WATTS CREEK WATERCOURSE AND WATERSHED MANAGEMENT PLAN

Prepared for:

National Capital Commission
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Ottawa, ON

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Project No.: 1634-00982

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1.0 Introduction

The Nation Capital Commission (NCC) is a major riparian landowner within the Watts Creek watershed. This watershed is composed of two watercourses. The first watercourse is the Watts Creek channel that flows from Kanata center to Shirley's bay. The second watercourse is the Kizzel Municipal Drain flowing from Morgan's Grant until it discharges into the Watts Creek watercourse south of Carling Avenue. The NCC is the primary steward of Watts Creek and the lower portion of the Kizzel Municipal Drain. The Watershed area plans Watts Creek and Kizzel Drains are shown on Figure A and B on the page following.

In response to the development pressures currently taking place within the watershed, the NCC retained Stantec Consulting Ltd. (Stantec) to document the potential impacts of development on Watts Creek. In addition, Stantec is to set out a responsible plan, including in stream works and combined upstream flow control, which will protect and ensure the long term sustainability of Watts Creek.

1.1 BACKGROUND

A review of available background information was completed in accordance with the National Capital Commission's request to perform an update of the sub-watershed study for Watts Creek. The purpose of this review is to establish an information baseline on which the current state of the creek conditions can be compared and to develop a watercourse management plan that is responsible and feasible.

A listing of the background information/studies reviewed herein is as follows:

- 1973 Report on Improvement of the Kizzel Municipal Drain Lot6 Conc. IV, Township of March Lot 1, Con A O.F. , Township of Nepean. By-Law 34-73. By J.L. Richards Ass. Ltd. (formal bylaw under the Drainage Act)
- 1984 Marchwood Lakeside Master Drainage Plan Stormwater Management by CCL;
- 1999 Shirley's Brook and Watts Creek Sub-watershed Study by Dillon;
- 2001 Kanata lakes Natural Environmental Area (NEA) Implementation Plan by CH2M Hill
- 2008 Kanata lakes Stormwater Management Facility CofA
- Draft Approved 06/02/2006/Draft Plan Extended 06/02/2009 Conditions for Final Approval KNL Developments Ltd./Lakeside Subdivision (refers to 1999 Dillon study)
- Tile Drainage Maps (NCC & OMAF);

- Design reports for recent crossing upgrades (Carling Avenue, Corkstown, NCVC Pathway…); and,
- Aerial photography.

1.1.1 Shirley's Brook and Watts Creek Subwatershed Study:

In September 1999 a "Shirley's Brook and Watts Creek Subwatershed Study" (Study) was filed with the City of Kanata and the Regional municipality of Ottawa Carleton. This Study examined the impact of the authorities' future development plans. It was noted that developments increase the amount of impervious surfaces resulting in increased runoff discharging into watercourses. On page 5-9 of that study it was boldly stated that:

> *"The potential impacts associated with an increase in uncontrolled runoff of this magnitude [33% increase in average annual runoff volumes and a 39% reduction to average annual ground water recharge volumes] would translate to increased peak flows and water levels in the downstream reaches of Shirley's Brook and Watts Creek. This, in turn, could lead to increased flooding and erosion. In addition, changes to peak flows and runoff volumes could alter annual stream flow conditions, which in turn could negatively impact the natural features and ecological functions."*

The NCC views the stream a valuable geological and ecological feature to the National Capital and as such any detrimental impact is of concern. .

