

RE: DEER LAKE WATER QUALITY STUDY

MUNICIPAL MANAGER'S RECOMMENDATION:

ITEM	6
MANAGER'S REPORT NO.	66
COUNCIL MEETING	1982 11 29

1. THAT the recommendations contained in the report of the Director Planning & Building Inspection, Chief Public Health Inspector, Director Engineering and the Director Recreation & Cultural Services be adopted.

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TO: MUNICIPAL MANAGER 1982 NOVEMBER 23
FROM: MUNICIPAL STAFF COMMITTEE OUR FILE: 15.403.1
SUBJECT: DEER LAKE WATER QUALITY STUDY

RECOMMENDATIONS:

It is recommended

1. THAT the recommendations of the Deer Lake Water Quality Study prepared by Beak Consultants Ltd. affected by the proposed Provincial Government Deer Lake Project be tabled pending a decision as to whether the Municipality should enter into a partnership with the Province to jointly develop the Oakalla Prison site and part of Deer Lake Park.
2. THAT Council request the Parks and Recreation Commission to consider immediate implementation of Interim Management Measures 2, 3, 5, 7 and 9 as outlined on pages 7 and 8 of this report.
3. THAT \$18,000 from the Operating Contingency Account of the Provisional Budget be utilized to conduct a base line monitoring program consisting of a nutrient budget and water budget for Deer Lake.
4. THAT the \$18,000 for the base line monitoring program be administered by the Health Department, Environmental Health Division.
5. THAT a copy of this report be forwarded to the Parks and Recreation Commission for its consideration.

SUMMARY:

This report summarizes the findings of the Deer Lake Water Quality Study prepared by Beak Consultants Ltd. Beak has determined that Deer Lake suffers from poor water quality principally caused by a high phosphorus and silt load; the results of an urbanized watershed. It is also the opinion of Beak that if the lake is allowed to continue its present rate of deterioration, its value as a park resource will greatly diminish and any effort to restore the lake subsequently will result in much higher costs.

This report also recommends that until there is resolution of the proposed Provincial Government Deer Lake Project only those recommendations not affected by this proposal be considered at this time.

REPORT

I. BACKGROUND

The Municipal Council on 1980 September 20 approved the retention of Beak Consultants Limited to undertake a study of methods of maintaining and enhancing the water quality of Deer Lake for recreational purposes. More specifically, the scope of the study was to:

1. Recommend a prioritized water quality improvement program for Deer Lake with cost estimates.
2. Examine in detail the impact of the Deer Lake Park development concept on the water quality of Deer Lake with particular reference to:
 - a. Determination of the present role in nutrient dynamics of the drained marshland at the western end of the lake. The proposal to create ponds and water gardens should be evaluated against the role of the marshland as a nutrient trap or a nutrient donor.
 - b. Recommend an alternative concept for the western end of the lake, if necessary, based on the above findings.
 - c. If the ponds and water gardens are considered appropriate, will significant engineering procedures be required to implement the proposal as conceived.
 - d. Recommend methods of minimizing any potential nutrient input arising out of the development of the Oakalla lands as park.
3. Recommend measures that could be taken to improve Deer Lake as a habitat for fish.
4. Recommend methods of minimizing pollutants entering Deer Lake from its watershed.

The Consultants completed a extensive physical, chemical and biological analysis of Deer Lake and the surrounding lands between March and December of 1981. This technical data base, their assessment of the data and their recommendations have now been completed and are contained in a report entitled Deer Lake Water Quality Study - 1981. Because of the voluminous nature of the report, copies have only been provided to members of Council. Copies are available for review by the public at the Planning & Building Inspection Department.

A Municipal staff committee consisting of members from the Engineering, Health, Recreation & Cultural Services and Planning & Building Inspection Departments maintained a close liaison with the consultant throughout the study. Coordination of the project was through the Planning & Building Inspection Department.

