Chapter 4

“Stormwater Management on Somebody Else’s Land!”

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Dwindling resources and social incompatibilities are two of the key reasons why land developers often encounter difficulties in implementing stormwater management facilities on their land, in, or adjacent to existing communities (i.e. NIMBY). Public works departments are concerned with the cost of maintaining a growing number of geographically disparate facilities. Developers are concerned with the costs of construction, and the often greater cost of land dedication for facilities. Community residents, particularly those already in the neighbourhood, are concerned with safety, odour, aesthetics, and taxes.

The simple solution is to avoid the problem altogether by integrating the land use and infrastructure planning process. Unfortunately, in many if not most circumstances, planning decisions have already been committed to, and in some cases (i.e. in-fill situations) master planning may never become a reality.

This chapter describes a case study, which through intensive stakeholder consultation and comprehensive alternative screening, has resulted in a superior stormwater management proposal, addressing the concerns of the municipality, development community and public. The analysis and documentation procedures are necessarily more comprehensive, in order to address the broader-based issues of additional stakeholders. The results however, in terms of economics, physical environment and social acceptance, are in some instances considered superior to conventional stormwater practice.

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4.1 Introduction

We live in a “user pays” society. Proponents are expected to cover costs associated with the gain they realize. While there is nothing particularly flawed with this philosophy, it can often lead to singular or one-dimensional thinking when it comes to problem solving.

A specific case is management of the impacts on stormwater resources associated with land development. Traditionally, where developments are of sufficient size, a stormwater management facility (or facilities) is planned and designed near the lowest portion of the site. The facility often serves multiple uses such as flood and erosion control, water quality enhancement and passive recreation. Where the social (including economic) and physical environments are compatible, the foregoing approach works well. It obviously works best when land use planning and master planning of infrastructure are integrated into a common process.

Difficulties arise in jurisdictions which either have not integrated land use and master servicing planning, or in which land use decisions predate current planning and design policy and procedures. These situations demand innovative procedures to ensure that stormwater management practices remain compatible with the social and physical environments.

This chapter describes, through a case study, the various undertakings associated with implementing an “off-site” stormwater management project, including decision-making points, consultation, screening, analysis, results and conclusions. The case selected is one of several available for which “off-site” solutions were proven to be advantageous.

4.2 Rationale

There are numerous reasons which support the “off-site” approach to stormwater management. These include:

Incompatibility with existing development:

- where new development is proposed adjacent to existing development, stormwater management facilities are often considered to be safety hazards, sources of odour and an aesthetic concern;
- existing development in its lot sizes, roadway configurations and setbacks, usually has not taken stormwater management infrastructure into account; and
- existing residents in older neighbourhoods are reluctant to be exposed to new development and its infrastructure, particularly when it is perceived to devalue their property.

Physical and environmental incompatibilities:

- there are often better locations for facilities within a watershed (i.e. other than the developer's land) which can provide more effective stormwater management to the benefit of the overall physical environment; and
- site conditions can be such that physically a facility is difficult to construct on the developer's lands.

Economic:

- siting facilities on the developer's property, often leads to costly construction due to on-site subsurface conditions, requirements for off-site upgrades, or duplicate infrastructure;
- numerous smaller geographically-disparate facilities may increase the short and long term maintenance costs of the operating authority; and
- larger, more centralized facilities located in more construction-friendly environs, are typically less costly due to economy of scale factors.

Why then, if the rationale is so compelling, has the off-site philosophy of locating stormwater management on somebody else's land, not become more widespread? To answer this question, one must closely examine the federal, provincial and municipal regulations which govern stormwater and environmental management. Policy makers have prescribed standards and criteria which specify that new development must manage and mitigate potential impacts resulting from more and degraded storm runoff. Policies are in place which regulate flooding, erosion, fisheries, vegetation, wildlife and more. Where agency endorsed master plans are not in place, policy makers have set further standards, usually more conservative, to account for uncertainties due to a lack of regional or system analysis.

