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TO: Chair and Members, BWAB

Subject: Water quality sampling & objectives, Kearney and Paper Mill Lakes

Under the terms of the Secondary Planning Strategy for Bedford West, HRM is to undertake water quality monitoring, and set water quality objectives, as outlined in Policy BW-3 (attached).

For the pending phase of the Bedford West development, the lakes likely to experience possible impacts are Kearney Lake, and Paper Mill Lake. Kearney is peripherally involved but may receive some drainage from the proposed development, while Paper Mill Lake is directly downstream. HRM has developed a preliminary sampling program, consisting of seasonal sampling (spring, early summer, late summer and fall) for water quality at the deep station for each lake (surface during spring and fall, 3 depths during summer when the lakes are likely to stratify), and surface samples at the inlets (2) and the outlet for each lake.

Parameters to be measured should include RCAP-MS (suite of parameters, details attached), Total Phosphorus (TP, 0.002mg/L Detection Limit), Total suspended solids (TSS), faecal coliform bacteria, and chlorophyll.

Setting of water quality objectives to track eutrophication (as per BW-3) involves setting a threshold value for total phosphorus using the CCME Guideline for Phosphorus. The Guideline provides a framework for setting a threshold, not a numerical limit. Under the Guideline, several approaches are possible (see attached process outline):

- Set a management objective for the lake in question, and set a phosphorus threshold based on this objective.
- Determine the baseline reference (pre-development) TP level of the lake using historic data (if available), modelling or other method, determine the upper limit of the trophic range for this reference level, and set the threshold at this value.
- Adopt an ecozone approach to defining reference conditions.

If the threshold value is exceeded, then further assessment is required.

For Morris and Russell Lakes in Dartmouth, HRM adopted a management objective of preservation of the lakes in their current trophic state. Trophic state limits as used by CCME are:

CCME Lake Trophic Categories

TP (ug/l)	Trophic state	TP (ug/l)	Trophic state
0-4	Ultra-oligotrophic	20-35	Meso-eutrophic
4-10	Oligotrophic	35-100	Eutrophic
10-20	Mesotrophic	100+	Hypereutrophic

Morris and Russell Lakes, based on available historic and recent data, are within the low end of the mesotrophic range. While the CCME framework would allow adoption of the upper limit for this range as the threshold value, HRM (through Harbour East Community Council) adopted the mid-range value of 15 (ug/l) TP as the threshold.

For Kearney Lake and Paper Mill Lakes, the pre-development TP level was very likely in the Oligotrophic range, as would have been the case for most of the lakes in the HRM area. The situation is slightly complicated by the fact that these are in some sense artificial lakes created by impoundments, but the state of the lakes prior to significant development in the watershed was likely oligotrophic. Phosphorus models provided by the Soil & Water Conservation Society indicate that the background levels were possibly ultra-oligotrophic.

Available historical data for Kearney Lake indicate that TP levels were in the 4-10 range during the 1980s and 90s, with a value of 9 found in 2000 by BIO. Sampling in 2006 by HRM found a TP level of 6 in spring, and undetectable levels in fall. Available historical data for Paper Mill Lake indicate that TP levels were also in the 4-10 range during the 80s and 90s, with a value of 11 found in 200 by BIO. Sampling in 2006 by HRM found a TP value of 7 in spring, and 6 in fall. Summer sampling was not conducted in 2006, but levels would likely have been higher during that period.

TP modelling conducted for Annapolis by CWRS (2004) considered development scenarios and combinations of serviced and on-site areas within the watersheds. The study predicted that Kearney Lake would likely change from oligotrophic to mesotrophic (12-17 ug/l TP depending on on-site inputs), and that Paper Mill would also change to mesotrophic (16-20 ug/l TP). Actual resulting levels depend on management of on-site systems (impact can be reduced by connecting more on-site locations to central servicing), and stormwater management (reduction of nutrient inputs, treatment options, buffer strips).

If the management objective for these lakes is to maintain the current trophic status, and based on the likely reference conditions, then the phosphorus threshold value would be 10 ug/l TP. If the management objective is to prevent progression to meso-eutrophic conditions, then the phosphorus threshold would be 20 ug/l TP.

In setting a threshold level, consideration must be given to practical considerations. Progression to mesotrophic conditions seems likely for both Kearney and Paper Mill Lakes with significant further development within their watersheds. Under the CCME Framework,

progression beyond a threshold value triggers further assessment, and the necessity of a management decision whether the change is acceptable. If not, then further actions are required such as nutrient reduction, flow management, education and monitoring.

Nutrient reduction options would include community stewardship initiatives such as fertiliser reduction and pet waste management. More significant measures would include the requirement of stormwater treatment for nutrients (engineered wetland - type solutions), reduction of on-site systems within the watersheds, or limits on any further development under planning strategies.