II. PURPOSE

The purpose of this report is threefold:

1. Summarize the findings of the Consultant.
2. Outline the recommendations of the Consultant.
3. Municipal staff to recommend a future course of action based on the Consultant's findings.

III. THE FINDINGS

A. Identifying the Problem

Deer Lake suffers from poor water quality. This deterioration impinges directly and indirectly on Deer Lake recreational activities such as swimming and wading, boating, fishing and general aesthetic use. Table 1 illustrates the major symptoms of poor water quality, their immediate cause, and the recreational activity impinged upon.

TABLE 1: Symptoms of Deer Lake Deterioration

Symptom	Cause	Recreation Affected
High turbidity	planktonic growth, heavy silt load, sediment mixing	swimming, wading, aesthetics
High coliforms	inflows, ducks	swimming, wading, aesthetics
Prolific submerged weed growth	high nutrient concentration	swimming, wading, boating, aesthetics
Unightly growths of algae	high nutrient concentration	swimming, wading, aesthetics
Odor	algal blooms, urban inflow contaminants	swimming, wading, aesthetics
Toxicity	blue-green algal blooms	swimming, wading, aesthetics
Low trout survival	high temperature, low oxygen, shallow basin	fishing

Even with the present undeveloped lands around Deer Lake, Beak has determined that "Deer Lake water quality is deteriorating and some restoration measures are necessary to ensure that the lake does not become unsightly and unusable as a recreational resource. If no measures are taken and the lake is allowed to continue its present rate of deterioration, its value as a park resource will greatly diminish and any effort to restore the lake subsequently will result in much higher costs. Any commitment to the continued maintenance and further development of this unique facility must include a sound ecological management and restoration program. Otherwise, as Northcote *et al.*, (1978) so aptly stated: Deer Lake may rapidly change from the community gem to the community eyesore".

1. Urban Runoff

The two principal factors causing deterioration of Deer Lake are:

- a. High phosphorus load.
- b. High silt load.

Both phenomena are dictated by the hydrology of the watershed which is presently dominated by urban runoff. Urban runoff is caused by an increase in impermeable surfaces in the water shed (concrete, pavement, buildings, etc.) which reduce ground penetration of water (Figure 1). Other urban-related practices, leading to increased nutrient export and erosion of the watershed are operative (e.g. construction, vehicular traffic, maintenance of lawns and gardens, etc.).

