December 23, 2021

Ben Wade, Program Manager
Colorado Water Conservation Board
Water Supply Planning Section
1313 Sherman Street, Suite 718
Denver, CO 80203

Subject: White River Algae Research POGG1 2019-2747 – Final Report

Dear Mr. Wade,

We are pleased to provide the following final report for the WSRF Grant POGG1 2019-2747. All the data has been collected and analyzed for this study. USGS is in the process of finalizing the reports and ensuring accuracy through their quality control processes. The final USGS algae study reports will be published and provided to CWCB by June 2022. The final portion of this project will be funded through Colorado Water Plan grant and other partners.

After many concerned citizens experienced trouble with "green stuff" in the river, fourteen local agency members were convened by the White River and Douglas Creek Conservation District (Districts) to create the Technical Advisory Group (TAG). This group worked with USGS and developed a Scope of Work (SOW) to study the potential causes of the excessive algae growth in the White River. Representatives of the following agencies make up the TAG: Rio Blanco Water Conservancy District, CO Parks and Wildlife, CO River Water Conservation District, Rio Blanco County, Town of Meeker, Town of Rangely, Meeker Sanitation District, White River Conservation District, Douglas Creek Conservation District, Natural Resource Conservation Service, US Forest Service, Bureau of Land Management, US Geological Survey, and Trout Unlimited. The TAG's mission is to ascertain what is driving the algae growth in the White River to improve the overall health of the watershed.

Therefore, the Districts hired the United States Geological Survey (USGS) who is guided by the Districts and TAG in data collection and research into potential causes of the nuisance levels of benthic algae growing in the White River. Since January 2018, the USGS has been collecting data related to streamflow, water quality, and algal occurrences in the White River. Data collection for the study was completed October 2020.

In addition to the specific tasks identified in the SOW (listed below), the Districts obtained landowners' permission in many stretches of the White River to allow Rio Blanco County and the Districts to fly a drone and get photos of the river to see where the algae may be more/less prevalent. Pictures were taken three years in a row and are compared annually to better understand the behavior of the algae.

Multiple volunteer citizens took weekly and/or daily photos of the river at study sites to assist in identifying the peak algae bloom for USGS data collection. Photos were shared with the USGS through

the Districts. This helped to involve local citizens in the project and saved USGS from making trips to the basin to monitor peak growth.

Additionally, the Districts partnered with CPW and Trout Unlimited to hire GEI Consultants to analyze collected data and develop the White River Macroinvertebrate Analysis Report. By hiring this third party, the report was finalized in time for the information to be included in the final USGS Algae Study Report.

The TAG has meet approximately ten times over the last five years to identify the Scope of Work (SOW) for this project and to hear updates from USGS on the progress of the study. The TAG will meet several times in January/February 2022 to consider the data and analysis along with local knowledge and provide input on the USGS final report.

The following is a list of tasks, their descriptions and the items completed within each one from the USGS Scope of Work. Tasks 1-7 were completed as of October 2020. Task eight is underway and expected to be completed by June 2022.

**Green wording is from the WSRF grant application SOW

Task 1 Data Mining and Historical Synthesis: Literature search for algal topics and determine from the search what information is relevant to the White River. Evaluation of findings from other local studies will be completed and synthesized into a single document that is relevant to the conditions in the White River. These reports and other Historical information (from local interviews and surveys) will be used to guide further investigations in the white river.

- ✓ Compilation and analysis of existing literature and data for study area and nearby areas. This provided additional temporal and spatial perspective using existing data sets.

Task 2 Continuous Monitoring: Dissolved oxygen and temperature at 19 sites.

- ✓ Three reconnaissance stream samplings were taken for determination of concentrations and loads of nutrients (total Nitrogen and Phosphorous and component chemical compounds), and suspended sediment concentrations. The importance of this was to reveal loading, spatial, temporal, sources; apportion source contributions to various input streams and perhaps diffuse groundwater inputs to specific reaches.
- ✓ Water quality sondes (DO, pH, water temp.) were deployed at the 19 study sites on the White River. Each sonde ran continuously for one week collecting data at 15-minute intervals.