It is, hence, primarily a matter of convenience and ease of straight-line thinking which has led to the internally contained user-pay philosophy of stormwater management. If you need it and you benefit from it, then you must build it--even if the community does not like it, the environment suffers and it costs twice as much as an alternative solution.

Approvals for conventional stormwater management systems are reasonably efficient and well understood by agencies and the development community. The cost and time lines associated with the supporting technical analysis and documentation is also relatively standard and easy to predict. Also, when proponents proceed with a conventional solution on their own lands, they are rarely required to enter into consultation with other stakeholders with disparate objectives. Since the land-use planning requirements would be assumed to be in-place, the only stakeholders under the conventional scenario would be the local municipality and approval agencies - not private landowners or special interest groups.

Proposed off-site solutions introduce uncertainty associated with:

- the approval process,
- cost and time of studies and designs, and
- stakeholder input.

It is this uncertainty that has discouraged development proponents from implementing off-site solutions.

4.3 Case Study

This chapter focuses on a case study which demonstrates the economic and environmental benefits associated with the off-site stormwater management solution. The Montgomery Creek watershed, the focus of this chapter, is a tributary area of the Red Hill Creek watershed, in the eastern part of the Regional Municipality of Hamilton-Wentworth (Figure 4.1). The development area, subject to management, is located in the headwater above the Niagara Escarpment.

4.4 Montgomery Creek Class Environmental Assessment

4.4.1 Background

Contiguous land holdings in the Regional Municipality of Hamilton-Wentworth, City of Hamilton, and City of Stoney Creek were proposed for development in an area east of Mount Albion Road located to the north and south of Mud Street (reference Figure 4.1). Due to previously identified downstream concerns particularly focussed on erosion through a golf course, as well as water quality remediation efforts directed at a provincial Area of Concern, it was considered prudent to initiate a high-level, comprehensive study.

The process set out for the Municipal Engineers Association (MEA) Class Environmental Assessment for Water and Wastewater Projects (MEA, 1993) process was selected as the appropriate vehicle to complete the study, because of the potential requirement for centralized stormwater management facilities outside of each development site, such sites having not previously been identified on development plans.

The purpose of the class environmental assessment (Class EA) process is to promote the protection and conservation of the environment through comprehensive planning and informed decision-making. It allows for the evaluation of the environmental impacts of a project or alternatives to a project, as well as the assessment of the impacts of alternative methods of carrying out a project.

Figure 4.1 Stormwater management alternatives.

The primary purpose of this Class EA study was to determine the preferred stormwater management for developments located in the headwaters of the Red Hill Creek on the Montgomery Creek (development area). The study was primarily focused on:

- determining the requirements for mitigation of flooding, erosion and water quality impacts of future development, and,
- where facilities are required, the potential to provide stormwater management in a more efficient, co-ordinated manner for the entire development area through centralization of such facilities.

4.4.2 Problem Statement

Urbanization generally reduces opportunities for stormwater to infiltrate. This increases the volume and rate of stormwater runoff resulting in higher, more frequent peak flow rates from the developed area, leading to increased occurrences

of flooding and erosion. Of particular importance to the Montgomery Creek study were the watercourse reaches located below the Niagara Escarpment, downstream of the development area, currently experiencing significant erosion within the golf course.

Urbanization also typically degrades water quality (i.e. high loading of pollutants such as nutrients, organic compounds and heavy metals). Without proper stormwater management, urbanization of the development area, may increase erosion and flooding on the downstream watercourses, potentially incurring damage to downstream properties, as well as degrade water quality in the receiving watercourse system, including the Hamilton Harbour Area of Concern. Impact limits of the study (i.e. study area) conform with the local Montgomery Creek subwatershed, which is a tributary to the Red Hill Creek (Figure 4.1). The subwatershed basis for the study area definition is considered appropriate, as it includes all areas which receive and contribute surface flow to the development area.