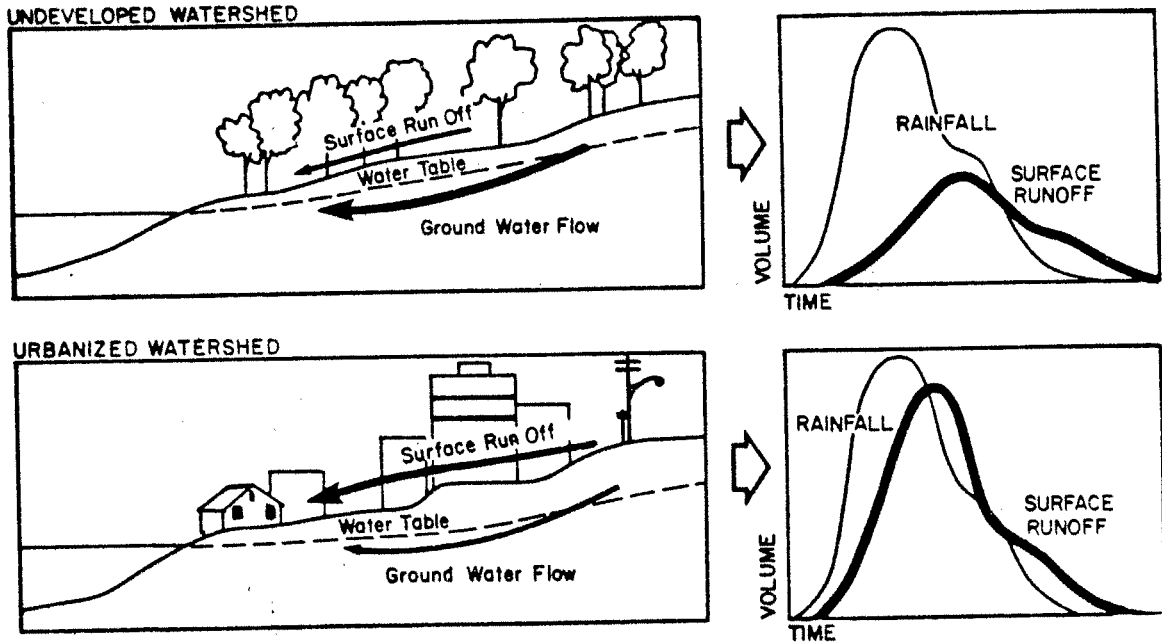


Figure 1: Hydrology of an Undeveloped and Urbanized Watershed.

Urban stormwater is far from clean. Such runoff encounters a varied collection of residues from vehicles, garbage, animal wastes, construction silt, fertilizers from gardens and lawns, leachate from leaves and dust fall (atmospheric pollution).

The main vectors of urban runoff to Deer Lake are the stream inflows which carry stormwater from storm drains: chiefly the marsh inflow at the western end; the steeply graded inflows at the south side; and the two inflows at the beach site on the eastern end of the lake. Inflow streams contribute 57% of the water volume and 58-64% of the total phosphorus load to the lake. The flash flood nature and the erosion along the south side inflows contributes most of the high silt load to the lake.

TABLE 3: Sources of Phosphorus to Deer Lake by Major Inflows, 1981. (see Figure 2)

Subdrainage Basin	Area (%)	Creek #	Total Phosphorus Loading		Waterload %
			kg/yr	%	
A	5	1,2	5	1	negligible
B	48	3	161	44	30
C	14	11	43	11	1
D	6	12	19	5	5
E	6	13	58	15	12
F	8	14	5	1	negligible
G	13	16,17	86	23	52
TOTAL	100		377	100	100

The Deer Lake watershed is now approximately 75% urbanized. Any additional urbanization of the watershed would increase urban runoff and lead to increased phosphorus loads to Deer Lake and erosion of the watershed. Beak has indicated that further development of the watershed will potentially increase the problem.

2. Deer Lake Park

The park area is characterized by an upland and a lowland. Highly productive grass and bog shrubs dominate the lowland area. Beak identified the wetland as both a sink and a source of phosphorus. The grassland and marsh act as sinks of phosphorus in the summer and fall, while releasing their nutrient store in the winter and spring, particularly with the onset of heavy rains and urban runoff.

Tests indicate that 3 to 6 times the phosphorus concentration considered tolerable may be released from the upland and lowland area, respectively, should disturbance take place.

B. Recent Staff Actions

1. Possibility of Sewage Contamination in Storm Drains Feeding Creeks 12, 13, 16 and 17

The Environmental Health Division had conducted bacteriological sampling of Creeks 12, 13, 16 and 17, which were noted in the Beak Consultants' report as possibly having sewage contamination. Analysis of sampling data received to date from the Provincial Health Laboratory has not revealed a significant sewage contamination of the storm drains. The Environmental Health Division will continue to sample pertinent storm drains feeding to Creeks 12, 13, 16 and 17 in order to fully investigate the possibility of sewage contamination.

2. Deer Lake Swimming Area

During May through September of each year, the Environmental Health Division conducts weekly sampling of the major tributaries to Deer Lake in six areas within Deer Lake proper. Analysis of sampling data shows concern for the bacteriological water quality of the Deer Lake swimming area. The sampling data from recent years has revealed a significant deterioration in the bacteriological quality of the lake water within the recognized swimming area at Deer Lake. During the 1982 Swimming season, May through September, the levels of bacteriological contamination within the swimming area were at a level which bordered on the Health Department proceeding with action under authority of the Provincial Health Act to close the recognized swimming area due to unsatisfactory bacteriological contamination.