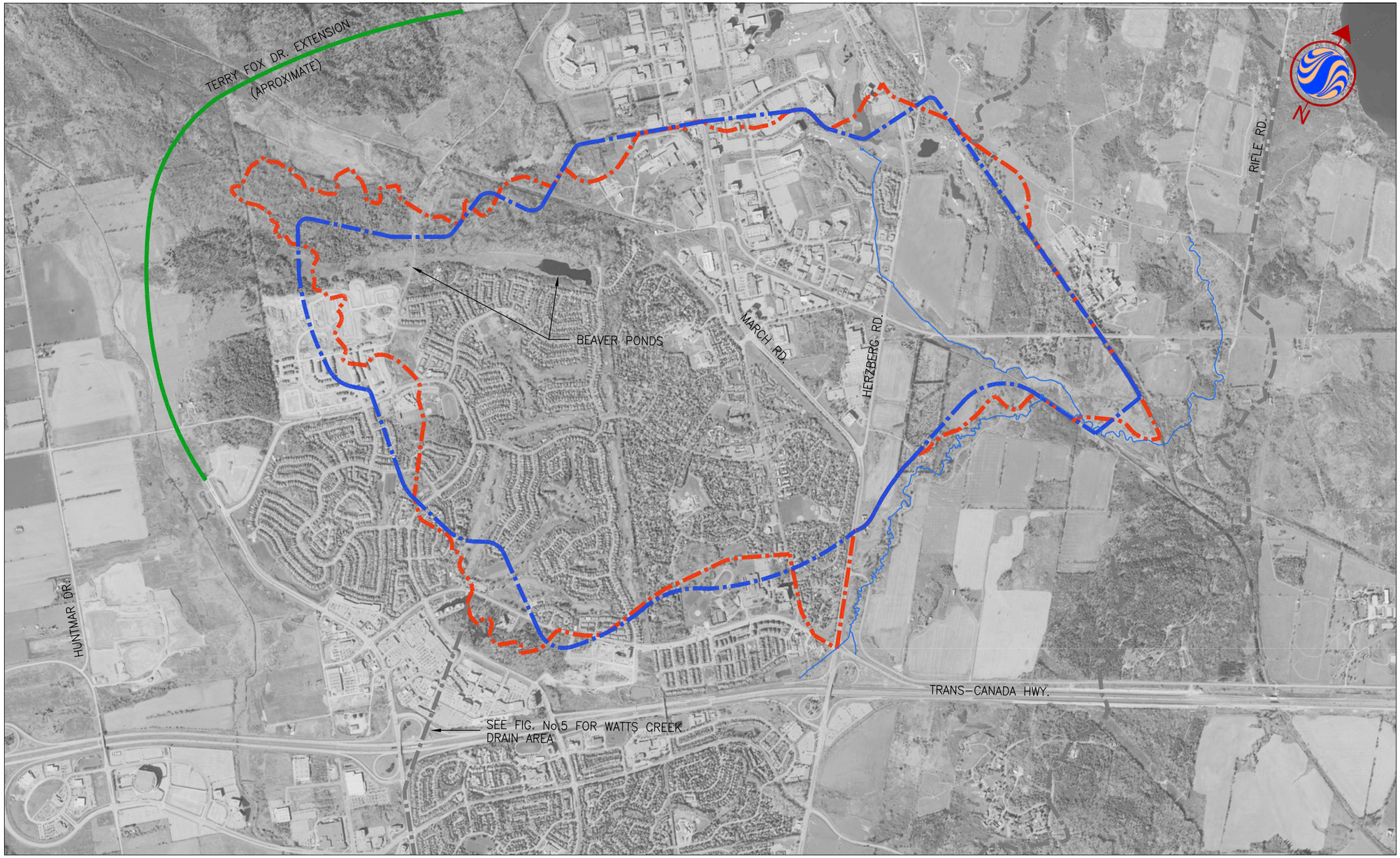
The Study provides a management strategy for future developments within the City of Kanata and the Region of Ottawa-Carleton. The Study notes that the urban areas contributing flow to the Watts Creek Subwatershed upstream of the 417 highway have a direct impact on creek erosion downstream of the highway. During high rainfall events, impermeable urban areas and storm sewers contribute larger flows in a shorter period of time than undeveloped lands resulting in increased flow in Watts Creek leading to erosion of the banks.

The Study also noted that Watts Creek maintains cooler temperatures (17°C) than the Kizzel Drain (22°C). This difference in temperatures has been attributed to factors such as the warming effect of the beaver pond situated on the Kizzel Drain, the lack of shade, and the warming effect of stormwater runoff from large pavement areas.

In addition to the impact assessment of future development, as identified above, the Study produced a recommended implementation strategy. The significant elements to this strategy center on a combination of stream restoration, agricultural best management practices, and engineered urban storm water ponds. The strategy provided guiding principles which needs to be further quantified and detailed in this report.

Six water resource issues were identified in the Study:

- Flooding and erosion problems;
- Lack of a comprehensive stormwater management strategy;



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ORIGINAL SHEET - ANSI B

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Legend

- KIZELL DRAIN WATERSHED BOUNDARY BY DILLON CONSULTING LTD. (1999)
- KIZELL DRAIN WATERSHED BOUNDARY (APROXIMATE) BY LOW (1973)
- TERRY FOX DR. EXTENSION (APROXIMATE)

Notes

WATERSHED AREA DEPICTED IS APROXIMATE AND IS BASED ON SHIRLEY'S BROOK AND WATTS CREEK SUBWATERSHED STUDY, FIGURE 3.9b SUBMITTED BY DILLON CONSULTING LTD. IN SEPTEMBER 1999