4.4.3 Baseline Conditions

An inventory of the physical and social environment associated with the study area identified the following key features:

- multiple proponents of development;
- shallow bedrock within the development area (i.e typically within 1 metre of the ground surface);
- significant in-stream erosion in receiving watercourse; the watercourse is highly sensitive to potential increases in erosion-causing flow events;
- environmentally sensitive area, which includes the watercourse system, downstream of the development area;
- previously constructed storm sewer infrastructure at depth; the depth and configuration of the existing storm sewer system would preclude its use in conjunction with a central stormwater management facility within the development area; and
- substantial urban residential development within subwatershed (approximately 60 ha) with no stormwater controls.

4.4.4 Alternative Screening

Based on consideration of the baseline conditions, several stormwater management solutions were subjected to a screening process. The purpose of the screening was to determine a range of reasonable stormwater management solutions for resolving the identified problems. A watershed program, the Hydrologic Simulation Program - Fortran (HSP-F), was used to assess the effects of various storm water management alternatives on erosion and flood potential

in the downstream reaches of the Montgomery Creek. Water quality mitigative techniques were screened on the basis of compliance with provincial stormwater management practices (Marshall Macklin Monaghan Limited, 1994).

Each stormwater management alternative was analyzed in terms of its functional effectiveness to address the following:

- prevent increases in flood potential,
- prevent increases in erosion potential, and
- prevent degradation of water quality in accordance with provincial objectives and guidelines.

The stormwater management alternatives which were screened included:

1. do nothing (i.e. uncontrolled future development),
2. source controls,
3. watercourse improvements,
4. combination of watercourse improvements with supplemental water quality treatment, and
5. end-of-pipe storage facility.

Based on the foregoing screening process, two stormwater management alternatives were considered to be appropriate:

Alternative 4 - combination of watercourse improvements with supplemental water quality treatment, and

Alternative 5 - end-of-pipe storage facility only.

A further evaluation of these two alternatives was undertaken based on the following criteria:

- functional effectiveness
 - flood potential
 - erosion
 - water quality
 - terrestrial
 - fisheries
 - hydrogeology,
- social/land use,
- staging/timing, and
- economic.

4.5 Detailed Evaluation

4.5.1 Flow Assessment

To assess the impact of proposed urban development on the Montgomery Creek tributary, HSP-F was adopted for system evaluation and design. Continuous simulation using historical rainfall data as input to generate a long term

time-series of flows at various key points in the watershed provided the peak flows and their frequency. In addition, continuous simulation offered significant benefits in the evaluation of water quality and quantity management strategies through the full range of flow conditions, from baseflow to flood flows.

HSP-F, originally developed by HydroComp Inc. for the US EPA, is a program approved by the Province of Ontario. It was used in 1989 to develop a calibrated model of the Red Hill Creek (Philips Planning and Engineering, 1989), which was modified and discretized to the level of detail required for this study. Precipitation, evaporation, and snowmelt processes were simulated in the updated HSP-F program, in order to assess the seasonal performance of stormwater management alternatives over a full year.

The continuous time series was analyzed using the three-parameter log-normal distribution where the coefficient of skew is positive. Return period flows were generated as shown in Table 4.1.

Table 4.1 Frequency flows - existing and future land use.

Return Period	Peak Flows (m ³ /s)							
	Development Area Outlet		Storm Sewer Outfall		Toe of Escarpment		Golf Course	
Yrs	Exist.	Future	Exist.	Future	Exist.	Future	Exist.	Future
2	0.33	0.95	1.65	2.26	4.41	4.48	5.36	6.09
5	0.51	1.26	2.52	3.28	6.79	7.30	8.73	9.44
10	0.62	1.44	3.14	3.99	8.44	9.00	11.2	11.70
20	0.74	1.61	3.75	4.68	10.10	10.70	13.6	13.80
50	0.89	1.80	4.58	5.60	12.20	12.90	17.0	16.60
100	1.00	1.94	5.23	6.31	13.90	14.60	19.7	18.70
Reg. Storm	3.82	3.23	7.13	9.97	23.3	23.41	30.9	31.11

The results illustrated in Table 4.1 indicate that full development without mitigation would result in maximum increases in peak flows of 39% from the 2700 mm diameter storm outfall during a 2-year event. This increase would be due largely to the increased drainage area to the storm sewer system, because of a redistribution of flow from the local watercourses to the storm sewer system. The net increase in peak flow is 7.5% reflected at the Toe of the Escarpment (i.e. confluence of the storm sewer outfall and Montgomery Creek).