Another concern of the Health Department, insofar as the lake being used for primary water activities, is the continuing loading of nutrients which is causing growths of algae. Continued increasing growth of algae is reducing the clarity of the water within Deer Lake and in future years could affect the area being recognized by the Municipality as safe for swimming.

IV. SOLVING THE PROBLEM

Beak's recommendations for solving the problem fall into three categories:

- Water Quality Improvement Program
- Interim Management Measure for Deer Lake Park
- Recommendations for Further Research

The Burnaby Health Department, Environmental Health Division, strongly supports the recommendations contained in the Deer Lake Water Quality Study prepared by Beak Consultants Ltd.

A. Water Quality Improvement Program

A park plan - lake restoration program, according to Beak, must achieve the following objectives from a water quality and lake use perspective.

1. Reduce silting and erosion.
2. Reduce nutrient inflow and algal turbidity.
3. Maintain flushing rate.
4. Improve the quality of water entering the lake.
5. Preserve and restore the lake as a recreational and fishing habitat.

To achieve this, Beak recommends a prioritized water quality improvement program which combines lake restoration methods with mitigation methods for specific park development impacts, these include:

Technique	Cost (1982 \$)	Phosphorus Removal (kg/yr)	Silt Removal	Coliform Reduction
Settling Ponds	1.35-4.1 million (depending on option)	112	high	high
Storm Drain Diversion - partial diversion	1.2 million	206	very high	high
Artificial Marsh	10,000	30-50	high	high
Rooted Plant Harvest	20,000	60-80	--	--
Watershed Source Treatment	?	18	--	--
		50-100	high	very high
TOTAL	2.58-5.34+ million	270-400 kg/yr	very high	high

The cost of the option recommended by Beak is approximately \$3 million.

The diversion of storm drains as shown on Figure 3 will reduce phosphorus, silt and coliform bacteria to the lake. The settling ponds would be used to remove sediment, particulate phosphorus and other material related to urban runoff. An artificial marsh in the ponds is proposed to remove nutrients not removed by settling in the ponds.

The prioritized water quality improvement program outlined above satisfies the major water quality concerns of Deer Lake: phosphorus loading, silt loading and coliform concentrations. The program is estimated to reduce coliform counts and much of the silt and sufficient phosphorus loading to improve Deer Lake for present use. The harvest of rooted plants in Deer Lake are not as urgent presently as they may be in the future, particularly considering cost and the amount of phosphorus removal. These weeds do not presently pose a great problem in Deer Lake. However, harvesting the artificial marsh is strongly recommended.

Methods which will reduce the siltation and phosphorus loading problem at their sources are:

1. Frequent street cleaning.
2. Leaf and grass-clipping removal.
3. Limited and efficient use of fertilizers and pesticides.
4. Pet control.
5. Set up criteria for proper maintenance of constructing sites (e.g. newly opened areas susceptible to erosion should be covered).
6. New construction to include porous pavement.

Waterfowl in swimming areas is undesirable. The bacterial and nutrient enrichment of the beach area by waterfowl is considerable. If the beach is to be utilized for swimming, "resident" waterfowl populations should be removed and the area efficiently policed against feeding the birds. Such a mandate may be facilitated by encouraging bird feeding in areas away from the swimming beach.

Beak has also assessed the impact of the arboretum, educational farm, horticultural centre, water gardens, ponds, model boat area, greenhouses, outdoor forum and roadway construction proposed in the Deer Lake Park Plan would have on the water quality of Deer Lake. Based on this assessment recommendations have been formulated to minimize the impact of these proposed land use/activities when development is undertaken.

