FIRST AMENDMENT TO MEMORANDUM OF UNDERSTANDING

(CRMC/Chatfield Watershed Authority)

THIS FIRST AMENDMENT TO MEMORANDUM OF UNDERSTANDING ("First Amendment") is entered into the 5 day of December 2019 (the "Effective Date") by and between Chatfield Reservoir Mitigation Company, Inc., a Colorado nonprofit corporation ("CRMC"), and Chatfield Watershed Authority ("CWA"). CRMC and CWA may be referred to collectively as "the Parties."

RECITALS

A. Whereas: The U.S. Army Corps of Engineers' Record of Decision (ROD) for the Reallocation Project, dated May 29, 2014, requires water quality monitoring at Chatfield Reservoir, and such monitoring was initiated by the CRMC in 2014 in coordination with the CWA.

B. Whereas: The CWA and the CRMC entered into a Memorandum of Understanding (MOU) on the 25th of February 2016 to cooperate in their respective monitoring programs at Chatfield Reservoir to maximize their effectiveness and minimize their respective expenses.

C. Whereas: A detailed monitoring plan (Monitoring Plan) for the coordination of monitoring activities has been approved by the decision-making bodies of CWA and the CRMC which Monitoring Plan can be modified from time to time by the Parties.

D. Whereas: The Monitoring Plan includes Exhibits B and C of the MOU. Exhibit B is comprised of tables summarizing monitoring constituents, sampling frequency and location, laboratory, and responsible party. Exhibit C is comprised of tables summarizing estimated monitoring costs in 2014 dollars.

E. Whereas: The Monitoring Plan information in the MOU was included in a November 2015 report called the *CRMC and CWA Coordinated Sampling and Analysis Plan* (2015 SAP) by incorporating Exhibit B of the MOU in tables 4-1 through 4-8 of the 2015 SAP. The SAP also provided more detail regarding monitoring objectives, quality assurance and quality control procedures, and data management, assessment and oversight.

F. Whereas: Subsequent to the execution of the MOU, the CRMC has determined a need to do additional monitoring activities at Chatfield Reservoir at the expense of the CRMC and those additional efforts are documented in Appendix A (as Special Studies) of a February 2019 revision to the SAP (2019 SAP)

G. Whereas: the CWA and the CRMC wish to amend previsions of the MOU by replacing Exhibit B of the MOU with the 2019 SAP. This amendment brings the MOU up to date with all monitoring activities taking place at this time.

AGREEMENT

NOW, THEREFORE, the Parties mutually covenant and agree as follows:

1. The 2019 SAP, specifically at Tables 4-1 through 4-8 and Appendix A, hereby replace Exhibit B of the Feb. 25, 2016 MOU. The 2019 SAP is attached as Exhibit A to this amendment.

2. All other terms and conditions of the above-mentioned MOU, except as modified herein, are hereby restated and reaffirmed.

SIGNATURE PAGE FOR
FIRST AMENDMENT TO MEMORANDUM OF UNDERSTANDING
BETWEEN
CHATFIELD RESERVOIR MITIGATION COMPANY
AND
CHATFIELD WATERSHED AUTHORITY

CHATFIELD WATERSHED AUTHORITY

By:

12/5/19

Chair
Date

George P. Teal

Printed Name

12/5/19

Vice-Chair
Date

LESLEY DAHLKEMPER

Printed Name

CHATFIELD RESERVOIR MITIGATION COMPANY

By

8/28/19

President
Date

Randy Ray

Printed Name

8/28/19

Vice President
Date

Scott Roush

Printed Name

2015

EXHIBIT A
FOR
FIRST AMENDMENT TO MEMORANDUM OF UNDERSTANDING
BETWEEN
CHATFIELD RESERVOIR MITIGATION COMPANY
AND
CHATFIELD WATERSHED AUTHORITY

Revised coordinated Sampling and Analysis Plan (SAP) dated September 2019

Chatfield Reservoir Reallocation Project and Chatfield Watershed Authority

Coordinated Sampling and Analysis Plan (SAP)

Chatfield Reservoir Mitigation Company
and
Chatfield Watershed Authority

Updated:
November 2015
February 2019
September 2019

Acceptance Page

The Chatfield Watershed Authority and the Chatfield Reservoir Mitigation Company approved this Sampling and Analysis Plan as indicated below:

Chatfield Reservoir Mitigation Company

9-12-19

General Manager Date

Chatfield Watershed Authority

12/5/19

Chair Date

12/5/19

Vice-Chair Date

12/5/19

Administrator Date

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1. Chatfield Water Quality Monitoring Program

1.1 Background

The Chatfield Watershed Authority (CWA) is the water quality management agency for the Chatfield Watershed (Figure 1-1). The Chatfield Watershed contains Plum Creek, Deer Creek, and the portion of the South Platte River from the Strontia Springs Reservoir to Chatfield Reservoir (Reservoir). The Chatfield Watershed also includes all tributaries to the Plum Creek and smaller drainages that directly connect to the Reservoir. The CWA implements the *Chatfield Reservoir Control Regulation* (Regulation #73), as adopted by the Colorado Water Quality Control Commission and is responsible for water quality monitoring within the Chatfield Watershed. The Chatfield Reallocation Project (CRP) will store 20,600 acre-feet (AF) of water in Chatfield Reservoir to develop future surface water supplies. The Chatfield Reservoir Mitigation Company (CRMC) was created to coordinate the efforts of the governments participating in the CRP and will conduct such business as may be necessary to satisfy the water quality mitigation obligations as described in the CRP Record of Decision (ROD).

1.2 Sampling Plan Objectives

The coordinated water quality monitoring program will characterize selected water quality parameters at three locations within Chatfield Reservoir (Table 1-1), two inflow locations (South Platte River and Plum Creek) and one outflow location (South Platte River, Table 1-2) to address the needs of both the CRMC and CWA (Figure 1-2). Special studies may also be conducted in conjunction with this routine sampling to address specific needs of the Adaptive Management Plan (AMP).

Table 1-1: Reservoir Sampling Parameters.

Field Parameters	Temperature, pH, Specific Conductance, Dissolved Oxygen (DO), Oxidation Reduction Potential (ORP), Secchi Depth, and Chlorophyll *a*
Miscellaneous Analyses	Total Suspended Solids (TSS), Total Dissolved Solids (TDS), *Escherichia coli* (*E. coli*), Total Organic Carbon (TOC), Dissolved Organic Carbon (DOC), Carbonaceous Biochemical Oxygen Demand (CBOD), Alkalinity (ALK), Sulfate (SO_4), and Silica
Nutrient Analyses	Total Phosphorous (TP), Total Dissolved Phosphorous (TDP), Ortho-Phosphorous (SRP), Nitrate+Nitrite-Nitrogen (NO_3+NO_2), Total Ammonia Nitrogen (TAN), and Total Kjeldahl Nitrogen (TKN)
Biological Analyses	Chlorophyll *a*, Phytoplankton, and Zooplankton
Metals Analyses[1]	Arsenic (As), Cadmium (Cd), Chromium (Cr), Copper (Cu), Iron (Fe), Lead (Pb), Manganese (Mn), Mercury (Hg), Nickel (Ni), Selenium (Se), Silica (Sio2), Silver (Ag), Zinc (Zn), and Total Hardness

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[1] Analyses include total and dissolved fractions for the metals listed for both Reservoir and stream sampling.

Table 1-2: Stream Sampling Parameters.

Field Parameters	Temperature, pH, Specific Conductance, Dissolved Oxygen (DO), and Instantaneous Flow
Miscellaneous Analyses	Total Suspended Solids (TSS), Total Dissolved Solids (TDS), *Escherichia coli* (*E. coli*), Total Organic Carbon (TOC), Dissolved Organic Carbon (DOC), Carbonaceous Biochemical Oxygen Demand (CBOD), Alkalinity (ALK), and Silica
Nutrient Analyses	Total Phosphorous (TP), Total Dissolved Phosphorous (TDP), Ortho-Phosphorous (SRP), Nitrate+Nitrite-Nitrogen (NO_3+NO_2), and Total Ammonia Nitrogen (TAN), and Total Kjeldahl Nitrogen (TKN)
Metals Analyses[1]	Arsenic (As), Cadmium (Cd), Chromium (Cr), Copper (Cu), Iron (Fe), Lead (Pb), Manganese (Mn), Mercury (Hg), Nickel (Ni), Selenium (Se), Silica (Sio2), Silver (Ag), Zinc (Zn), and Total Hardness

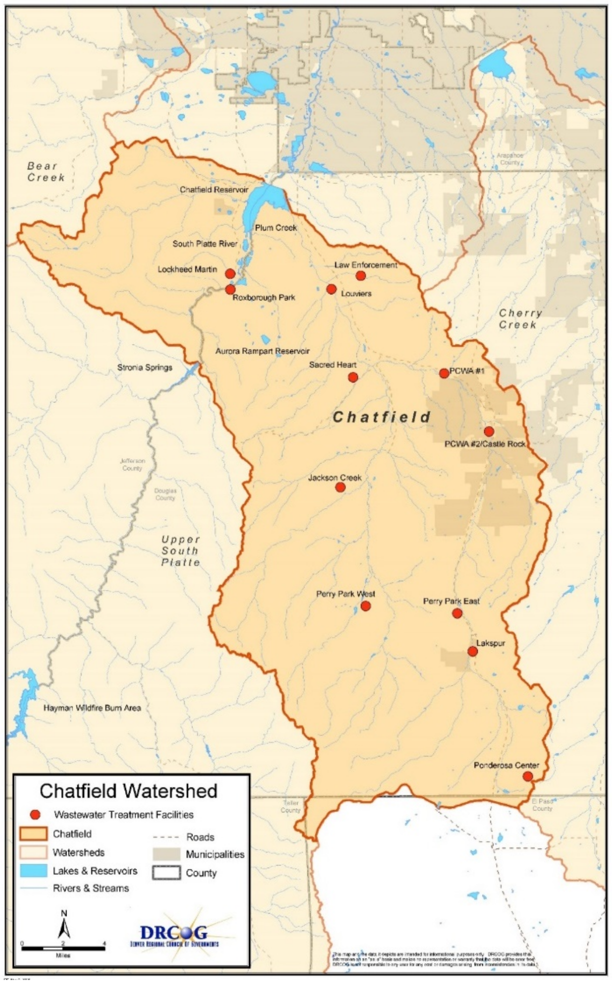

Figure 1-1: Chatfield Reservoir Watershed.

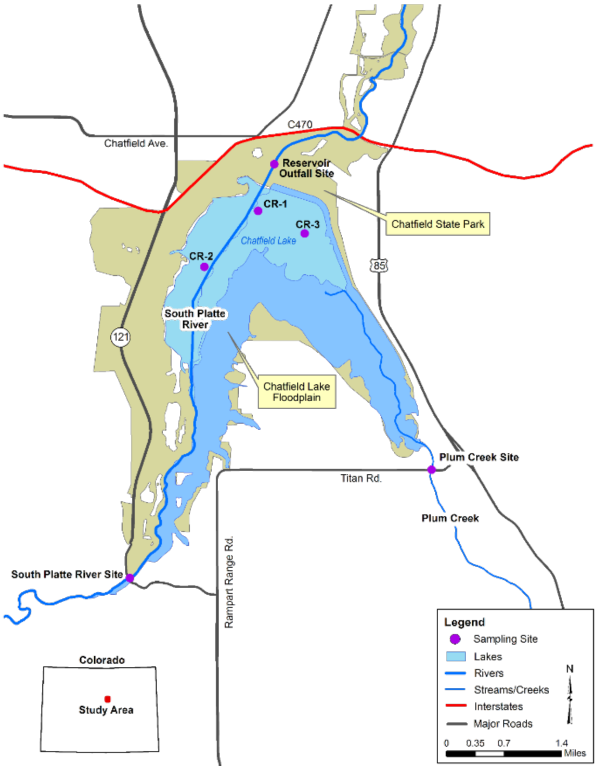

Figure 1-2: Routine sampling sites.

