SMITH AND BYBEE LAKES SEDIMENT ASSESSMENT

submitted by

METRO

PARKS AND GREENSPACES DEPARTMENT

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PHASE I - DIAGNOSTIC/FEASIBILITY STUDY OF SMITH AND BYBEE LAKES

ASSESSMENT OF LAKE SEDIMENTS

SUMMARY

Application for Clean Lakes Grant Funds is being submitted for completion of the Phase I Diagnostic/Feasibility Study of Smith and Bybee Lakes in Portland, Oregon. The first year of Phase I investigation included characterization of lake water quality and hydrodynamic modeling. The proposed second year of Phase I work will include investigation of lake sediments to determine the impact of non-point source pollutant loading and the paleolimnological history of the lakes. The second year investigation will result in a recommendation for the most feasible and cost-effective methods for lake restoration.

BACKGROUND

Smith and Bybee Lakes Natural Area is a 810-hectare natural area within the City of Portland that contains regional significant wildlife habitat, provides popular warmwater fishery, serves as an increasingly important environmental education site, and provides solace that is accessible to the region's urban dwellers. Smith and Bybee Lakes, with a total surface area of approximately 425 hectares, and their adjacent wetlands and uplands, are mostly under government ownership. A management and a recreation plan have been developed to guide decisions governing use of the area, with the aid of zoning ordinances protecting the resources.

The goal of the *Natural Resources Management Plan for Smith and Bybee Lakes* is to protect and manage the area as an environmental and passive recreational resource. They will be maintain and enhanced, to the extent possible, in a manner that is faithful to their original natural condition. The *Smith and Bybee Lakes Recreation Master Plan* outlines development of passive recreational opportunities that are compatible with the environmental objectives of the Management Plan.

Metro is responsible for monitoring and maintaining the environmental integrity of the natural area. In 1993, Metro was awarded a $21,000 Clean Lakes grant from Oregon DEQ for conducting a diagnostic/feasibility study of the lakes to investigate restoration of these waters to a state closer to their former natural conditions. The initial part of this Phase I study is focused on monitoring the water quality status of the lakes, while acquiring available information on the surrounding waters of the Columbia Slough, Willamette and Columbia Rivers. This data is

being used in a hydrodynamic model to determine the feasibility of augmenting water input into the lakes directly from the Columbia River.

The comprehensive Phase I study is designed to determine the extent and causes of disturbance to the lake system, evaluate possible solutions, and recommend feasible methods for restoring and protecting lake water quality. To date, data has been collected on the lakes' water quality according the schedule outlined in current Phase I Scope of Work. Continuous water level stage recordings in the lakes, the adjacent Columbia Slough, and the Columbia River are being gathered to calibrate the hydrodynamic model. To complete the Phase I assessment, the following is being proposed:

(1) determine the impact of nonpoint sources of pollutants, storm water and landfill leachate, on the lakes through a synoptic sediment survey; and,

(2) reconstruct the recent limnological history of the lakes by analyzing lake sediment cores.

LAKE DESCRIPTION

Smith and Bybee Lakes are located within the city limits of Portland, in Multnomah County, Oregon, adjacent to the confluence of the Willamette and Columbia Rivers. Lake data given below assumes the surface water elevation of the lakes is at 10.4 feet AMSL, which is the elevation of the former fixed weir at the east end of North Slough, which was replace with an adjustable weir in 1992. Smith and Bybee Lakes are directly connected over the normal surface water levels observed. Although they are distinct basins, they can be treated as one water body when exploring management option.

Physical Characteristics

	Smith & Bybee Lakes		Smith Lake	Bybee Lake
Surface Area	425 ha		293 ha	132 ha
Drainage Area	650 ha	---	---	
Volume	4,763,000 m^3		3,282,000 m^3	1,481,000 m^3
Maximum Depth	-----		2.0 m	2.3 m
Trophic Status	-----		Eutrophic	Eutrophic

Hydrology

The lakes and associated wetlands have been historically manipulated for development and waterfowl management purposes. By 1980, the entire north side of the lakes area had been filled for industrial development. The historic direct link from the lakes to the Columbia River was eliminated by this development. The more indirect link to the Willamette and Columbia Rivers through the Columbia Slough was restricted by the 1983 construction of a water level control structure at the east end of the North Slough. This structure not only restricted flow exchange between the lakes and the slough, but also maintained the lakes at a static level year-round. This dramatically increased the retention time of the lakes and changed the vegetation types in the lakes and wetlands (Fishman Environmental Studies Summary Report 1988).