B. Interim Management Measures for Deer Lake Park

During the interim period prior to actual implementation of the park plan, certain measures to maintain and improve the Deer Lake environment have been recommended by Beak. Some of these measures require further study and funding allocations prior to implementation. However, it is recommended that measures 2, 3, 5, 7 and 9 of the following interim management measures recommended by Beak be considered for immediate implementation by the Parks and Recreation Commission.

1. Tree farm: the tree farm should ideally be moved to the upland area where an arboretum should be suitably located and where irrigation or drainage is not necessary. The tilled, uncovered areas should be grassed as soon as possible.
2. Dumping (soil, etc.): this practice may be carried out if done carefully away from creeks and drainage canals leading to the lake. Maximum spreading should ensure that little disturbance occurs. The unstable lowlands have a tendency to "cave in" in places (the peat acts like a wet spongy floating mass) if extensive dumping occurs within a limited area. The uplands are more suitable for dumping practices.
3. Dredging the stream or ditches: this should not be carried out until a specific development plan has been agreed to by all parties involved. Any dredging should occur in the dry period (summer) and should focus on existing main stream and ditches as opposed to producing new channels. When dredging existing channels, silt traps (filters, etc.) should be installed to minimize pollution to the lake. Dredge material (high in nutrients and organic acids, especially if in lowland area) should ideally be trucked away, or if deposited in the park site should be spread out and revegetated in the upland areas, away from the dredging site. Attention should be focussed on disturbing the area as little as possible.

4. Management of the lowland: mowing and harvesting the grassland is encouraged, particularly if done during peak biomass (July) and if the material is removed from the park site. 121
5. Hog fuel trails: because this material contains, and is known to leach out, tannic and humic acids, hog fuel is not suitable for park trails. Existing trails should be maintained by using other materials (e.g. sand or gravel in the more stable areas). New trails using hog fuel as a base are discouraged. We suggest any inert material as a substitute. Porous pavement can be used in the more stable areas. Trails in the lowland area should be minimized.
6. Monitoring equipment: Beak has installed two piezometers (ground water wells) at the park site (refer to Figure 2.1-1) and staff gauges in several streams. Burnaby field staff should remain cognizant of these as they will be useful during future lake monitoring.
7. Park site construction activities: it is recommended that construction activity in this area, the lowlands in particular, be minimized until a park plan is finalized.
8. Weir Installment at outlet: it is recommended that the weir proposed by GVS & DD be flexible by using stop logs or some other means of raising or lowering the barrier. It is further recommended that a flow recording station be installed at the outlet.
9. Bird feeding: it is recommended that bird feeding regulations be enforced in the beach area to reduce bacterial and nutrient enrichment.
10. Street cleaning: it is recommended more frequent street cleaning be undertaken in areas contributing to the lake inflows. We recommend that material collected during the street cleaning operation be removed from the watershed and that flush water be used minimally until storm drain diversions are in place.
11. Garden refuse disposal: it is recommended that a public information campaign be undertaken to curtail this activity around the periphery of the undeveloped watershed areas.
12. Construction site runoff: it is recommended Burnaby undertake to include construction site sediment control requirements in all building permits within the watershed and routinely inspect to ensure compliance.

C. Beak Recommendations for Further Research

In addition to general and specific enhancement/mitigation measures already outlined, Beak recommends that the following research be carried out.

1. THE SURFICIAL MATERIALS IN THE LOWLAND AREA WERE OF A HETEROGENOUS NATURE, THEREFORE:

before construction and excavation begins in this area, a more detailed soils profiles must be obtained for the specific site.

2. GROUNDWATER MAY BE A POTENTIALLY HIGH CONTRIBUTOR OF NUTRIENTS FROM THE LOWLAND AREA, THEREFORE:

a thorough examination of groundwater movement into and out of the lake would resolve this issue.

3. DATA REVEALED THE POSSIBILITY OF SEWAGE CONTAMINATION IN STORMS DRAINS FEEDING CREEKS 13, 12, 16 AND 17, THEREFORE:

the storm drain network feeding these creeks should be investigated.