Task 3 Pebble Counts Streambed material measurements will be made by the USGS using standard methods to determine particle size characteristics of the channel and, if present, of the alluvial bars at up to 60 cross sections in the White River (three cross sections at each of the 19 sites).

- ✓ Assessment of channel substrate size, orientation, and embeddedness on all study sites in 2018.

Task 4 Scouring-Flows An important consideration regarding the proliferation of algae in certain reaches of the White River is peak streamflow and duration. Peak streamflow magnitude can play a crucial role in scouring benthic algae from streambeds thus decreasing or resetting total algal biomass on an annual basis. Specific channel characteristics also play a role in benthic algal control but are less apt to change from year to year. Characteristics such as bed-sediment particle size and channel form can place large controls on algal growth. Particle size of the streambed can dictate the suitability of algal attachment

points and, if large enough, can armor the channel and minimize scour even during wet years. Cross-section surveying and particle-size analysis in conjunction with incipient motion analysis is needed to address data gaps and promote understanding of the role of streamflow in algal proliferation. This analysis will also assist in the prediction of where algae will be most prolific.

The following activities were conducted all three years (2018 – 2020)

- ✓ 30 streamflow measurements and depth velocity profile measurements
- ✓ 30 high water surveys
- ✓ 30 hydrophone measurements for coarse bedload verification
- ✓ 30 radar targeted velocity verifications

Task 5 Scouring-flows analysis Sediment transport, or movement, in streams occurs when the forces acting on the particle exceed the resistive forces. Transport of bed material (the particles that are representative of the range of particle sizes commonly occurring along the streambed) is approximated through comparisons of boundary shear stress (a tangential stress created by flowing water acting on sediment particles resting on the streambed or other inundated alluvial surfaces) and particle size and shape. Entrainment potential for sediment on a specific geomorphic surface is estimated by relating flood generated boundary shear stress and the critical shear stress of the sediment particles.

- ✓ This was assessed during peak streamflow in 2018-20 using high-flow measurements, channel surveys, and grain-size analysis. High flows in 2018 and 2020 DID NOT cause streambed mobilization at the site WR below North Elk Creek near Buford, CO. High flows in 2019 DID mobilize the streambed at this location. Differences in streamflow magnitudes in 2018-2020 provided a good opportunity to characterize the lower and higher ranges of sediment mobility for each site.

Task 6 Isotope Sampling The relative abundance of measured stable isotopes from a water sample can act as a 'signature' to compare against when investigating different potential nutrient sources.

- ✓ The District Manager collected river water samples and Meeker Sanitation District Manager tested the samples for nitrate levels to determine if/when levels were high enough for USGS to collect and test isotopes.
- ✓ 27 water samples collected by USGS among 9 sites (3 replicate samples collected at each site for quality assurance).
- ✓ 12 water samples sent to the USGS lab. Only 4 of the 9 sites sampled had high enough nitrate concentrations for isotope analysis.

Task 6.1 Taxonomic Identifications The results will identify whether filamentous algae are Cladophora and will identify and quantify the presence of other algae including didymo and blue-green algae. The task includes field collection/sample processing and laboratory analysis. It will complement the chlorophyll-a and ash-free dry-mass analyses planned for the same sites and will provide additional data for relations among water quality, macroinvertebrates, and the physical system.

- ✓ Algae samples were taken and analyzed from the 20 study-area sites

Task 6.2 Supplementing Streamflow Measurements This task better separates flow quantity in the North and South forks of the White River, in areas where no currently installed stream gage exist and to aid in the State of Colorado gaging station during high-flow on the White River near Sleepy Cat. This helps to better understand streamflow correlations between sites and to have a better understanding of peak flows throughout the upper basin. Measurements taken during high flow conditions helped

characterize stream channel mobility, or the tendency for the channel bed to have moved. Bed movement can help control algae levels by cleaning or abrading rock surfaces.

- ✓ Streamflow measurements collected at three sites that bracket the confluence of the North and South Forks.