The maximum increase in peak flow at the downstream limit with the golf course would be approximately 13% for a 2-year storm event. Under more severe storm events (i.e. less frequent), the peak flows would increase marginally or even decrease.

4.5.2 Erosion Assessment

The watercourse reaches located below the Niagara Escarpment, downstream of the proposed development area are currently experiencing significant erosion. Based on this existing condition, it is considered that any additional urban development without proper stormwater management may potentially increase erosion potential on the downstream watercourses incurring damage to downstream properties.

In a typical natural watercourse, the long-term stream morphology is primarily influenced by bank-full flow conditions which may occur annually in natural watersheds (OMNR, 1994). Within urbanized watersheds, unless or until the channel reaches a new dynamic equilibrium, the bank-full flow events occur more frequently, which, in conjunction with man-made alterations to stream geometry, or the relationship of the stream to flood plain, increase erosion potential.

The watercourse immediately downstream of the 2700 mm diameter storm outfall to the toe of the escarpment, is typically resistant to erosion despite changes in flow regime. This characteristic is based on its substrate and type, verified through field reconnaissance.

The channel in this location exhibits steep channel slopes of approximately 6%, with substrate consisting of large angular limestone cobbles progressing to boulders and bedrock approaching the Niagara Escarpment Crest. This section of the watercourse also exhibits stepped pool sequences with a small meander amplitude (i.e. sinuosity = 1.1). Based on the Rosgen classification system this section of the watercourse can be categorized as a Type A stream. This type of stream is inherently stable and resists erosion when subjected to changes in flow regime (Rosgen 1994, Annable 1994). Based on the foregoing, the stream morphology of the upper reach of the Montgomery Creek, as it traverses the escarpment (i.e. to the upstream limit of the golf course) would not be expected to experience a significant change in erosion rate or morphology, due to the proposed upstream development.

The watercourse through the golf course however exhibits a number of active erosion sites. The bank soils are primarily sandy loam with low cohesion underlain by a cohesive clay unit. The cross-sectional geometry is also typically characterized by steep-sided slopes which leave the stream bank vulnerable to erosion even during low to moderate runoff events.

An assessment of the existing watercourse's susceptibility to erosion, in relation to proposed development and stormwater management techniques, was undertaken as part of the Class EA using a duration analysis approach. Duration analysis is based on the principle of determining the length of time a watercourse is exposed to erosive flow rates. Typically a watercourse is stable under low flow

and extreme flood flows when spill of flow onto the floodplain causes backwater effects which partially relieve shear stress; it is the flow rates associated with frequent storm events which most often are cited as erosive.

As indicated, the watercourse downstream of the proposed developments exhibits numerous erosion zones which typically feature near vertical side slopes and exposed soils (i.e. typically erodible sandy loam). In essence this existing unstable condition means that any storm event would cause some erosion. Based on these site conditions, the erosion assessment has conservatively included evaluation of shear force (i.e. erosive force) resulting from all flows in excess of $0.1 \text{ m}^3/\text{s}$, which essentially ensures that all erosive rainfall/runoff events are included in the assessment. The sum of the cumulative shear, (i.e. long term summation of shear stress multiplied by time) which occurs at various channel cross-section locations, was used as a measure to predict the effectiveness of the various stormwater management alternatives considered in this assessment.

Table 4.2 provides a summary of cumulative shear force at various locations along Montgomery Creek. The summary is based on existing and future land use (i.e. development area) for a three year period, corresponding to wet, dry and average rainfall years.

Table 4.2 Cumulative shear force existing and future land use (no stormwater management).

