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Aquatic Solutions

MEMORANDUM

To: Rob Buirgy, Big Thompson Watershed Forum and Small Lakes Focus Group
Josie Plaut, High Plains Environmental Center

From: Christopher F. Knud-Hansen, Ph.D., CLM, Aquatic Solutions, LLC

Date: April 3, 2003

Re: Equalizer Lake and Houts Reservoir: preliminary 2002 water quality analysis and 2003 sampling recommendations

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Introduction

Equalizer Lake and Houts Reservoir are the two lakes located within the Centerra community in Loveland, CO, and owned/operated by the Greeley-Loveland Irrigation Co. Equalizer Lake has about 95 surface acres with a maximum storage capacity of about 600 acre-feet. Houts Reservoir has about 76 surface acres with a maximum storage capacity of about 500 acre-feet. Both lakes are included in the Small Lakes Focus Group (SLFG) within the Big Thompson Watershed Forum.

The High Plains Environmental Center (HPEC), also located within the Centerra community, has taken the responsibility of developing a water quality monitoring program to assess and protect the ecological integrity of both lakes. Towards that goal, HPEC contracted Wright Water Engineers (WWE) to help develop this program. WWE submitted their recommendations to HPEC in February 2002 (Wright Water Engineers, 2002). The HPEC first began water quality monitoring sampling these two lakes during the summer of 2002.

Summer 2002 Data Analysis

Equalizer Lake and Houts Reservoir were sampled four (4) times during the summer of 2002, at approximately monthly intervals (i.e., 19 June, 16 July, 13 August, and 17 September). Water was collected at three Equalizer Lake stations (i.e., Inlet, Outlet, and Center) and at one Houts Reservoir station (i.e., Center). Water samples were analyzed for sulfate, chloride, total suspended solids (TSS), ammonia-N, nitrate-nitrite-N, and total phosphorus. Water samples from both Equalizer and Houts Center stations were also analyzed for phytoplankton biovolumes. Field data were collected at the two Center lake stations, and consisted of vertical profiles of water temperature, specific conductance, dissolved oxygen (DO), and pH, as well as Secchi depth determinations.

3215 Heidelberg Dr., Boulder, Colorado 80303
Tel: 303.494.5343 • Fax: 303.554.0584

Seasonal trends: The four sampling dates covered the summer months between June and September. Two general trends were hypothesized during this period. The first hypothesized trend was an increase in dissolved solids as indicated by specific conductance, and concentrations of sulfate and chloride. This trend was anticipated because of the concentration effect of dissolved constituents due to evaporation caused by summer drought conditions. Although chloride data remained relatively constant over time, sulfate and conductivity data did increase in Equalizer from June to September. Houts indicated an increase in sulfate after June. However, conductivity data decreased from about 890 µS/cm to about 810 µS/cm by the end of the summer. The reason for the observed decrease in Houts conductivity is unclear.

The second general trend concerns algal productivity. Typically, algal biomass in June is the lowest for the summer because of dilution from snowmelt runoff, and the fact that water temperatures are rapidly changing. This temperature transition creates conditions too warm for existing cold water algal species (e.g., diatoms), yet just beginning to be suitable for emerging warm water species (e.g., green and cyanobacteria /blue-green algae). By July and August, populations of warm water algal species are able to thrive and algal densities tend to increase relative to June's low concentrations. Both phytoplankton biovolume data (Figure 1) and Secchi depths from Equalizer and Houts illustrated this trend.

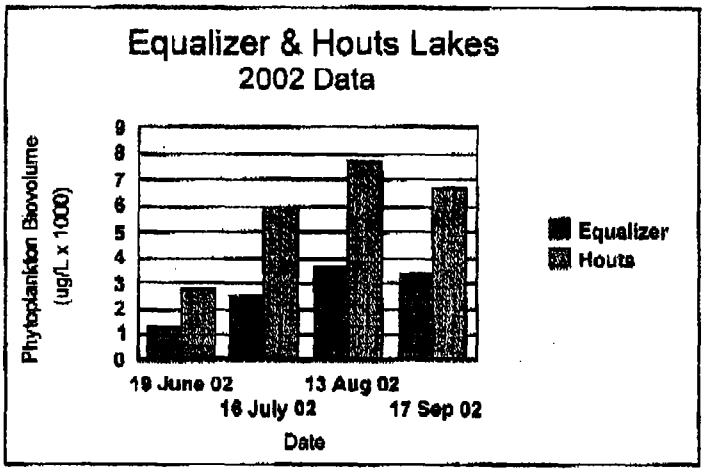

Figure 1. Phytoplankton biovolume for data collected at Equalizer Lake and Houts Reservoir during the summer of 2002.

