TAILWATERS

STAGECOACH COLORADO

Water Quality Study

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C O N T O U R
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Introduction

1.1 Purpose and Scope

Stagecoach reservoir is a valuable water resources located in southern Routt County that provides recreational, water supply and power generation opportunities to the surrounding community. The reservoir, which was constructed in 1988-1989 covers approximately 819 acres. Stagecoach Reservoir, upstream from Steamboat Springs on the Yampa River, is the largest storage facility in the Upper Yampa River Basin (UYRB) with a total capacity of approximately 36,500 acre-feet. Allocation of water from the Stagecoach Reservoir includes approximately 18,000 acre-feet for recreation and dead-pool storage, 11,000 acre-feet for industrial water, and 2,000 acre-feet for municipal water. An additional 2,000 acre-feet is unallocated water for municipal and industrial purposes (AECOM and Colorado Water Conservation Board, 2009). The dam at Stagecoach Reservoir supports a hydroelectric power station, and the dam and reservoir are owned and operated by the Upper Yampa Water Conservancy District.[1]

Figure 1 - Stagecoach Reservoir

[1] USGS, Scientific Investigations Report 2021-5016, Assessment of Streamflow and Water Quality in the Upper Yampa River Basin, CO 1992-2018, pg. 5.

During multiple summer sampling events at Stagecoach Reservoir over the past decade, the physical and chemical factors indicated conditions conducive to cyanobacterial blooms, including surface-water temperatures greater than 20 degrees Celsius and total phosphorus and total nitrogen concentrations in exceedance of Colorado Department of Public Health and Environment interim concentrations for water-quality standards. Local geological features (predominately sandstones and shales) and additional inputs from upstream land use likely contribute to the elevated nutrient conditions in Stagecoach Reservoir.[2]

Although the Stagecoach reservoir is owned and operated by the UYWCD, the land surrounding the reservoir is part of Stagecoach State Park which is operated by the Colorado Department of Parks and Wildlife. Colorado Parks and Wildlife (CPW) manages the recreational uses of the reservoir under a lease with the water district. CPW manages park passes and camping within the State Park as well as fishing, hunting, trails, along with boating and watersports in the reservoir. In addition to the state park and campgrounds surrounding Stagecoach Reservoir the Stagecoach community contains over 500 residential dwelling units that have been constructed over the past 50 years.

Tailwaters at Stagecoach LLC (the "Applicant") is proposing to develop a 89-acre lot located just to the south of Stagecoach reservoir. The lot is situated between County Road 18A to the west and Little Morrison Creek which runs along the eastern border of the property. The Applicant is proposing to develop the parcel with 200 residential units and a small neighborhood commercial area (the "Project"). As part of the Sketch Plan approval process, the County Planning Commission and County Commissioners included a condition that the Applicant complete "A water quality study that takes into account the effluent and stormwater flowing into Stagecoach Reservoir focusing on phosphorus and nitrogen." from the proposed Project.

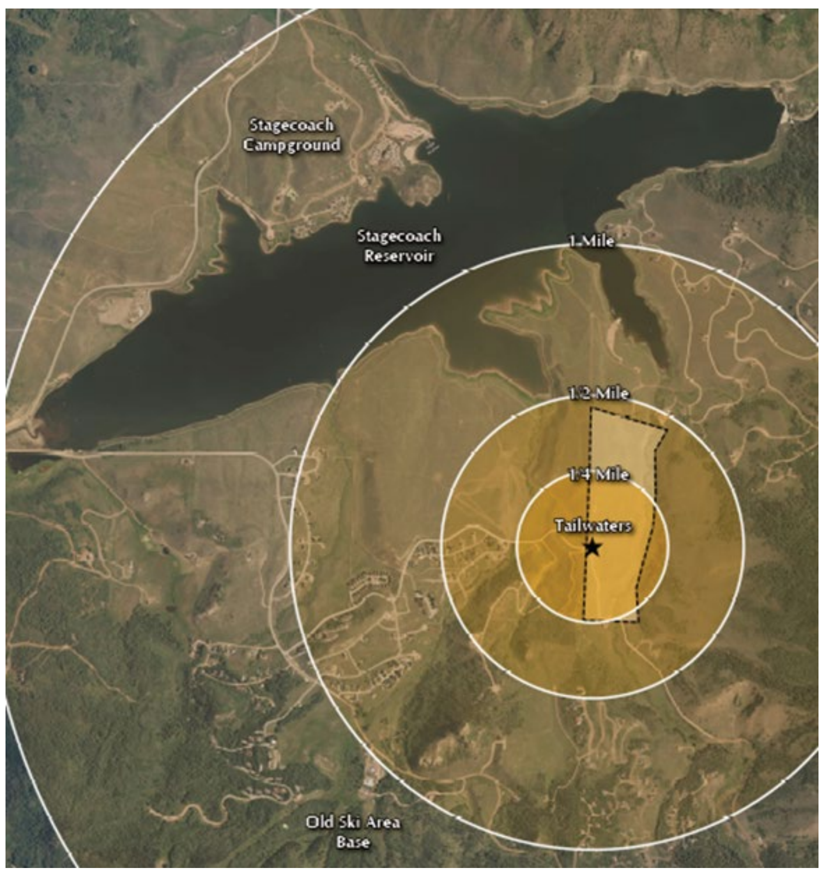


Figure 2 - Vicinity Map

As part of this study, we will analyze past area water quality assessments and results, for the Yampa River in the vicinity of Stagecoach reservoir, Little

[2] USGS, Scientific Investigations Report 2021-5016, Assessment of Streamflow and Water Quality in the Upper Yampa River Basin, CO 1992-2018, pg. 2.

Morrison Creek, and Stagecoach reservoir itself. These results will be compared with effluent discharges from the Morrison Creek Metropolitan Water and Sanitation District as well as CDPHE interim limitations. Finally, this study will recommend measures to monitor and potentially mitigate discharges from the proposed Project.

1.2 Historical Reference[3]

Historically, Routt County Road (CR) 14 was part of a stagecoach route running from a train stop at Wolcott, Colorado, north to Steamboat Springs. From this two-track wagon trail, the road eventually evolved into a primary arterial road that is often used as a shortcut between Steamboat Springs and southern Routt County. During the early 1970s, Woodmoor Corporation acquired land south of CR 14 and east of Colorado Highway 131 and began to plan for a large new community named Stagecoach. At that time, neither Stagecoach Reservoir nor the ski area existed, but Woodmoor envisioned both a lake and a ski mountain and had plans for a golf course, equestrian center and full-service marina as part of its new planned development. Woodmoor also envisioned thousands of single-family homes and multi-family units scattered across a large portion of south Routt County.

In 1972 Routt County granted Woodmoor urban-scale zoning for the entire site. The zoning allowed for the development of both multi-family and single family lots of less than 1 acre—if central water and sewer services were provided. The County also approved 16 subdivision plats referred to today as the original Woodmoor Subdivisions, covering 1,938 single-family lots with the potential for thousands of additional condominium and townhouse units. Single family lots in Stagecoach were rapidly sold to over 1,400 different owners from all over the country and other parts of the world. Between that time and 1999, 78 single family homes were built on those lots. In addition, 172 multi-family units were constructed, but most of the multi-family tracts were retained for future development. Portions of the land that were not subdivided at that time received County zoning approval that would allow for a total of over 4,500 more dwelling units, if developed at maximum density. Even if developed at lower densities, the Woodmoor approvals would have accommodated housing for nearly as many people as lived in Steamboat Springs at that time.

To provide water and sewer services for the anticipated development, Woodmoor helped create the Morrison Creek Metropolitan Water and Sanitation District (the "Metro District"). The Metro District sold bonds to investors and used the proceeds to begin constructing an extensive system of water wells, water pipes, sewer collection lines, and a sewage treatment plant. To achieve construction efficiencies, it sized these facilities to serve between 1,000 and 2,000 dwelling units. When future homes were built and hook-up fees and real property taxes were collected, those revenues would be used to repay bondholders.

Unfortunately, in 1974 Woodmoor experienced hard times and filed for bankruptcy. Without an

[3] Stagecoach Community Plan, Adopted March 16, 2017 pgs 1-4, 27-29

active sales program, lot sales and resales slowed down. Without a master developer, construction of multi-family units stopped altogether. Some of those who had sold the land to Woodmoor received portions of the land back following the bankruptcy, subject to zoning and platting that the County had approved.

Since houses were not being built, real estate tax revenues to the Metro District did not rise as fast as expected and hook-up fees were not paid either. As a result, the Metro District was unable to build additional infrastructure and facilities to serve new development unless the property owners agreed to pay for the construction. Since most property owners were not able to finance those utility extensions themselves, home construction declined and stayed at a very low level for most of the next 15 years. Although it did not have the financial capacity to expand, the Metro District continued to operate and maintain the oversized infrastructure that had already been built. The Metro District emerged from bankruptcy in the early 2000's, allowing it to assume responsibility for its financial affairs and plan for its future with more freedom.

