1.0 DRAFT SEDIMENTATION STUDY PLAN ANNOTATED OUTLINE

1.1 PROJECT NEXUS AND RATIONALE FOR STUDY [§ 5.9(B)(4)-(5)]

The proposed Cutler Hydroelectric Project (Project) operations could have the potential to resuspend and mobilize bed sediments in key areas of Cutler Reservoir.

- Changing reservoir surface elevation levels could change water velocity within the thalweg[1], scour or shift deposited bed sediments, and potentially lead to increased lateral erosion of high banks within the Project Area.
- High inflows or substantial rainfall during lowered reservoir levels could potentially deposit substantial amounts of sediment in deeper areas of the reservoir.
- Suspected high concentrations of phosphorus or other nutrients and pollutants bound in bed sediments have the potential to affect water quality.
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This study will improve the understanding of existing conditions, especially regarding the potential re-suspension and mobilization of bed sediments in Cutler Reservoir. This information will provide a clear picture of potential changes that could potentially occur under operational scenarios. The study will also address the practicability of dredging as a sediment management measure and assess its environmental effects.

1.2 STUDY GOALS AND OBJECTIVES [§ 5.9(B)(1)]

The Sedimentation Study Plan (Study Plan) addresses the following goals and objectives:

- Characterize and map sediment depth and composition.
  - Assess depth to gravel or highly compacted clay (depth to embeddedness).
  - Assess depth of unconsolidated material or highly mobile sediment and highly organic soils.
  - Collect sediment samples to determine bound phosphorus and other potential pollutant concentrations.
  - Assess interstitial concentrations of dissolved phosphorus in unconsolidated material.
  - Determine the release rate of phosphorus into the water column (results and analysis discussed in other study plans.)
- Characterize sediment deposition throughout Cutler Reservoir.
- Assess mobility potential of sediment.
- Assess resuspension and settling rates of sediment.

[1] In geography and fluvial geomorphology, a thalweg is the line of lowest elevation within a valley or watercourse.

- Assess potential of dredging and its' resultant effects.

1.3 RELEVANT RESOURCE MANAGEMENT GOALS AND PUBLIC INTEREST CONSIDERATIONS [§ 5.9(B)(2)]

Currently there are no Resource Management Goals in the 1995 Resource Management Plan for Cutler Reservoir that are directly related to sedimentation. However, the outcome of this study will provide valuable insight into management options for other resource areas, i.e. hydraulic resources and aquatic resources.

This Study Plan will review and incorporate existing information related to sedimentation within the Project Boundary. References for studies, reports, and other sources of information analyzed as part of this study will be provided in this section as they are identified. Below is a partial list of these information sources:

1. Middle Bear River and Cutler Reservoir Total Maximum Daily Load (TMDL). Utah Division of Water Quality (2010).
2. Utah Division of Water Quality database (AWQMS). 2020.
3. United States Geological Survey database (NWIS). 2020.
4. Acoustic Bathymetric Case Study – Hydrographic Survey of a River Channel in Texas. 2018.
5. Sediment Coring Case Study – Sediment coring in Lake Bonito, New Mexico. 2018.
6. Bathymetric and Sediment Survey Case Study. 2018.

1.4 STUDY AREA

The sedimentation study area will encompass Cutler Reservoir with all surveyed areas located inside the Project Boundary. Potential areas of focus include:

- Canyon areas from Cutler Dam to Wheelon Dam.
- Canyon areas from Wheelon Dam to Highway 23 bridge.
- Areas defined as critical for sediment transport and hydraulic analysis.
  - Inflow areas, and constricted areas within the reservoir (e.g. bridges).
- Areas defined as critical by water resource specialists.
  - Areas of important habitat for aquatic species.

1.5 METHODS [§ 5.9(B)(6)]

1.5.1.1 SEDIMENT CORING

Numerous coring methods exist to collect sediments in deep waters, or littoral habitats. These include:

- Traditional drill rigs.

- Geo-probes or push probes.
- Vibration corers.