For both Equalizer and Houts, algal biovolumes measured in August were nearly three times the values measured in June. For both lakes, Secchi depths decreased proportionally to increasing algal biomass measurements. In fact, the statistical linear correlation between these two independent measurements was very strong ($P < 0.001$, Figure 2).

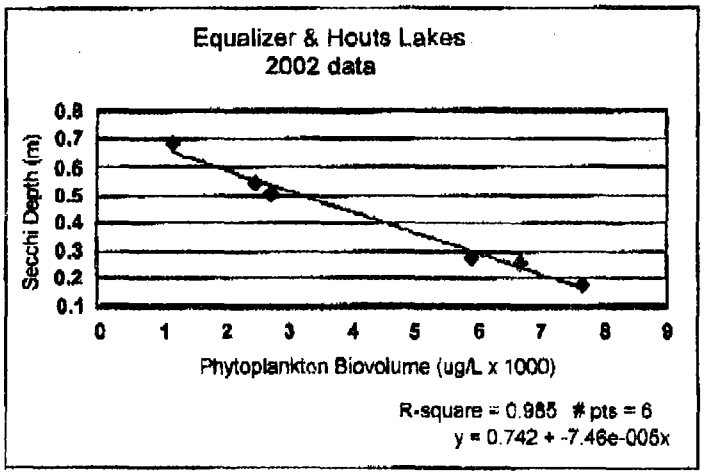

Figure 2. Relationship between Secchi depth and phytoplankton biovolume for data collected at Equalizer Lake and Houts Reservoir during the summer of 2002.

This very strong correlation (which was not improved with log transformations) suggests that both Secchi depth and phytoplankton biovolumes were measured well. This relationship also indicates that Secchi depth may serve as a simple, yet accurate indicator of algal biomass in these two lakes.

One summer trend not observed in either lake was the development of persistent thermal stratification. In deeper lakes (e.g., Silver Lake), the water column can become thermally stratified with warmer surface waters overlying colder bottom waters. This stratification creates a separation between surface and bottom waters which typically remains until fall turnover. In productive systems, organic matter produced in surface waters (e.g., from algal photosynthesis) will settle to the bottom creating a bacterial demand for dissolved oxygen. If the available dissolved oxygen becomes depleted, then bottom waters become anoxic and soluble nutrients (particularly P) are released from the sediments into overlying waters. When these anoxic waters mix again in the fall, both algal blooms and fish kills can result.

Vertical profiles of both temperature and dissolved oxygen indicate that Equalizer and Houts were too shallow to establish persistent thermal stratification during the summer. With maximum depths measured at less than 3 meters, bottom water DOs remained above 4 mg/L at all four sampling dates. The lakes' shallow depths and broad exposures to wind facilitate this whole-lake mixing. This regular mixing apparently keeps bottom waters oxygenated, thus preventing significant inputs of soluble P from the sediments while providing sufficient DO for lake biota. Therefore, neither lake appears to require any additional aeration or whole-lake mixing equipment as part of their lake management strategies.

Equalizer versus Houts: In addition to trends over time, it is useful to examine differences between Equalizer and Houts lakes. Most of the nutrient water quality data is either inconclusive or missing - there were a relatively large number of values below levels of detection or missing data points for ammonia-N, nitrate-nitrite-N, and total phosphorus. Nevertheless, a few distinctions are evident from the dissolved solids and algal biomass data.

Specific conductance data for Houts (≈ 800-900 µS/cm) was about 30% greater than values measured for Equalizer (≈400-500 µS/cm). This observation is consistent with both the chloride and sulfate data, which also showed proportionally higher values for Houts. Higher dissolved solid concentrations in Houts makes sense because as a terminal lake, it does not have the same hydraulic flushing capabilities as Equalizer. Although there is water exchange between the two lakes, the residence time for water in Houts is likely much longer than for Equalizer, which has both an inlet and outlet independent of Houts. Therefore, evaporation will tend to concentrate dissolved solids more in Houts relative to Equalizer.