2. Monitoring Program Management

2.1 Project/Task Organization

The project and task organization for the Chatfield Watershed water-quality monitoring program is shown in Figure 2-1. The roles and responsibilities of each of the organizations identified in Figure 2-1 are summarized in Sections 2.2 through 2.7.

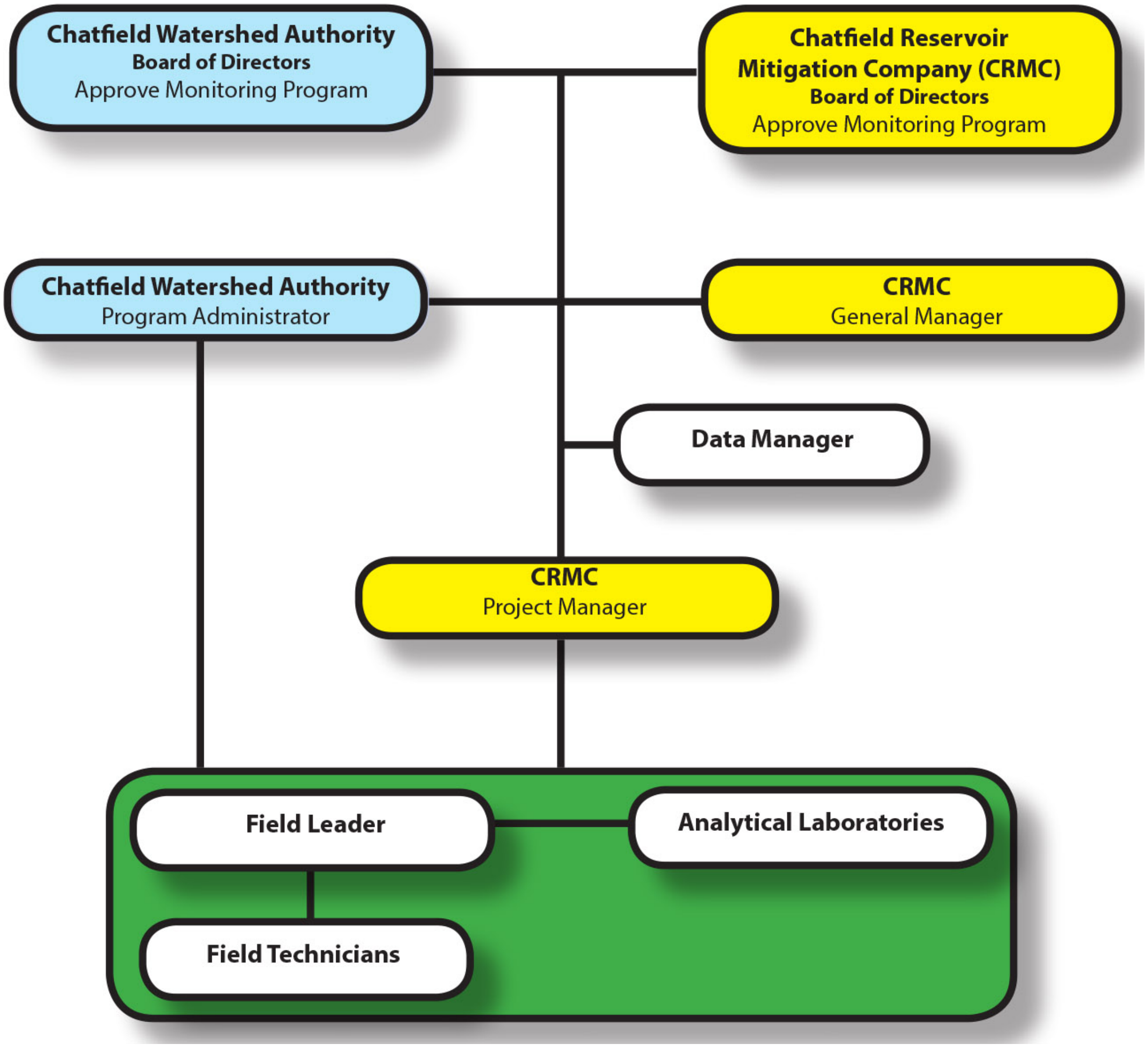

Figure 2-1: Project Organization.

2.2 Chatfield Reservoir Mitigation Company (CRMC) and the Chatfield Watershed Authority (CWA)

The CRMC has the ultimate responsibility for ensuring that the monitoring program is conducted to attain compliance with the Final Feasibility Report and Environmental Impact Statement and Adaptive Management Plan for the CRP. The CWA has the ultimate responsibility for ensuring that the watershed water-quality monitoring program is conducted in accordance with this SAP and the Chatfield Reservoir Control Regulation (#73).

2.3 Technical Review Committee (TRC)

The TRC is composed of members of the CWA and is a standing committee of the Chatfield Watershed Authority Board of Directors. As directed by the Chatfield Board of Directors, the TRC will provide review and recommendations of technical material pertinent to the water quality monitoring program, data analyses, including periodic reviews of the monitoring program. The TRC determines the monitoring program compliance with the intent of the control regulation.

2.4 Program Administrators

The Program Administrators are responsible for overseeing the performance of the water-quality monitoring program and acting on behalf of the CRMC and CWA to ensure that the program is conducted in accordance with all requirements.

2.5 Project Manager

The CRMC Project Manager is responsible for the implementation of this SAP and the water-quality monitoring program. While the CWA oversees the laboratory and field activities, the CRMC Project Manager ensures that the program is staffed with the appropriate number of qualified and trained staff and performs periodic oversight of field teams. The CRMC Project Manager reviews field data sheets, verification/validation of analytical data, maintenance of the program database, and all required reporting. The CRMC Project Manager performs required quality assurance and quality control duties, reporting back to the CRMC General Manager and Chatfield Watershed Authority Program Administrator annually.

2.6 Field Teams

Multiple entities (field teams) will conduct individual field components of the CRMC/CWA water quality monitoring program. Each entity will ensure that their Field Team Leader is appropriately trained and qualified to perform the monitoring activities. The Field Team Leader schedules laboratory and other required services and reviews/approves the field data sheets prior to transmittal to the CRMC Project Manager. In addition, the Field Team Leader will ensure that all field activities conducted by technicians are performed in accordance with this SAP.

2.7 Analytical Laboratories

Multiple analytical laboratories will be responsible for analyzing specific components of the monitoring program. Each laboratory will be responsible for performing the requested analyses in accordance with established procedures and approved quality assurance plans.

No changes in analytical laboratories shall be made without agreement by both parties and appropriate QA/QC protocols providing for split sampling and duplicates between the original laboratory and new laboratory.

3. Monitoring Objectives and Data Evaluation

The water quality concerns for the Chatfield Reservoir reallocation focus on the potential change to water quality conditions (i.e., nutrients and chlorophyll *a*) based on the expansion of the hypolimnion and inundation of shoreline areas following the increased storage capacity (ERO 2013). There is uncertainty whether the expansion of the hypolimnion will increase the areal coverage of anaerobic sediment conditions and result in increased internal phosphorus loading that may impinge on the Total Maximum Annual Load (TMAL) for the Reservoir. Furthermore, the inundated shoreline vegetation may also increase phosphorus loading to the Reservoir. The following core objectives have provided the basis for the adaptive management plan and the CRP monitoring program (ERO 2013).

1. Internal loading from "new" anoxic sediments attributed to reallocation pool level increases will not cause water quality standards for chlorophyll *a* and total phosphorus or the total phosphorus TMAL to be exceeded.
2. Internal loading from "newly" inundated vegetation attributed to reallocation pool level increases will not cause water quality standards for chlorophyll *a* and total phosphorus or the total phosphorus TMAL to be exceeded.
3. Expansion of hypoxic conditions and potential release of reduced contaminants from anaerobic sediments will not cause other water quality standards (i.e., other than chlorophyll *a* and total phosphorus) to be exceeded.

The CRMC and CWA are coordinating their respective objectives to maximize efficiency and minimize costs. The increased spatial coverage of Reservoir monitoring locations and the increased sampling frequency will provide a more complete data set to address the following water quality questions for the Reservoir as well as the future water quality modeling effort of the CRP:

1. Does Chatfield Reservoir meet the growing season total phosphorus and chlorophyll a standard annually?
2. Are total phosphorus loads in compliance with the TMAL?
3. Are the requirements of the CRP Record of Decision on water quality monitoring and analyses satisfied?

Water quality data are used to characterize the trophic state of the Reservoir, evaluate trends in the watershed and to assess compliance with basic/site-specific water quality standards and the phosphorus TMAL identified in the control regulation. The in-Reservoir total phosphorus data are used by the Colorado Water Quality Control Division to determine compliance with the total phosphorus standard of 0.030 mg/L (30 µg/L) and chlorophyll *a* standard of 10 µg/L as a growing season average (July-September). The monitoring program characterizes inputs into the Reservoir, the Reservoir water column, and outflow from the Reservoir.

3.1 Evaluation of Data

In addition to the routine compilation of the monitoring data collected, data evaluations include:

1. Compare results to water quality standards established for the Upper South Platte River Basin;
2. Perform time-trend and spatial analyses for selected annual monitoring programs;
3. Evaluate historical data; and
4. Verify and validate data, and conduct statistical evaluation for outliers.

3.2 Graphical Presentation of Data

In addition to the compilation and presentation of tabular forms of the monitoring data collected, additional graphical presentations of the data at CWA meetings and in the two separate annual monitoring reports for the CWA and for the CRMC will assist in data evaluation.

3.3 Data Quality Objectives

The project objectives are to collect data in a manner that complies with WQCD guidance for surface-water quality monitoring programs, to support decisions related to TMAL development, stream standards modifications, permit decisions, water quality assessments and CRP ROD compliance. The following paragraphs define the measurement performance criteria necessary to support the project objectives.

3.3.1 Representative Sample Sites

Three monitoring sites within the Chatfield Reservoir were selected for routine sampling. These three sites were selected to represent 1) a deep-water location near the dam, 2) a mid-Reservoir location characteristic of the South Platte River arm, and 3) a mid-Reservoir location characteristic of the Plum Creek arm of the Reservoir. Vertical profile sampling will occur at the three Reservoir sites to document physicochemical stratification of the Reservoir. In addition, the routine stream sampling locations selected are representative of the inflows to and outflow from the Reservoir. Two stream sites were selected on each the South Platte River and Plum Creek upstream of the Reservoir and one stream site was selected immediately downstream of the Reservoir outflow.

3.3.2 *Comparability*

One of the ways that the CRMC monitoring program will ensure data comparability is to follow established analytical protocols for assessment and analysis. All laboratory analyses will be performed in accordance with established EPA analysis methods or other widely accepted methods (see Section 4.4). In addition, the lowest possible minimum detection limits (MDLs) should be used for all parameters.

3.3.3 *Completeness*

Samples will be collected from at least 90% of the scheduled sites unless unanticipated weather conditions or lack of running water prevent sampling. Fluctuations of Reservoir levels could prevent sampling at certain depths during monthly depth profile sampling.