4. SPRING TOTAL PHOSPHORUS CONCENTRATION IN THE LAKE COULD BE USED TO PREDICT THE SUMMER PLANKTON BIOMASS, THEREFORE:

the total phosphorus concentration in the lakes should be determined in March to provide expected summer conditions. This may be used to determine if any development is causing additional problems to the lake and to what degree.

5. BECAUSE A PRINCIPAL MANDATE OF THE PARK PLAN IS TO MAINTAIN AND IMPROVE DEER LAKE WATER QUALITY:

a base-line monitoring program should continue; this would include water quality sampling of major inflows and the lake, with particular emphasis placed on nutrients and suspended solids. A nutrient budget and water budget should be constructed each year to determine the success of any actions taken toward improving the lake.

6. A CONTINUOUS DISCHARGE MEASURING STATION SHOULD BE INSTALLED ON THE LAKE OUTLET TO FACILITATE FUTURE LAKE ENHANCEMENT STUDIES

V. MUNICIPAL STAFF RECOMMENDATIONS

The Provincial Government has recently proposed a major residential development for the Deer Lake Park area. Many of the recommendations and the implementation approach recommended by Beak can only be addressed after a decision is made as to whether the Municipality should enter into a partnership with the Provincial Government to jointly develop the Oakalla Prison site and part of Deer Lake Park as proposed by the Province in their Deer Lake proposal. Accordingly, staff would recommend that all of Beak's recommendations so affected be tabled pending a decision on the Provincial Government proposal. A draft report addressing the Deer Lake Project has been completed and is being submitted to the Management Committee for consideration.

There are, however, certain interim management measures for Deer Lake Park as recommended by Beak which are not affected by the Provincial proposal that would help maintain and improve the Deer Lake environment. Accordingly staff would recommend that:

1. Any park maintenance and construction work for Deer Lake Park prior to the actual implementation of the park plan utilize the interim management measures recommended by Beak as a guide.

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2. A base-line monitoring program consisting of a nutrient budget and water budget for Deer Lake started by Beak should be continued by the Environment Health Division at an estimated annual cost of \$18,000. The Environmental Health Department has already developed a program to undertake the work outlined in this latter recommendation. This monitoring program is critical in order to be able to determine the condition of Deer Lake from year to year. Cost of this program is estimated at \$18,000 per annum for equipment rental and laboratory analysis costs. The Treasurer has indicated that funds from the Operating Contingency Account of the Provisional Budget should be utilized at this time. In the event that a joint partnership between the Province and the Municipality is agreed to, then recovery of a proportion of these funds could result from the partnership arrangement.



