Appendix H. Cutler Reservoir Monitoring Plan

Monitoring Plan for Cutler Reservoir
Phased TMDL Study
August, 2009

INTRODUCTION
Cutler Reservoir was created in the 1920's as an impoundment of the Bear River in Cache Valley, Utah. Water delivery and hydroelectric power generation were originally the primary reasons for the construction of the reservoir, but more recently it is also used for a variety of other purposes including aquatic habitat and recreation. The reservoir is also popular with bird watchers and hunters and is an aesthetic focal point of the surrounding area. The Utah Division of Water Quality (UDWQ) began monitoring Cutler Reservoir in the mid-1970's to establish baseline water quality data on the reservoir under a range of weather and flow conditions. From these data the UDWQ has observed impairment to the reservoir's designated beneficial use for warm water aquatic life.

Cutler Reservoir was placed on the state's 303d list of impaired waters in 2002. The warm temperatures in the summer combined with high nutrient loads results in a decline in dissolved oxygen levels in the reservoir due in part to excessive growth of algae. Increasing urban development throughout Cutler Reservoir's watershed is also changing the character of the reservoir's tributaries. In response to the impaired status of Cutler Reservoir a Total Maximum Daily Load (TMDL) water quality study was initiated in 2004 to identify the sources of water quality impairment and determine the maximum allowable loads of pollutants to restore and maintain its beneficial uses. Implementation of this TMDL will be staged over a 10 year timeframe to allow for revisions based on new information and to account for uncertainty in the original analysis associated with the linkage between dissolved oxygen and the pollutant of concern identified in the TMDL, total phosphorus. The purpose of this monitoring plan is to outline the next steps to be taken to identify progress towards and ultimate attainment of the TMDL water quality goals and endpoints.

EPA and its partners are conducting a survey of the nation's lakes, ponds and reservoirs. This National Lakes Assessment is designed to help provide statistically valid regional and national estimates of the condition of lakes. It uses a probability-based sampling design to represent the condition of all lakes in similar regions sharing similar ecological characteristics. Consistent sampling and analytical procedures ensure that the results can be compared across the country. The UDWQ will review the National Lakes Assessment guidelines and incorporate applicable elements into the Cutler Reservoir monitoring plan.

BACKGROUND
The Bear River Cutler Reservoir Advisory Committee (BRCRAC) in conjunction with UDWQ has completed the first phase of the TMDL study for Cutler Reservoir. This phase identifies reductions in total phosphorus from all sources in the watershed in order to attain dissolved oxygen water quality standards. This Water Quality Monitoring Plan is consistent with the sampling procedures of UDWQ and the Utah Department of Environmental Quality. The plan presents the additional data to be collected as identified by recommendations from the public and

the BRCRAC. All monitoring procedures for this study are based on UDWQ's standard operating procedures (SOPs) for various monitoring methods. Field teams will follow these procedures during the execution of the monitoring program. UDWQ will cooperate with the BRCRAC to conduct the following sample collection and analysis activities.

Existing Water Sampling Locations

The sampling locations for the water quality monitoring of Cutler Reservoir are shown below. Both stream and lake sampling locations were selected to provide the best representation of the water quality and pollutant loading of Cutler Reservoir. Stream sample locations were selected that had safe and easy access. Access must be relatively easy and unencumbered during winter sampling. Safety is also a concern, so sites on streams with steep slopes and difficult terrain were avoided. Historical flow data are limited for most of the tributaries to Cutler Reservoir. However, the UDWQ is working to establish stage discharge relationships for each of the monitoring locations. All relevant historical data will be used during this study for quantifying the drivers of low dissolved oxygen in the reservoir. Flow and water quality data will be collected from all stream sampling locations. Water quality data will be collected from the lake sampling locations and profile data will be collected at critical time intervals. The table below presents the sample locations for the monitoring activities to be conducted during this study.

Tributary Sampling Sites

Site #	Waterbody	Location	Abbreviation and Storet
1	Logan River	At Mendon Road	LR #4905040
2	Spring Creek	At Mendon Road	SC #4904900
3	Little Bear River	At Mendon Road	LB #4905000
4	Blue Springs	At 3200 West	BS #4905060
5	Swift Slough	Upstream Logan WWT Wetlands	SSUP #4905060
6	Swift Slough	Below Logan WWT Wetlands	SS #490590
7	Bear River	Near Benson	BR # 4903260
8	Newton Creek	atSR23	NC #4903110

Reservoir Sampling Sites

Site #	Waterbody	Location	Storet and Abbreviation
1	Cutler Reservoir	At Valley View Highway	CVV
2	Cutler Reservoir	Near Swift Slough	CSS #4905060
3	Cutler Reservoir	At Benson Marina	CBM #5901000
4	Cutler Reservoir	At Clay Slough	CCS #5900980
5	Cutler Reservoir	At Cache Junction	CCJ #5900980

These locations will be sampled monthly using grab sampling, vertical profiling, and manual field and laboratory analyses. Continuous probe measurement stations will be established on the river sites and in selected reservoir locations. In addition, six rainfall events will be targeted for sampling with mobilization of sampling teams for manual collection of samples for field and laboratory measurements of water quality parameters to monitor the response to these runoff events.