The lakes have been essentially isolated from influences of the slough and rivers much of each year. However, when the lakes' level or the slough/river levels exceed 10.4 feet AMSL, there is a direct connection between the North Slough and the lakes. This usually occurs during the Willamette River freshet in winter months and during the Columbia River freshet in late spring. Based on Fishman (1988) and recently-collected data (Metro, unpublished data) the major components of the water budget are precipitation and evaporation. Surface runoff inflow and groundwater flux are relatively minor in the water budget.

WATERSHED DESCRIPTION

Smith and Bybee Lakes drainage basin encompasses approximately 1600 acres in the northwest Portland area. Most of watershed is comprised of the adjacent wetlands and uplands, with two storm water discharges from nearby industrial developments. The adjacent uplands are mostly within the Management Area, are relatively undisturbed, heavily vegetated, with low slopes. The storm water discharges receive passive treatment prior to discharge to the lakes.

The St. Johns Landfill, located within the Management Area and immediately adjacent to Smith Lake, is no longer active and is proceeding through an extensive closure process. There are two surface water discharges from the closed landfill that enter Smith Lake. The significance of its impact on water quality of the lake is not known.

The largest population center nearest the lakes is Portland, having an estimated population of 453,000 as of July 1, 1991. The four-county metropolitan area that is accessible to the lakes includes approximately 1.4 million people.

SCOPE OF WORK

Storm Water and Landfill Leachate

Currently, there are three known storm water discharges to the lakes and two proposed storm water discharges. No quantity or quality data are available on existing discharges. Given their small catchment area relative to the size of the lakes and their adjacent uplands, the quantity of storm water discharge from these areas is relatively insignificant. However, given the industrial land use associated with these catchment areas, storm water impact on lake water quality may be significant.

There are two storm water catchment areas proposed for discharge to the lakes. Passive treatment facilities are included in their design that have performance standards designed to meet state water quality standards. The proposed discharges have been included in a numerical dispersion model for the lakes and will be included in the evaluation of cumulative storm water impacts.

The local proximity of the St. Johns Landfill has allowed surface water runoff from the landfill to enter Smith Lake. These discharges are known to contain landfill leachate, which is water that has had prolonged contact with landfill solid waste. Historical lake water quality sampling has focused on monitoring mid-lake water quality. Localized impact of landfill-influenced discharges may best be assessed by examining the sediments in proximity to the known discharge points.

Objective: **Examine the surficial sediments throughout the lakes to determine impacts of suspected sources of contamination.**

Rationale

When undisturbed, sediments can provide a history of patterns of contamination in aquatic systems, allowing correlation of contaminants to their sources. Assessment of the surficial sediments for contaminants is important since organisms in contact with the sediment, such as invertebrates and fish, may be adversely affected, and may transfer this uptake throughout the food web.

In the horizontal plane, the spatial distribution of contaminants in the sediments associated with storm water and landfill leachate discharges to the lakes will be assessed. With existing storm water discharges have been in place for some time, long-term inputs can assessed by examining accumulation in the surface sediments. Due to the temporal variation in storm water flow, sediments near the outfalls may be an effective indicator of long-term pollutant inputs, integrating contaminants with deposition over time.

Approach

At known discharge locations, sediment surface grab samples (Eckmann dredge) will be taken in a linear pattern radiating out into the lakes from the suspected sources. A control site within the lakes, where there is no known pollution source in proximity, will be included in the sampling strategy.

TABLE 1. Synoptic Sediment Sampling in Smith and Bybee Lakes

# Transects	# Samples/ Transect	Frequency	Parameters
5	4	1/study	metals (Pb, Cd, Ar, Cu, Cr, Ni, Zn, Hg) organochlorine pesticides and PCBs polynuclear aromatic hydrocarbons (PAHs) percent water, loss-on-ignition

The synoptic sediment survey of the lakes will compliment the intensive sediment investigations and remediation work currently being conducted in the Columbia Slough by the City of Portland and Metro.

Paleolimnology

Without sufficient historical water quality data for Smith and Bybee Lakes, realistic restoration goals may be difficult to establish. The primary management mission for the lakes, as stated in the *Management Plan*, is to restore the lakes, to the extent possible, to their former natural condition. A history of the lakes, using current methodologies of paleolimnology, can illuminate the vagaries of recent limnological conditions in the lakes. Only with clear restoration goals can we, as managers, strategically plan to restore this system to a condition that is faithful to natural processes.

Objective: Reconstruct the recent paleolimnological history of Smith and Bybee Lakes.

Rationale

The purpose of this objective is to understand how the lakes may have changed in this century, giving us, as resource managers, an opportunity to develop management strategies to achieve realistic objectives.