Between 1980 and 2017 several Master Plans were developed for the Stagecoach community. All of these plans have identified the Stagecoach areas as a future growth area. The preferred land use and direction described by the community is that Stagecoach will continue to evolve as a diverse community with a unique and desirable rural Routt County character, with recreational opportunities while emphasizing self-reliance within a supportive local community that the community values. Future multi-family developments should be directed to the areas in the north equipped with the necessary infrastructure to handle high density development or to locations that can be served by a central sewage collection system.

The former ranch lands where Stagecoach is today were bought in 1971 by the Woodmoor Corporation, which planned to build a residential and recreational community with ski areas and golf courses, but the company went bankrupt in 1974. The site was later bought and developed by the Upper Yampa Water Conservancy District (UYWCD) and power companies, which funded the reservoir's construction in 1988.

Stagecoach reservoir was conceived in 1983 by the Board of the UYWCD and designed to provide a reliable source of water for the growing population and economy of Northwest Colorado. The reservoir furnishes water for agricultural irrigation, municipalities and industry, as well electrical generation having served the community for over three decades as a multi-purpose conservation reservoir.

Previous to a reservoir site, the land under the existing reservoir was pastureland used for cattle grazing. For decades leading up to the post-war era, cattle excrement was enriching the reservoir lands with nitrogen and phosphorus — nutrients that fuel the growth of blue-green algae. Those involved in planning and constructing Stagecoach Reservoir were told algae blooms were a likelihood, as reported by Stagecoach State Park manager Craig Preston.

1.3 Existing Hydrology

The Yampa River originates in the Flat Tops as the Bear River, flows northward to the town of Yampa, CO., and becomes the Yampa River where Phillips Creek converges with the Bear River (fig. 3). Major tributaries to the Yampa River include Oak Creek, upstream from Steamboat Springs; the Elk River, downstream from Steamboat Springs; and Elkhead Creek, downstream from Hayden, CO. Minor tributaries include Fish Creek east of Steamboat Springs, Trout Creek, Sage Creek, and Fortification Creek.

Figure 3 - Upper Yampa River and Little Morrison Creek Hydrology

Streamflow in the UYRB, above Stagecoach reservoir is dominated by snowmelt runoff; streamflows increase in March, peak in April and May, and decrease at the end of July. Streamflow from August through March is often dominated by base flow from groundwater discharge. Mean and average monthly streamflow from 1988 through 2023 on the Yampa River above Stagecoach reservoir show seasonal patterns of streamflow (fig. 4).

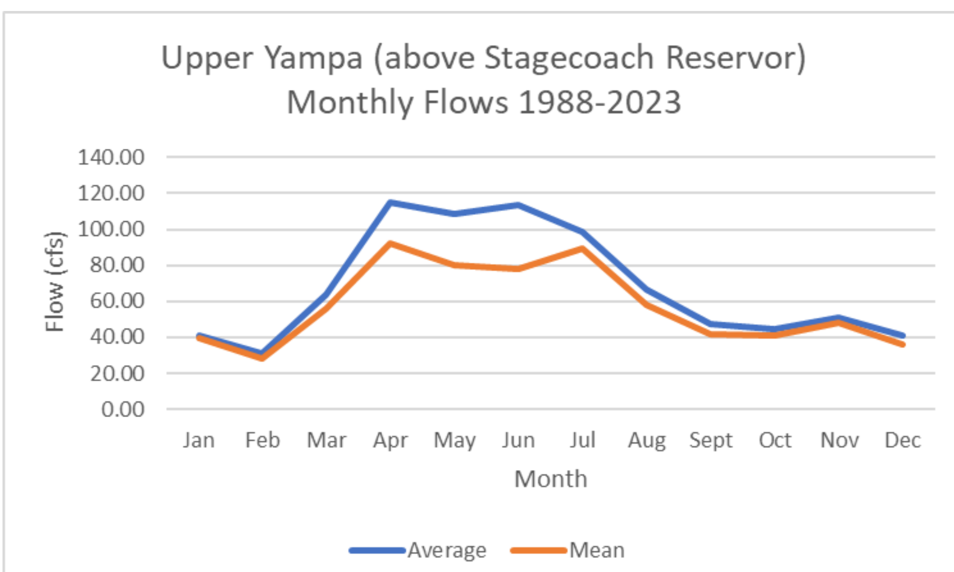


Figure 4 - Yampa Seasonal Flows

The Stagecoach reservoir drainage basin is mainly open grasslands, meadow and sagebrush that has historically been used for cattle grazing and agriculture. More recent development of both the Stagecoach reservoir recreation and camping areas as well as the Stagecoach residential community are within the reservoir basin.

The United Stages Geological Service (USGS) has collected extensive water quality data on the Yampa River, Little Morrison Creek, Stagecoach Reservoir and numerous other water resources within the Yampa River valley going back several decades. This abundance of data allows for the analysis of flows and nutrient loading within the Stagecoach basin.

Stagecoach Reservoir, upstream from Steamboat Springs on the Yampa River, is the largest storage facility in the UYRB with a total capacity of approximately 36,500 acre-feet. Allocation of water from the Stagecoach Reservoir includes approximately 18,000 acre-feet for recreation and dead-pool storage, 11,000 acre-feet for industrial water, and 2,000 acre-feet for municipal water. An additional 2,000 acre-feet is unallocated water for municipal and industrial purposes (AECOM and Colorado Water Conservation Board, 2009). The dam at Stagecoach Reservoir supports a hydroelectric power station, and the dam and reservoir are owned and operated by the Upper Yampa Water Conservancy District.

1.4 Nutrient Effects on Water Quality

Nutrients are chemical elements and compounds found in the environment that plants and animals need to grow and survive. For water-quality investigations, the various forms of nitrogen and phosphorus are the nutrients of interest. The forms include nitrate, nitrite, ammonia, organic nitrogen (in the form of plant material or other organic compounds) and phosphates (orthophosphate and others). Nitrate is the most common form of nitrogen and phosphates are the most common forms of phosphorus found in natural waters. High concentrations of nutrients in waterbodies can potentially cause eutrophication and hypoxia (USGS, December 2006).

Nitrogen and phosphorus are common components of fertilizers, animal and human wastes, vegetation, agriculture and some industrial processes. Nutrients in surface waters come from both point and nonpoint sources including agricultural and urban runoff, wastewater treatment plants, forestry activities and atmospheric deposition. Nutrients in nonpoint source runoff come mostly from fertilizer and animal wastes. Nutrients in point source discharges typically come from human waste, food residues, cleaning agents and industrial processes.

The primary limiting nutrients in freshwaters are phosphorus (P) and nitrogen (N). A limiting nutrient is a chemical necessary for plant growth. Once the limiting nutrient is exhausted, plant growth ceases. Phosphorus and nitrogen have different chemical properties and are involved in different chemical processes; however, both are transported to receiving waterbodies by rain, stormwater runoff, groundwater and industrial and residential waste effluents. Phosphorus is a mineral nutrient introduced into biological processes through the breakdown of rock and soil minerals. It is primarily found in two forms – organic and inorganic. Phosphorus readily absorbs to clay particles in the water column, which reduces its availability for uptake by algae, bacteria and macrophytes (aquatic plants).

Nitrogen (N_2), however, is primarily found in the air. Nitrogen gas is not readily available for plant uptake; however, a number of bacteria and cyanobacteria (blue-green algae) are able to convert nitrogen gas to a useable form. Most plants and animals utilize ammonium (NH_4^+) and nitrate (NO_3^-) ions – the mineral forms of nitrogen – in everyday biological functions (EPA, July 2000). Both are important factors to consider when evaluated watershed function and health.

While nutrients are beneficial to aquatic life in small amounts, excessive nutrient concentrations can stimulate algal blooms and plant growth in streams, ponds, lakes, and reservoirs. Through respiration and decomposition, algal blooms can deplete the water column of dissolved oxygen and contribute to serious water quality problems. Algal blooms can also be aesthetically undesirable, alter the native composition and species diversity of aquatic communities, impair recreational uses of surface waters, impede commercial fishing and pose problems for water treatment systems. In many waterbodies, light, temperature, algal buoyancy, organic and inorganic nutrients and predation by larger organisms (i.e., zooplankton, crustaceans, rotifers, etc.) will influence algal growth (Wetzel, 2001).