Algal biovolumes were about two times greater in Houts, with Secchi depths correspondingly smaller. The reasons for consistently greater algal productivity in Houts are not clear, since nutrient loadings to both lakes are unknown. Nevertheless, both lakes indicated frequent mixing during the summer so bottom water DOs remained above 40% of saturation, thus reducing the risk of a fish kill during fall turnover.

Lastly, Equalizer has both inlet and outlet sampling sites in addition to the center lake station. Although there was no indication in the data that water quality varied significantly between the three Equalizer sampling sites, the data are too few to make any conclusions regarding in-lake processes at this time.

2003 Sampling Protocol for Equalizer Lake and Houts Reservoir

The comments below are consistent with suggested recommendations made for Silver Lake (Aquatic Solutions, 2002). Maintaining this consistency is desirable, and a goal of the SLFG. Although WWE provided a comprehensive and credible monitoring plan (as well as other very useful information), a more focused monitoring approach will be more cost-effective without sacrificing analytical relevance.

Sampling locations:
There are currently three Equalizer sampling stations and one Houts station. WWE (2002) had recommended two stations for Houts, but there does not appear to be any additional benefit to a second sampling site. At this point, retaining the three Equalizer stations is recommended through 2003. A more complete data analysis at the end of 2003 should better indicate whether or not the inlet and outlet stations at Equalizer should be retained. The center lake stations for both Equalizer and Houts should be maintained, however, and no additional lake stations need to be added.

Sampling frequency:
The recommended sampling frequency for Equalizer and Houts is the same as established for Silver Lake (Aquatic Solutions, 2002), which provides consistency within the SLFG. Under this schedule, the lakes are sampled every two weeks from May through October, and once a month (or less) from November through April. This is a more intensive sampling schedule than was used in 2002, and is recommended in order to understand relevant factors controlling algal growth in Houts and Equalizer.

In the effort to balance costs with analytical utility, however, the sampling schedule should be reexamined at the end of 2003. If costs become an issue during 20003, field data collection should remain as scheduled, but water samples may be reduced to monthly rather than bi-weekly collections during the summer. The lack of persistent stratification (i.e., due to frequent mixing) in both lakes allows for this possible modification. However, a review of existing data should precede any proposed reduction in sampling frequency to ensure analytical needs can be met with any modifications to the sampling protocol.

Sampling depths:
Field measurements are made with a submersible probe. The 0.5 m intervals currently used is fine. Surface (i.e., 0 m) field measurements were not made in 2002, and should be added. Water for chemical analyses is collected at about 1 m below the surface. This is also fine. The fact that both lakes appear frequently mixed and are only about 3 m deep indicates that collecting a second sample 1 m off the bottom is not necessary for either lake.

Sampling variables:
The field water quality variables made with a submersible probe are water temperature, dissolved oxygen (and percent saturation), pH, and conductivity. Vertical profiles are established from measurements made every 0.5 m. These measurements should continue, as they are important in understanding dynamic aspects of Equalizer and Houts ecology.

Water samples are analyzed for sulfate, chloride, total suspended solids, ammonia-N, nitrate-nitrite-N, and total phosphorus. All of these water quality parameters are useful for understanding and managing eutrophication in the two lakes except for sulfate and chloride. Similar to Silver Lake, unless alternative uses for these data are identified, it is recommended that both sulfate and chloride be discontinued for 2003. Specific conductance data are sufficient for monitoring dissolved solid concentrations.

Similar to recommendations made for Silver Lake, measurements of dissolved phosphorus, total alkalinity, and chlorophyll *a* would be useful additions to the sampling protocol. On the other hand, adding other water quality measurements including total Kjeldahl nitrogen (TKN), total nitrogen, total hardness, and heavy metals is not recommended because of their limited analytical utility in understanding eutrophication processes in relation to their costs.

Phytoplankton speciation and biovolumes were measured monthly in both lakes during 2002. If

biomanipulation (e.g., altering the fish community to favor large, algal-feeding zooplankton) is a future management option, then phytoplankton speciation data should be useful. However, if all that is needed is an indication of algal growth, then both the Secchi depth (Figure 2) and the recommended chlorophyll *a* measurements will give that information at a lesser cost. Since it is not clear which lake management options will be pursued, it is recommended that monthly (as opposed to bi-weekly) phytoplankton assessments be continued for 2003. Again, this recommendation should be revisited following a systematic analysis of 2003 data.