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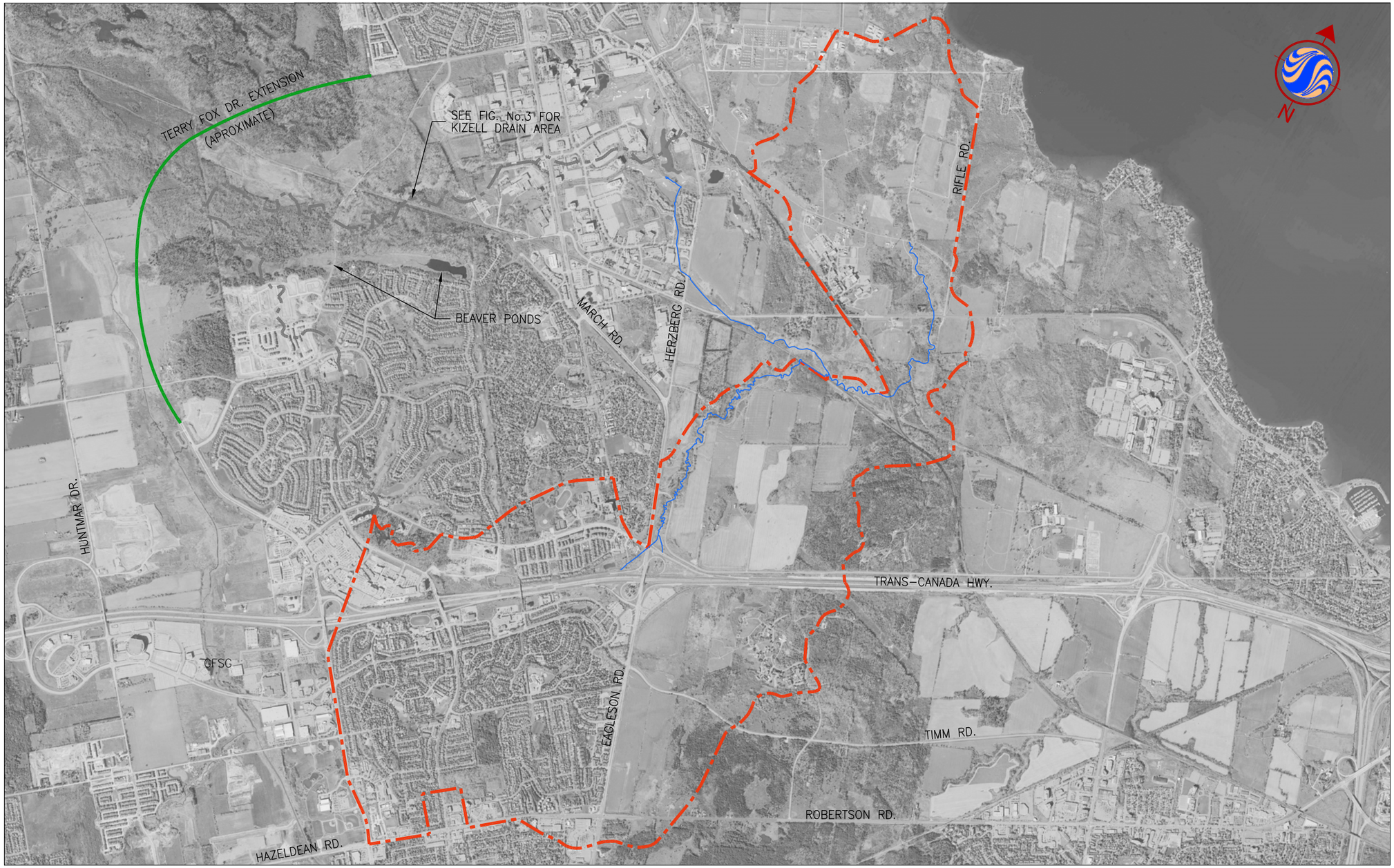
NATIONAL CAPITAL COMMISSION
WATERCOURSE AND
WATERSHED MANAGEMENT PLAN

Figure No.
A

Title
WATERSHED AREA PLAN



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Legend

- WATTS CREEK DRAIN WATERSHED BOUNDARY
- TERRY FOX DR. EXTENSION (APROXIMATE)

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Client/Project
NATIONAL CAPITAL COMMISSION
WATERCOURSE AND
WATERSHED MANAGEMENT PLAN

Figure No.
B

Title
WATERSHED AREA PLAN

- Poor surface water quality;
- Degraded fish & aquatic habitat;
- Loss of terrestrial habitat & linkages; and
- Groundwater supply and quality constraints.

In respect of these issues the study provided discussions, public input and recommendations to mitigate the impacts of ongoing landuse changes on the watercourse..