Algal growth and the depletion of dissolved oxygen caused by nutrient enrichment fluctuate seasonally, sometimes over the course of a single day (diurnal fluctuations). In the presence of sunlight, for example, algae and other plants produce oxygen through the process of photosynthesis. At night, however, photosynthesis and dissolved oxygen production slow down causing oxygen to be consumed by algae through respiration. During the summer months, the daily cycle of daytime oxygen production and nighttime depletion can result in supersaturation - a condition that occurs when dissolved oxygen levels are greater than the saturation value for a given temperature and atmospheric pressure. High dissolved gas levels can be lethal to fish populations by inhibiting respiratory processes.

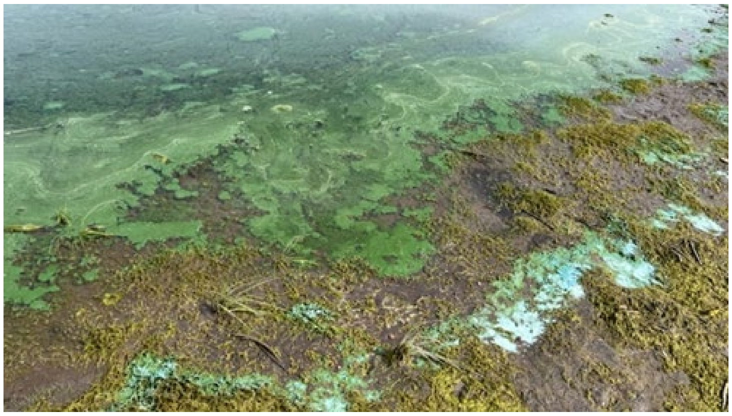


Figure 5 - Algae Bloom

Algae may also settle to the bottom of a waterbody and contribute to sediment oxygen demand (SOD) as it decomposes through bacterial action. This type of decomposition lowers dissolved oxygen concentrations in the bottom waters of lakes, rivers and estuaries. Hypoxia – waters that contain less than 2 parts per million (ppm, or 2 milligrams per liter) dissolved oxygen – can cause severe stress and even kill bottom dwelling organisms. This lose of biological activity and fish kills can lead to significant cultural and economic impacts on local communities dependent on recreational and commercial fisheries (EPA, July 2000).

Many aquatic plants positively affect water quality by removing and storing nutrients from the aquatic system. They also provide food and shelter for many aquatic organisms. Excess N and P inputs, however, can lead to excessive growth. Some examples of aquatic plants include milfoil, alligator weed and Hydrilla. Diurnal changes in pH and dissolved oxygen, which occur during photosynthesis and respiration, impact the release and/or uptake of heavy metals or other toxic substances in the water column. If water clarity is decreased (turbidity increases and sunlight cannot penetrate the water column), macrophytes can die, but algae may thrive and create a dense algal mat. Increased algal biomass and loss of macrophytes can reduce habitat availability, change water chemistry and alter aquatic species diversity and abundance (EPA, July 2000). Chlorophyll a, a constituent of most algae, is a widely used indicator of algal biomass.

Toxic algae feed off phosphorus and nitrogen, nutrients sourced from fertilizers, vehicle emissions, sewage, soil, animal excrement and plant material. If ingested in levels above state health standards, the toxins cause sickness, liver and brain damage when ingested during recreational lake activity or when drinking contaminated water.

1.5 Nutrient Sources at Stagecoach Reservoir

As previously discussed, nitrogen and phosphorus are common components of fertilizers, animal and human wastes, vegetation, and aquaculture. Nutrients in surface waters come from both point and nonpoint sources including agricultural, wastewater from treatment plants and septic systems, forestry activities and atmospheric deposition. Nutrients in nonpoint source runoff come mostly from fertilizer and animal wastes. Nutrients in point source discharges typically come from human waste and runoff from development.

Point sources of nutrients are typically easier to assess and potential influence as compared to non-point sources. A significant non-point source that is assumed to have a major influence on nutrient levels is current and former land uses around the reservoir. Previous to a reservoir site, the land under the existing reservoir was pastureland used for cattle grazing. For decades leading up to the post-war era, cattle excrement was enriching the reservoir lands with nitrogen and phosphorus — nutrients that fuel the growth of blue-green algae. Those involved in planning and constructing Stagecoach Reservoir were told algae blooms were a likelihood due to the high levels of nutrients from years of agricultural use at the reservoir site. Other anthropogenic non-point sources of nutrients to the reservoir likely include stormwater runoff from adjacent development that goes untreated, as well as septic systems that are located surrounding the reservoir site. Due to the dispersed nature of non-point source pollutants, it may be impossible to provide an accurate estimate of nutrient loading from these sources.

Figure 6 - Stagecoach Reservoir

The main point source of nutrients to the reservoir include the Yampa River, Little Morrison Creek and the Morrison Creek Wastewater Plant which discharges treated effluent directly into the reservoir. The plant, which is currently being upgraded has a January 2016 discharge permit from CDPHE which has specific effluent limits and reporting requirements for nutrients discharged from the plant.

Researchers have been focusing on the region to determine which specific sources of nitrogen and phosphorus prompt harmful algal growth. The USGS has been collecting data on algae compositions in Stagecoach Reservoir and in the greater Yampa River watershed and has analyzed possible sources of blue-green.

Previous Studies and Testing

2.1 2021 USGS Purpose and Scope

The Scientific Investigations Report 2021 – 5016, Assessment of Streamflow and Water Quality in the Upper Yampa River Basin, Colorado, 1992–2018 is a thorough assessment of nutrient loading in the Upper River Basin that focuses on the effects to Stagecoach reservoir. Below are excerpts from the Report that focus on Stagecoach Reservoir. We recommend anyone with interest in nutrient loading in this area read the full Report.

Geological features and land use upstream from Stagecoach Reservoir likely contribute to the increasing frequency of cyanobacterial blooms in the reservoir. Concerns of cyanobacterial blooms and elevated phosphorus concentrations have been associated with Stagecoach Reservoir since its completion (Bureau of Reclamation, 1986). Stagecoach Reservoir overlies sandstones and shales, which contribute dissolved materials to surface water (Terziotti and others, 2010); thus, it is likely that geological features contribute to the elevated levels of phosphorus. Across all sites examined, annual median and median annual concentrations of suspended sediment were highest at Yampa River above Stagecoach Reservoir. No trends in phosphorus concentrations were observed at this site, but existing phosphorus concentrations in combination with other changes, such as increasing temperatures, can further promote algae blooms (Paerl and Otten, 2013). Land use in the Yampa River above Stagecoach Reservoir subbasin contains the highest percentage of hay fields and pastureland in the UYRB. Grazing practices may exacerbate soil erosion (Duniway and others, 2019). Fertilizer application may also contribute to dissolved phosphorus levels in the rivers in summer months when conditions are most favorable for algae blooms (Van Meter and others, 2020). Maximum concentrations of Kjeldahl nitrogen, total nitrogen, total phosphorus, and orthophosphate occur slightly later at Yampa River above Stagecoach Reservoir than other sites (in May, June, and July), indicating that different factors control nutrient inputs at this site.[4]

On multiple sampling events at Stagecoach Reservoir, the physical and chemical factors indicated conditions conducive to cyanobacterial blooms. Surface-water temperatures exceeded 20 degrees Celsius on multiple sampling days. Total phosphorus concentrations in surface waters exceeded the interim Colorado Department of Public Health and Environment water-quality standard of 0.025 mg/L in August and September of both 2017 and 2018, whereas total nitrogen exceeded the interim standard of 0.426 mg/L on every sampling date. The total nitrogen-total phosphorous ratios (TN:TP) in samples collected at 3 feet ranged from 15 to 31. Cyanobacteria had the highest cell densities compared to other planktonic algae in samples collected in Stagecoach Reservoir and total cyanobacterial cell densities exceeded the World Health Organization guideline values for a moderate probability of adverse health effects (100,000 cells per milliliter) in July and August of 2017. The cyanotoxin microcystin was

[4] USGS, Scientific Investigations Report 2021-5016, pg. 39.

detected in Stagecoach Reservoir in September 2018, but the total microcystin concentration of 0.26 microgram per liter was much less than the U.S. Environmental Protection Agency recreational advisory level of 4 micrograms per liter for microcystins. Two other types of cyanotoxins, total saxitoxins and total cylindrospermopsins, were also measured and were below detection limits on all dates.[5]

2.2 Yampa River Water Quality Upstream of Stagecoach Reservoir

In addition to the Scientific Investigations Report 2021 – 5016, the USGS has been regularly sampling a number of areas in the UYRB. At Stagecoach reservoir the USGS has four samples sites as indicated in Figure 7 below. Site 1 is located on the Yampa River upstream of Stagecoach, Site 2 is located on Little Morrison Creek upstream of Stagecoach, Site 3 is within Stagecoach Reservoir itself, and Site 4 is located just downstream of the Stagecoach dam.

