2003 Water Quality Assessment Report

Volume II: Lakes

Denver Department of Environmental Health

Division of Environmental Quality
March 2005

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Acknowledgements

The expanse of material encompassed within this report required the input of a variety of personnel and agencies. The Denver Department of Parks and Recreation's (DPR) Parks Operations Personnel provided valuable input regarding current and historical management practices. The DPR's Planning Division provided literature as well as beneficial expertise regarding current and past renovation activities. Also with the DPR, the Natural Areas Program provided useful critique and supportive information regarding management alternatives and recommendations. The Natural Areas Management Plan provided valuable balance to this report as did its author, Maureen Dudley. The Denver Department of Public Work's Wastewater Laboratory performed analyses of many of the parameters assessed within this report. This effort was completed by the hard work of numerous Denver Department of Environmental Health personnel within the Division of Environmental Quality (DEQ; previously the Environmental Protection Division and Environmental Services Division). The lake sampling program also received valuable assistance from Steve Lundt of the Metro Wastewater Reclamation District and Kevin Urie of the Denver Water Department concerning lake ecology and sampling protocols. Chlorophyll-*a* analyses was performed by Linda Rosales, also with the Denver Water Department. The 2002 fish sampling at Berkeley Lake was made possible by Greg Gerlich and the Colorado Division of Wildlife.

Executive Summary

The Denver Department of Environmental Health's (DEH) Division of Environmental Quality (DEQ) began sampling lakes annually in 1996. This sampling has evolved into an on-going Lakes Assessment Program which serves to ensure the well being of the environment and the citizens within the City and County of Denver (CCOD). Results from the sampling are compared with state water quality standards presented in the Colorado Department of Public Health and the Environment's (CDPHE) Regulations 31 (CDPHE 2001a) and 38 (CDPHE 2001b). These standards have been established to protect for a variety of water uses, including recreational, aquatic life, and agricultural (irrigation). If water quality standards are met, conditions in the lakes are assumed to be protective for these uses.

This is the first annual report by the DEQ on the state of the Denver Lakes. Within this report, the 2003 sampling results for individual lakes are compared to results from other Denver Lakes as well as to CDPHE water quality standards and federal sediment guidance. Each lake is described with an emphasis on water and sediment quality. Additional observations with environmental and human health management implications are also addressed. This report, and those to follow, will emphasize management recommendations on both a city-wide and a lake-specific basis. In addition to reporting on the 2003 monitoring efforts, this report will be unique form those to follow in that it includes a comprehensive discussion on parameters measured by the DEQ and on lake management challenges and strategies.

A primary goal of the Lake Assessment Program is to help the CCOD maintain water quality within the established CDPHE guidelines. If standards are not met, the DEQ will take action with the appropriate agencies to help remedy the situation. In addition to assessing water quality regarding CDPHE standards, results from the Lake Assessment Program established background conditions and provide valuable information for CCOD agencies responsible for the management of the Lakes. Primary beneficiaries of this information include the DEH and the Denver Department of Parks and Recreation (DPR) during planning for renovations and contaminant cleanup issues.

These sampling results have also been used by the CDPHE in their triennial 303(d) review. The 303(d) review highlights stream and lake segments that are out of compliance regarding standards, and requires appropriate stewards to take action towards remediation of the problem. The CDPHE, Colorado Division of Wildlife, and US Environmental Protection Agency utilized the DEQ lake monitoring results regarding arsenic and fish consumption issues at Berkeley Lake. The DEQ's Lake Monitoring Program also enhanced the Denver Water Department's understanding of the dynamics between the City Ditch water supply and water quality in the Washington and City Park Lakes. Lastly, management decisions guided by results from the Lake Assessment Program can play an important role in the Mayor's goal of making Denver a better place to live.

Field & Lab
Routine sampling included assessment of water quality and sediment once during June and July, 2003. Field parameters measured at each sample site included: pH, temperature, dissolved oxygen (DO), conductivity, and secchi depth. Other parameters for which water samples were collected for laboratory analyses included: alkalinity, hardness, nutrients, dissolved organic carbon, bacteria (fecal coliform and *E. coli*), chlorophyll-*a*, and metals. Sediment metal concentrations were also assessed.

Analyses & Results
The results presented on an individual lake basis highlight parameters which identify water and sediment quality differences between the lakes in 2003, temporal trends within the lakes, and how the water and sediment quality compares to state water quality standards (CDPHE 2001 and 2002) and federal sediment toxicity guidance (USEPA 2001 and 2002). A summary of the 2003 findings, primary issues, and management recommendations are provided at the end of each individual lake subsection.

The lakes are grouped and discussed based upon their respective primary water subsidy source. These water sources include the Rocky Mountain Ditch, City Ditch, Agricultural Ditch, South Platte River, and three lakes with miscellaneous sources. Many of the issues and management recommendations apply to all or most of the lakes, including: long water residence time (limited water quantity and an inefficient water path between the primary inlet and outlets), potentially lethal water quality to aquatic life (high temperatures combined with low DO), and high likelihood for turf management to impact lake water quality. Suggested management recommendations for these issues include:

- as opportunities arise, move the inlet and/or outlet to improve the water path through the lake and decrease water residence time;
- direct urban runoff towards the lakes to increase water quantity, but include water quality mitigation efforts to minimize the contaminant and nutrient loading;
- install aeration which will provide habitat refuge for aquatic life during physically stressful periods; and
- increase Natural Area presence along lake perimeters and on the islands to decrease potential for negative impacts on water quality associated with turf management.