A vision statement was developed for the Shirley's Brook and Watts Creek Subwatersheds as follows:

- The identified water quality objectives are met to support a diverse range of aquatic species;
- That significant terrestrial habitats are protected and linked;
- That degraded aquatic and terrestrial habitats are restored; and
- That stormwater from urban development is managed in a responsible manner so that natural systems are not significantly impacted.

The study provides various suggested goals and objectives to address this vision including landuse controls, stream buffer zone enhancements, creation of fish habitats and stream restoration in some parts of the Kizzel Drain and Watts Creek.

1.1.2 Marchwood-Lakeside Master Drainage Plan and Stormwater Management

This study report was completed in 1984 and is not referenced in the following noted CofA nor in the previously noted 1999 Shirley's Brook and Watts Creek Sub-watershed Study by Dillon. Accordingly its status is uncertain.

Regardless of the reports status, it is worthwhile to note that a proposed flow diversion from Shirley's Brook into the Kizzel Drain was suggested as a preferred option in this report.

1.1.3 Kanata lakes Natural Environmental Area Implementation Plan

This study was completed in March 2001 and its purpose is to identify and document environmental constraints, recreational opportunities, servicing constraints and development options for storm water management to assist the City of Ottawa in making decisions in and around Kanata lakes Natural Environment Area (NEA) within the context of ongoing development pressures.

Section 4.3 of the report refers to the Shirley's Brook to Kizzel Drain diversion. It is stated that "Notwithstanding the conclusions of previous studies which established that the Beaver Pond has adequate capacity to accept runoff from the entire Marchwood/lakeside development, diversion of all flows (especially low flows) away from Shirley's Brook would likely have negative

impacts on aquatic habitat. The headwaters of any stream system represent and important source of base flow to the system, and given that summer dry weather flows in the lower reaches of Shirley's Brook are less than 10l/s, any flow reduction due to diversion from the system should be considered a significant loss."

On the bases of this section, the proposed diversion is still very much undecided and this report recommends "abandoning the plans for at least some of the diversion to the Beaver Pond". It further recognizes " the impact that this modification to the drainage plan would have on downstream structures on Shirley's Brook would need to be examined in detail, as several new culverts have been constructed based on reduced flows due to the diversion planned in the 1984 MDP".

1.1.4 Kanata Lakes Stormwater Management Facility CofA

In 2008 the City applied for and received a C of A for the Kanata Lakes Storm water Management Facility, under section 53 of the Water Resources Act.

The CofA was required in response to the developmental pressures related to lands within the Kizzel Drain watershed, specifically those lands that drain into the Kanata Lakes SWM facility from the south.

In accordance with a Ministry of Environment 2008 C of A for the aforementioned facility has catchment area of 397 hectares (approximately 1000 acres) and services the Kanata Lakes Subdivision.

There are several inlets into the pond, both natural opens drains and urban development storm sewers. The storm sewer inlets include an energy dissipater prior to discharging into the wetland. Flow from the wet pond is controlled by an 600mm diameter orifice for all design flows up to the 100 year, and a 1.65 meter long weir spillway for failure events or storms greater than the 100 year. The 100 year flow from the SWM facility into the Kizzel Drain is regulated by the C of A to rate of 0.96m3/s via a 80 meter long 1200mm diameter culvert.

Although effective in attenuation of peak flows, the slow release of these flows does not totally mitigate all the impacts. The increase volume of surface flow and the reduction in groundwater recharge conditions due to increase in impervious area associated with urbanization (i.e., roads, rooftops and parking lots) are unaccounted for issues that may or may not be significant.

In respect of water quality, The Ministry of Environment CoA requires that the Kanata Lakes Stormwater Management Facility "provide Enhanced Level 1 water quality protection and to attenuate post development flows in two cells in series, upstream Kizzel Cell and downstream Beaver Cell', discharging into the Kizzel Drain.

In respect of operation and maintenance; the CofA requires the owner to ensure that, the design minimum liquid retention volumes are maintained at all times. The need to eventually dredge the pond or to monitor for water quality is absent from the report. To some degree dredging of

sediments from the pond can be done, (i.e. at the base of each energy dissipater) however, a complete dredging of the pond is not practical or desirable.

1.1.5 Draft Approved 06/02/2006/Draft Plan Extended 06/02/2009 Conditions for Final Approval KNL Developments Ltd./Lakeside Subdivision

It is our understanding that the aforementioned SWM facility CofA is applicable to the lands south of the pond.