The last lake ecological variable to be monitored is an algal nutrient limitation assessment through simple algal bioassays. This is a very simple test which volunteers and/or school kids could do. Information gained will help understand eutrophication processes in both lakes, and results would be analyzed together with nutrient and phytoplankton biomass data. A workshop could be held to teach the method and associated ecological principles to the SLFG and significant others, who would then be able to teach the method to volunteers, etc.

References Cited

Aquatic Solutions, 2002. Silver Lake Recommendations for 2003. Memorandum submitted to the Big Thompson Watershed Forum's Small Lakes Focus Group, November 26, 2002. 5 pp.

Wright Water Engineers, 2002. Water Quality Monitoring Program for Houts Reservoir and Equalizer Lake - Quality Assurance Project Plan (QAPP) and Volunteer Monitoring Aids. Report prepared for High Plains Environmental Center, February 2002. 51 pp + appendices.

Equalizer Reservoir and Houts Lake
Web Info
7/28/03

The High Plains Environmental Center is responsible for stewarding over Equalizer Lake and Houts Reservoir and the surrounding wetlands and open space. These bodies of water are located within the Centerra community in Loveland and are owned and operated by the Greeley Loveland Irrigation Company (GLIC). Centerra is a developing master planned community with that will eventually have 2000 homes and 10 million square feet of commercial and light industrial space. Both lakes are included in the Small Lakes Focus Group within the Big Thompson Watershed Forum.

Recreational usage is limited to fishing in designated areas. The cost of stocking the lakes will be borne by the Colorado Department of Wildlife because the lakes are open to the public for recreational fishing. The Center leases the surface rights from GLIC and these rights are paid for by a transfer fee collected from the sale and resale of homes in High Plains Village (the primary residential development inside of Centerra). The Center chooses to limit all surface use of the lakes to protect the habitat for waterfowl that use the lakes.

History

The Center is still researching the history of Houts Lake and Equalizer Reservoir. We do know that the lakes were created almost 100 years ago as part of the Greeley Loveland Irrigation Project. The primary function of these lakes is for agricultural water storage destine for eastern Colorado. The water has also been used to irrigate surrounding farmland. In the future these pumping rights will be used to irrigate parks and open space within the residential development. The use of the lakes and lands surrounding them is in the process of changing from primarily agricultural to primarily urban with the intention of maintaining and improving the lakes habitat.

Hydrology

The water for the lakes is supplied by the Greeley Loveland Irrigation Canal. This water is diverted from the Big Thompson River and is also fed by the drainage from several surrounding bodies of water. Equalizer Lake has about 95 surface acres with a maximum storage capacity of about 600 acre feet. Houts Reservoir has about 76 surface acres with a maximum storage capacity of about 500 acre feet. The lakes are separated by a narrow land bridge with Houts to the north and Equalizer to the south.

The Centerra development is routing much of the drainage through a series of swales and detention ponds that eventually feed into the lakes. This eliminates much of the need for sewer pipes and should control the loading issues from the commercial and residential sites. A major reason for conducting the water quality testing is to determine the effectiveness this system and generally to understand the effects of development to the water quality.

Natural History

The area surrounding the lakes is booming with waterfowl, raptors and small mammals. We have identified over 50 types of birds with several breeding on sight. Some of the species that visitors are likely to see are killdeer, herons, hawks, grebes, owls, pelicans, kestrels, mallards and bald eagles (in the winter). Many of these birds feed on the existing fish, rodent and insect populations.

The lakes have been periodically stocked with sport fish, but not recently. In conjunction with the DOW we have conducted two fish surveys and this indicates a history of stocking and some loading from other parts of the system. We have an overabundant population of white suckers and populations of carp, perch, catfish, crappie, white bass, large mouth bass and walleye. Few of the populations are recurring (reproducing or coming in from other parts of the system) in including white bass, yellow perch, bullheads, crappie, suckers, gizzard shad and carp. We are currently researching the possibilities of resuming stocking for these lakes. It is our intention to consider as many native species and as much diversity as possible. We are also looking at trying to control the less desirable species by introducing more predation.

There is little or no vegetation on the lake bottoms, but there is an abundant amount of cattails surrounding much of the shoreline.

The Center's mission focuses on stewarding over these lands and habitat with the intention of protecting and even enhancing the animal populations and the lake ecosystem.

