum No. 1, hydroacoustic and lidar data will be collected throughout Operable Unit (OU) 1 and the upper reaches of OU 2 (the Data Gap Study Area), which encompasses the UCR river channel from the U.S.-Canada border to an area just south of Marcus Flats within the Site (Attachment B1). Continuous water level sensor data will also be logged at several monitoring stations throughout the Data Gap Study Area.

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 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 B2-1 summarizes potential physical hazards posed by proposed Site activities. Table B2-2 presents potential physical hazards that are expected to be present during sampling activities.

Table B2-1. Summary of Activities and Potential Hazards

Activity	Potential Hazard
Hydroacoustic data collection and water level sensor installation	Water hazards; uneven terrain/tripping, slippery walking surfaces; cold/hypothermia (depending on sampling event); heat stress (depending on sampling event); material handling; operating powered hand tools; adverse weather; drowning; work in remote areas; biting and stinging insects; poisonous plants; wildlife; traversing rough terrain.
Aerial lidar data collection	Specified and addressed by contractors conducting lidar data collection.

Table B2-2. 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 B2); 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 B3); potential for heat stress will depend on season.
Material handling	X		Lift properly; seek assistance if necessary; do not overfill coolers or boxes.
Powered hand tools	X		Wear proper PPE (eyewear, ear protection and gloves), avoid loose-fitting clothing and other sources of entanglement; follow specific user manuals.
Adverse weather	X		Seek shelter during storms; work in adverse weather conditions only with proper training, clothing, and equipment.

Table B2-2. Potential Physical Hazards and Proposed Safety Procedures (continued)

Potential Hazard	Yes	No	Proposed Safety Procedure
Drowning	X		All employees, when working in, on, or near water (i.e., within 10 ft or 3 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.
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		Avoid 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 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.

Table B2-2. Potential Physical Hazards and Proposed Safety Procedures (continued)

Potential Hazard	Yes	No	Proposed Safety Procedure
Wildlife encounter	X		See individual animals listed below.
Poisonous snakes (rattlesnakes)	X		Wear appropriate PPE, such as ankle-high leather boots, long pants, snake chaps, long sleeves, 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 or 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 and 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 the 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 judgment while still following safety tips described above to determine whether you can reach the vehicle.

Water work. This work will include sampling by TAI field contractors and ERM employees on or near water where there is a potential to voluntarily or involuntarily enter the water. Hydroacoustic data collection and water level sensor installation will be conducted from a boat within waterbodies in the Data Gap Study Area. All employees, when working **in** or **near** water (i.e., within 10 ft or 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. Prioritize safety on small boats by always wearing a properly fitted U.S. Coast Guard-approved PFD, maintaining 3-point contact when moving, and keeping weight low and centered. Ensure that all emergency equipment, radio checks, and weather checks are completed before departure. Never overload the vessel, avoid working alone, and keep the deck clear of hazards. 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 on-site 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 whether there is a suitable and safe alternative route around the obstruction at that location. Consult local maps to determine whether 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 PPE AND SAFETY EQUIPMENT

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

4.1 PPE

Based on chemical and physical hazards associated with hydroacoustic and lidar data collection activities and water level sensor installation, Tables B4-1 and B4-2 identify the PPE required for each Site activity.

Table B4-1. Level of Protection Required for Site Activities

Site Activity	Level of Protection	
	Initial ^a	Contingency ^b
Hydroacoustic data collection	MD	Leave Site, reassess situation
Lidar data collection	MD	Leave Site, reassess situation
Water level sensor installation	D	Leave Site, reassess situation

^a See Table B4-2 for definitions.

^b Based on unexpected change in Site conditions.