For the lands north of the pond, reference is made to condition 59 for Final Approval KNL Development Ltd. /Lakeside Subdivision, wherein it is stated:

> *"Prior to commencement of construction, the owner shall provide all Storm water Management reports that may be required by the City for approval. The reports shall be in accordance with the approved Shirley's brook and Watts Creek Subwatershed Study prepared by Dillon Consulting and the Carp River Subwatershed Study, as the study(ies) pertains to this subdivision and all City or Provincial standard, specifications and guidelines. The reports shall include but are not limited to, the provision of erosion and sedimentation control measure, implementation or phasing requirements, all storm water management measures have been constructed to the satisfaction of the City".*

1.1.6 Kizzel Municipal Drain Engineers Report

The report on the improvement of the Kizzel Municipal Drain was initiated under Section 53 of the Drainage Act R.S.O. 1970. The drain as described in the report has legal status under the Act and unless the drain status has been legally abandoned, all work within the Drain must conform to the 1973 Report. The report includes the following:

- The terms of reference, the Kizzel Drain construction and proposed improvements as part of the Engineers report.
- The 1973 estimate of construction and material costs, in sufficient detail to identify the cost of each length of the drain, actual engineering costs to date and estimates of engineering costs to complete.
- The categories of assessment, the actual schedules of assessment, the methods of maintaining the drainage works and cost sharing thereof.
- The specifications to which the drainage works are to be built, the plan, the profile and cross sectional area.
- The plans and profiles, prepared in a professional manner of the Drainage Area and Drain. Including, north arrows, scales, date, legend, lots, concessions, municipalities, ownership lines and names, roadways, railways, natural watercourses, proposed drain location, flow directions, and the watershed of the drainage works and parts thereof,.
- The profile of the drain includes prepared in a professional manner showing the original ground profiled as staked: any adjacent ditch bank, ditch bottom, intercepted drainage works or other utility should be shown. The design profile grade of the new by law ditch

bottom including culvert inverts are shown as well as the percentage of grade, and the vertical control of the design grade. All established bench marks are included. The location of special appurtenances is shown. The plan includes a professional stamp by the engineer.

The information provided in the report is sufficient to maintain the drain in accordance with that report.

1.1.7 Drainage Rights and Obligations

Under Common Law, the NCC is required to accept the waters that flow naturally into the drain. On the other hand, should a person above or below drain make any change to the natural flow, that results in the material injury of the riparian owner situated upon it, the person changing the flow regime is typically liable for damages. The riparian owner has first rights to the drain and its capacity to convey flow over and above that which would naturally occur.

In respect of water shed diversions …..Under Common Law “any landowner whose lands abut a natural water course has the right to drain those lands into the natural stream, but may not bring water in from another watershed”. Thus, to allow for a possible proposed watershed diversion to proceed, the aforementioned common law governance noted will require an update to the Master Drainage Plans and Watershed Study reports as allowed under the Water Resources Act.

Municipal Drainage Act

The Kizzel Drain, including that portion of Watts Creek from the Kizzel Drain to twin CNR railway culvert, is a Municipal Drain/watercourse, with the added owner’s rights as is permitted by the Drainage Act. It is noted that the Drainage Act does not curtail the common law rights of riparian owners.

Under section 78 of the Drainage Act “Where for the better use, maintenance or repair of any drainage works constructed under by-law passed under this Act, or for lands or roads, it is considered expedient to change the course of the drainage works …..the council of any municipality whose duty it is to maintain and repair the drainage works or any part thereof may, without the petition required under section 4 but on the report of an engineer appointed by it, undertake and complete the drainage works as set forth in such report.” Accordingly we see no why, the preparation of a water course management plan including the provision of fish habitat, monitoring stations, channel realignment for the Carling Avenue culvert replacement, bio-engineered channel protection and other water course enhancements within the NCC’ control could not be implemented under the Drainage Act.

Ontario Water Recourses Act

Ministry of Environment Certificate of Approvals was obtained under section 53 of the Ontario water Resources Act. The Kanata Lakes Stormwater Management Facility has a certificate of

approval number 5190-7L6RRY. That certificate indicated the catchment area to the pond cells, water quantity and quality criteria's from the pond cells, volumes and elevations in the pond cells, and the number of sewer outlets into the pond cells. Any changes to the sewage works will require an amendment to the existing CofA. It is noted that the existing CofA permit was obtained as part of the works being proposed south of the Pond.