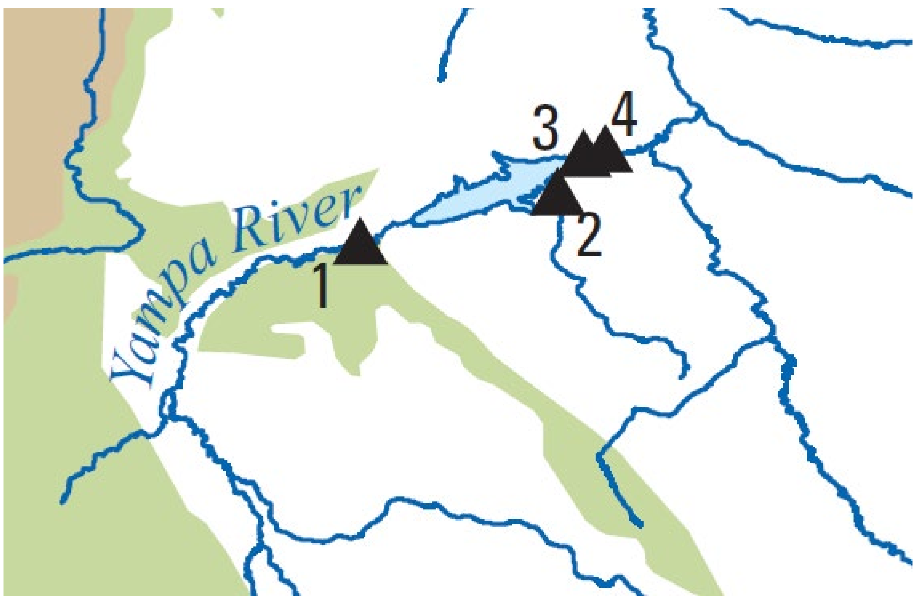


Figure 7 - USGS Samples sites at Stagecoach

Sample results for the Yampa River just above Stagecoach reservoir (Site 1, Figure 7) have been taken consistently from 2012 through 2023[6]. The graphs show Total Nitrogen, Organic Nitrogen, Ammonia, Ammonia + Organic Nitrogen, Nitrate + Nitrite, and Phosphorus levels in the stream. Table 1 below shows consistent seasonality in all nutrient measurements with peak levels typically occurring in June of each year - typically during peak flows within this section of river. It is also appears that levels are generally trending downward from a peak in 2015.

[5] USGS, Scientific Investigations Report 2021-5016, pg. 41.
[6] Sampling has occurred for decades previous to this but not as consistently.

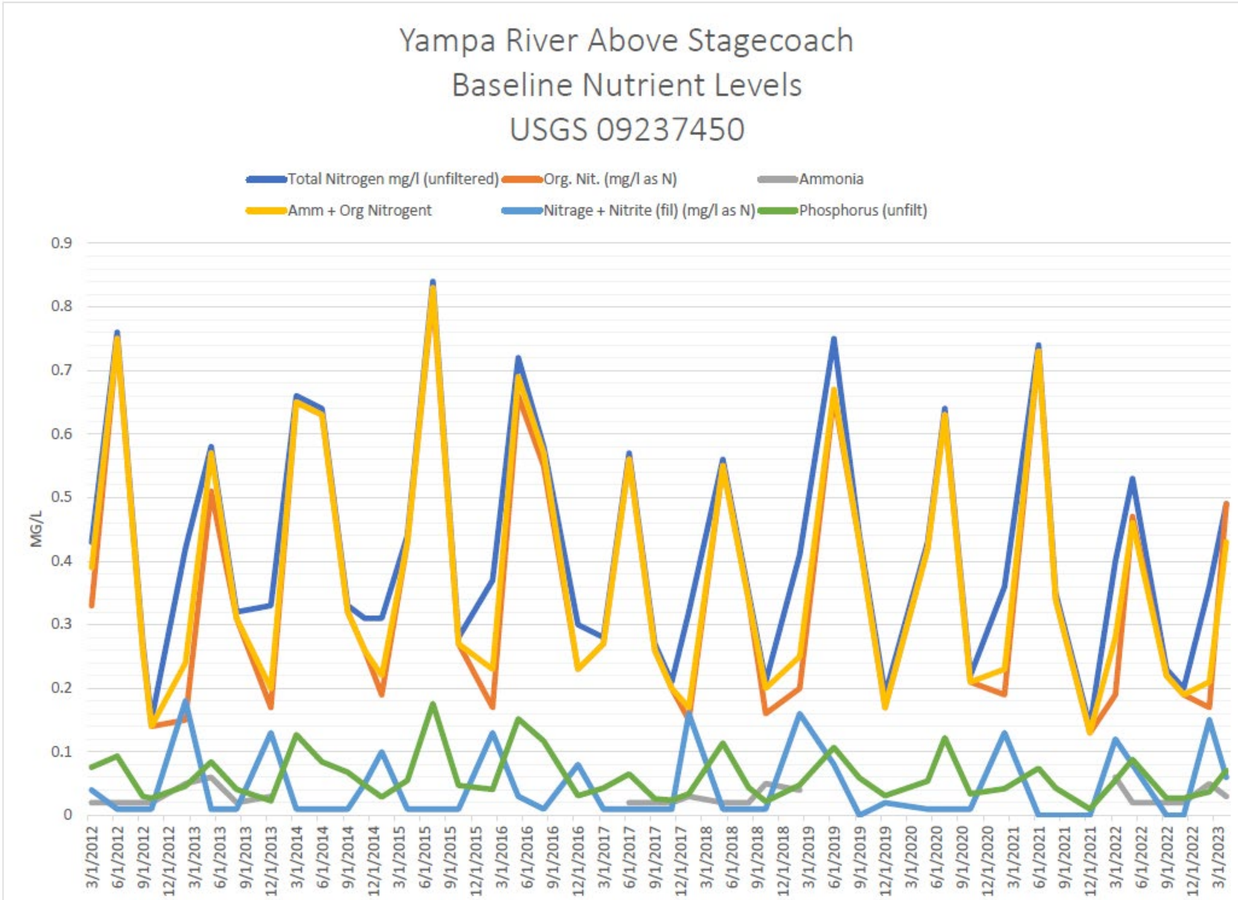


Table 1 - Nutrient Loading from Yampa into Stagecoach

Table 1 above shows the nutrient loading coming into Stagecoach reservoir from the upstream drainage basin. Nitrogen levels tend to peak at between 0.6-0.8 mg/l while phosphorus levels are generally at or below 0.1 mg/l.

2.3 Yampa River Water Quality Downstream of Stagecoach Reservoir

Sample results for the Yampa River just below Stagecoach reservoir (Site 4, Figure 7) were analyzed between 2012 through 2023. Table 2 below shows Total Nitrogen, Organic Nitrogen, Ammonia, Ammonia + Organic Nitrogen, Nitrate + Nitrite, and Phosphorus levels in the stream. Unfortunately, the sampling frequency below the reservoir is not as consistent as some of the other sample sites. The graph does appear to indicate seasonality in all measurements with peak levels typically occurring in June of each year - typically corresponding with peak flows within this section of river. It is also appears that levels are generally trending downward from a peak in 2012.