Table B4-2. Levels of Protection and PPE

Protection Level	Required	PP
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):

- | | |
|---|---|
| <input type="checkbox"/> Photoionization detector | <input type="checkbox"/> Air sampling pumps |
| <input type="checkbox"/> Lower explosive limit/oxygen meter | <input type="checkbox"/> Miniram |
| <input type="checkbox"/> Hydrogen sulfide meter | <input type="checkbox"/> Radiation meter |
| <input type="checkbox"/> Detector pump and tubes | <input type="checkbox"/> Other _____ |

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

- | | | | |
|-------------------------------------|-------------------|-------------------------------------|-------------|
| <input checked="" type="checkbox"/> | Emergency blanket | <input checked="" type="checkbox"/> | Sunscreen |
| <input checked="" type="checkbox"/> | Insect repellent | <input type="checkbox"/> | Other _____ |

Other (check the items required for this project):

- | | | | |
|-------------------------------------|--|-------------------------------------|---|
| <input checked="" type="checkbox"/> | Eyewash | <input type="checkbox"/> | Fit test supplies |
| <input checked="" type="checkbox"/> | Drinking water | <input checked="" type="checkbox"/> | Fire extinguisher |
| <input type="checkbox"/> | Stopwatch for monitoring heart rate | <input type="checkbox"/> | Windsock |
| <input type="checkbox"/> | Thermoscan® thermometer
(or equivalent) for heat stress
monitoring | <input checked="" type="checkbox"/> | Cellular telephone |
| <input checked="" type="checkbox"/> | Survival kit | <input checked="" type="checkbox"/> | Radio sets (if no cellular or satellite
telephone service) |
| <input checked="" type="checkbox"/> | Personal flotation device | <input checked="" type="checkbox"/> | Global positioning system |
| | | <input checked="" type="checkbox"/> | Other: Satellite telephone,
hip/chest waders,
snake chaps, bear spray |

5 AIR MONITORING

The principal chemicals of potential concern 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 the installation of water level sensors or hydroacoustic and lidar data collection activities. If windblown dust becomes problematic to the field crew, operations may be suspended. Tables B5-1 and B5-2 provide air monitoring requirements and action levels to be used during sampling activities.

Table B5-1. Site-Specific Air Monitoring Requirements

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

Table B5-2. 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:

- Local emergency medical provider (i.e., fire department; see Table B6-1 for local contact information)
- First aid-trained field staff (for remote areas only).

Table B6-1. 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 (Adenea Sellars; 509-684-7563) 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 St. in Colville. Turn LEFT on E. Columbia Ave. Go 0.6 mile. Arrive at 982 E. Columbia Ave. Hospital is on right. (See detailed hospital location maps in Attachment B1.)	Not applicable	Not applicable
Alternative Hospitals	St. Joseph's Hospital, Chewelah, 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 B6-1. 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 to be determined	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 B6-2.

Table B6-2. Corporate Emergency Telephone Numbers

Corporate Resources	Name	Work/Cellular Telephone
TAI Project Coordinator	Rob Orr	Work: 509-623-4551 Cellular: 509-368-4332
TAI Assistant Project Coordinator	Elena Wolf	Work: 509-623-4524 Cellular: 509-867-7795
ERM Task Manager	Preston Martin	Work: 425-967-5285 Cellular: 206-962-0214
ERM Principal Investigator	Jennifer Holder	Work: 805-684-2801 Cellular: 805-680-8484

Table B6-3 provides local hospital contact and location information. See Attachment B1 for a detailed hospital location map.

Table B6-3. Project Area Hospital Information

Facility Name	Open for Emergency Services	Telephone Number	Address	City
Mount Carmel Hospital	24 hours	509-684-2561	982 E. Columbia Ave.	Colville
St Joseph's Hospital	24 hours	509-935-8211	500 E. Webster St.	Chewelah
Ferry County Memorial Hospital	24 hours	509-775-3333	36 Klondike Rd.	Republic
MultiCare Valley Hospital	24 hours	509-924-6650	12606 E. Mission Ave.	Spokane
Coulee Community Hospital	24 hours	509-633-1753	411 Fortuyn Rd.	Grand Coulee
Holy Family Hospital	Dependent on case	509-482-0111	N. 5633 Lidgerwood Ave.	Spokane
Veterans Affairs Medical Center	24 hours	509-434-7000	N. 4815 Assembly St.	Spokane
Sacred Heart Medical Center	24 hours	509-474-3131	W. 101 Eighth Ave.	Spokane
Deaconess Medical Center-Spokane	24 hours	509-473-7178	W. Fifth Ave.	Spokane
Lincoln Hospital	24 hours	509-725-7101	10 Nichols St.	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 in the QAPP [TAI 2018]) to ensure that future health and safety issues are addressed.