3.4 Documentation and Records

Each CRMC/CWA field-sampling sheet is completed on-site at the time sampling occurs. Field technicians record the site number, date and time the sample was collected, the name of each person present, weather conditions present at the time of sampling, and any other information pertinent to the collection of the sample. Field technicians also use standard forms for recording all field measurements (e.g., pH, temperature, conductivity, etc.) for each sampling location. The information is consistent with meta-data requirements of STORET.

4. Measurement and Data Acquisition

4.1 Routine Sampling Locations

The routine sampling locations represent a combination of sites that have been sampled by stakeholders in the Chatfield Watershed. These include three primary Reservoir sites that document different regions in the waterbody. The inflow sites on South Platte River and Plum Creek have been sampled in different locations with sites being established at the USGS stream gages such that both water quality and flow data are available. Additional inflow sites have been established near the tributary inlets to the Reservoir, although these locations do not have stream gage stations. These different tributary locations document potential changes in water quality due to influences by groundwater or other surface conditions.

4.1.1 Reservoir

The Reservoir monitoring sites established by the CRMC and CWA are shown in Section 1.0 (see Table 1-1). These sites include 1) a deep-water location near the dam, 2) a mid-Reservoir location characteristic of the South Platte River arm, and 3) a mid-Reservoir location characteristic of the Plum Creek arm of the Reservoir (Appendix B).

4.1.2 Inflow/Outflow Streams

The inflow/outflow and Reservoir monitoring sites used by the CRMC and CWA are shown in Section 1.0 (Table 1-2). These sites include 1) on the South Platte River @ Waterton Road upstream of the Reservoir, 2) on Plum Creek @ Titan Roach upstream of the Reservoir and 3) immediately downstream of the Reservoir outflow. Additional, inflow sites on the South Platte River (WS-LP-010) and Plum Creek (WS-LP-023) are located near the inlet to the Reservoir (Appendix B).

4.1.3 Alluvial Wells

The CWA historically sampled groundwater in the Plum Creek basin as part of a groundwater study (CWA 2003). Five alluvial sites were located along Plum Creek; Site 1W at Plum Creek Wastewater Treatment Plant; Site 2W at Town of Sedalia Cistern; Site 3W at Douglas County Fairgrounds, Town of Castle Rock; Site 4W a residential well on Airport Road southwest of Louviers-Flying C Ranch; and Site 5W a residential well west of Louviers. The alluvial sampling sites consisted of a faucet at the wellhead, a pumping station, or open cistern; however, sampling has not occurred at these sites during the Chatfield Reallocation Project.

Considering the lack of permanent groundwater monitoring wells that are owned and maintained by CWA or CRMC, outside data sources such as the U.S. Geological Survey National Water Information System and U.S. Environmental Protection Agency Storet databases should provide the necessary groundwater data to meet the needs of the Adaptive Management Plan for the CRP.

4.2 Routine Monitoring Parameters

The routine monitoring parameters are provided in Table 4-1 to Table 4-6, and were selected based on the monitoring objectives discussed in Section 3.2. The data sources are listed as either field or laboratory generated along with the entity responsible for the analytical result – Centennial Water and Sanitation District (CWSD), Colorado Parks and Wildlife (CPW), Denver Water (DW), GEI Consultants, Inc. (GEI), or Plum Creek Water Reclamation Authority (PCWRA). Denver Water will be responsible for collecting Reservoir water samples with exception to the *E. coli* samples collected by CPW; CWSD will be responsible for collecting inflow/outflow water samples from the South Platte River and Plum Creek except for year round near-real time temperature collected by GEI; PCWRA will be responsible for collecting water samples from the Plum Creek Reclamation Project upstream of the inflow site; and CWA will be responsible for collecting alluvial well samples. Routine sampling will be conducted following the Standard Operating Procedures (SOPs) in Appendix B.

Table 4-1: Depth Profile Samples in Reservoir.

Constituent	Monthly Sampling Frequency (Apr-Oct)	Depth Profile Reservoir Locations	Notes	Data Source
Temperature (°C)	X	CR-1, CR-2, CR-3	Sonde – Depth Profile - Collected at 1-meter intervals through entire water column	Field, DW
pH (s.u.)	X	CR-1, CR-2, CR-3	Sonde – Depth Profile - Collected at 1-meter intervals through entire water column	Field, DW
Dissolved Oxygen (mg/L)	X	CR-1, CR-2, CR-3	Sonde – Depth Profile - Collected at 1-meter intervals through entire water column	Field, DW
Specific Conductance (µS/cm)	X	CR-1, CR-2, CR-3	Sonde – Depth Profile - Collected at 1-meter intervals through entire water column	Field, DW
Oxidation – Reduction Potential (mV)	X	CR-1, CR-2, CR-3	Sonde – Depth Profile - Collected at 1-meter intervals through entire water column	Field, DW
Chlorophyll *a* (µg/L)	X	CR-1, CR-2, CR-3	Sonde – Depth Profile - Collected at 1-meter intervals through entire water column	Field, DW
Total Phosphorus (mg/L as P)	X	CR-1, CR-2, CR-3	Collected at 3-meter intervals through entire water column	Lab, GEI
Ortho Phosphorus (mg/L as P)	X	CR-1, CR-2, CR-3	Collected at 3-meter intervals through entire water column	Lab, GEI

Table 4-2: Near Surface and Bottom Layer Samples in Reservoir.

Constituent	Monthly Sampling Frequency (Apr-Oct)	Near Surface and Near Bottom Sampling Locations	Monthly Sampling Frequency (Apr-Oct)	Near Surface and Near Bottom Sampling Locations	Twice Monthly Sampling Frequency (Jul-Sep)	Near Surface and Near Bottom Sampling Locations	Data Source
Dissolved Phosphorus (mg/L as P)	X	CR-1	--	--	--	--	Lab, GEI
Total Phosphorus (mg/L as P)	X	CR-1	X	CR-2, CR-3	X	CR-1, CR-2, CR-3	Lab, GEI
Ortho-phosphorus (mg/L as P)	X	CR-1	X	CR-2, CR-3	X	CR-1, CR-2, CR-3	Lab, GEI
Chlorophyll *a* (µg/L Lab)	X	CR-1 (top meter only)	X	CR-2, CR-3 (top meter only)	X	CR-1 (top meter only)	Lab, GEI
Nitrate+Nitrite- Nitrogen (mg/L as N)	X	CR-1	X	CR-2, CR-3	X	CR-1, CR-2, CR-3	Lab, GEI
Ammonia Nitrogen (mg/L as N)	X	CR-1	X	CR-2, CR-3	X	CR-1, CR-2, CR-3	Lab, GEI
Total Kjeldahl Nitrogen (mg/L as N)	X	CR-1	--	--	--	--	Lab, CWSD
Total Organic Carbon (mg/L)	X	CR-1	--	--	--	--	Lab, CWSD
Dissolved Organic Carbon (mg/L)	X	CR-1	--	--	--	--	Lab, CWSD
Carbonaceous Biochemical Oxygen Demand (mg/L)	X	CR-1	--	--	--	--	Lab, CWSD
Alkalinity (mg/L as $CaCO_3$)	X	CR-1	X	CR-2, CR-3	X	CR-1, CR-2, CR-3	Lab, CWSD
Total Dissolved Solids (mg/L)	X	CR-1	--	--	--	--	Lab, CWSD
Total Suspended Solids (mg/L)	X	CR-1	--	--	--	--	Lab, CWSD
Sulfate (mg/L as SO_4)	X	CR-1	--	--	--	--	Lab, CWSD
Silica (mg/L)	X	CR-1	--	--	--	--	Lab, CWSD
Phytoplankton Identification, Enumeration, and Biovolume (#/mL)[2]	X	CR-1	X	CR-2, CR-3	X	CR-1	Lab, GEI
Zooplankton, Identification and Enumeration (#/L)[3]	X	CR-1	--	--	--	--	Lab, GEI
Secchi Depth (meters)	X	CR-1	X	CR-2, CR-3	X	CR-1, CR-2, CR-3	Field, DW

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[2] Sample collected from the near surface only (i.e., one-meter layer).

[3] Sample collected as vertical water column tow from near bottom to surface

Table 4-3: Metals Monitoring in Reservoir.

Constituent	Sampling Frequency (May, July, Sep)	Near Surface and Near Bottom Reservoir Sampling Locations	Data Source
Arsenic, Dissolved and Total (µg/L)	X	CR-1	Lab, DW
Cadmium, Dissolved and Total (µg/L)	X	CR-1	Lab, DW
Chromium, Total and Dissolved (mg/L)	X	CR-1	Lab, DW
Copper, Dissolved and Total (µg/L)	X	CR-1	Lab, DW
Iron, Dissolved and Total (µg/L)	X	CR-1	Lab, DW
Lead, Dissolved and Total (µg/L)	X	CR-1	Lab, DW
Manganese, Dissolved and Total (µg/L)	X	CR-1	Lab, DW
Mercury, Total (µg/L)	X	CR-1	Lab, DW
Nickel, Dissolved and Total (µg/L)	X	CR-1	Lab, DW
Selenium, Dissolved and Total (µg/L)	X	CR-1	Lab, DW
Silver, Dissolved and Total (µg/L)	X	CR-1	Lab, DW
Zinc, Dissolved and Total (µg/L)	X	CR-1	Lab, DW
Total Hardness (calculated, mg/L)	X	CR-1	Lab, DW

Table 4-4: Bacteria Monitoring in Reservoir

Constituent	Sampling Frequency Weekly May-September	Sampling Locations	Date Source
E. coli (#/100 mL)	X	North and south area of swim beach	Lab, CWSD

Note: All samples collected by Colorado Parks and Wildlife.

Table 4-5: South Platte River, Plum Creek, and Outflow Monitoring.

Constituent	Sampling Frequency				Sampling Locations All at So. Platte @ Waterton Plum Creek @ Titan Rd. and Outflow**	Data Source
	Year Round Near-Real Time	Biweekly (Apr-Sep)	Monthly (Oct-Mar)	Storm Events (Apr-Sep)[4]		
Temperature (°C)[5]	X	X	X	X	X	Field, CWSD
Dissolved Oxygen (mg/L)	--	X	X	X	X	Field, CWSD
pH (s.u.)	--	X	X	X	X	Field, CWSD
Specific Conductance (µS/cm)	--	X	X	X	X	Field, CWSD
Total Organic Carbon (mg/L)	--	X	X	X	X	Lab, CWSD
Dissolved Organic Carbon (mg/L)	--	X	X	X	X	Lab, CWSD
Carbonaceous Biochemical Oxygen Demand (mg/L)	--	X	X	X	X	Lab, CWSD

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[4] At least three events per year and no storm sampling occurs at the outflow

[5] Temperature loggers installed 2.8 miles downstream from So. Platte @ Waterton and 2.3 miles downstream from Plum Creek @ Titan Rd.

Constituent	Sampling Frequency Year Round Near-Real Time	Biweekly (Apr-Sep)	Monthly (Oct-Mar)	Storm Events (Apr-Sep)[4]	Sampling Locations All at So. Platte @ Waterton Plum Creek @ Titan Rd. and Outflow**	Data Source
Total Phosphorus (mg/L as P)	--	X	X	X	X	Lab, GEI
Dissolved Phosphorus (mg/L as P)	--	X	X	X	X	Lab, GEI
Ortho-Phosphorous (mg/L as P)	--	X	X	X	X	Lab, GEI
Nitrate+Nitrite-nitrogen (mg/L as N)	--	X	X	X	X	Lab, GEI
Ammonia Nitrogen, (mg/L as N)	--	X	X	X	X	Lab, GEI
Total Kjeldahl Nitrogen (mg/L as N)	--	X	X	X	X	Lab, CWSD
Alkalinity (mg/L as CaCO3)	--	X	X	X	X	Lab, CWSD
Total Dissolved Solids (mg/L)	--	X	X	X	X	Lab, CWSD
Total Suspended Solids (mg/L)	--	X	X	X	X	Lab, CWSD
Silica, Dissolved (mg/L)	--	X	X	X	X	Lab, CWSD

Table 4-6: Sampling on Plum Creek Related to Plum Creek Restoration Project.