Setting of objectives for other parameters under CCME Guidelines is also possible, for example faecal coliform bacteria, pH and TSS.

Recommendation:

Set the management objectives for Kearney and Paper Mill Lakes as being preservation of the current oligotrophic state of the lakes, and set the TP threshold levels at 10 ug/l TP.

Alternatives:

Set the management objectives for Kearney and Paper Mill Lakes as being prevention of progression to meso-eutrophic conditions, and set the TP threshold levels at the mid-range of the mesotrophic range 15 ug/l TP, or at the upper end of the mesotrophic range 20 ug/l TP.

Bedford West Secondary Planning Strategy policy BW-3

Policy BW-3:

A water quality monitoring program shall be undertaken for the Paper Mill Lake watershed, illustrated on Schedule BW-2 to track the eutrophication process. The program is to be designed in accordance with national guidelines established by the Canadian Council for Ministers of the Environment (the CCME guidelines) and undertaken by a qualified persons retained by the Municipality and financed in whole or in part by developers within the watershed area. Specifics of the program are to be negotiated under the terms of a development agreement in consultation with the Bedford Watershed Advisory Board. The monitoring program shall:

- A. specify the duration of monitoring for the pre-construction, construction and post-construction phases of development. Pre-construction phase means a period of time before construction activity starts. Post-construction phase means a period of time that commences at full build out of the area permitted by a development agreement. Construction phase means the full time period between the pre-construction and post-construction phase);
- B. specify the physical and chemical water quality indicators to be measured, the location and frequency of testing and the format of submissions to the Municipality in each phase referenced under clause (a);
- C. establish physical and chemical water quality indicator threshold levels for the recreational uses of the lakes which would be used as a basis for reevaluating watershed management controls and future development potential within the area. The threshold indicators are to be established prior to any development approvals being granted;
- D. conform with all water quality policies, specifications, protocols and review and approval procedures approved by Regional Council.

RCAp Parameters	RCAp-MS includes RCAp parameters plus:
Sodium	
Potassium	Nitrate plus Nitrite
Calcium	Aluminum
Magnesium	Antimony
Hardness as CaCO ₃	Arsenic
Iron	Barium
Manganese	Beryllium
Copper	Bismuth
Zinc	Boron
Alkalinity as CaCO ₃	Cadmium
Sulphate	Chromium
Chloride	Cobalt
Reactive Silica as SiO ₂	Lead
Nitrate + Nitrite as N	Molybdenum
Ammonia as N	Nickel
o-Phosphate as P	Phosphorous
Total Organic Carbon	Selenium
pH	Silver
Conductivity	Strontium
Colour	Thallium
Turbidity	Tin
Bicarbonate as CaCO ₃	Titanium
Carbonate as CaCO ₃	Uranium
Saturation pH (4oC, 20oC)	Vanadium
Langelier Index (4oC, 20oC)	
Cation Sum	
Anion Sum	
Ion Balance	
Total Dissolved Solids (calc'd)	

Use of Canadian Guidance Framework for the Management of Phosphorus in Freshwater Systems (Environment Canada, 2004) and the CCME Phosphorus Guideline

CCME Process

- Step 1: Set Ecosystem Goals and Objectives: (eg. enhance, protect or restore)
- Step 2: Define Baseline/Reference Condition
- Step 3: Select Trigger Range (limits of Reference trophic category)
- Step 4: Determine Current TP
- Step 5: Compare to Trigger Range (or 50% increment over Baseline)
- Step 6: Management Decisions

Two illustrative Case Studies are provided in the Environment Canada 2004 Report:

1) Lake Simcoe, ONT

Goal: “restore a self-sustaining cold-water fishery”

Baseline/Reference Condition: set at 9-10 ug/L suitable to this kind of fishery. Baseline is set only in regard to desired ecosystem goal. No reference to historical data, comparison to reference lakes, or model hind-casting

Trigger Range: 4-10 ug/L (oligotrophic)

Threshold: 10 ug/L

Trigger range is exceeded by current TP (15) so further assessment is advised even though baseline is at upper limit of trigger range (50% increment over baseline is also exceeded).

Management Decision: reduce phosphorus loading, refine loading estimates

2) Kodiak Lake, NWT

Goal: not explicitly set, although environment described as “pristine and fragile”. Intent is to predict impact of new diamond mine.

Baseline/Reference Condition: pre-mining data used to set baseline at 11.1 ug/L (1994-1996 ice-free mean). No reference to pristine conditions prior to nearby development or model hind-casting.

Trigger Range: 10-20 ug/L (mesotrophic)

Threshold: 20 ug/L

Implied goal is thus to maintain existing mesotrophic status.

Modelling predicts exceedance of threshold due to mine operation.

Management Decision: options to reduce external and internal phosphorus loading.