Task 7 Pre-, Peak-, Post- Algae and Water -Quality Sampling Events Water-quality samples (primarily nutrients) will be analyzed under varying conditions (pre-algal growth, peak- algal growth, and post-algal growth) as part of this study. Determinations of these periods will be based on local observations and flow conditions.

- ✓ Sampling in 2019 and 2020 included the following parameters on all sites: Chlorophyll a, ash free dry mass, salinity (major ions), alkalinity, Streamflow, turbidity, pH, specific conductance, temperature, dissolved oxygen (DO).

Task 8 Analysis & Publication An analysis of factors contributing to nuisance-levels of benthic algae in the White River will utilize multivariate-regression techniques. In this analysis, the data collection (described previously) provides a dataset designed to assess the role and importance of several potential contributing or mitigating conditions (explanatory variables: field parameters, water-column chemical properties, channel condition, channel form, and scouring forces) in controlling the range of observed conditions in algal abundance (dependent variable: chlorophyll-a or ash-free dry mass).

Task 8.1 Water Quality Report –

- ✓ The draft manuscript for the Water Quality report is 80% through the review process as of December 2021.

Task 8.2 Algae Report –

- ✓ The draft manuscript for the Algae report is 40% through the review process as of December 2021.

Task 8.3 Fact Sheet –

- ✓ The fact sheet will be completed after both the Water Quality and Algae Reports are completed as a quick way for the lay person

The publicly available supporting data releases are 75% completed.

From the beginning of this process, it has been important to the local communities, Districts, and TAG that the data and reports were ground-truthed to ensure the data and analysis reflects the reality on the ground. On December 16, 2021, the TAG met with USGS and reviewed the *Characterization of Streamflow and Nutrient Occurrence in The Upper White River Basin, Colorado, 1980-2020* (Identified as Task 8.1) which describes historical streamflow and water quality characteristics. This meeting allowed the TAG to ask questions and make recommendations to the USGS to improve the quality of the report. The *Investigation of Factors Controlling Benthic Algae in The Upper White River Watershed, Colorado, 2018–21 (*Identified as Task 8.2) was delivered to the TAG during the week of December 20th. The TAG will provide comments to USGS on both reports by the end of January 2022 to be considered in the final USGS reports.

The final USGS Algae Study reports are expected to be ran through all USGS quality control processes and completed by June 2022. The Districts will provide a copy of the final report to the Yampa, White, Green Basin Round Table and the Colorado Water Conservation Board when available.

Please see the attached budgeted and actual accounting of funding for this project.

Thank you for your continued support in this study. Please contact me with any questions you may have.

Sincerely,

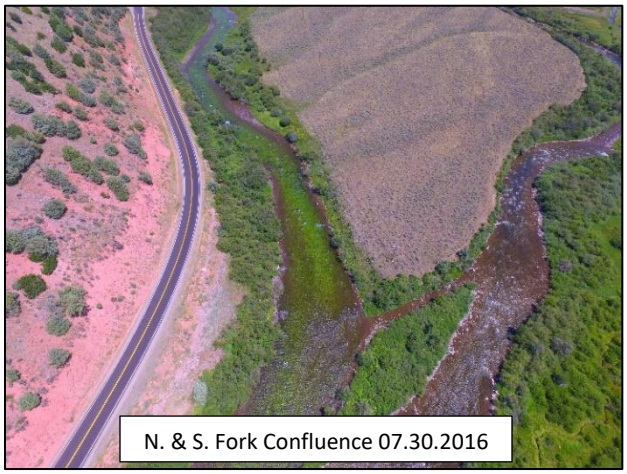
Callie Hendrickson
Executive Director

White River & Douglas Creek Conservation Districts

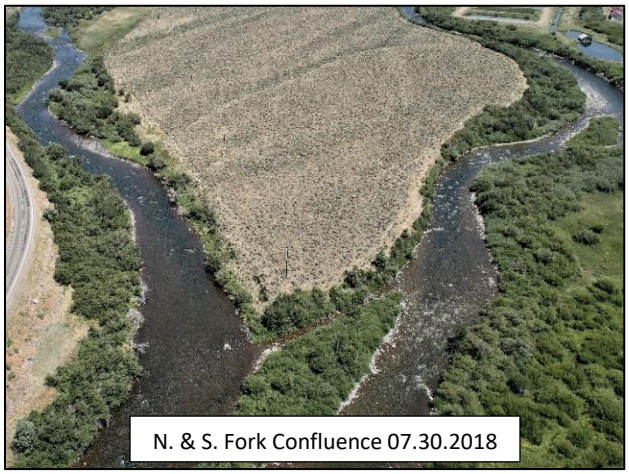
Promoting the wise use of all natural resources