Constituent	Sampling Frequency Monthly (Jan-Dec)	Location PC-0.25 (1/4 mile above Reservoir)	Data Source
pH (s.u.)	X	X	Field, PCWRA
Specific Conductance (µs/cm)	X		Field, PCWRA
Temperature (°C)	X	X	Field, PCWRA
Dissolved Oxygen (mg/L)	X	X	Field, PCWRA
E. coli (#/100 mL)	X	X	Lab, PCWRA
Alkalinity (mg/L as $CaCO_3$)	X	X	Lab, PCWRA
Total Phosphorus (Total mg/L as P)	X	X	Lab, PCWRA
Ortho-phosphorous (mg/L as P)	X	X	Lab, PCWRA
Nitrate+Nitrite-Nitrogen (mg/L as N)	X	X	Lab, PCWRA
Ammonia Nitrogen (mg/L as N)	X	X	Lab, PCWRA
Total Suspended Solids (mg/L)	X	X	Lab, PCWRA

Note: All samples taken by Plum Creek Water Reclamation Authority (PCWRA)

4.3 Special Studies

This SAP was structured to meet the data requirements of the Chatfield Reservoir Reallocation Adaptive Management Sampling Plan as well as the additional data needs of the stakeholders. As the CRMC progresses through the implementation and data evaluation phase of the project, the SAP is periodically updated with non-routine water quality and biological special studies tasks that the management team has identified to be carried out by the entities listed above. These special studies may occur within Plum Creek, Deer Creek, the South Platte River from the Strontia Springs Reservoir, Chatfield Reservoir, or their drainages. Special studies are described in Appendix A and will be conducted following the SOPs in Appendix B.

4.4 Unsafe Reservoir Conditions

The Field Teams are not expected to sample the reservoir when unsafe boating conditions exist (i.e., high winds, lightning, or storm events) or when unsafe ice cover conditions exist during winter. Other stream sampling may occur during weather related events, especially storm event sampling; however, safety measures need to be implemented when sampling under these conditions. The reservoir sample taken within 3 days is considered as representative of the same sample set as the inlet and outlet sample.

4.5 Sample Handling and Custody Requirements

The CRMC/CWA SAP contains information on sampling protocols and equipment. Table 4-7 summarizes this information.

Table 4-7: Acceptable Analytical Methods for Determining Water Matrix Constituent Concentrations. Note – this table contains information for 4 different sampling groups. For example, the VanDorn is not used for stream sampling.

Constituent	Sampling Equipment	Sample Container	Sample Preservative	Hold Time	Analytical Method
pH	Field Meter	In situ	None	Immediately	Field
Temperature	Field Meter	In situ	None	Immediately	Field
Specific Conductance	Field Meter	In situ	None	Immediately	Field
Chlorophyll *a*	Field Meter	In situ	None	Immediately	Field
Oxidation Reduction Potential	Field Meter	In situ	None	Immediately	Field
Dissolved Oxygen	Field Meter	In situ	None	Immediately	Field
Secchi Depth	Secchi Disc	In situ	None	Immediately	Field
Alkalinity	VanDorn Sampler	100 ml poly	4°±2°C	14 days	2320 B SM20
Carbonaceous Biochemical Oxygen Demand	VanDorn Sampler	1000 ml poly	4°±2°C	48 hours	SM5210 B
Suspended Solids, Total	VanDorn Sampler	1000 ml poly	4°±2°C	7 days	SM2540 D, 160.2 EPA
Dissolved Solids, Total	VanDorn Sampler	1000 ml poly	4°±2°C	7 days	SM2540 C
E. coli	Container immersion	250 ml sterile	4°±2°C	6 hours	9223 B SM20
Organic Carbon, Dissolved	VanDorn Sampler	250 ml glass	H_2SO_4 4°±2°C	28 days	SM5310 C
Organic Carbon, Total	VanDorn Sampler	250 ml glass	H_2SO_4 4°±2°C	28 days	SM5310 C
Phosphorus, Total	VanDorn Sampler	250 ml glass	H_2SO_4 4°±2°C	28 days	QC 10-115-01-4-B, EPA 365.1
Phosphorus, Ortho	VanDorn Sampler	500 ml poly	4°±2°C	48 hours	QC 10-115-01-1-T, EPA 365.1
Phosphorus, Dissolved	VanDorn Sampler	250 ml glass	H_2SO_4 4°±2°C	28 days	QC 10-115-01-4-B
Nitrite+Nitrate – Nitrogen	VanDorn Sampler	500 ml poly	4°±2°C	48 hours	QC 10-107-04-1-C, 4500-NO3 F SM20

Constituent	Sampling Equipment	Sample Container	Sample Preservative	Hold Time	Analytical Method
Ammonia – Nitrogen	VanDorn Sampler	250 ml glass	H_2SO_4 4°±2°C	28 days	QC 10-107-06-2-A, 4500-NH3 G SM20
Kjeldahl Nitrogen, Total	VanDorn Sampler	500 ml glass	H_2SO_4 4°±2°C	28 days	4500 Norg B
Sulfate	VanDorn Sampler	250 ml poly	4°±2°C	28 days	EPA 375.4
Chlorophyll *a*	VanDorn Sampler	1 L amber	4°±2°C	24 hours	APHA 10200 H (Modified)
Phytoplankton	VanDorn Sampler	60 ml amber	Lugol's 4°±2°C	28 days	HPMA (Crumpton 1987)
Zooplankton	Plankton net	250 ml amber	Iso-alcohol 4°±2°C	28 days	APHA 10200 G
Hardness, Total (calculated)	VanDorn Sampler	250 ml poly	HNO_3 4°±2°C	180 days	SM2340B
Cadmium, Dissolved and Total	VanDorn Sampler	250 ml poly	HNO_3 4°±2°C	180 days	EPA 200.8
Copper, Dissolved and Total	VanDorn Sampler	250 ml poly	HNO_3 4°±2°C	180 days	EPA 200.8
Lead, Dissolved and Total	VanDorn Sampler	250 ml poly	HNO_3 4°±2°C	180 days	EPA 200.8
Mercury, Total	VanDorn Sampler	250 ml poly	HNO_3 4°±2°C	180 days	EPA 200.8
Selenium, Dissolved and Total	VanDorn Sampler	250 ml poly	HNO_3 4°±2°C	180 days	EPA 200.8
Iron, Dissolved and Total	VanDorn Sampler	250 ml poly	HNO_3 4°±2°C	180 days	EPA 200.8
Arsenic, Dissolved and Total	VanDorn Sampler	250 ml poly	HNO_3 4°±2°C	180 days	EPA 200.8
Chromium, Dissolved and Total	VanDorn Sampler	250 ml poly	HNO_3 4°±2°C	180 days	EPA 200.8
Manganese, Dissolved and Total	VanDorn Sampler	250 ml poly	HNO_3 4°±2°C	180 days	EPA 200.8
Nickel, Dissolved and Total	VanDorn Sampler	250 ml poly	HNO_3 4°±2°C	180 days	EPA 200.8
Silica, Dissolved	VanDorn Sampler	250 ml poly	HNO_3 4°±2°C	180 days	EPA 200.8
Silver, Dissolved and Total	VanDorn Sampler	250 ml poly	HNO_3 4°±2°C	180 days	EPA 200.8
Zinc, Dissolved and Total	VanDorn Sampler	250 ml poly	HNO_3 4°±2°C	180 days	EPA 200.8

Note: Hold times for dissolved and total metals is 14 days when samples are not preserved.
EPA Method 200.8 is not an approved method for iron or silica, although 2018 third-party performance testing for iron confirm acceptable results. Third-party performance testing for silica will be conducted in 2019.

4.5.1 Chain of Custody

Proper sample handling and custody procedures ensure the custody and integrity of samples is maintained from the time of sampling and continues through transport, sample receipt, preparation, and analysis. A sample is in custody when it is in actual physical possession or in a secured area that is restricted to authorized personnel. The Chain of Custody (COC) form is used to document sample handling during transfer from the field to the laboratory. The following information concerning the sample is recorded on the COC form (See CWA SOPs): 1) date and time of collection; 2) sample identification; 3) sample matrix; 4) number of containers; 3) preservative used or when the sample was filtered; 4) analyses required; 5) name of collector; 6) custody transfer signatures and dates and time of transfer; and 7) bill of lading (when applicable).

4.5.2 Sample Labeling

Sample information is recorded on each sample bottle or bottle label with an indelible marker. Label information includes the sample identification, date, time of sampling, sample collector, and preservative added when applicable.

4.5.3 Sample Handling

All samples submitted to the laboratory for analyses must have proper documentation as to its source, method of collection, and maintenance of integrity during transport and delivery. Field personnel maintain custody of the samples until they are either relinquished directly to a laboratory or to a common carrier (e.g., Federal Express) for shipment to a laboratory.

The samples are received in the laboratory by the sample custodian or assigned alternate. After checking the COC form for completeness, the sample custodian records the date, time, and signs the form. The sample custodian also verifies that all custody seals are intact and immediately notifies the consultant when it appears that the custody of the samples may have been compromised. The sample custodian also verifies the temperature of the samples and notifies the consultant when the temperature is not within prescribed limits (for samples that are directly delivered to the laboratory, the chilling process must be initiated, but it is recognized that the samples may not have reached the prescribed limits). Each analytical laboratory used for this program maintains an internal quality control system for handling samples before, during, and after analyses.

4.5.4 Failed Chain of Custody and Corrective Action

All issues associated with chain-of-custody procedures are immediately reported to the CRMC Project Manager. These include such items as delays in transfer, resulting in holding time violations; violations of sample preservation requirements; incomplete documentation, including signatures; possible tampering of samples; broken or spilled samples, etc. The CRMC Project Manager, in consultation with the CWA Program Administrator will determine when the procedural violation may have compromised the validity of the resulting data. The CRMC Project Manager in consultation with the CWA Project Administrator will decide how the issue will be resolved based on best professional judgment and inform the TRC and CWA. Possible courses of action include, document and proceed; redo the entire sampling event; or selectively analyze samples. The resolution of the situation will be reported to the TRC and CWA at the next regularly scheduled meeting.

4.6 Analytical Method Requirements

The current accepted analytical methods, associated matrices, and performing laboratories are listed in Table 4-7. The laboratory analyses cited in Table 4-7 are EPA approved or other widely accepted standard methods, except where otherwise noted. Alternative analytical methods can be proposed and used after review and concurrence with the Water Quality Control Division.

4.7 Sampling Equipment, Sample Containers and Preservation

Specifications for sample containers, preservatives, and holding times for all analytes are described in Table 4-7. The analytical laboratory's SOPs also contain information concerning sampling containers and preservatives. In addition to any preservatives, all samples will be placed in a cooler on ice immediately after sample collection.

4.8 Failures in Measurement Systems and Corrective Actions

Failures in field and laboratory measurement systems involve, but are not limited to, instrument malfunctions, failures in calibration, blank contamination, quality control samples outside defined limits, etc. In many cases, the field technician or lab analyst will be able to correct the problem. When this occurs, the problem will be documented on the field data sheet or laboratory record and the analysis will be completed. When the problem is not immediately resolvable, it is conveyed to the CRMC Project Manager, who will make the determination whether the analytical system failure caused invalid results. If the problem is due to laboratory instrument failure, then lab personnel will implement the following corrective actions:

1. The lab will immediately contact the CRMC Project Manager to inform of the nature and potential consequences of the problem.
2. If instrument failure will result in loss of analytical data and there is adequate holding time remaining, the lab will be instructed to send unopened samples to an alternate lab.