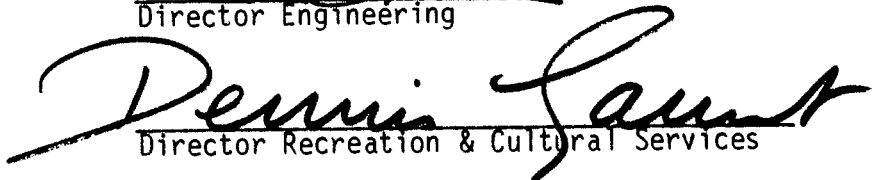
Director Planning & Building Inspection



Chief Public Health Inspector



Director Engineering



Director Recreation & Cultural Services

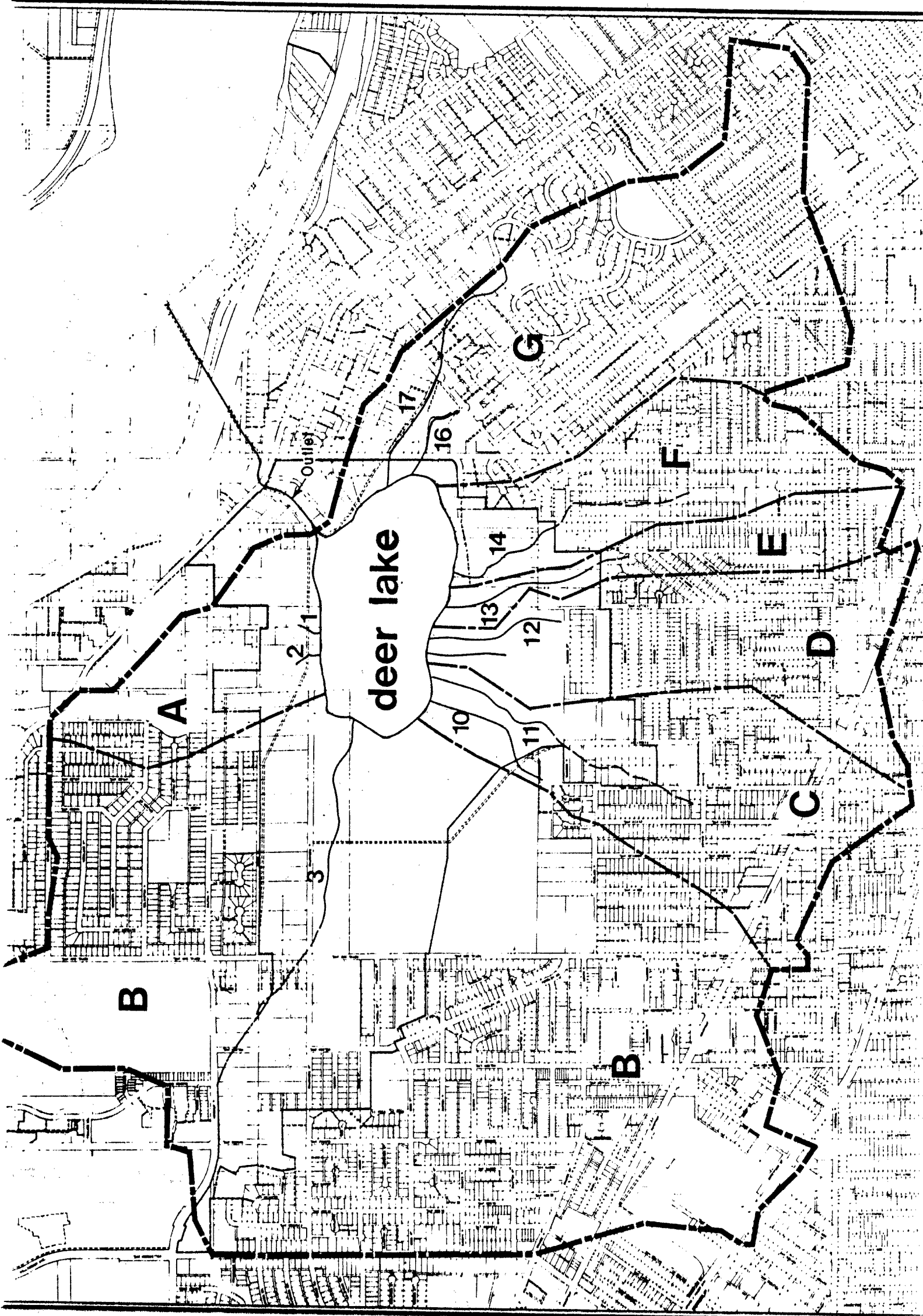
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c.c. Municipal Treasurer