SUMMARY TABLE REPORTS			
Study	**NCC Benefits**	**NCC Concerns**	**Mitigate Actions**
Shirley Brook And Watts Creek Sub Watershed Study Completed: Sept. 1999 Submitted by: Dillon Consulting Ltd.	The report provides a management strategy for Watts Creek, Shirley Brook and the Kizzel Drain. It does not make mention of a Shirley's Brook diversion which implies it was not directly raised during the developer meetings. The study clearly identifies that the upstream land development in Kanata has had flow regimen impacts on Watts Creek thus leading to erosion of its banks.	The NCC should be concerned that they are properly managing their water courses	NCC should review all their drains to ensure proper landuse and water course management
Marchwood-Lakeside Master Drainage Plan and Storm water Management Completed: April 1984 Submitted by CCL	Status is uncertain at best. Did not follow the EA Act.	Proposed flow diversion suggested as a preferred option in this report	This report has been superseded by updated reports and has no current status
Kanata Lakes Environmental Area Implementation Plan Completed: March 2001 Submitted by: CH2Hill	States that the Kanata Lakes NEA is valuable to the community. Recommends that the boundaries be adjusted to reflect the conservation of wetland and the higher quality forested areas.	Review of past reports identified discrepancies in the Beaver Pond storm water drainage area and recommended treatment alternatives.	Additional studies to confirm the facility drainage area and treatment objectives
Kanata Lakes Storm water management facility CofA Issued Nov 26,2008	Specifies thee catchment area at 397 hectares and that Enhanced (Level1) water quality protection is required	Monitoring and Record keeping is limited to operation and maintenance activities	NCC should request the MOE for changes in the Cof A to include a complete and exhaustive sets of water quality and quantity monitoring. NCC is interested in pre and post condition monitoring on the Kizzel Drain at Carling Ave as well as on Watts Creek.
Draft Approval 06/02/2006 draft plan Extension 06/02/2009 Conditions for Final Approval KNL Developments Ltd./Lakeside Subdivision	Makes reference to the Shirley Brook Study as a condition to subdivision approval	Once all the conditions are met development will likely proceed. Following which only recourse is costly litigation for ensuing damages under common law.	Actively participate in the planning process and if necessary appeal to the OMB
Kizzel Municipal drain Engineers Report/By-Law 34-73 April 1973 By: JL Richards Ass. Ltd.	Give the Drain Legal status under the Drainage Act, allowing it to be managed under the Drainage Act. The By-law allows for cleaning and Maintenance of the drain in accordance with the approved plans and profile. Costs are recovered in accordance with the assessment schedule in the report.	Does not include for fish habitats and changes beyond the approved drawings will require a new Drain by-law under section 78 of the Drainage Act.	Revise the report/by law to allow for additional fish habitat work, erosion control works and a revised assessment schedule to collect by costs within the watershed.