If alternate sample analyses cannot be performed, the CRMC Project Manager will make a decision whether a resample is appropriate and necessary, with concurrence from the CWA Program Administrator. The corrective action plan is intended to ensure that every effort is made to obtain analytical data from all samples. The nature and disposition of problems are reported on the data report that is sent to the CRMC Project Manager. The CRMC Project Manager will include this information in its next monthly status report to the CWA.

4.9 Quality Control Requirements

4.9.1 Field Quality Control Requirements

Field QC samples are submitted as separate samples to the laboratory and reported accordingly, on the data reports. Specific requirements are outlined below. The only field QC samples routinely used on this program are field duplicates.

> Field duplicates – A routine water quality monitoring field duplicate is defined as a second sample, from the same location, collected in immediate succession, using identical techniques. This applies to all cases of routine surface water collection procedures, including in-stream grab samples, bucket grab samples (e.g., from bridges), pumps, and other water sampling devices. It is recommended that field grab duplicate samples (10% annual basis) be collected when the total number of routine samples is greater than 10 samples per year. Duplicate samples are sealed handled, stored, shipped, and analyzed in the sample manner as the primary sample. Precision of

duplicate results is calculated by the relative percent difference (RPD) as defined by 100 times the difference (range) of each duplicate set, divided by the average value (mean) of the set. For duplicate results, D_1 and D_2, the RPD is calculated from the following equation:

$$\mathrm{RPD} = \frac{(\mathrm{D}_1 - \mathrm{D}_2) * 100}{(\mathrm{D}_1 - \mathrm{D}_2)/2}$$

Equation ES-1: Field Duplicate Relative Percent Difference

Best professional judgment is used to determine the acceptability of field duplicate analyses.

4.9.2 Laboratory Quality Control Requirements

Detailed laboratory QC requirements are contained within each analytical laboratory's Standard Operating Procedures (SOP) and are also available upon request. Laboratory quality control procedures include the following practices.

Laboratory replicate – Laboratory replicates are used to assess precision. A laboratory replicate is prepared by splitting aliquots of a single sample (or a matrix spike or a laboratory control standard) in the laboratory after prep techniques have been completed. Both samples are carried through the entire analytical process. Laboratory replicates are performed on 10% of samples analyzed. Precision is calculated by the relative percent difference (RPD) of duplicate results as defined by 100 times the difference (range) of each replicate set, divided by the average value (mean) of the set. For replicate results, D_1 and D_2, the RPD is calculated from the following equation:

$$\mathrm{RPD} = \frac{(\mathrm{D}_1 - \mathrm{D}_2) * 100}{(\mathrm{D}_1 - \mathrm{D}_2)/2}$$

Equation ES-2: Laboratory Replicate Relative Percent Difference

Laboratory Control Standard (LCS) – A laboratory control sample is analyte-free water spiked with the analyte of interest prepared from standardized reference material. The laboratory control standard is generally spiked at a level less than or equal to the mid-point of the calibration curve for each analyte. The LCS is carried through the complete preparation and analytical process. The LCS is used to document the accuracy of the method due to the analytical process. LCS's are generally run at a rate of one per batch. Acceptability criteria are laboratory specific and usually based on results of past laboratory data. The analysis of LCS's is a measure of accuracy and is calculated by Percent Recovery (%R) and defined as 100 times the observed concentration, divided by the true concentration of the spike. Acceptance criteria are based on laboratory control charts, but not greater than the prescribed criteria. The formula used to calculate percent recovery, where %R is percent recovery includes SR as the sample result and SA as the spike added:

$$\text{Percent R} = \text{SR} * 100/\text{SA}$$

Equation ES-3: Laboratory Control Standard Percent Recovery

Matrix spikes (MS) – A matrix spike is an aliquot of sample spiked with a known concentration of the analyte of interest. Percent recovery of the known concentration of added analyte is used to assess accuracy of the analytical process. The spiking occurs prior to sample analysis. The MS level varies based on the method but is typically spiked at a level less than or equal to the midpoint of the calibration or analysis range for each analyte. The MS is used to document the accuracy of a method due to sample matrix and not to control the analytical process. The analysis of matrix spikes is a measure of accuracy and is calculated by Percent Recovery %R is defined as 100 times the observed concentration, minus the sample concentration, divided by the true concentration of the spike. The formula used to calculate percent recovery, where %R is percent recovery; SSR is the observed spiked sample concentration; SR is the sample concentration; and, SA is the spike added; is:

$$\text{Percent R} = [(\text{SSR} - \text{SR})/\text{SA}] * 100$$

Equation ES-4: Laboratory Matrix Spike Percent Recovery

Method blank – A method blank is an analyte-free matrix to which all reagents are added in the same volumes or proportions as used in the sample processing. The method blank is carried through the complete sample preparation and analytical procedure. The method blank is used to document contamination in the preparatory and analytical processes. The analysis of method blanks will yield values less than the Minimum Analytical Level. For very high-level analyses blank value will be less than 5% of the lowest value of the batch.

Additional method specific QC requirements – Additional QC samples are run (e.g., surrogates, internal standards, continuing calibration samples, interference check samples) as specified in the methods. The requirements for these samples, their acceptance criteria, and corrective action are method-specific and are therefore not listed in this plan.

4.9.3 Quality Control Failures and Corrective Actions

The CRMC Project Manager, in consultation with the CWA Program Administrator, evaluates all sampling QC excursions. In that differences in duplicate sample results are used to assess the entire sampling process, including environmental variability, the arbitrary rejection of results based on pre-determined limits is not practical. Therefore, judgment will be relied upon in evaluating results. Rejecting sample results based on wide variability is a possibility. Notations of field duplicate excursions are noted in the monthly status report and annual data report. The laboratory staff evaluates laboratory measurement failures. The dispositions of such failures and conveyance to the CRP are discussed under Failed Analytical Systems and Corrective Action section.

4.10 Instrument and Equipment Testing/Maintenance

All sampling equipment testing and maintenance requirements are detailed in the *SOPs*. Equipment records are kept on all field equipment and a supply of critical spare parts is maintained. All laboratory tools, gauges, instruments, and equipment testing and maintenance requirements are contained within each laboratory's Quality Assurance Manual. Testing and maintenance records are maintained and are available for inspection by the consultant and/or CRP.

4.10.1 Instrument Calibration and Frequency

Detailed laboratory calibrations are contained within each laboratory's Quality Assurance Manual and are also specified in the EPA-approved analytical methods. Table 4-8 lists field equipment calibrations.

Prior to each sampling event, the multiprobe for field measurements must be calibrated based on the manufacturer's recommended calibration protocols for pH, specific conductance, dissolved oxygen, oxidation reduction potential, and chlorophyll *a* (Table 4-8). Temperature should be calibrated monthly. Total phosphorous and nitrate-nitrogen should be calibrated on an annual basis.

Table 4-8: Field Equipment Calibration Requirements

Analysis	QC Elements	Frequency
pH	One Point or Three Point Calibration	Day of Event
Temperature	NIST Thermometer Cal.	Monthly
Specific Conductance	Control	Day of Event
Dissolved Oxygen	Control	Day of Event
Oxidation Reduction Potential	Control	Day of Event
Chlorophyll *a* (Field)	Manufacturer's Cal.	Monthly

4.10.2 Supply Inspection and Acceptance Requirements

The procurement of equipment and supplies and verification that the equipment and supplies received met the required specifications is a critical step to maintain the quality of samples collected under this program. As applicable, procurement documents include: a definitive scope of work; administrative requirements; technical requirements describing items to be furnished; applicable quality requirements for the supplier(s); right of access to supplier's facilities and records for the purposes of inspections and audit; and documents to be provided by the supplier in support of compliance to procurement requirements. Procurement documents are reviewed by the CRMC Project Manager to ensure they include appropriate and adequate provisions to meet intended requirements.

Once procured items are received, receiving personnel will ensure that the items received are in conformance with the specifications of the order. Any items determined to not be in conformance will be clearly identified as such to prevent their use. All documentation regarding quality received with the items shall be maintained as quality records and shall be traceable to the items procured via lot numbers, bar codes, or other appropriate system. Examples of these types of records include documentation related to cleanliness levels of equipment and sample containers.

4.10.3 Other Data Acquisitions

In addition to the data collected under this monitoring program, data is obtained from the following sources for use in preparation of the annual data report: 1) stream flow data for Plum Creek (field code PC) – U.S. Geological Survey; 2) stream flow data for the South Platte River (field code SP) – Colorado Division of Water Resources; and 3) stream flow data for the Chatfield Reservoir outfall (field code SO) – U.S. Army Corps of Engineers. These data are included in the annual data report but are not used for making any regulatory decisions. Consequently, no additional quality requirements are applied to these data. These data are qualified as provisional data in the annual data report to indicate that the agencies have not completed verification of the data.

5. Data Management, Assessment and Oversight

5.1 Data Management

Field data sheets are reviewed by the Field Team Leader at the end of each sampling event and should be available for review by the CRMC Project Manager upon request. Any discrepancies noted during a review should be promptly resolved. Field and laboratory data are recorded in an Access database developed by the project consultant and are transferred electronically to the CWA Program Administrator in conjunction with the final annual monitoring report. A database is maintained which contains information on each site visit including (at a minimum) sampling date, sampling time, consultant personnel, volunteer assistance, weather conditions, subjective stream and reservoir observations or conditions (e.g., reservoir - choppy surface with turbid green water), problems, instrument calibrations, and quality assurance and quality control samples. The database belongs to the CWA and must be transferred upon request.

The database has been designed so that the majority of the analytical data received from laboratories can be loaded into the database directly from electronic files received from the laboratory. The database also performs some basic error checking routines when the electronic files are loaded to flag erroneous data prior to the data being loaded into the database. Data is analyzed with EXCEL spreadsheets.

5.2 Assessment and Response Actions

Review of Chatfield Watershed field activities is the responsibility of the CRP Field Team Leader, in conjunction with the CRMC Project Manager. Each field team may be accompanied and their performance evaluated by one of these individuals once a year. When possible, field technicians in need of performance improvement will be retrained on-site during the evaluation. When errors in sampling techniques are consistently identified, additional training may be scheduled more frequently. All field and laboratory activities may be reviewed by state, CRMC and other appropriate personnel as requested.

5.3 Data Validation and Usability

All data obtained from field and laboratory measurements will be reviewed and verified for integrity and continuity, reasonableness, and conformance to project requirements, and then validated against the data quality objectives. Only those data that are supported by appropriate quality control data and meet the data quality objectives defined for this project will be considered acceptable.

The procedures for verification and validation of data are described below. The Field Team Leaders will be responsible for ensuring that field data are properly reviewed, verified, and submitted in the required format to the CRMC Project Manager. Likewise, the Laboratory Supervisor for each laboratory will be responsible for ensuring that laboratory data are reviewed, verified, and submitted in the required format to the CRMC Project Manager for uploading to the project database. The CRMC Project Manager is responsible for verifying that field and laboratory data have been entered correctly into the project database and for validating that all data collected meet the data quality objectives of the project.

All data will be verified to ensure they are representative of the samples analyzed and locations where measurements were made, and that the data and associated quality control data conform to project specifications. The consultant staff and management and subcontract laboratories are responsible for verifying the data each task generates or handles. The field and laboratory staff ensure the verification of raw data, electronically generated data, and data on chain-of-custody forms and hardcopy output from instruments.