Land Use	Cumulative Shear at Stations (Pa*15 min)				
	Toe of Bank (0 x Bankfull Depth)	20% of Bankfull Depth	50% of Bankfull Depth	80% of Bankfull Depth	100% of Bankfull Depth
Existing	193161	114708	8967	4081	2224
Future (No Stormwater Management)	193263	116879	9817	4328	2349
% Change	0.05	1.89	9.49	6.06	5.62

The results indicate that uncontrolled development of the development area would increase erosion potential within the downstream watercourse (through the golf course) by a maximum of 9.49 % in a typical stream cross-section.

4.5.3 Alternative Assessment

As outlined in Section 4.4, the only viable alternatives considered appropriate for mitigating the potential impacts from the development area involve end-of-pipe storage or a combination of storage and watercourse improvements.

End-of-Pipe Storage

Based on the foregoing screening, the use of end-of-pipe storage under a number of reasonable alternative configurations were subject to an evaluation of performance. Essentially, end-of-pipe facilities were considered to be located either within the development area (on-site) or at some point downstream of the development area (off-site). The results of the evaluation of the selected end-of-pipe facilities with various storage/discharge relationships are provided in Table 4.3

Table 4.3 Cumulative shear force existing and future land use with end-of-pipe treatment.

Facility Location	Stormwater Management Alternative	% Change in Cumulative Shear at Various Bed and Bank Stations as compared to Existing Conditions				
		Toe of Bank	0.2 Depth	0.5 Depth	0.8 Depth	1.0 Depth
On-Site	Future Land Use with End-of-Pipe Facility within the Development Area (3500 m ³ storage, 24 hour drawdown and 1-3 L/s infiltration losses from facility)	0.06	-0.5	0.14	-1.59	-2.39
On-Site	Future Land Use with End-of-Pipe Facility within Development Area (3150 m ³ storage, 24 hour drawdown and no infiltration losses from facility)	2.28	3.12	0.07	-1.31	-2.31
On-Site	Future Land Use with End-of-Pipe Facility within Development Area [3150 m ³ storage, 168 hour (7 day) drawdown and no infiltration losses from facility]	1.49	0.94	1.45	0.65	-0.21
Off-Site	Future Land Use with End-of-Pipe Facility on Golf Club Lands (3500 m ³ storage within quality and quantity facility)	1.46	4.3	5.05	-4.90	-5.89
Off-Site	Future Land Use with End-of-Pipe Facility on Golf Club Lands (2800 m ³ storage within quality and quantity facility)	0.97	3.48	5.27	-3.99	-4.00
Off-Site	Future Land Use with End-of-Pipe Facility on Golf Club Lands (2300 m ³ storage within quality and quantity facility)	-1.27	0.52	7.23	2.39	2.69
N/A	Future Land Use - No Stormwater Management	0.05	1.89	9.49	6.06	5.62

The foregoing analysis demonstrated the following:

- the effectiveness of the end-of-pipe above the escarpment is primarily related to the release rate from the facility and performance is improved with consideration of infiltration losses from the facility;
- end-of-pipe facilities utilizing 24 hr drawdown and 38 mm/ha storage were effective in mitigating increased erosion at higher bank stations (i.e. during near bankfull flow);
- standard extended detention storage and drawdown periods do not effectively mitigate increased erosion potential in low bank stations (i.e. toe of slope region);
- the introduction or promotion of seepage loss from the stormwater storage system, which essentially loses flow from the system would effectively mitigate increased erosion potential at all channel bank stations;
- an off-site facility would provide effective mitigation of upper bank station (i.e. top of channel bank) erosion impacts, however large volumes of storage would be required to control erosion impacts on lower bank stations (i.e. toe of channel bed/bank); and
- stabilization of the toe region of the downstream watercourse merits attention as a supplemental erosion mitigation technique to storage.