All sampling times, data, and site characteristics will be recorded in field sheets and on chain of custody forms as required by UDWQ SOP's. The forms will be maintained until the completion of this study and will be made available to the public at the study's conclusion.

Sample labels will contain at least the following information:

- project ID;
- site/station ID;
- date and time;
- parameter sampled;
- Initials of person(s) collecting the sample.

If any portion of any sample is discarded, it will be recorded in the field notes as to which bottle was discarded and the basis for this decision.

Quality Assurance (QA) and Quality Control (QC) activities are designed to achieve the specific data quality goals associated with the sampling program and will follow all EPA guidance. The data collected during this monitoring program will be useable to support the development of water quality models and provide a basis for improving the linkage between dissolved oxygen and pollutant loads in Cutler Reservoir.

Additional monitoring sites for the Southern Reservoir, including the littoral areas

The lack of additional phosphorus monitoring data for the Southern Reservoir contributed to the decision to group the reservoir into 2 (rather than 5) segments for management purposes, including identification of water quality endpoints. In general, routine water quality sampling in Cutler Reservoir is biased towards the open water limnetic areas. Very high concentrations of chlorophyll a were recorded during supplemental monitoring (554 ug/l and 1,262 ug/l) of Cutler Reservoir in 2004. Sampling field notes and personal communication with the samplers (Tonya Dombrowski personal communication with Erica Gaddis February 25, 2009) indicate that these values represent chlorophyll a conditions in Clay Slough during algal bloom periods. These data indicate severe eutrophication in the littoral areas of the reservoir.

UDWQ believes that additional water quality monitoring in the littoral parts of the Southern Reservoir will improve our understanding of the system and the relation between these areas and the open water areas. DWQ and its partners will collect additional data in the littoral areas of the reservoir that will improve our understanding of the spatial extent of the water quality impairments.

This monitoring could support establishment of additional water quality endpoints in littoral areas of the reservoir during a subsequent phase of the TMDL.

Hydrologic and water quality monitoring for the irrigation canals and pipes discharging directly to the reservoir

Irrigation return flows will be monitored to improve pollutant source estimates contained in the TMDL.

Water quality data will be collected from irrigation canals on a periodic basis that use Logan City effluent and those that do not. Water quality data will also be collected from identified pipe discharges around the reservoir particularly to the western side of the reservoir as there is limited data from that area. Samples will also be taken from canals draining to Swift Slough. Samples will be collected during different hydrologic periods/seasons (spring runoff, storms, dry periods, irrigation and non-irrigation seasons) to help determine any pattern which might identify a source. Sample analyses will include nutrients, biological oxygen demand (BOD), organic matter, total suspended solids (TSS), and total organic carbon (TOC).

Quantified Linkage between phosphorus, DO, and Chl a

Simultaneous sampling of phosphorus (total, dissolved, and orthophosphate), nitrogen (total, TKN, nitrate, ammonia), Chl a and diurnal DO at both open water (most existing sampling sites) and littoral areas of the reservoir will be collected. Intensive sampling will be designed to understand the factors affecting DO levels in Cutler Reservoir. This will include concurrent measurements of Chl a, nutrients, light extinction (or Secchi depth), TSS, BOD, particulate organic carbon (POC), temperature, pH, and DO. Special studies will then be conducted to further understand the linkage between phosphorus, Chl a, and DO. Concurrent with the intensive surveys, instruments will be installed to continuously record DO, temperature, and pH in Cutler Reservoir over a 7-day period.

Sediment Oxygen Demand

UDWQ and its partners will develop special studies to further understand SOD and sediment nutrient fluxes in Cutler Reservoir. The monitoring will be frequent enough in terms of spatial and temporal frequency to see patterns in each reservoir segment across different seasons. Care will be taken to make sure the method employed will give actual sediment oxygen demand rather than maximum potential SOD. The strategy employed will insure that SOD values are ‘real’ rather than maximum potential SOD. Sediment nutrient concentration sampling will be preformed and analyzed to identify potential hot spots that could respond well to isolated dredging/sediment removal.

Fisheries studies

In accordance with EPA guidance (Consolidated Assessment and Listing Methodology: Toward a Compendium of Best Practices, First Edition, USEPA 2002), assessment of impairment with biological data should quantify "the difference between reference or expected conditions of aquatic communities and those found at a specific site being evaluated." Reference conditions serve as the "benchmark of biological integrity against which a waterbody's conditions are compared." Where a reference condition can not be established, EPA recommends that a "disturbance gradient be constructed to extrapolate to an appropriate reference condition." Although the USU Fisheries Report for Cutler Reservoir (Budy et al. 2007) compares fish metrics to other systems, it does not compare the observed fishery data in the reservoir to an established reference condition.