These methods all have benefits and limitations. The three options for collecting cores of deposited sediments based on depth of water, suspected depth of sediment, ease of mobility will be assessed, and the best method to collect sediment samples within a given area of the reservoir will be selected. A stratified random design with a sample size weighed according to surface area will be used to survey distinct sections of the reservoir. Because Cutler is very shallow above the Cache Junction Bridge, the vibrating corer will likely be utilized in the majority of the reservoir based on the following criteria:

- Best value and high mobility within the shallow areas of the reservoir.
- Typically have a maximum penetrative depth of 20 feet, or when the corer reaches dry, highly compacted clays, or gravels and bedrock.
- Can reach enough depth to characterize highly mobile bed sediment.

Sediment cores will be preserved for characterization with the following tests:

- Size grading for mobility (sieve and hydrometer for finer material below a No. 230 or 63µ sieve). Data will be provided to other specialists for sediment transport analysis.
- Organic versus inorganic composition.
- Upper approximate four inches[2] of selected cores will be analyzed for phosphorus concentrations.
- Flocked sediments may be preserved for dissolved phosphorus in interstitial voids to be determined in future discussions prior to finalizing this Study Plan.

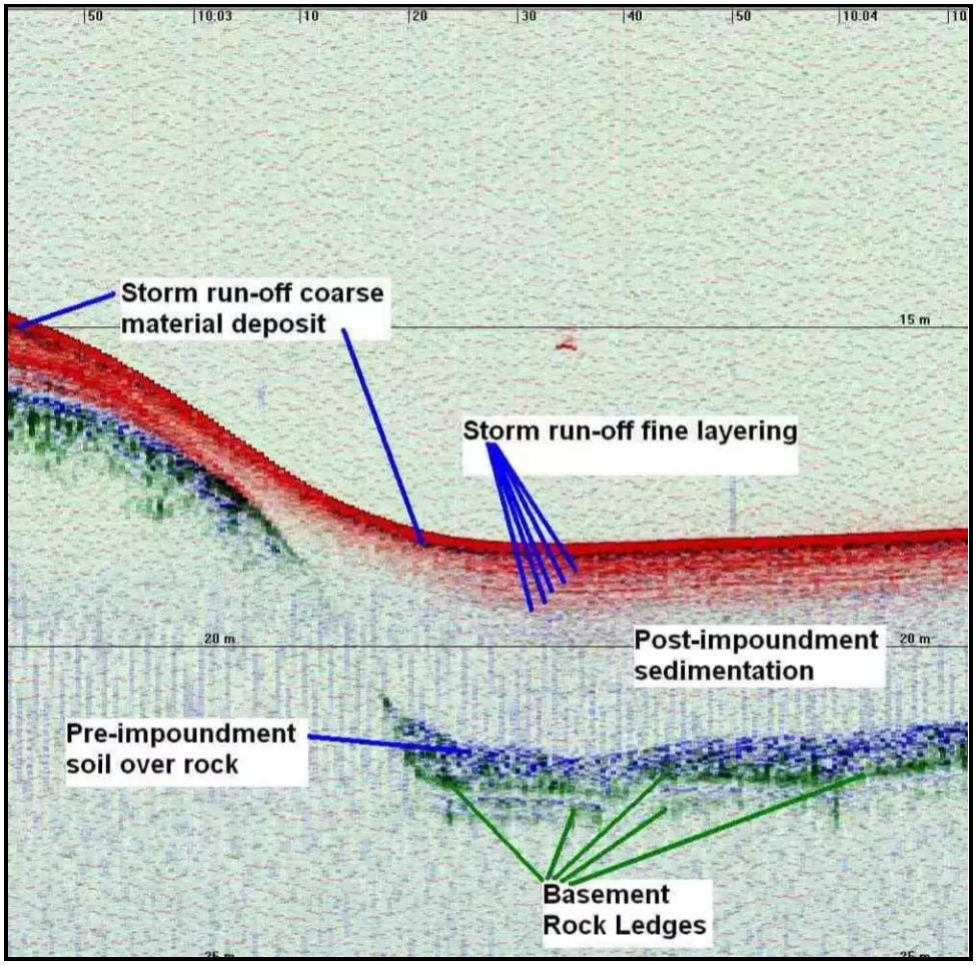
1.5.2 CHARACTERIZATION AND DISTRIBUTION OF SEDIMENT DEPOSITS IN CUTLER RESERVOIR

To fully address the magnitude and depth of sediments within the reservoir, a multiple frequency echosounder will be deployed to collect a significant number of data points recording bed sediment depth. Important aspects of this survey method include:

- High frequency sounders typically stop at the soft bed, and lower frequencies penetrate deeper into bed sediments (Figure 1).
- Use a 3-to-5-frequency[3] sounder to collect sub-bottom depth.
- Can be operated in as little as 12 inches of water.