Verification of data will be performed using self-assessments and peer review, as appropriate to the project task, followed by technical review by the CRMC Project Manager. The data to be verified are evaluated against project specifications and are checked for errors, especially errors in transcription, calculations, and data input. Potential outliers are identified by examination for unreasonable data or identified using computer-based statistical software. When a question arises or an error or potential outlier is identified, the CRMC Project Manager is responsible to resolve the issue. Issues that can be corrected are corrected and documented electronically or by initialing and dating the associated paperwork. When an issue cannot be corrected, the task manager consults with the CRP Project Administrator to establish the appropriate course of action, or the data associated with the issue are rejected.

The CRMC Project Manager is responsible for validating that the verified data are usable. One element of the validation process involves evaluating the data again for anomalies. The CRMC Project Manager may designate other experienced water quality experts familiar with the project to perform this evaluation. Before data validation can be completed the CRMC Project Manager must address any suspected errors or anomalous data.

As soon as possible after each sampling event, calculations and determinations for precision, completeness, and accuracy will be made and corrective action implemented if needed. When data quality indicators do not meet the project's specifications, data may be discarded and re-sampling may occur. The cause of failure will be evaluated. When the cause is found to be equipment failure, calibration/maintenance techniques will be reassessed and improved. When the problem is found to be sampling team error, team members will be retrained. Any limitations on data use will be detailed in both monthly status and annual data reports, and other documentation as needed.

When failure to meet project specifications is found to be unrelated to equipment, methods, or sample error, specifications may be revised for the next sampling season.

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Appendix A Special Studies

A.1 Shoreline Construction Monitoring

GEI will collect shoreline total suspended solids (TSS) samples and turbidity measurements during the various construction phases of shoreline construction. Coordination between CRMC and GEI will occur to effectively monitor potential short-term effects on the Reservoir. The turbidity measurements will provide information relative to the visible portion of water clarity that is often noticed in waterbodies, while the TSS data will provide information relative to the sediment load in the water column. Opportunistic sampling will occur near the shoreline in wadeable water depths at three areas planned for construction (marina, swim beach, and north boat ramp area) and one area outside the construction area (gravel pond). During active construction and even post construction, GEI proposes to collect TSS samples and turbidity measurements to identify the project's effect on near shore conditions, as well as possibly identify the effectiveness of best management practices (BMPs) in minimizing the TSS load to the open waters of the Reservoir. These samples will be collected during active construction or when conditions warrant sampling. Comparison of active/post construction to background conditions will provide some insight to the possible effects that may occur above what the Reservoir already experiences during natural shoreline erosion events.

Opportunistic water samples (TSS and turbidity) will be collected from each of the three construction areas and the area outside the influence of construction (Table A-1). This sampling will be conducted following the Standard SOPs in Appendix B, and will be analyzed for TSS content by the GEI Laboratory (Table A-2).

Table A-1: Shoreline Construction Water Monitoring.

Constituent	Sampling frequency	Location	Data Source
Suspended Solids, Total	2 sampling events during active construction or when conditions warrant sampling	Marina, swim beach, and north boat ramp area	Lab, GEI
Turbidity	2 sampling events during active construction or when conditions warrant sampling	Marina, swim beach, and north boat ramp area	Field, GEI

Table A-2: Acceptable Analytical Methods for Determining Shoreline Water Matrix Constituent Concentrations.

Constituent	Sampling Equipment	Sample Container	Sample Preservative	Hold Time	Analytical Method
Suspended Solids, Total	Container immersion	1 L poly	4°±2°C	7 days	SM2540 D
Turbidity	Container immersion	Glass	None	Immediately	EPA 180.1

A.2 In-Reservoir Mercury

Mercury is a bioaccumulative metal that builds up in fish tissue over time and is harmful to humans when consumed at low levels. The U.S. Environmental Protection Agency has developed a fish tissue criterion of 0.30 mg/Kg of methylmercury that is protective of human consumption and derived a water quality criterion of 0.01 µg/L for total mercury. The water quality criterion theoretically limits the bioaccumulative potential through the food chain and is thus protective of humans considering that both water and fish may be consumed. This task will provide more detailed information regarding the status of mercury in the water column and top predatory fish (walleye) that can be used to address concerns identified in the AMP and Reservoir modeling effort.

In 2004, total mercury concentrations in the reservoir exceeded the water quality standard, due in large part to the erosion and runoff from the Hayman Fire burn areas. The increased sedimentation in Chatfield Reservoir from the Hayman Fire, along with other mercury sources, provides a potential pathway for mercury bioaccumulation in fish. Furthermore, the storage reallocation could potentially exacerbate the anoxic bottom water conditions that facilitate the release of reduced mercury from anaerobic sediments. The reduced mercury form is more readily available for methylation which then can work its way up the food chain.

Since 2004, the Colorado Department of Public Health and Environment (CDPHE) has performed two separate mercury fish tissue studies (2004, n = 87 and 2013, n = 32) that primarily focused on walleye, but also included a small number of smallmouth bass, and rainbow trout. In 2004, all measured mercury concentrations were reported as <0.30 mg/Kg, whereas in 2013, measured concentrations were reported for each fish tissue sample. The mean value for the 2013 fish tissue data was 0.11 mg/Kg with a range of 0.035 mg/Kg to 0.27 mg/Kg which supported CDPHE's decision not to post fish consumption advisories for the Reservoir.

A.2.1 Water Quality

GEI will collect water samples from Site CR-1 during May, July, and September and analyze for methylmercury and total mercury concentrations to document the near surface (3 samples) and near sediment boundary layer (3 samples) conditions (Table A-3). A "clean" sampling technique will be used to minimize sample contamination and one field blank will be collected during each event. This sampling will be conducted following the Standard SOPs in Appendix B. Samples will be analyzed using the low-level methylmercury and total mercury methods by Eurofins Frontier Global Sciences (Table A-4).

Table A-3: In-Reservoir Mercury Water Sampling.

Constituent	Sampling Frequency	Location	Data Source
Methylmercury	Samples near surface and near sediment boundary (May, July, Sept)	CR-1	Lab, GEI

Constituent	Sampling Frequency	Location	Data Source
Mercury, Total	Samples near surface and near sediment boundary (May, July, Sept)	CR-1	Lab, GEI
Mercury	Walleye collected by Colorado Parks and Wildlife (Mar)	Chatfield Reservoir	Lab, GEI
Mercury	Opportunistic	Construction and potential deposition locations	Lab, GEI

Table A-4: Acceptable Analytical Methods for Determining In-Reservoir Matrix Constituent Concentrations.

Matrix	Constituent	Sampling Equipment	Sample Container	Sample Preservative	Hold Time	Analytical Method
Water	Methylmercury	Water Pump	250 ml poly	None, preserved at lab	28 days	EPA 1630/FGS-070
Water	Mercury, Total	Water Pump	250 ml poly	≤ 4°C, preserved at lab	48 days	EPA Method 1631E
Walleye Tissue	Mercury	Tissue punch	Poly	≤ -18°C	2 years	EPA 1631B
Sediment	Mercury	Ekman Dredge/corer	Poly	≤-11°C	1 week	EPA 1631B

A.2.2 Fish Tissue Monitoring

GEI will collect walleye tissue samples from the Reservoir, but this work is contingent upon collaborating with the Colorado Parks and Wildlife (CPW) during their spring (~March) walleye egg collection event for the Reservoir (Table A-3) and will not be performed annually. In the past, GEI has collaborated with CPW on other walleye sampling events to collect mercury fish tissues from fish collected by the agency, to assess fish consumption criteria. Muscle plugs will be collected from up to 30 fish or similar, consumable size and composited to five plugs per sample during one event. This maximizes the number of fish sampled that is required by CDPHE to evaluate a fish consumption advisory for mercury, while reducing the analytical costs. A minimum of 30 fish tissue samples from each species/size class are necessary to calculate a mean value to determine attainment of the fish tissue threshold level (CDPHE Section 303(d) Listing Methodology 2018). Even though methylmercury is the bioaccumulative form in fish, total mercury, which includes all organic and inorganic forms, will be analyzed as a conservative approach. This sampling will be conducted following the Standard SOPs in Appendix B. Fish tissue samples will be analyzed for total mercury by Eurofins Frontier Global Sciences (Table A-4).

A.3 Reservoir Sediment Analyses

In 2014, reservoir sediment analyses were performed to determine the phosphorus fractionation and anoxic release rate of phosphorus from the sediment. The AMP originally required this effort be completed each year, but the U.S. Army Corps of Engineers granted a waiver from 2015 through 2018 dependent on the implementation requirements of the reservoir model. As a result, GEI will periodically characterize the different phosphorus fractions available in the active sediment layer (i.e., top5-10 cm) and determine phosphorus flux rate under anoxic conditions at three locations (CR1, CR2, CR3) in Chatfield Reservoir. Phosphorus fractionation analyses will extract five pools: loosely bound (and pore water) P, redox-sensitive P (bound to iron and manganese), P bound to oxides of aluminum and nonreducible iron, calcium bound P (i.e., apatite bound), and mobile and immobile pools of organic P (Table A-5). Sediment samples will also be analyzed for will be analyzed for the total metals (i.e. iron, manganese, aluminum) content that bind with phosphorus, including total phosphorus, total nitrogen, total organic carbon, solids, density, and particle size analysis for gravel-sand-clay size classes of the two sediment layers of interest. This sampling will be conducted following the Standard SOPs in Appendix B. Samples will be analyzed by GEI (Table A-6).

The phosphorus flux and release rate under anoxic conditions and sediment oxygen demand of the reservoir sediment will also be quantified. Briefly, sediment cores with overlying lake water will be incubated at ambient bottom water temperature and the overlying water column will be purged with either air or nitrogen to maintain oxic or anoxic water column conditions. Phosphorus can be released under both oxic and anoxic conditions; however, the release under anoxic conditions can be substantially greater. GEI will perform the phosphorus flux experiment and will analyze both total phosphorus and ortho-phosphorus content in the overlying water column, over a period of 28 days to estimate the release rate for reservoir sediment.

The sediment oxygen demand analysis is similar to the anoxic release experiment where sediment cores will be incubated at bottom water temperature while the initial water column will be well-oxygenated. Baseline dissolved oxygen content will be determined, and conditions will be measured frequently (i.e., every 10 minutes) over a period of approximately 3 hours to document the decrease in concentration. Bacteria will consume oxygen as the decomposition of organic matter occurs, resulting in a decrease of dissolved oxygen concentration in the overlying water column of the sediment core. The rate at which dissolved oxygen decreases provides an estimate of the sediment oxygen demand for the sediment.

Table A-5: Reservoir Sediments Sampling

Constituent	Sampling Frequency	Sampling Locations	Data Source
Organic Bound Phosphorous, Total	multiple cores, periodically	CR-1, CR-2, CR-3	Lab, GEI
Loosely Bound and Pore Water Phosphorus	multiple cores, periodically	CR-1, CR-2, CR-3	Lab, GEI
Iron-Bound Phosphorous	multiple cores, periodically	CR-1, CR-2, CR-3	Lab, GEI
Calcium-Bound Phosphorous	multiple cores, periodically	CR-1, CR-2, CR-3	Lab, GEI
Aluminum-Bound Phosphorous	multiple cores, periodically	CR-1, CR-2, CR-3	Lab, GEI
Percent Solids	multiple cores, periodically	CR-1, CR-2, CR-3	Lab, GEI
Organic Carbon, Total	multiple cores, periodically	CR-1, CR-2, CR-3	Lab, GEI
Iron, Total	multiple cores, periodically	CR-1, CR-2, CR-3	Lab, GEI

Constituent	Sampling Frequency	Sampling Locations	Data Source
Calcium, Total	multiple cores, periodically	CR-1, CR-2, CR-3	Lab, GEI
Aluminum, Total	multiple cores, periodically	CR-1, CR-2, CR-3	Lab, GEI
Phosphorous Flux Under Anoxic Conditions	multiple cores, periodically	CR-1, CR-2, CR-3	Lab, GEI

Table A-6: Acceptable Analytical Methods for Determining In-Reservoir Sediment Matrix Constituent Concentrations.