Although sediment samples have been collected in Smith and Bybee Lakes, previous efforts focussed on particle size distribution (Fishman Environmental Services [FES] 1987, Clifton 1983) and some chemical characterization (Clifton 1983). The FES (1987) study was based on analysis of sediments collected with an Eckmann grab sampler and provides no analysis of change in sediment. In the USGS study (Clifton 1983), sediments were collected with a tube sampler, but sediments were simply partitioned into upper and lower sediments.

More recent analysis of lake sediments in Oregon have shown the benefits of sequential analysis of sediment for reconstruction of both long-term (Eilers et al. 1994a) and short term (Eilers et al. 1994b) lake history. By using current methodology, it is now possible to precisely relate watershed activities to responses in the lakes. By increasing certainty in assessing lake history, it provided a greater chance of achieving desired objectives in lake management.

Approach

The recent limnological history of Smith and Bybee Lakes will be reconstructed from undisturbed sediment cores collected from each lake. Sediment will be collected from the deeper portion of each basin, where disturbance is least likely to have occurred, using a 5-cm diameter piston corer capable of collecting up to 1 meter of sediment. The cores will be returned to shore and sectioned in 0.5 to 1.0 cm sections for the first 10 cm and 1.0 to 5.0 cm sections for the remainder of the core. The sediment will be analyzed incrementally in three stage (Table 2). The decision to proceed with subsequent stages in the sediment analysis will be based on the ability to satisfactorily date the cores in Stage 1 and to observe significant change in diatom community composition in Stage 2.

TABLE 2. Analysis of Sediments in Smith and Bybee Lakes

Stage	Analysis	Rationale
1	Percent Water Loss-on-Ignition Lead-210 Activity	Required to determine dry mass of sediment. Provides estimate of organic content. Provides estimate of sediment accumulation rate (age of sediments) for the previous 150 years.
2	Diatoms	Species and relative abundance provides assessment of (1)

		source of water (riverine vs. lotic diatoms) and (2) historical water quality by relating trophic preferences of species to inferred changes in water quality.
3	Metals	An ICP-MS analysis of the sediments will provide an assessment of sediment source through changes in metals associated with crustal materials (e.g. Al, Fe, Mn, Ca) and anthropogenic contaminants (Pb, Vd, Zn, Ni, Hg).

The sediment data will be compiled in a digital data base, Paradox, for interpretation and reporting. The focus of the analysis will be on recent changes (i.e., the last several decades) in sediment history, although interpretation will be provided throughout the portion of the sediment core that is amenable to dating.

BUDGET AND SCHEDULE

Synoptic Sediment Survey

Sediment Collection		
Labor		$ 1,200
Travel	50	
Equipment and Supplies		250
		$ 1,500
Sediment Analysis (20 samples)		
Percent Dry Weight		300
Loss on Ignition		300
Metals	5,760	
Pesticides and PCBs		3,200
PAHs		3,800
		$ 13,360
Data Interpretation and Reporting		
Labor		$ 3,800
SUB-TOTAL		$ 18,660
Contingency (6%)		$ 1,120

Project Management (6%)	$ 1,120
TOTAL	**$ 20,900**

Paleolimnology (assumes 2 cores)

Sediment Collection		
Labor	$ 1,040	
Travel	100	
Equipment and Supplies		250
Shipping		60
		$ 1,450
Sediment Analysis		
Percent Water	$ 250	
Loss on Ignition		250
Lead-210 Dating		4,000
Diatom identification	5,100	
Metals (ICP-MS)		3,600
		$ 13,200
Data Interpretation and Reporting		
Labor		$ 3,120
SUB-TOTAL		$ 17,700
Contingency (6%)		$ 1,070
Project Management (6%)		$ 1,070
TOTAL		**$ 19,840**

Budget Summary

	Clean Lakes Grant	Metro Contribution	TOTAL
Synoptic Sediment Survey	$ 5,200	$ 15,700	$ 20,700
Paleolimnology	$ 19,840	$ 0	$ 19,840

TOTAL	**$ 25,040**	$ 15,700	$ 40,740

Schedule

Activity	Completion Date
Receive Award Announcement	May 1, 1994
Sign Contract with DEQ	June 1, 1994
Collect Sediment Samples	August, 1994
Receive Analytical Results	October, 1994
Data Analysis/ Draft Report	December, 1994
Final Report & Recommendations	March, 1995

APPLICATION FOR FUNDING

UNDER THE CLEAN LAKES PROGRAM

Administered by

Oregon Department of Environmental Quality

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