[2] Phosphorus in the upper four inches is most often associated with the whole lake metabolism. Mobilization of phosphorus down to ten-inches can occur, but is system dependent.
[3] Echosounders with a variety of frequency's (200 kHz, 50 kHz, 28 kHz, 12 kHz, and 4 kHz) can penetrate bed sediments and define bands of deposits, gravels, and bedrock.

- Survey track lines will be developed to complete a raster coverage of the bed of Cutler Reservoir.
- Often used for dredging applications.
- Bottom profile can be used in areas not measured by LiDAR due to water coverage.
- Sediment core data will be used to validate soundings for depth of sediment.
- Vertical accuracy is sub-centimeter for bottom profiling.
- Horizontal accuracy is sub-meter to centimeter, depending on global positioning system (GPS) selection.
  - Can utilize Utah TurnGPS system for centimeter accurate positioning.
- Can be completed before and after the planned 2019 drawdown period (preferred).



Source: SDI 2019

FIGURE 1 EXAMPLE OF A SUB-BOTTOM PROFILE FOR SEDIMENT MAPPING

As the Study Plan is developed, track lines of the survey area will be created to define the extent of coverage focusing on areas of special concern.

1.6 ANALYSIS AND REPORTING

Sediment core depth will be measured, mapped, and reported in feet from the top of bed to reservoir bottom or maximum penetrative depth. Other items in the Study Plan report will include:

- Precise location will be recorded with sub-meter GPS and mapped.
- Depth of water column will be recorded.
- Depth of core achieved (original bed or penetrative depth) will be recorded.
- Cores will be classed with sieves and/or hydrometer to classify soil type and reported as a percent size class.
    - This information will be used in the sediment transport analysis.
    - Upper section of the cores (0 to 3 feet) will be examined and tested for organic percentage (less than 30 percent) as needed to qualify for hydrometer analysis (note that cores with more than 30 percent organic material will bias hydrometer readings and cannot be used).
- Upper section of cores (0 to 1 foot) will be preserved for nutrients (phosphorus and other) and pollutant analysis as necessary.
- Interstitial void in highly saturated soils will be preserved as needed, for water extraction and dissolved phosphorus testing. This test will be based on recommendations from water resource specialists.
- Percentage of readily available phosphorus bound in sediments will be determined.
- Analyze sediment model output and report transport analysis.

Analysis of sub-bottom profiling will be used to create a map of sediment depth within the reservoir. The map will display the information created from bathymetric survey measurements of Cutler Reservoir. This coverage can be used to identify:

- Sediment depth.
- Sediment type based on size class.

The data could also be used by PacifiCorp in the future to evaluate:

- Potential dredging options.
- Potential use and schedule of flushing flows to reduce deposition.

1.7 SCHEDULE, PERIODIC REPORTING, AND ONGOING CONSULTATION

The anticipated work schedule will commence once the study plan is approved. Work can be conducted outside of any drawdown schedule.

An Initial Study Report (ISR) will be prepared following the initial survey year. This report will be submitted to PacifiCorp for review and filed with the Federal Energy Regulatory Commission (FERC). The Initial Study Report will be reviewed by stakeholders. If no additional information is warranted, the ISR will identify why no second year of surveys are warranted and that an Updated Study Report (USR) will not be filed. A letter will be filed with FERC in lieu of the USR identifying the lack of need for a second year of studies. If additional information is warranted, a USR will be filed following a survey in year 2. All study reports will be consulted upon by stakeholders and filed with FERC.

1.8 LEVEL OF EFFORT AND COST [§ 5.9(B)(7)]

The level of effort and cost will be determined when the Sedimentation Study Plan is finalized.

1.9 REFERENCES

Bridgerland Audubon Society. 2010. Cover page photo of Cutler Marsh. Photo by Mike Fish. Accessed June 14, 2019. https://bridgerlandaudubon.org/our-projects/cutler-reservoir-marsh-important-bird-area/.

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