Watercourse Improvements

Improvements to the downstream watercourse not only address the current problems but also future erosion impacts. Watercourse stabilization would primarily consist of altering the channel section to achieve a stable form along with re-establishment of riparian vegetation to prevent further recurrences of erosion.

The use of watercourse improvements while focussing on erosion impacts would also provide residual water quality benefits through a reduction in suspended solids loading to the watercourse during runoff events, due to reduced bank erosion. Notwithstanding this benefit, watercourse stabilization as a standalone mitigation technique would not be considered to address water quality impacts from new development.

Stormwater Management Alternatives

Based on foregoing analysis, Class EA study process, and input of various stakeholders the range of stormwater management alternatives was narrowed to two main alternative strategies which were carried forward for further analysis:

- on-site stormwater management within the development area (escarpment alternatives including single and multiple facilities); and
- off-site stormwater management (golf course alternative).

A brief description of each alternative follows:

1. *On-Site Stormwater Management within the Development Area (Escarpment Alternatives)*. This would provide a traditional development drainage form utilizing urban road cross sections and directing discharge to a storm sewer conveyance system. Stormwater would then be conveyed to an end-of-pipe management facility for water quality treatment and management of erosive flows.

Based on the shallow bedrock topography in the study area, a constructed wetland with its associated shallow permanent pool components, as well as extended detention component for erosion control was selected for further evaluation, rather than a deeper wet pond configuration.

The on-site stormwater management (escarpment alternatives) have been screened to include two sub-alternatives with respect to facility location, namely:

- consolidated stormwater management facility servicing all of the development, and
- individual stormwater management facilities located within each primary development site.

2. *Off-Site Stormwater Management (Golf Course Alternative)*. This alternative would involve the construction of stormwater management facilities within the existing golf course lands. The golf course alternative would consist of three primary components:

1. stormwater facilities
 - water quality management facility
 - water quantity (erosion) management facility,
2. watercourse stabilization, and
3. golf course alterations to accommodate facilities.

An off-site facility within the golf course would control the entire subwatershed drainage area, thereby providing a high degree of runoff control. The drawbacks, however, would be that such a system would require control of significantly larger volumes of runoff, hence land requirements for a facility would be demanding. In addition, securing approvals for the golf course alternative due to its broader scope and additional stakeholders would likely constrain current development objectives.

The technical analysis of the off-site facility indicated that it would be essentially infeasible to construct a standalone facility large enough on the golf course property to effectively maintain existing erosion potential.

Flood Assessment: Both the escarpment and golf course alternatives effectively address off-site flood potential by managing the potential peak flow increases associated with frequent flow events.

Erosion Assessment: Table 4.4 demonstrates that to some degree both the off-site and on-site management alternative address erosion potential. The off-site alternative though, principally due to the size of the watershed which is managed, necessarily requires supplemental bank stabilization (i.e. watercourse improvements). Notwithstanding, the watercourse improvements enhance the overall stream ecosystem and reduce long term maintenance concerns.

Water Quality - Pollutant Removal Assessment: The pollutant removal performance of the two primary stormwater management alternatives (i.e. on-site and off-site) was assessed using two methodologies:

- the water quality component and storage volumes for end-of-pipe facilities located within the development area (i.e. escarpment alternatives) have been based on the Stormwater Management Practices - Planning and Design Manual (MOEE, 1994).
- sediment removal for off-site stormwater management (i.e. golf course alternative) was assessed on the basis of average annual loading using the event mean concentration (EMC) for various land uses from which annual sediment loadings have been derived. The annual sediment removal was in turn, estimated based on the foregoing loading in conjunction with continuous simulation analysis to determine the total stream flow which is treated in the proposed off-line system.

Table 4.4 Sediment removal assessment.