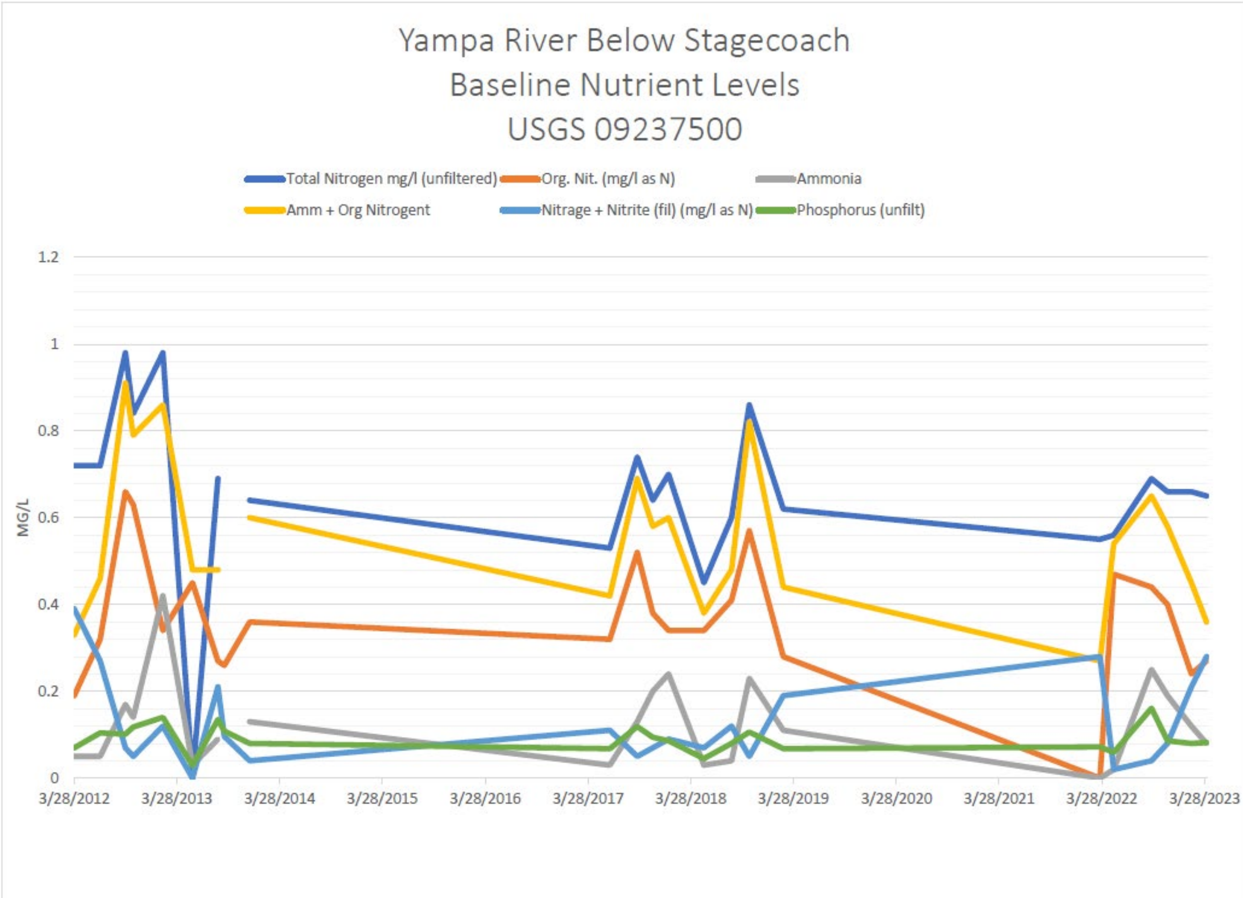


Table 2 - Nutrient Levels Discharging from Stagecoach

Table 2 above shows the nutrient levels discharging from Stagecoach reservoir. Total Nitrogen, Organic Nitrogen, and Ammonia + Organic Nitrogen levels are not as consistent as those entering the reservoir. Nitrogen levels tend to peak at between 0.8-1.0 mg/l while phosphorus levels be at or just above 0.1 mg/l. Both of these values are higher than concentrations from the Yampa River upstream of the reservoir site potentially indicating other sources entering the reservoir.

2.4 Little Morrison Creek Water Quality Upstream of Stagecoach Reservoir

Sample results for Little Morrison Creek just above Stagecoach reservoir (Site 2, Figure 7) were analyzed from 2012 through 2023. Table 3 below shows Total Nitrogen, Organic Nitrogen, Ammonia, Ammonia + Organic Nitrogen, Nitrate + Nitrite, and Phosphorus levels in the stream. Unfortunately, the sampling frequency of the Creek is not as consistent as some of the other sample sites. The graph does appear to indicate seasonality in all measurements with peak levels typically occurring in May of each year - typically corresponding with peak flows within this section of creek. The nutrient levels generally show consistent peak levels from a peak in 2013.

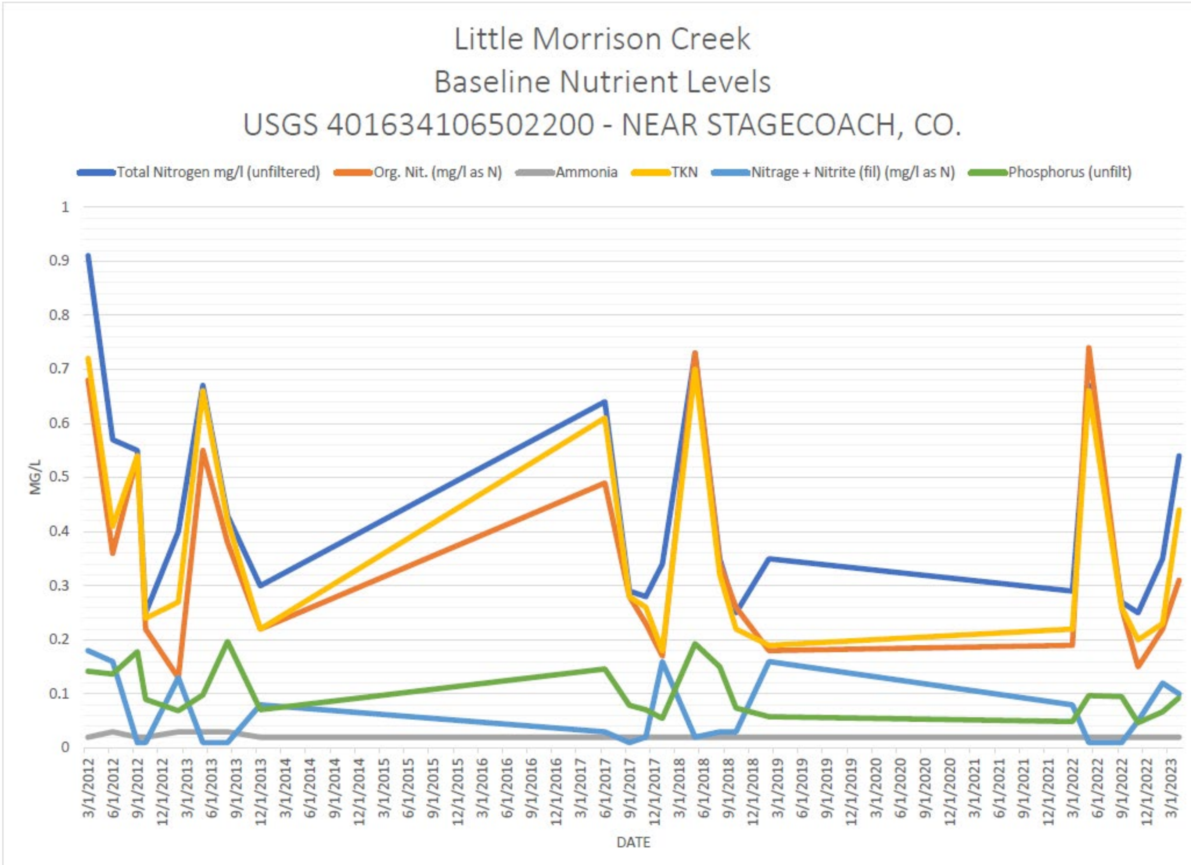


Table 3 - Nutrients Loading from Little Morrsion Creek

It should be noted that the overall effect of nutrient loading from Little Morrison Creek is a fraction of what comes from the Upper Yampa. The average annual flowrate in the creek is less than 2 cfs, whereas the average flow rate from the Yampa into Stagecoach is nearly 70 cfs. Table 3 above shows the nutrient loading coming into Stagecoach reservoir from the upstream drainage basin. Nitrogen levels tend to peak just under 0.7 mg/l while phosphorus levels are generally between 0.1-0.2 mg/l.

2.5 Stagecoach Reservoir

Stagecoach Reservoir has a number of water sources that feed the reservoir. These sources can vary significantly over the course of the year depending on snowmelt and rainfall as previously discussed. Over the course of a year, on average the Yampa River which is the main tributary to the reservoir has an annual average flow of 37 MGD (million gallons per day) while Little Morrison Creek adds an average just under 0.95 MGD. Other minor tributaries and groundwater flows also enter the reservoir but it is assumed these tributaries contribute significantly less flow into the reservoir. In addition, the Morrison Creek Wastewater Treatment Plant is permitted to discharge up to 0.35 MGD into the reservoir, although the annual average is only 0.054 MGD.

Based on the average annual flow rates as well as the average nutrient levels within each source we are able to calculate an estimated daily contribution of total nitrogen and phosphorus into Stagecoach reservoir from each point source as shown in Table 4 below. It is very difficult to estimate what percentage of nitrogen and phosphorus come from non-point sources within the Stagecoach drainage basin. (All Data from USGS Site https://waterdata.usgs.gov/monitoring-location/09237450)

Source	Discharge (MGD)	Total Nitrongen Ammonia			Total Phosphorus		
		Average Concentration (mg/l)	Daily Loading (lbs/day)	Point Source Loading Contribution	Average Concentration (mg/l)	Daily Loading (lbs/day)	Point Source Loading Contribution
Yampa River	37	0.4	123.51	96.6%	0.06	18.53	92.3%
Little Morrison Crk	0.95	0.44	3.49	2.0%	0.1	0.79	3.0%
Morrison WWTP	0.054	1.82	0.82	0.5%	1.67	0.75	2.8%
Total Point Source Loading			**127.82**			**20.07**	

Table 4 - Estimated Daily Nitrogen and Phosphorus Loading to Stagecoach Reservoir

The following two tables (Tables 5 and 6) show the USGS measured total nitrogen and phosphorus influent (from Site 1 and 2, Figure 7) and discharge (from Site 4, Figure 7) from Stagecoach reservoir. Influent nitrogen levels from Little Morrison and the Upper Yampa appear to trend very closely which may indicate they are collecting similar runoff from the surrounding landscape. The discharge levels from Stagecoach are consistently higher than influent levels indicating the reservoir itself as well as other nonpoint sources may be contributing to the production of nitrogen.