EPA guidance (2002) also identifies the following metrics for fishery data for use in assessing biological condition:

- Native taxa richness
- Morphological composition
- Habitat preference composition
- Genetic diversity
- Temperature guilds
- Specialized spawners
- Specialized feeders
- Biomass
- Abundance
- Migration
- Anadromous spawning
- Top carnivore support
- Morbidity
- Tissue contamination

Furthermore, when used in assessment of impairment, these metrics should be recorded over time to document trends in the biological community and/or compared to a reference or expected condition. The USU Fisheries Report quantifies several of these metrics and sets up a baseline for future fisheries studies in the reservoir to assess trends; however, the USU report itself can not be used to identify trends in the biological community or to determine impairment. Finally, to use biological criteria for impairment determinations, states must first establish thresholds marking the criteria "above which the waterbody is considered to be in attainment." The State of Utah has not yet established biological criteria specific to fish, however the project plan is to follow EPA guidance in this area.

3D Beneficial Use (birds and their food chains such as benthic macroinvertebrates)

Currently there is very little direct data on the health of the Class 3D beneficial use (protected for waterfowl, shore birds and other water-oriented wildlife not included in Classes 3A, 3B, or 3C, including the necessary aquatic organisms in their food chain). The state has performed no avian surveys. There is a small amount of macroinvertebrate data collected by USU students under the direction of Dr. Wayne Wurtsbaugh. The UDWQ will work with the Division of Wildlife Resources and the Audubon Society to identify sampling methods and appropriate metrics to understand bird population densities at Cutler Reservoir and to potentially compared those to the Bear River Migratory Bird Refuge nearby. The same EPA guidelines (above) for biological criteria for fish apply to macroinvertebrates and/or birds. The first biological criteria used by Utah in impairment determinations refer to macroinvertebrate assemblages in streams and are being incorporated into the Integrated Report by UDWQ. Utah is in the process of

developing methods to use macroinvertebrate assemblages to assess reservoirs and lakes for future 303(b) reporting.

Periphyton and Macrophytes

At sites where attached algae (periphyton) and macrophytes are prevalent samples will be collected simultaneously with phosphorus, nitrogen, diurnal oxygen, and suspended algae (Chl a). Studies will be designed to measure periphyton, macrophyte, and epiphyte biomass in Cutler Reservoir. This information will then be used to determine respiration rates and to make a direct linkage between water column nutrient concentration, sediment nutrient concentration, and dissolved oxygen in the reservoir.

Biogeochemistry of Phosphorous

There is a question as to how much phosphate should precipitate out of the reservoir, given the high pH and high Ca. If these ions are allowed to interact and are not disturbed they should form CaHPO4 and then slowly crystallize to apatite, a very insoluble mineral. Possibly the large number of carp are keeping these reactions from happening when they disturb the sediment. Additional research on the kinetics and equilibria of these reactions in Cutler will be considered for future reservoir studies. This may be a good university graduate student topic.

Implementation Monitoring and Reporting to a Centralized Project Database

Each organization should monitor implementation of management strategies by tracking the progress and accomplishments of each activity. Annual reports will provide details about sediment and phosphorus reduction measures, operation efficiencies, and projected load reductions; reports should be submitted to the appropriate organization and agencies for their review. The watershed would benefit from a centralized database that tracks the progress and success of implementation projects throughout the reservoir. The database would initially include water quality data and implementation planning efforts gathered as part of TMDL implementation planning but could be expanded to incorporate implementation monitoring and other types of data generated in the watershed. Examples of the types of information that should be tracked in this database include:

Implementation monitoring

- Project lead agency/organization and contact information
- Coordinating plan under which project is implemented (i.e. MAG 2003, ECWC 2004)
- Source addressed, land use, and specific location (e.g., golf course, ski resort, or other landowner)
- Resources spent, secured, or needed
- Type of funding/matching funds
- Methods planned to measure success
- Timeline
- Status

Effectiveness monitoring

- Quantitative

    - Project specific water quality plans and results indicating BMP effectiveness (pre- and post- project if possible, and up and down stream of project)
    - Estimated total phosphorus reduced as a result of the project
- Qualitative (examples)
    - Photographic documentation (pre- and post- project; up and down stream of project)
    - Development and distribution of Information and Education materials
    - Documentation of irrigation control system upgrades
    - Record changes in sediment volume in collection basins (i.e., high, medium, or low)
    - Compile and publish ski resort and golf course Watershed Restoration Action Plans
    - Track enforcement and violation of Construction Storm Water Pollution Prevention Plans and Erosion Control Plans

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