Constituent	Sampling Equipment	Sample Container	Sample Preservative	Hold Time	Analytical Method
Organic Bound Phosphorus, Total	Corer/Dredge	125ml poly	4°±2°C	28 days	M365.1, (Lukkari et al. 2007)
Loosely Bound and Pore Water Phosphorus	Corer/Dredge	125ml poly	4°±2°C	28 days	M365.1, (Lukkari et al. 2007)
Iron - Bound Phosphorus	Corer/Dredge	125ml poly	4°±2°C	28 days	M365.1, (Lukkari et al. 2007)
Calcium - Bound Phosphorus	Corer/Dredge	125ml poly	4°±2°C	28 days	M365.1, (Lukkari et al. 2007)
Aluminum - Bound Phosphorus	Corer/Dredge	125ml poly	4°±2°C	28 days	M365.1, (Lukkari et al. 2007)
Percent Solids	Corer/Dredge	125ml poly	4°±2°C	7 days	CLPSOW390, PART F, D-98
Organic Carbon, Total	Corer/Dredge	250ml glass	4°±2°C	28 days	ASA No. 9 29-2,2,4 IC Combustion
Iron, Total	Corer/Dredge	125ml poly	4°±2°C	28 days	CLPSOW390
Calcium, Total	Corer/Dredge	125ml poly	4°±2°C	6 months	M7742 Modified
Aluminum, Total	Corer/Dredge	125ml poly	4°±2°C	14 days	ASA No. 9 29-2.2.4

A.4 Inflow Monitoring

To support the Reservoir modeling efforts, GEI will provide additional inflow monitoring to define conditions near the Reservoir inlets at sites WS-LP-010 (South Platte River GEI) and WS-LP-023 (Plum Creek GEI). GEI will install continuous water temperature data loggers (HOBO Pro V2) at each site and maintain/download data each month. Basic physicochemical parameters will be measured in the thalweg using a Hydrolab MS4 water quality sonde during each sampling event. GEI will also collect monthly water quality samples to be analyze for multiple water quality parameters (Table A-7). All sampling will be conducted following the Standard SOPs in Appendix B. Samples will be analyzed by GEI for phosphorus fractions, nitrogen fractions except for total Kjeldahl nitrogen, total suspended solids, and alkalinity while SGS Accutest in Wheat Ridge, CO will analyze for total Kjeldahl nitrogen, organic carbon, and total dissolved solids (Table A-8). Laboratory split samples will be portioned for selected sampling events that are representative of different flow regimes and sent to High Sierra Water Lab in Truckee City, California.

Table A-7: Inflow Water Monitoring.

Constituent	Sampling Frequency	Sampling Locations	Data Source
Temperature	Continuous	WS-LP-010, WS-LP-023	Field, GEI
pH	Monthly	WS-LP-010, WS-LP-023	Field, GEI
Dissolved Oxygen	Monthly	WS-LP-010, WS-LP-023	Field, GEI
Specific Conductance	Monthly	WS-LP-010, WS-LP-023	Field, GEI
Alkalinity	Monthly	WS-LP-010, WS-LP-023	Lab, GEI
Phosphorus, Total	Monthly	WS-LP-010, WS-LP-023	Lab, GEI
Phosphorus, Total Dissolved	Monthly	WS-LP-010, WS-LP-023	Lab, GEI
Phosphorus, Ortho-phosphorus	Monthly	WS-LP-010, WS-LP-023	Lab, GEI
Nitrogen, Total	Monthly	WS-LP-010, WS-LP-023	Lab, GEI
Nitrogen, Total Kjeldahl	Monthly	WS-LP-010, WS-LP-023	Lab, SGS
Nitrogen, Nitrate+Nitrite	Monthly	WS-LP-010, WS-LP-023	Lab, GEI
Nitrogen, Ammonia	Monthly	WS-LP-010, WS-LP-023	Lab, GEI
Organic Carbon, Total	Monthly	WS-LP-010, WS-LP-023	Lab, SGS
Organic Carbon, Dissolved	Monthly	WS-LP-010, WS-LP-023	Lab, SGS
Suspended Solids, Total	Monthly	WS-LP-010, WS-LP-023	Lab, GEI
Dissolved Solids, Total	Monthly	WS-LP-010, WS-LP-023	Lab, SGS

Table A-8: Acceptable Analytical Methods for Determining Inflow Water Matrix Constituent Concentrations.

Constituent	Lab	Split (Mar, Jun, Aug)	Sampling Equipment	Sample Container	Sample Preservative	Hold Time	Analytical Method
Temperature	GEI	--	Logger	In situ	None	Immediately	Field
pH	GEI	--	Sonde	In situ	None	Immediately	Field
Dissolved Oxygen	GEI	--	Sonde	In situ	None	Immediately	Field
Specific Conductance	GEI	--	Sonde	In situ	None	Immediately	Field
Alkalinity	GEI	--	Container immersion	1 gal poly	4°±2°C	14 days	2320 B SM20
Phosphorus, Total	GEI	X	Container immersion	1 gal poly	H_2SO_4 4°±2°C	28 days	QC 10-115-01-4-B, EPA 365.3
Phosphorus, Total Dissolved	GEI	X	Container immersion	1 gal poly	H_2SO_4 4°±2°C	28 days	QC 10-115-01-4-B, EPA 365.3
Phosphorus, Ortho-phosphorus	GEI	X	Container immersion	1 gal poly	4°±2°C	48 hours	QC 10-115-01-1-T, SM 4500-PE
Nitrogen, Total	GEI	--	Container immersion	1 gal poly	H_2SO_4 4°±2°C	28 days	QC 10-107-04-4-B
Nitrogen, Total Kjeldahl	Accutest	X	Container immersion	1 gal poly	H_2SO_4 4°±2°C	28 days	EPA 351.2
Nitrogen, Nitrate+Nitrite	GEI	X	Container immersion	1 gal poly	4°±2°C	48 hours	QC 10-107-04-1-C, EPA 353.1
Nitrogen, Ammonia	GEI	X	Container immersion	1 gal poly	H_2SO_4 4°±2°C	28 days	QC 10-107-06-2-A, EPA 350.1
Organic Carbon, Total	Accutest	--	Container immersion	1 gal poly	H_2SO_4 4°±2°C	28 days	SM 5310B-2011/9060A
Organic Carbon, Dissolved	Accutest	--	Container immersion	1 gal poly	H_2SO_4 4°±2°C	28 days	SM 5310B-2011/9060A
Suspended Solids, Total	GEI	--	Container immersion	1 gal poly	4°±2°C	7 days	SM2540 D, 160.2 EPA
Dissolved Solids, Total	Accutest	--	Container immersion	1 gal poly	4°±2°C	7 days	SM 2540C-2011

Appendix B Standard Operating Procedures

B.1 Purpose

The standard operating procedures (SOP) describe the collection, preparation, and handling of surface water from streams and reservoirs, alluvial well and sediment samples. These SOPs are applicable to the water-quality monitoring program for the CWA and CRP. SOPs are used in conjunction with the Sampling and Analysis Plan (SAP) that defines sample locations, schedules, list of analytes, and quality assurance/quality control (QA/QC) procedures.

B.2 Field-Survey Preparations

All field instruments and meters are calibrated and a maintenance check is performed to ensure proper function. Calibration of the equipment is conducted in accordance with the manufacturers' specifications, and spare parts are kept on hand while in the field in the event of an equipment malfunction. A record of all calibrations, standardization including standard lots and expiration dates and maintenance is maintained in a bound logbook. Information on dates, operator, time, location, comments and recommended maintenance also are recorded for each use. The logbook is inspected regularly by the Field Team Leader to ensure recommended maintenance is completed. The Field Team Leader will sign and date the logbook to indicate approval. Several general procedures are applicable to the collection of all surface water samples. These procedures include:

1. Prepare all sampling equipment and containers prior to site visit;
2. Follow sampling plan in every detail;
3. Document steps in the sampling procedures (The CRMC Project Manager will maintain field forms that can be used for documenting sampling procedures);
4. Evaluate site for safety hazards and any physical conditions that may affect sample condition before commencing sample collection;
5. Observe number and location of sample points, landmarks, references, and routes of access or escape;
6. Record pertinent observations, including a sketch, where appropriate, identifying sample locations;
7. Collect samples and securely closing containers as quickly as feasible; and
8. Make field observations (pH, temperature, specific conductance) at the source using a probe rather than in the containers, whenever possible.

B.3 In-Reservoir Depth and Secchi Depth Measurement

Sample depths are measured with a calibrated sounding line to the nearest 0.1 meter. The Secchi depth may be used to determine the mid-euphotic point, which is equal to the Secchi depth, and it may also be used to determine the euphotic layer depth by multiplying the Secchi depth by a factor of two. The euphotic layer is characterized as the layer where photosynthetic activity occurs. The Secchi depth is determined using the following procedure:

1. The sampler must not wear sunglasses.
2. Measurements are taken between 9 a.m. and 3 p.m. and the time noted.
3. Weather and other conditions are noted.
4. Measure on the shady side of the boat with the sampler's face as close to the surface as possible.
5. Lower the Secchi disk until it disappears from view.
6. Raise the disk until it reappears and record this depth.
7. Repeat the procedure three times and average the results.

B.4 In-Reservoir Water Sample Collection

Reservoir samples are collected from the same three locations during each sampling event. The sample locations should be determined using a GPS unit. The GPS coordinates for the in-Reservoir sampling locations are:

1. CT-1 (aka Main Body): N 39.55301 W -105.06395
2. CT-2 (aka South Platte Arm): N 39.54313 W -105.07619
3. CT-3 (aka Plum Creek Arm: N 39.54902 W -105.05333

The boat is then anchored if drift control is necessary. Water samples at the appropriate depths are collected with a Van Dorn or a similar discrete-zone sampling device. A Van Dorn sampler consists of an 18-inch long, three-inch diameter PVC cylinder, open on both ends, with a mechanism that can be triggered to close the caps of the sampler at the desired sampling depth, thereby collecting a discrete sample at the depth where the caps were closed. The method followed for such a sampler is as follows:

1. Rinse Van Dorn samplers and sample transfer device with Reservoir water.
2. Open the device and lower it to the desired depth using a calibrated rope.
3. Gently raise and lower to device to rinse it at the sampling depth.
4. Trigger the closure mechanism to collect the sample and lift to the surface.
5. Rinse sample transfer device with sample water.
6. Transfer sample into sample containers.
7. Tighten sample container lid.
8. Decontaminate sample container outside surface by rinsing with deionized water.
9. Complete all information on the sample label.
10. Sign and date custody seal and place over the sample container's lid.

11. Place sample in a zip-lock plastic bag.
12. Place bagged sample in prepared DOT-compliant shipping container with ice when required.

In-Reservoir water samples are taken through the ice using this same method when it is safe to do so. A Secchi disc reading will not be reliable so the mid-euphotic zone will be assumed at 1.5 meters.