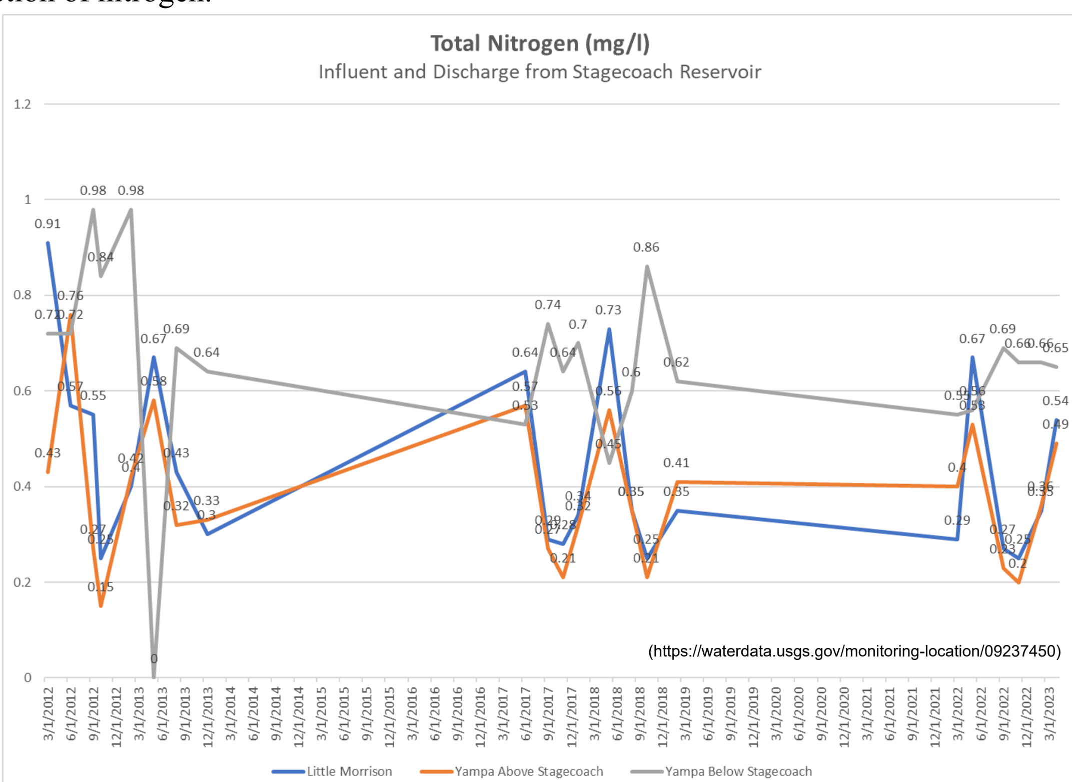


Table 5 - Total Nitrogen into and out of Stagecoach Reservoir

Influent phosphorus levels from Little Morrison Creek are significantly higher than those of the Upper Yampa but overall both sources appear to trend closely. Phosphorus levels in the land tributary to Little Morrison Creek may contain higher levels of phosphorus which is consistent with the history of the landscape as previously discussed. The discharge levels from Stagecoach are consistently higher than influent levels from the Upper Yampa but below the levels of Little Morrison Creek which may indicate the reservoir itself as well as other nonpoint sources may be contributing to the production of phosphorus.

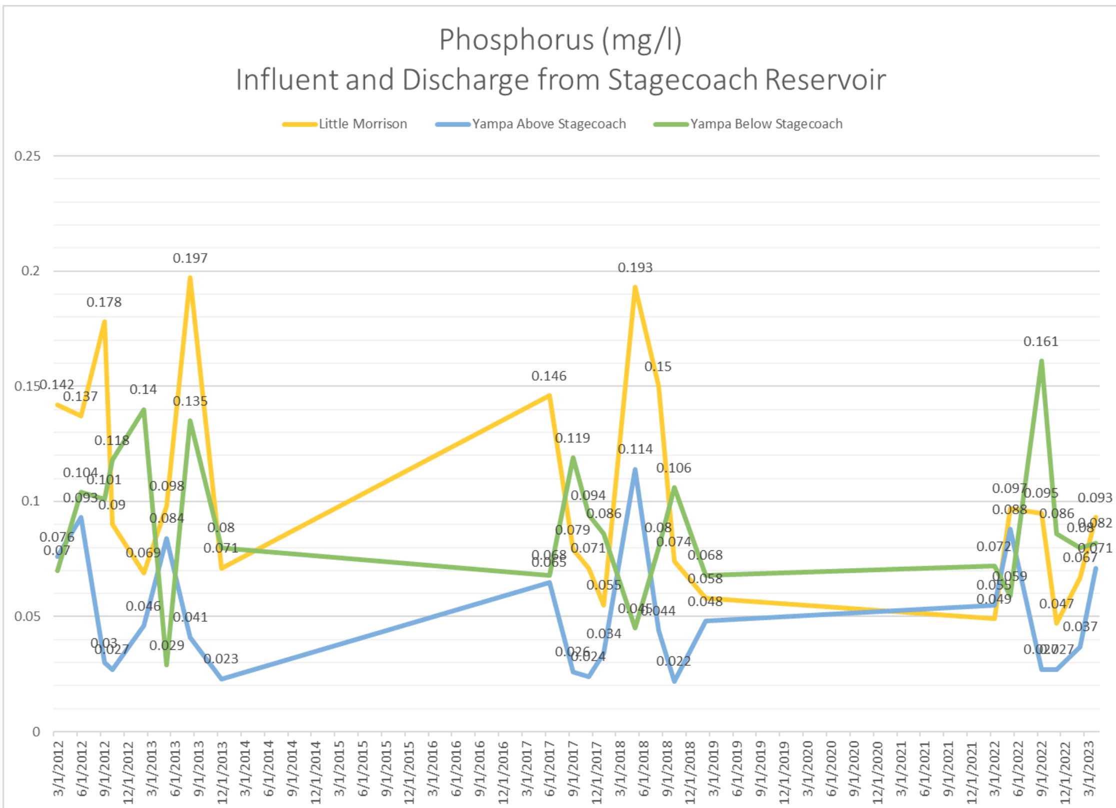


Table 6 - Phosphorus into and out of Stagecoach Reservoir

Nitrogen and phosphorus levels within the lake itself have been also monitored over the past decade. Measurements have been taken near the dam at the water surface (0-3' deep) and at the bottom of the reservoir (100'-120' deep). As shown in tables 7 total nitrogen levels are consistent with influent and effluent levels. Nitrogen levels tend to be lower closer to the surface although some spikes are reflected in graph, these surface spikes do appear to influence nitrogen levels at depth, but to a much smaller degree. Phosphorus levels shown in table 8 also show nutrient levels at varying depths of the reservoir. Unlike nitrogen, the phosphorus levels are consistently higher at depth (over double the concentrations). These elevated concentrations appear to be higher than influent levels which may support the theory of phosphorus production in the reservoir bed due to decomposing native reservoir bed material which is consistent with historic land uses and was anticipated during reservoir construction.