A summary of management recommendations for each of the monitored Denver Lakes is provided in Table ES-1.

Management Challenges & Recommendations
The Denver Lakes pose many challenges to maintaining acceptable conditions. Because the Denver Area Lakes are expanded and/or created water bodies, they lack natural controls that would typically exist to maintain some balance in these systems. Some of the typical symptoms of this imbalance include excessive productivity in the form of algae and submerged vegetation, poor water clarity, and depressed DO. Management complexity is further compounded in an urban environment in which the necessary input of stormwater quantity is either diverted away, or is discharged to the lake usually accompanied with poor quality.

Based on information garnered over the past eight years, the DEH has several management recommendations with which to address above mentioned challenges, including: dredging, mitigation of incoming water quality, forebays, aeration, chemical treatment, water drawdown, and Natural Area establishment in and around the lakes. Each of these approaches has advantages and disadvantages and none of them alone will provide the entire solution. Management options are discussed in Section V of this report. A summary of recommendations provided in this report specific to the Denver Area Lakes is provided in Table ES-1.

Table ES-1. Summary of DEH management recommendations for the CCOD Lakes. The row designated "All Lakes" provides suggestions applicable to all fifteen regularly sampled lakes.

Water Subsidy Source / Lake	Management Recommendations
All Lakes	
Apply to all Lakes	-increase urban runoff to lake with associated water quality mitigation -establish Natural Area (NA) around lake perimeter and on islands
Rocky Mountain Ditch	
Berkeley Lake	-additional fish tissue sampling -survey park visitors for fish consumption information -provide aeration in a few key locations
Rocky Mountain Lake	-integrated approach to maintain acceptable densities of submerged vegetation (not eradication) -provide aeration in a few key locations
Sloans Lake	-monthly to biweekly bacterial monitoring from May - September -consider dredging if and when technology provides a feasible option
City Ditch	
Grasmere	-see recommendations applicable to "All Lakes" above
Smith	-move inlet and/or outlet (irrigation intake) to improve water path through the lake
Ferril	-improve water quality mitigation capabilities of the 17th Ave. Pond -increase staff awareness of avian botulism and need for vigilant cleanup of dead waterfowl and fish
Duck	-use and assure operational capability of aeration system -increase staff awareness of avian botulism and need for vigilant cleanup of dead waterfowl and fish -increase educational efforts to discourage feeding of wildlife -obtain a greater seasonal range of measurements for DO and bacteria

Table ES-1. (Continued)

Water Subsidy Source / Lake	Management Recommendations
Agricultural Ditch	
Harvey Lake	-move inlet and/or outlet (irrigation intake) to improve water path through the lake -maintain mudflats associated with islands and shoreline -manage productivity to maintain a balance between submerged vegetation and phytoplankton -increase diversity of riparian zone (i.e., add trees)
Garfield Lake	-provide aeration in key locations within the lake
Huston Lake	-consider wetland expansion for water quality mitigation of Salisbury Lateral Ditch water
South Platte River	
Overland Pond	-periodic dredging of sediments -addition of trees along south and east shoreline -mitigation of nutrients and other potential contaminants associated with incoming water (i.e., wetland)
AquaGolf Lake	-move inlet and/or outlet (irrigation intake) to improve water path through the lake -maintain water levels to minimize groundwater infiltration -integrated treatment of algae/phytoplankton -consider dredging if sediment characterization deems appropriate
Miscellaneous	
Barnum Lake	-Weir Gulch basin-wide review of BMPs to minimize negative aspects of urban runoff on lake water quality -bacterial monitoring in the Weir Gulch drainage to better understand this parameter and its association with the lake -maintain mudflats associated with the islands
Vanderbilt Lake	-dredge sediments if deemed appropriate after further sampling -maintain healthy riparian zone in light of future renovation -provide urban runoff water quality mitigation -posting for educational and enforcement purposes regarding illegal dumping
Lollipop Lake	-move groundwater discharge and/or irrigation intake to improve water path through the lake -aeration in targeted areas to decrease nutrient availability and provide aquatic life refuge during stressful periods

Parameter Overview / Glossary

An overview of the parameters assessed by the DEH is included in the appendix of the 2003 report. This overview explains the ecological and management significance of each of the parameters. There is also a glossary included in the 2003 report which provides a succinct explanation for many of the technical terms used within.

Conclusions

After eight years of mid-summer sampling, the DEH has accumulated enough data to establish trends within the Denver Lakes individually and as a whole. Although this information applies to the lakes during one season, it provides valuable information for the CCOD that can be

utilized for management purposes. The data has also been of value to the CDPHE for assessment of state water quality standards, to the Denver Water Department for the assessment of the impacts of City Ditch on lake water quality, and to the EPA regarding public health issues.

Some important findings from the 2003 monitoring included:

- Berkeley Lake arsenic levels are near the screening level concerning fish consumption risk and warrant further investigation;
- the change in City Ditch source water from the South Platte River to de-chlorinated tap water had limited impacts on lake water quality after one year;
- variation in submerged vegetation conditions had significant impacts on lake conditions in some of the lakes (i.e., Harvey Lake);
- the South Platte River nutrient loading has a strong impact on Overland Pond and AquaGolf Lake;
- a groundwater plume may be intermittently impacting water quality in AquaGolf Lake;
- the renovations at Garfield and Barnum Lakes provided islands that are valuable to wildlife, and subsequently the Denver residents that appreciate this; and
- concentrations of organic constituents are at levels of concern in Vanderbilt Lake.

Comments regarding this report can be made by contacting the Department of Environmental Health's DEQ at 720-865-5452.

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