Summary table
Statutory Acts

Act	NCC Benefits	NCC Concerns	Mitigate Actions
Common Law Aspects of Watercourse Management	Scarborough Golf vs. City of Scarborough...The Court confirmed that an upper riparian owner has the right to natural drainage into a water course and a lower riparian owner is obliged to accept that t drainage. However, the drainage by the upper riparian owner must be reasonable and must not increase their "volume" by artificial means. the court held that the means used by the City were not "natural" or "reasonable", and found as a fact that they substantially increased the volume of water and this increase caused damage to the plaintiff golf course.	The NCC should be concerned that they are properly managing their water courses	NCC should review all their drains to ensure proper management
Municipal Drainage Act	Allows water course to be maintained and costs are assessed in accordance with the by-law. Section 78 of the Act may be used to initiate erosion protection works and incorporate fish habitat at the same time. Change to the watershed or drainage system would require revisions to the existing Drain Bylaw.	The Act can be used to initiate water course drainage improvements that may be disruptive to fish habitat and downstream landowners. Not a land use planning tool.	The Drainage Act is a provincial legislation other approvals are required including DFO, Conservation Authorities and in the case of an "urban stream" the Ministry of Environment.
Ontario Water Resources Act	Municipal Sewage and storm water management systems must receive approval under the Ontario water Resources Act. Section 74 designates and regulates areas of public water or sewage services and thus has some capabilities to control land development, visa via if the available infrastructure has insufficient outlet to accept the increase in flow. In addition, other approvals, legislation policies and guidelines may apply. In most instances water course management projects will require approvals from the local Municipality, local conservation authority, federal department of Fisheries and Oceans, ministry of Natural Resources and Ministry of Environment.	It is understood that there are approved infrastructures that are indirectly related to the proposed Shirley's Brook diversion. waters inhabited by fish. Also a prosecutor wishing to obtain a conviction under the general prohibition in s. 30(1) of the OWRA must show some likelihood of impairment or toxicity. s. 30(1) of the OWRA requires that MOEE show a capacity to impair as a result either of the inherent toxicity of the substance, or the conditions of its discharge – that is, the quantity and concentration of the discharge as well as the time frame over which it took place. This increases significantly the evidentiary burden on the Crown with respect to prosecuting alleged contraventions of s. 30(1) of the OWRA.	It should be clarified that the previous "approvals" are not related to the proposed Shirley's Brook diversion and that CofA approvals based on Master Drainage Plan approvals are not sufficient for a stream diversion project that is noted below as being classified as a schedule C project under the Environmental Assessment Act.
Planning Act	Private Sector Developer Works approved under this Act are normally classified as Schedule A or B. Schedule C projects are subject to the same process as the EA Act. It is noted that "Construction of a diversion channel or sewer for the purpose of diverting flows from one water course to another" is classified as a schedule C project.	Under this process, the alternative solutions and the identification of impacts of each alternative solution needs to be fully explored and quantified respectively. Under this Act, proposed works may be appealed to the Ontario Municipal Board (OMB). The OMB is quasi judicial. Past approvals and completed works will be important considerations to the Board.	Early and active involvement by the NCC to ensure her concerns are addressed and they should provide a solution. Preparation for a potential OMB at early stage will increase the potential of winning the case. Start documentation and submit concerns early and frequently. Do not agree to the project in parts and ensure all the information provided under goes a critical review.
Environmental Assessment Act	Under the EA Act; in addition to showing need/opportunity (optional) and the identification of alternate solutions there are 2 additional steps Phase 3- the identification of alternative design concepts for the preferred solutions including detailed inventories, identify impacts of each alternative and evaluations. After mandatory review agency and public consultations a preferred design is selected. Phase 4- The ESR documentation review. The supporting technical material must be provided at an early stage in the process. Under this Act there is an opportunity to request a part 2 order from the Minister of Environment. If granted, the Minister will then hear arguments and make recommendations.	Under this process, the alternative solutions and the identification of impacts of each alternative solution needs to be fully explored and quantified, respectively. The additional steps regarding alternative design concepts and more detail inventories will add more NCC involvement and need for studies.	Early and active involvement by the NCC to ensure her concerns are addressed and they should provide a solution. Preparation for a potential Part 2 order being granted at early stage will increase the potential of winning the case. Start documentation and submit concerns early and frequently. Do not agree to the project in parts and ensure all the information provided under goes a critical review.
Fisheries Act	Under s. 36(3) of the *Fisheries Act* , it is sufficient to show that a deleterious substance has been discharged into waters inhabited by fish. Many experts believe that this difference makes s. 36(3) of the Fisheries Act a far superior tool when compared with s. 30(1) of the OWRA.		

2.0 Problem Definition and Opportunities

The NCC has identified problem areas that require erosion protection to ensure the long term sustainability of Watts Creek and the Kizzel Drain. A strategy needs to be established to protect Greenbelt lands from further erosion. These areas of improvement were identified in the Shirley Brook Study of 1999 and are being restated after visual and field assessment of the Creek in 2010.

To effectively manage watercourses in the Greenbelt there is a need to monitor condition information and identify effects from upstream activities. The major benefit of this report is that it will increase the likelihood of being able to identify the causes of observed changes in condition and respond accordingly

In order to implement any corrective measures the following are issues that need to be resolved:

- For priority areas, not part of development lands, design, costing and cost sharing of erosion protection and fish habitat enhancement works are required to be funded by the NCC.

- For development lands, establish monitoring sites to ensure developers meet environmental compliance targets. Similarly, there should be a method of policing for non-compliance (establishing responsibility and a means for corrective actions).

2.1 WATERSHED ISSUES

The NCC has recently received several requests for watershed changes. For each issue, a recommended action and an agency to lead the recommended action is required. The issues are as follows:

- Carling Ave/Kizzel Drain Culvert replacement. The culvert is structurally deficient and requires replacement.
- DND drainage and landuse changes..
- Status of a proposed Watershed Diversions and status of the 1984 Marchwood Lakeside Master Drainage Plan Stormwater Management Report.
- Proposed land use changes will change the water course characteristics (i.e. base flows, water temperature, water quality, etc) .The NCC, being the riparian downstream owner has a vested interest in upstream land uses changes. They wish to become an active reviewer in the development review process, setting watercourse targets and in establishing an integrated monitoring program to more accurately track the health of the water course.

- The possibility of decommissioning/rehabilitation of the Shirley's Bay containment Area and Watts Creek Sewage Treatment Plant need to be investigated further.
- There are erosion areas and obstructions within the Watts Creek and Kizzel Drain that require some water course management. Including cost recovery and a future maintenance plan.
- Within the scope of a water course management plan there is an opportunity to enhance the stream characteristics, including improving fish habitat, modify agricultural land use practices, improve access to the stream for public awareness and education purposes.