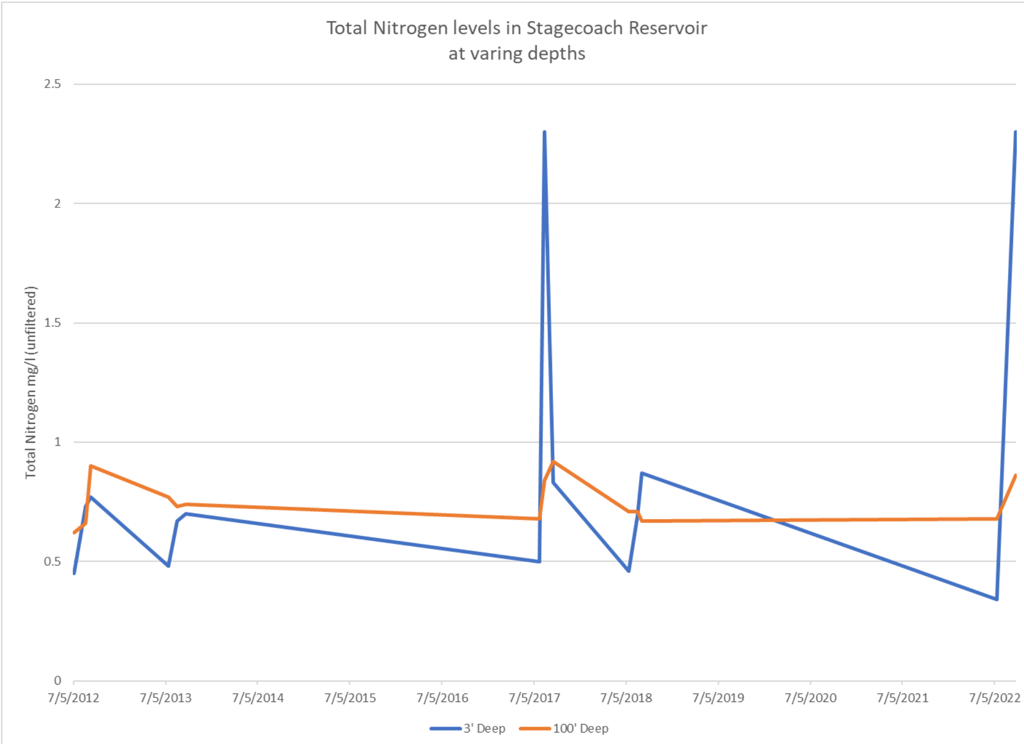
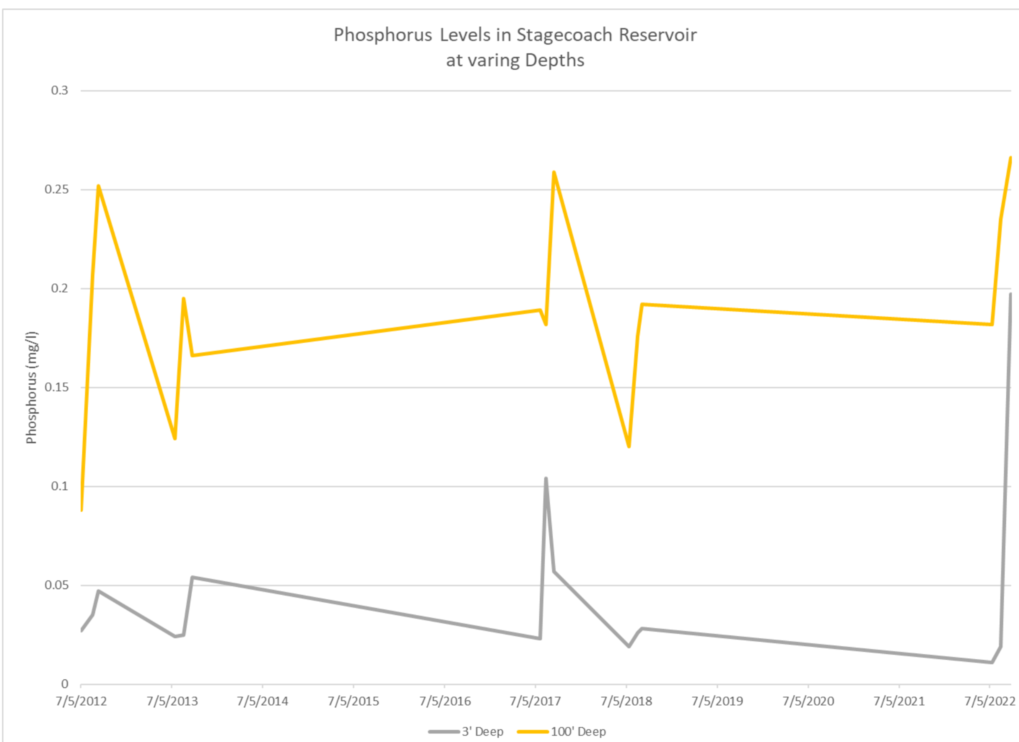


Table 7 - Nitrogen levels at varying depths of Stagecoach Reservoir



(https://waterdata.usgs.gov/monitoring-location/09237450)

Table 8 - Phosphorus levels at varying depths of Stagecoach Reservoir

Conclusions and Recommendations

3.1 Summary

Stagecoach reservoir was constructed on fertile lands that contain naturally occurring high levels of nutrients due to historic land use. It has been reported that during construction, those planning the reservoir were told that algae blooms within the lake would be likely. Warming temperatures have increased the likelihood of blooms as temperatures above twenty degrees Celsius are most conducive to algae growth. To a lesser extent, changes in land use and other anthropogenic influences have likely exacerbated high nutrient levels.

Sources that flow into Stagecoach Reservoir including the Yampa River, which is the main water source, have been analyzed and recorded for decades. There is significant documentation of influent and effluent water quality for this area, which provides a good understanding of nutrient sources to the Reservoir.

During multiple summer sampling events at Stagecoach Reservoir, the physical and chemical factors indicated conditions conducive to cyanobacterial blooms, including surface-water temperatures greater than 20 degrees Celsius and total phosphorus and total nitrogen concentrations in exceedance of Colorado Department of Public Health and Environment interim concentrations for water-quality standards.

Discharges from the Morrison Creek WWTP appear to contribute significantly less than 5% of the point source nutrient loading to the lake. If one were accurately able to quantify nonpoint nutrient loading it is conceivable that the WWTP may contribute less than 1% of nutrient loading to the reservoir. After speaking with the WWTP operators it appears the plant may have difficulty meeting future effluent discharge requirements (CDPHE Regulation 85) which will require effluent discharge limits of 1.0 mg/l for total phosphorus and 15 mg/l for total nitrogen beginning on 1/1/2028.

Regardless of regulatory requirements, it does not appear effluent from the WWTP is a significant contributor to nutrient levels within the reservoir. With the addition of 200 units from the Tailwaters Project, flows to the WWTP could increase by as much as 0.042 MGD (200 units multiplied by an average of 210 GPD/unit). Assuming nutrient discharge levels remain consistent with what they are today, this would result in approximately a 1% increase in nutrient loading to the reservoir from measurable point sources. Secondary treatment, which would be necessary to further reduce nutrient effluent levels, is prohibitively expensive and not a likely option for the WWTP, nor would it likely have any significant impact on Reservoir nutrient levels.

Other more cost-effective steps that may be taken to reduce nonpoint nutrient sources could include, the reduction of fertilizer allowed on lawns and agricultural lands surrounding the reservoir, the regular inspection and repair of residential and commercial septic systems in the area, and expansion of the service area of the WWPT should be further evaluated. Additionally, runoff from developed areas, included roads, parking lots and areas of higher development, should be captured and treated through extended detention or other best management practices.

3.2 Proposed Project Mitigation Overview

Several mitigation strategies are being proposed to control nutrient runoff from the Project. Individuals can reduce their water pollution contribution by reducing the volume of stormwater leaving their property and by reducing the amount of pollutants used for household cleaning and/or landscaping yards. Landowners often apply commercial fertilizers and pesticides before evaluating the soil's chemistry for nutrient concentrations. This often leads to over application of nutrients. The nutrients (i.e., nitrogen and phosphorus) that are not utilized by plants will become mobile during a rain event and enter the nearest waterbody as part of the stormwater runoff. Landowners should remember to use only the amount necessary and be careful to avoid paved or hardened surfaces that act as expressways for pollutants into the state's waterways.

Proposed land use covenants for the Project include homeowner regulations that reduce and discourage manicured lawns that would require water and fertilizers. Owners will be required to pick up pet waste and dispose of this properly. A robust stormwater system with extended detention basins has been designed to prevent nutrients contained in stormwater runoff from entering the reservoir.

The property is currently vacant with native vegetation including scrub oak, small trees, and variations of native grasses and shrubs. The greatest risk for potential negative impacts is to Little Morrison Creek which is located along the eastern edge of the property. No residential lot development within 50 feet of the Creek is proposed, areas within 100' will be protected with silt fence and other erosion control BMP's. All areas will be re stabilized with native seed mixes after construction. In some select locations grading from stormwater outfalls within 50 feet of Creek is proposed, a Waterbody Setback Permit will be applied for in these locations.

Potential negative impacts associated with any land development project include sediment pollution to offsite areas via stormwater erosion from disturbed areas, petrol-chemical spills from earthwork machinery, dust from disturbed areas, and noise from construction machinery. A Colorado Department of Public Health and Environment (CDPHE) general permit for stormwater associated with construction activities shall be required for construction due to the size and scope of this project.