B.5 In-Reservoir Sediment Sample Collection

Reservoir sediment samples may be obtained by using either an Ekman dredge or similar device, or using a sediment coring device such as the K-B core sampler depending upon the type of sample required for analysis. The sampler in current use is a metal clamshell-type dredge approximately 8 inches across, attached at the hinge to a line by which the sampler is dropped to the bottom. After dropping to the bottom, the jaws of the sampler are quickly closed by triggering the mechanism from the surface. Details of the sampling method are as follows:

1. Rinse the device in Reservoir water.
2. Lower the device to the Reservoir bottom.
3. Trigger the closure mechanism and lift to the surface.
4. Transfer the sample into a stainless-steel mixing bowl.
5. Mix the sample to homogenize after required volume is obtained.
6. Transfer sample into sample containers with a stainless-steel spoon after mixing.
7. Wipe residual sample from sample container cap threads.
8. Tighten sample container’s lid.
9. Decontaminate sample container’s outside surface by rinsing with deionized water.
10. Complete all information on sample label.
11. Sign and date custody seal and place over sample container’s lid
12. Place sample in a zip-lock bag.
13. Place bagged sample in prepared DOT conveyance with ice when required.

A sediment coring device will be similarly deployed, although the sample core will remain intact for additional studies, or sub-sectioned to collect the active layer (i.e., 5-10 cm top layer) for phosphorus fractionation and metals analysis. This type of sampling provides a more quantitatively defined sediment area to determine the available nutrient mass that may contribute to internal nutrient loading. Details of the sampling method are as follows:

1. Rinse the device in Reservoir water.

2. Lower the device to the Reservoir bottom.
3. Trigger the closure mechanism and slowly lift to the surface.
4. Cap the lower end of the coring device while the tube is still in the water to prevent loss of sample.
5. Remove the polycarbonate tube from the coring device and ensure the end caps are securely fastened to the tube to maintain sample integrity.
6. Complete all information on sample label and place polycarbonate tube vertically in a cooler with ice packs.
7. Transfer to laboratory for analysis.

B.6 In-Stream Water Sampling

In-stream water samples are collected as grab or composite samples from the South Platte River inflow, Plum Creek inflow, and the South Platte River outflow sites. The GPS coordinates for the in-stream sampling locations are: Loggers installed 2.8 miles downstream from So. Platte @ Waterton and 2.3 miles downstream from Plum Creek @ Titan Rd.

1. South Platte Inflow (aka @ Waterton Rd): N 39.48804 W -105.09354
2. South Platte Inflow GEI (aka WS-LP-010): N 39.5206 W -105.0791
3. Plum Creek Inflow (aka @ Titan Rd): N 39.50692 W -105.02432
4. Plum Creek Inflow GEI (aka WS-LP-023 or PC-0.3): N 39.53935 W -105.04885
5. South Platte Outflow: N 39.56118 W -105.06031

Composite samples can be flow or time based. Grab samples characterize a medium at a particular point in time and space. Grab samples are collected by container immersion or by using a transfer device such as a beaker or dipper. A representative sample is obtained as near the centroid of flow as safety allows. Sample sites located in standing water or near streambanks will be avoided. Sampling from the upstream side of a bridge aids in the prevention of contamination of the sample from debris or sediment from the road. When suspended particles are unlikely to be uniformly distributed across the channel cross section, a composite sample consisting of several grab samples is used. Do not include large non-homogeneous particles, such as leaves and detritus, in the sample. Collection of in-stream water samples by container immersion is performed as follows:

1. Submerge the sample bottle below the water surface with the opening pointing upstream at the centroid of the stream flow.
2. The sampler will minimize the disturbance of bottom sediment.
3. Allow container to fill to the desired volume.
4. Sample containers containing preservatives are filled to just below the bottom of the container neck to prevent loss of preservative.

5. Remove container from the water.
6. Decontaminate the sample containers outside surface by rinsing with deionized water.
7. Tighten sample container lid.
8. Complete all information on the sample label.
9. Sign and date custody seal and place over the sample container's lid.
10. Place sample in a zip-lock bag and seal.
11. Place bagged sample in a prepared U.S. Department of Transportation (DOT) compliant shipping container with ice as required.

Collection of in-stream water samples by the dip and transfer method is performed as follows:

1. Select the correct composition of the transfer device for the selected analytes.
2. Decontaminate the transfer device.
3. Place the device at the centroid of stream flow facing upstream
4. Rinse the device three times with surface water.
5. Collect and transfer sample directly into sample container.
6. Do not overfill containers that have preservative.
7. Do not let transfer device contact anything except surface water.
8. Tighten sample container lid.
9. Decontaminate sample container's outside surface by rinsing with deionized or distilled water.
10. Complete all information on sample label.
11. Sign and date custody seal and place over the container lid.
12. Place in a zip-lock plastic bag and seal.
13. Place bagged samples in a prepared DOT-compliant shipping container with ice as required.

B.7 Metals Chemistry Water Sample Collection

Samples that will be submitted to a laboratory for analysis of dissolved metals are filtered prior to transferring into sample containers. Do not preserve the samples prior to filtration. These samples are filtered using a vacuum filter holder, hand-vacuum pump, flask with a side arm, and 0.45 µm filter paper. The method to be followed is as follows:

1. Thoroughly decontaminate the filter holder and flask with deionized water.
2. Place a new 0.45 µm filter paper on the vacuum filter holder and re-attach the funnel to the filter holder.
3. Insert the stopper of the filter holder into the flask.

4. Attach the hand-vacuum pump to the side arm of the flask.
5. Pour the sample water into the funnel and begin pumping the vacuum pump to draw the water through the filter into the flask. Repeat until sample has been filtered.
6. Transfer the sample from the flask into the appropriate sample containers.
7. Tighten sample container lid.
8. Decontaminate sample container's outside surface by rinsing with deionized water.
9. Complete all information on sample label.
10. Sign and date custody seal and place over the sample container lid.
11. Place sample in a zip-lock plastic bag.
12. Place bagged sample in prepared DOT-compliant shipping container with ice as required.

B.8 Alluvial Well Sampling

The well sampling sites consist of a faucet at the wellhead, a pumping station, or open cistern. Sampling procedures for the pumped wells follow the sampling by dip and transfer method after the water source has been purged of stale water. Notes regarding the color, flow, and general character of the water are recorded. The open cistern is sampled with a transfer device secured with a rope. The device is lowered into the water and the sample transferred to the sample containers using the dip and transfer method. Safety issues will cause any sampling activities to cease.

B.9 Phytoplankton Sampling

Phytoplankton samples are collected at the same locations and using the same methods as the in-Reservoir water samples. Phytoplankton samples are always collected from the near surface depth that corresponds with the chlorophyll *a* sample depth. At the laboratory, samples are placed into an amber HDPE bottle and preserved with Lugol's Iodine Solution, then shipped to PhycoTech for analysis.

B.10 Zooplankton Sampling

Zooplankton samples will only be collected from Site CR-1 when other in-Reservoir water samples are collected from this site. The zooplankton sample is always collected following the collection of water samples, so as not to compromise the integrity of the water samples. Collection of a vertical water column zooplankton sample is performed using a Wisconsin 80 μm mesh net as follows:

1. Rinse the device with Reservoir water.

2. Fill the collection vessel at the end of the net with Reservoir water to provide weight.
3. Lower the net to the bottom of the sample column (1 meter from the bottom) in such a manner to prevent the net from becoming inverted.
4. Slowly raise the net through the water column to the surface.
5. Rinse all organic matter from the net into the collection vessel using distilled water.
6. Pour the contents of the vessel into a stainless-steel composting bowl.
7. Repeat the sampling procedure two more times for a total of three sample collections.
8. Pour the composites into the net to remove excess water.
9. Rinse the net contents into the collection vessel for a concentrated sample.
10. Transfer the sample to the required sample container prepared with the appropriate alcohol preservative.

B.11 Visual Flow Measurements

Flow measurements are determined in the field using a tape measure, stopwatch, and a float. The float will be light enough to represent the current of the stream but not be influenced by air current. Flow measurements are taken after the collection of samples.

Choose a section of streambed that uniformly matches one of the three area types: rectangular, inverted triangle, or semicircle. Measure the width and the depth of the streambed to the nearest 0.1 ft and apply it to one of the following formulas for a cross sectional area:

Rectangular area = (width) X (depth)
Triangular area = ½ [(width) X (depth)]
Semicircle area = ½ (3.14 X depth) [note depth will be ½ of the width]

Measure a section of streambed between two and six feet to the nearest foot. Start the float upstream from the measured section and time it as it flows through the measured section in the centroid of flow. Repeat the timing procedure three times to get an average value in seconds. Multiply the cross-sectional area by the measured streambed length and divide by the average seconds to get a result in the units of cubic feet per second. Field-flow measurements are compared to any additional available flow data for the sampling site from sources such as the USGS, State of Colorado, or U.S. Army COE.

B.12 Field Measurements

Field measurements of indicator variables consist of dissolved oxygen, specific conductivity, temperature, pH, oxidation reduction potential, and chlorophyll *a*. Measurements of dissolved oxygen and pH are recorded to the nearest 0.1 of the appropriate units; temperature is recorded to the nearest 0.5° C. Use, calibration, and maintenance procedures follow the manufacturer instructions. Field measurements are taken at the source whenever possible or from the holding container used for sample collection prior transferring the sample to the sample containers. All water quality meters are calibrated and proper function ensured prior to use and the results are documented in a field log book.

B.13 Field QA/QC Samples

The goal of the QA/QC program is to ensure the accuracy, precision, completeness, representativeness, and comparability of sampling data. In order to document the consistency and accuracy of analytical data generated by the contract water-quality laboratory, one or more of the following QA/QC samples can be employed. The CRMC/CWA QAPP/SAP defines which QA/QC samples are to be collected and the frequency of collection.

B.13.1 Field QA/QC Samples

A double volume of water is collected and preserved at the appropriate sampling site. The sample is then divided into identical containers that are given different location identification names. Label sample collection time for the duplicate sample will be entered as four letters (e.g., AAAA, BBBB, CCCC, XXXX, YYYY, ZZZZ). These are recorded in the field notes for future reference. Both samples are submitted to the laboratory for identical analyses. The laboratory is not advised of the duplication.

B.13.2 Field Blanks

A volume of commercially distilled water is taken to the field and placed in an identical sample container using the sampling techniques employed for standard sampling. The procedure for identifying duplicate samples above is followed for field blanks.

B.13.3 Equipment Blanks

Equipment blanks are prepared for metals-in-water samples whenever a new batch of filters are used, or every tenth sample filtered (or collected for total metal analysis). Equipment blanks consist of a volume of commercially distilled water that is taken to the field and filtered and/or handled like a regular sample. The procedure for identifying duplicate samples above is followed for equipment blanks.

B.14 Sample Shipment

Samples going to labs outside the Denver-metro area are packed into plastic bags and placed in a DOT-compliant shipping container (e.g., cooler) with sufficient ice to maintain sample temperatures as close to 4°C as feasible for a 24-hour period. Void space within the container is filled with packing material to avoid shifting of the samples during transport. The completed, signed, and dated chain-of-custody (COC) is enclosed in a plastic bag and placed inside the container on top of the contents. Copies of the COC and the shipping bill are kept with the field notes. The container lid is closed and secured with two complete wraps of packaging tape. Labeling consists of directional labels on all four sides and fragile stickers and the shipping label on the lid of the container. The container is shipped overnight to the contracted lab using a commercial carrier (e.g., Federal Express). Samples going to labs in the Denver metro area are transported in a cooler on ice and delivered the same day as collection or secured in a refrigerator pending delivery.