Issues/ Projects

The Center started sampling in 2002 with the intention of getting some baseline readings for determining future impacts of the surrounding development and of any attempts at enhancement projects. We will determine treatments and projects after we have collected sufficient data – probably beginning in 2004.

HIGH PLAINS
ENVIRONMENTAL CENTER

Fish Survey
Report and Recommendations
Discussion with Randy Van Buren from the DOW
July 27, 2002

Fall Data - Houts

- Gizzard shad (Found dead)
- Yellow perch
- Common carp
- Large mouth bass
- Big walleye
- Black bullheads - Native
- Crappie
- Channel catfish
- White suckers
- White bass

The gizzard shad and yellow perch are forage fish which serve as food for the larger fish. The walleye and catfish are remnants from stocking and not reproducing. The white bass and bullheads are probably migrating in from other places in the system. Four year classes of carp were identified, indicating that they are reproducing some years and not others.

Spring Data - Houts Tiger Muskie

- Huge number of white suckers
- No walleyes, but found all other species from fall
- Gizzard shad reproducing, 2-3 times every 5 years
- Saw more bullheads

Note: Randy surveyed Houts twice – he believes Equalizer is a mirror image and generally population is similar to Boyd Lake except for our high number of white sucker

Problems & Recommendations: The biggest problem fishery-wise is suckers. They are taking up biomass and eating worms and aquatic zooplankton as young fish. Zooplankton feed on algae, which helps to keep algae population in check.

We will have recurring (reproducing & coming in from the system):

- White bass – sport fish potential
- Yellow perch – marginal population
- Bullheads – sport fish potential
- Crappie
- Suckers
- Gizzard shad
- Carp

Stocking options include:

- Large & small mouth bass (large from fishery, small from salvage)
- Channel Catfish
- Yellow Perch & Crappie – would be salvaged from other lakes
- Walleye – fished from boats - not shoreline, so we may/may not stock them
- Wiper (white bass & striped bass hybrid)

We need predators to feed on suckers (these fish are generally not good 'kid's fare')

- Tiger muskies
- Walleyes
- Wipers

The DOW can provide the above stated predators plus catfish, large mouth bass and blue gills. The catfish are in short supply and may not be available. Stocking is free if the lakes are open to public fishing. The bluegills, catfish and white bass are all suitable for kids fishing.

Tiger muskies are a northern pike and muskie sterile hybrid and would benefit us in many ways. They could help to increase our desirable plant population by preying on suckers (that eat zooplankton) and carp (that stir up the water); by increasing the zooplankton population and decreasing turbidity we could improve our aquatic vegetation.

The gizzard shad are planktivores eating both zooplankton and phytoplankton. There are currently too many old age gizzard shad and we need to keep their population in check. Periodically they have nasty die-offs, typically in late winter.

We could potentially increase our aquatic plant life if we close the check dam between Houts and Equalizer. A greater level of control over the ecosystem in Houts would be achieved by having it isolated from the irrigation canal system. The DOW could put in plant fragments from Boyd Lake to assist in the revegetation process.

Suggested Policies & Considerations

- Standard fishing regulations apply (license required for 16 and over)
- Size limits of 15" minimum on small and large mouth bass
- Statewide limit on tiger muskies is 36"
- Bow fishing is legal for carp and we should consider our policy
- No Alcohol
- Pack your trash – add trash and recycling containers
- Many trash problems are best managed by making people walk to the fishing areas
- Catfish fishing is a dawn to dusk sport
- Belly boats – complications?
- Ice fishing – address it or no?
- Suggested areas include the dam on the south and south east sides of Equalizer and the south west side of Houts neat the land bridge. Randy suggested using short buck and rail fences with signs for containment
- Amy Rile is our DOW officer who would help with enforcement

Plan for the next few Years:

Next year start stocking walleyes and wiper in spring and muskie, catfish and bass in the fall. We are 3 years away from seeing the predation benefits of these fish.

Fishing is Fun Grant

If we grant public access and produce 25% of cost (can be in kind) amounting to 25-30K and provide restroom/vault facilities we could qualify for the Fishing is Fun Grant. In exchange we would get trail signage and interpretive support. Deadline for next year is 3/1/03. If we are awarded the grant, money is given 7/1/04. One draw back of restrooms is ongoing maintenance costs.