Mitigation techniques that shall be incorporated as part of an approved civil construction plan submittal for this project include:

- Implementation of an engineered erosion control plan and stormwater control measures.
- Sedimentation pond, perimeter silt fence, ditch checks, dust mitigation, and temporary seeding.
- Implementation of a construction site management plan to address things such as debris, spills, and noise.
- Minimization of total land disturbance via a phasing plan.
- Dust mitigation during periods of high wind with application of water via sprayer truck if necessary.
- Proper final stabilization and establishment of vegetation as soon as possible with the use of seeding and straw blanket stabilization on slopes.

Prior to and during construction the Applicant is proposing to implement a stormwater monitoring plan consisting of initial testing prior to construction, testing monthly during construction between Apr.-Nov., and then post-construction testing. Parameters included in the testing will consist of Temp., Ammonia, Alkalinity, Conductivity, Hardness, pH, Chlorophyll a, Turbidity, Total Phosphorus, Free Reactive Phosphorus, Nitrates & Nitrites, and Total Nitrogen. .For each testing period, we anticipate at least two samples per test; one from the creek just upstream of the limits of construction (as the Creek enters the Parcel), and then another just downstream of the limits of construction before the creek leaves the Parcel (See Appendix A Testing Locations). These will allow us to differentiate any nutrient loading coming from the already established development vs. the construction. A brief narrative of the test results will accompany each test result submission. The narrative will make a comparison of the test results to the baseline conditions.

Should the testing show elevated phosphorus being released due to construction, the applicant will install products that can be placed in the creek stream and will strip phosphorus from the flowing water (see attached informational sheet in Appendix B). If elevated nitrogen levels are detected, the contractor will complete additional testing from individual stormwater outfalls at the site to determine the source of elevated nitrogen laden runoff. The contractor will then detain any stormwater from this area to prevent elevated nitrogen runoff from entering Morrison Creek. This will continue until nitrogen levels reduce to acceptable levels.

Sampling will continue during active construction or if elevated nutrient levels are detected, sampling will cease when construction activity is completed and there are at least two consecutive samples showing nutrient levels are at or below 10% of the preconstruction nutrient sampling levels. UYWCD, Morrison Creek Metro District, and the County will be provided copies of the quarterly samples throughout the testing period.

REFERENCES

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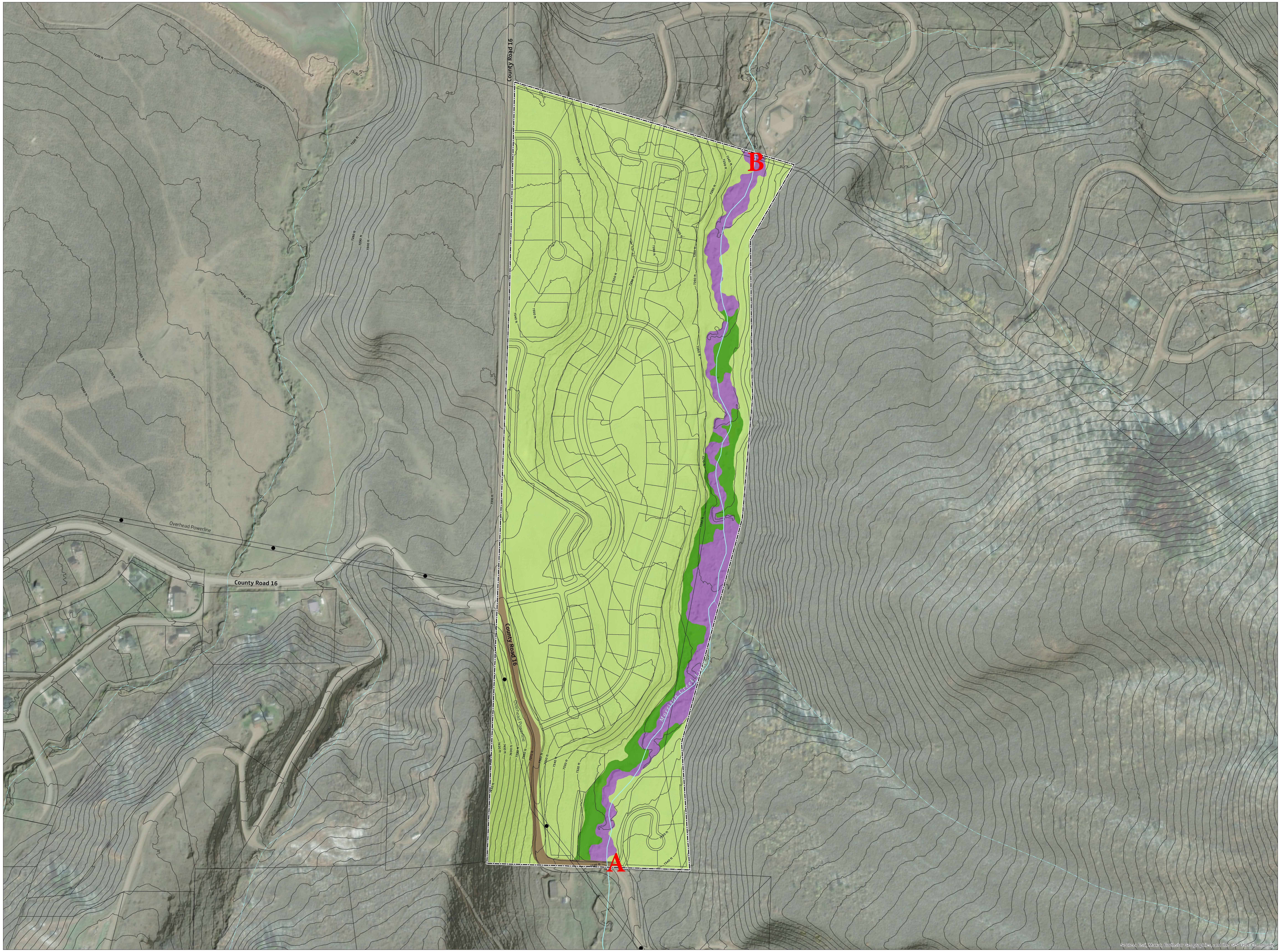
APPENDIX A



TITLE

Creek Sampling Locations

PROJECT

WQ Plan Submittal

CLIENT

Saltbox Custom Homes Inc.

LOCATION

LEGEND

Tailwaters Property Boundary

Parcel Boundary

Overhead Powerline

Perennial Stream

Intermittent Stream

VEGETATION TYPES

Bare Earth

Grassland

Riparian

Shrub Grassland

A Proposed WQ Sampling Location

DATE	09.10.2024	DRAWN BY	ZDP
VERSION	01	SHEET	1 / 1

PROJECTION State Plane Colorado North (US Feet)

DATUM North American Datum 1983 (NAD83)

SCALE 1 in = 200 ft | 1:2,400

400'

DISCLAIMER

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APPENDIX B

EutroSORB™

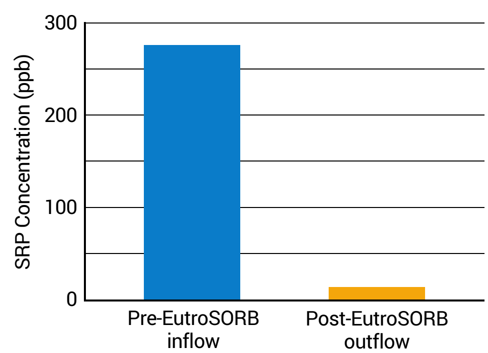
Phosphorus Filtration Technology

Filter Phosphorus. Stop Eutrophication. Restore Water Quality.

Phosphorus pollution in water resources is a widespread problem throughout the United States. Phosphorus is a key contributing factor leading to eutrophication. Eutrophication is one of the largest threats to freshwater resources and can result in degraded water quality and put entire aquatic ecosystems at risk.

Intercept Phosphorus

EutroSORB filters are a novel technology specifically designed for intercepting soluable reactive phosphorus (SRP) from moving water. EutroSORB provides water resource managers an efficient and economical solution to reduce phosphorus inputs, slow down or stop the eutrophication process, and restore water quality.



Removal efficiency will depend upon site specific conditions.

Rapid Phosphorus Filtration

EutroSORB filters rapidly remove SRP from moving water after being deployed in a water resource. EutroSORB reactive filter media has a high affinity and capacity for phosphorus and will continue to bind SRP until all binding sites have been exhausted.

Environmentally Compatible

EutroSORB is effective over a wide range of water chemistries. The filter media is safe to aquatic life, does not dissolve, and is removed from the environment when the filter has met capacity.

Water Quality Restoration

Program design and implementation strategies are based on site-specific conditions such as flow, phosphorus concentration, and overall water quality management objectives.

The Results

Immediate decrease in phosphorus levels for water quality restoration. EutroSORB is the new standard for rapid phosphorus filtration in moving water!

For more information about EutroSORB and assistance with developing a water quality restoration program, contact your SePRO Technical Specialist at **1-800-419-7779** or visit **www.sepro.com**