- - - Deer Lake Watershed Boundary
 - - - Subdrainage Boundary of Major Inflows

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FIGURE 2

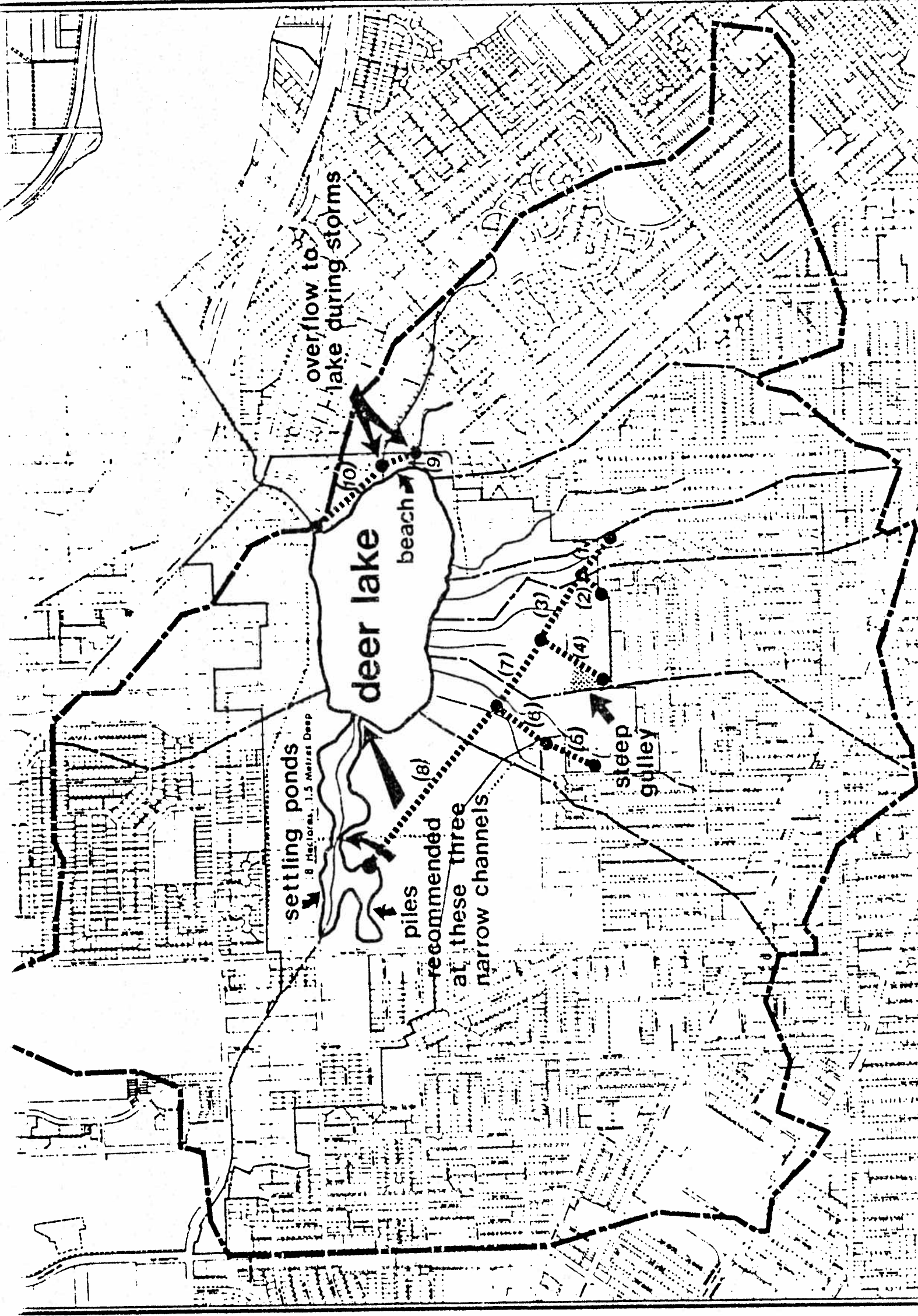


STORMWATER
DIVERSION
SYSTEM

Stormwater
 Diversion
 Lines

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FIGURE 3



overflow to lake during storms

deer lake

beach

setting ponds

8 Ponds, 1.5 Meters Deep

piles recommended at these three narrow channels

steep gully

(10)

(9)

(7)

(3)

(2)

(1)

(4)

(5)

(6)

(8)