Photos of the White River Algae Study 2018 - 2021

Drone Photos



N. & S. Fork Confluence 07.30.2016



N. & S. Fork Confluence 07.30.2018

N. & S. Fork Confluence 07.30.2020

P.O. Box 837 – Meeker - CO 81641 – Phone (970) 878-9838

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Volunteer River Photos

Bailey's Bridge 06-06-2021

Bailey's Bridge 06-27-2021

Bailey's Bridge 09-17-2021

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Volunteer River Photos

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Activity Photos

Scraping algae from river rocks in the White River
PC: USGS

TAG Meeting 07-19-2018

December 23, 2021

Ben Wade, Program Manager
Colorado Water Conservation Board
Water Supply Planning Section
1313 Sherman Street, Suite 718
Denver, CO 80203

Subject: White River Algae Research POGG1 2019-2747 – Final Budget Report and Narrative

Dear Mr. Wade,

The original budget submitted with the application for the White River Algae Study was for $99,000 (17%) WSRF Grant of a total $575,590. WSRF funds were for Water Quality Sampling (Task #7) and Analysis & Publications (Task #8) for this project with the expectation that the final report would be submitted by Dec. 31, 2021. Unfortunately, the publication of the final reports is running a little behind. The White River and Douglas Creek Districts (Districts) have a Colorado Water Plan Grant (CWP) that runs through June 2022 which has sufficient remaining funds to cover the costs in 2022 along with other partner funding.

See the final report for the WSRF grant for details on what was accomplished throughout the entire study. Below is a summary of the total income and expenses for the White River Algae Study.

As you can see, local landowners and a few NGO's provided 13%. Local governments provided another 13% of the total cost of this study. We are very pleased with the local support for this study. USGS contributed 33% with the remaining 41% being covered by the State of Colorado. Other State funds included $50,000 from the Colorado State Conservation Board, $20,000 from GOCO and Colorado Parks and Wildlife (CPW) along with the approximately $76,000 from the CWP grant. The CWP grant has approximately $14,000 remaining in it that will cover the remaining cost of developing the publication.

Funding:			
	Private	$ 77,500.00	13%
	Local Gov	$ 79,000.00	13%
	State	$ 253,304.46	41%
	Federal	$ 205,510.00	33%
	Total Funding	**$ 615,314.46**	

Expenses to date are noted below. The District has paid $363,152 to USGS for the original Scope of Work (SOW) plus two additional tasks that the TAG developed for the 2020 – 21 study years. See the final report for additional information on all tasks for USGS as well as supplemental efforts to help identify the potential causes of the algae. The difference between the total funding and the total expenses below is in the last expense for the final USGS Report in 2022.

Expenses:		
	USGS	$ 363,152.00
	GEI	$ 9,724.00
	Admin	$ 23,961.30
	USGS Contribution	$ 205,510.00
	Total Expenses	**$ 602,347.30**

The WSRF grant was for $99,000. As noted in the below table, $41,000 was requested in February 2020 and $36,365 is currently being requested. This will leave $21,635 in the WSRF grant that will not be requested.

WSRF funds were used only for USGS Tasks #7 and #8 as originally planned with additional sources of funds to cover the additional tasks developed by the TAG and the Macroinvertebrate Analysis Report.

WSRF Grant	$ 99,000.00	
2/5/2020 Reimbursement	$ 41,000.00	$ 58,000.00
12/23/2021 Reimbursement	$ 36,365.00	$ 21,635.00

Thank you for the support on this project and we look forward to sharing the final reports with you in 2022. Please contact our office with any additional questions.

Sincerely,

Callie Hendrickson

Callie Hendrickson
Executive Director