7 WORK ZONES

This section will only be applicable while working in areas where hazardous substances may present, or are reasonably suspected to be present, and pose an exposure hazard to personnel. For those situations, the following work zones are defined for the data collection activities:

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

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

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

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

8 DECONTAMINATION

This section is not applicable to water level sensor installation or data collection activities given that no environmental media will be sampled and stored (e.g., water, sediment).

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 hydroacoustic and lidar data collection activities, in addition to unexpected contact with the data collection equipment. Field personnel should always move about the shore, upland area, or onboard vessels with caution and wear properly fitting shoes or boots with nonslip 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.

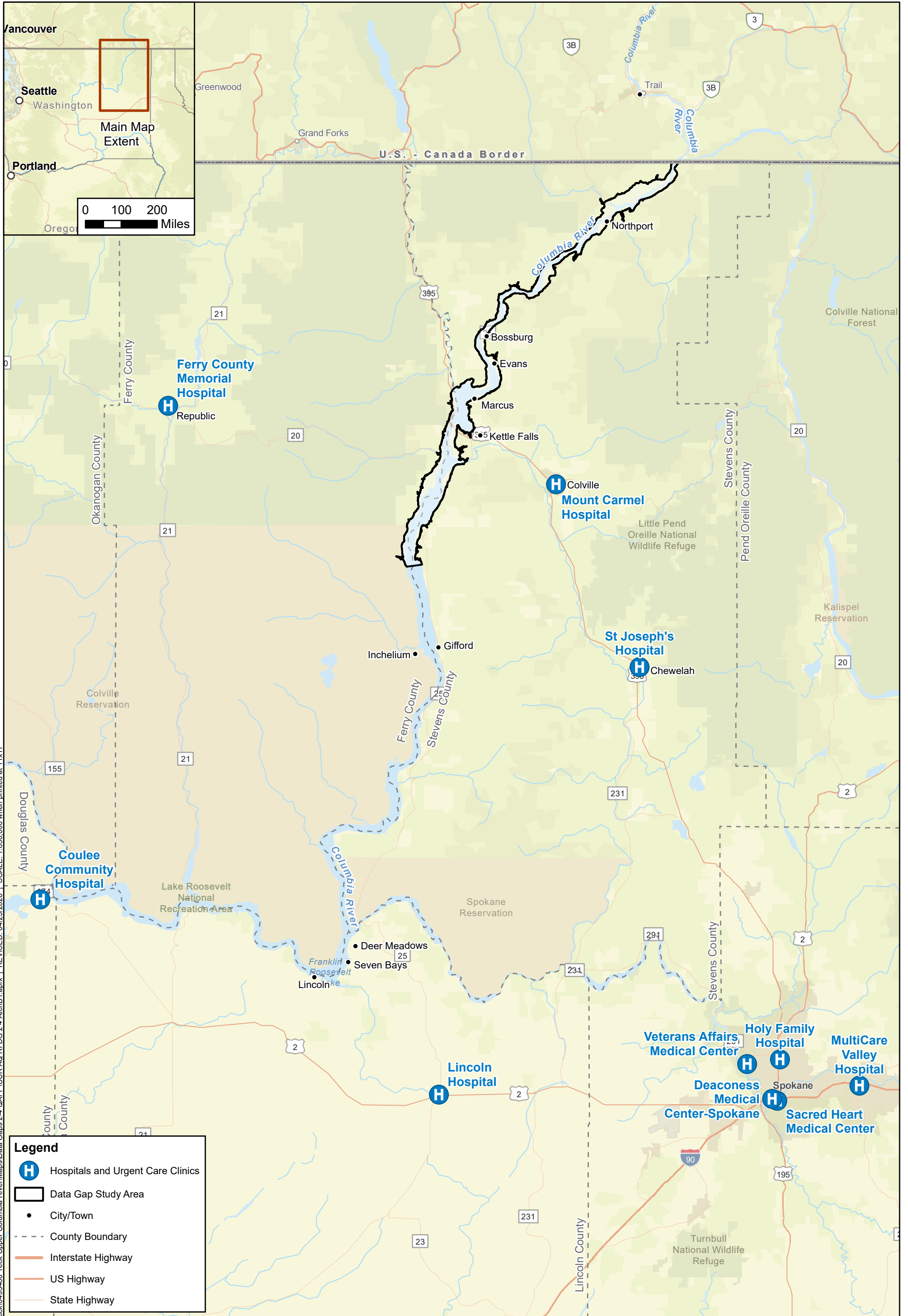
The areas that will be sampled are accessible to the public. Field crew members should always be aware of their surroundings, use the buddy system, and/or always keep in line-of-sight contact with other field personnel. If a crew member feels threatened, or if the situation feels unpredictable, leave the area immediately.