Alternative	Drainage Area (ha)	Land Use		Annual Sediment Loading (m ³ /yr)	% Annual Runoff Conveyed to Facility	Annual Sediment Removal (m ³)
		%	Usage			
On-site Stormwater Management Escarpment Alternative Stormwater Management Facility within Development Area	24.1	100	urban	38	100	27
Off-site Stormwater Management Golf Course Alternative Stormwater Management Facilities located downstream of Development Area (off-line constructed wetland)	207.3	39 6 55	urban agricult ure idle	276	21	41

The analysis was based on a mass loading approach combined with an assessment of the total volume of runoff treated within the golf course water quality facility and empirical removal efficiencies provided by constructed wetland systems. The golf course alternative (off-site) would remove approximately 53% more sediment from the watercourse than would the escarpment alternative (on-site).

The golf course alternative, located off-line on the Montgomery Creek would intercept and remove a greater volume of pollutants than the escarpment alternative and would therefore be considered to provide superior water quality performance in the context of the downstream sections of the Montgomery and Red Hill Creeks. The golf course alternative would however result in incremental increases in sediment and other pollutants associated with urban land use from the 2700 mm diameter outfall to the proposed facility. Downstream of the facility, water quality would be expected to improve over existing conditions due to the complete capture of frequent first flush runoff events with their high pollutant concentrations.

4.6 Selection of Alternative

The golf course is the preferred alternative, provided that the timing problem outlined below can be overcome.

4.6.1 Advantages of the Golf Course Alternative

The following summarizes the advantages of the golf course over the escarpment alternative.

Economic:

- The golf course alternative is less expensive than the escarpment alternative largely due to no requirement for rock excavation and the elimination of duplicate storm sewer runs on the escarpment.
- Through consultation, the golf course has indicated a willingness to undertake maintenance of the facility thereby overcoming the need to commit municipal resources.
- By implementing the golf course alternative, an additional 0.8 ha will be available within the development area for possible future development, subject to compliance with future land use studies.

Environment:

Physical

- The Montgomery Creek through the golf course will be stabilized through erosion/ sedimentation control measures.

- Bioengineering works will add to the overall biodiversity and reduce maximum in-stream temperature during summer.
- A measure of in-stream water quality improvement will be provided to the entire watercourse downstream of the water quality facility, improving runoff quality from existing and future development.
- Addition of wetland habitat within the golf course enhances the aquatic habitat of this environmentally sensitive area (ESA).

Social

- The golf course will become a better, more playable facility.

4.6.2 Disadvantages of the Golf Course Alternative

The disadvantages to the golf course alternative would be:

Timing:

- Given the involvement of additional stakeholders, as well as the broadened scope of works, there is an extended time frame required to implement the golf course alternative.

4.7 Conclusion

In certain circumstances, an off-site stormwater management approach may be preferred over the traditional on-site management approach as it may:

- reduce overall costs;
- provide more effective water quality treatment;
- be more compatible with existing and proposed land use; and
- provide greater habitat potential.

The class environmental assessment process provides an appropriate mechanism to evaluate alternatives in the context of a broad set of multi-faceted issues with broad public consultation. In this case, public consultation, as required by the Class EA process, has been one of the key factors that led to the selection of an off-site stormwater management solution.

Several questions which must be considered when weighing the merits of an off-site stormwater management approach include:

- Are there opportunities to positively improve existing off-site habitat conditions, if currently degraded ?
- Are there opportunities to remedy existing downstream problems within the framework of the objectives of the study proponents?
- In areas where some level of development has occurred without stormwater management controls, are there significant resources downstream of potential off-site facility locations which would

benefit from a combined stormwater management approach to maximize water quality treatment or flow rate control?

- In areas where stormwater conveyance infrastructure has been constructed in advance of development, are there opportunities to maximize the use of the existing infrastructure through off-site stormwater management?
- Is there an appropriate planning and evaluation process available to facilitate the broad public consultation required to select and implement an off-site stormwater management solution?
- Are the implementation timelines of the developers compatible with an off-site solution?

If the foregoing considerations can be addressed, there may be merit in considering an off-site stormwater management solution which may provide a means of addressing the individual objectives of a number of stakeholders within a consolidated management strategy. The key consideration to success of such an approach is the requirement for an appropriate planning and evaluation process such as that provided by the class environmental assessment legislation.

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