11 REFERENCES

- TAI (Teck American Incorporated). 2018. Final Quality Assurance Project Plan for the Phase 3 Sediment Study – Sediment Facies Mapping. Prepared for TAI by ERM in association and consultation with HDR, David Evans and Associates, Inc., Windward Environmental LLC, Gravity Consulting LLC, and Parametrix, Inc.
- 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, WA, and Parametrix, Seattle, WA.




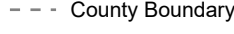
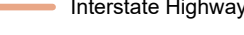
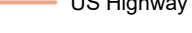
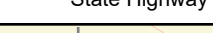
ATTACHMENT B1

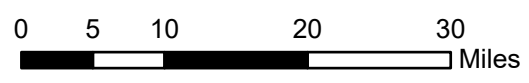
STUDY AREA AND HOSPITAL LOCATION MAP



FILE: M:\US\Projects\5-UT\Tech\0499466 Tech Upper Columbia River\Maps\Data Gaps 2-4 GAPP\UCR AQ RI DG 2-4 AtchB1.aprx | REVISED: 04/23/2026 | SCALE: 1:850,000 when printed at 11x17

Legend

-  Hospitals and Urgent Care Clinics
-  Data Gap Study Area
-  City/Town
-  County Boundary
-  Interstate Highway
-  US Highway
-  State Highway



Data Gap Study Area and Hospital Location Map
 Phase 3 Sediment Study – Sediment Facies Mapping QAPP Addendum No. 1
 Upper Columbia River, Washington

ATTACHMENT B2

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.

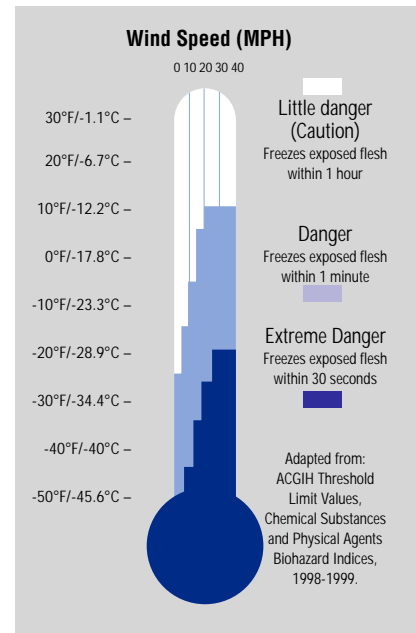
What to do: (water temperatures)

- 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.



ATTACHMENT B3

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.)

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.

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.

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**.