The NCC, being the riparian downstream owner has a vested interest in upstream land uses changes. They wish to become an active reviewer in the development review process, setting watercourse targets and in establishing an integrated monitoring program to more accurately track the health of the water course.

2.2 GOALS AND OBJECTIVES

A primary goal of the NCC is to ensure that the Watts Creek and Kizzel Drain water courses are managed in an environmentally responsible manner and were possible to enhance the structure and function of their aquatic ecosystems.

As part of the study review the following objectives have been established:

- Protect the Greenbelt, natural resources and users with respect to natural hazards, such as flooding and erosion and human made hazards.
- Protect and maintain the warm water fishery and associated aquatic communities.
- Protect, maintain and enhance the significant natural terrestrial features (land forest and wildlife) and ecological functions of the Subwatersheds.
- Protect, maintain and enhance the quality and quantity of surface resources in the Subwatershed.

These objectives can be best achieved by:

- The Compilation of existing information for the future collection and analysis of data to define and achieve strategic goals for this study area
- Establish indicators and targets and recommend associated research programs to implement
- Define and establish a monitoring plan/program that can be tracked over time.

3.0 Channel Description

3.1 WATTS CREEK

Watts Creek is a natural water course with a defined channel, with beds and banks, and has flowed over sufficient time to give it substantial existence. From Carling Ave to the siphon crossing its general alignment and several cross sections are shown on **Figures 1 and 2**. A location plan is provided on Figure 3

Watts Creek originates at Castlefrank Road situation in Katimavik/Hazeldean. The main branch of Watts Creek sources in the community of Katimavik from a storm sewer outfall located north of Chimo Drive. Several tributaries join the main branch within the community of Katimavik, each of which are also sourced from storm sewer outfalls. At this location, dry weather flow was observed discharging from a storm sewer outfall. Further downstream, several additional storm sewer outfalls were observed augmenting the flow. From Castlefrank Road, the Creek meanders 1,700 m northward through several residential subdivisions passing beneath several roadway culverts that include: Chimo Drive (via twin 1450 mm ø CMP), Katimavik Road (via twin 1650 mm ø CMP) and Hearst Way (via a 2.35 m x 3.75 m (HxW) CMPA). The Watts Creek watercourse, for the purpose of this study, commences on the south west corner of Highway 417 and Eagleson Road in Lot 1 Concession 3 of the former City of Kanata, and follows a north easterly direction crossing under Highway 417 to its north side then swinging east and crossing Campeau Drive. After Watts Creek passes beneath Eagleson Road via a 3.1mHx4.7mW CMPA it is within the stewardship of the NCC. The channel proceeds to meander in northerly direction for a distance of 400 meters where it crosses Corkstown Road via a 2.75mWx9.8mH CMPA and continues in a northerly direction for a distance of 600 meters to the Tri Party sanitary sewer siphon low level crossing on Lot 1 Concession 1. From this point the channel takes on a larger mender belt and continues to flow in a northerly direction for a distance of 1200meters to the pathway culvert crossing at the Lot 2/3 boundary. The streams arcs gradually towards the east prior to the culvert and after the culvert continues in an easterly direction for a distance of 150 meters then arcing north and proceeding for another 150 meters were it crosses the 2.1mx2.65m CN rail timber culvert. At this point it flows in an easterly direction parallel to the rail line for a distance of 250 meters then it starts to meander back and forth in an easterly meander belt direction. At its first meander after the CN culvert the Kizzel Drain watershed enters Watts Creek. From this point the channel characteristics differ in both channel size and slope. From its confluence with the Kizzel Drain, Watts Creek meanders in an easterly direction and arcs to the north, it does this for a distance of 700meters where it then crosses another CN rail culvert via a twin 2100mmdia concrete pipe culvert, and flows another 70 meters where it crosses a Bicycle Path culvert. From this point the watercourse flows with the aid of significant grade difference and, erosion is controlled by a rock bottom and stable banks. The drain is very aesthetic and there numerous deeper pools, minor rapids and meanders, it has general arc to the north for a distance of 900meters where it then crosses

Carling Avenue through a 4mHx10mW concrete bridge. From Carling Ave the drain continues in a generally northerly direction with a slight shift to the west, for a distance of 600meters where it crosses Sandhill Road via a 1.8mx5.85m concrete bridge. From Sandhill Road the drain again resumes its meandering characteristics but with larger oxbows and flows in the same northerly direction for a distance of 2000meters to Shirley Boulevard via 2.9mx4.3m CMPA. From this point Watts Creek continues to flow north for a distance of 800meters to its outlet at Shirley's Bay of the Ottawa River.

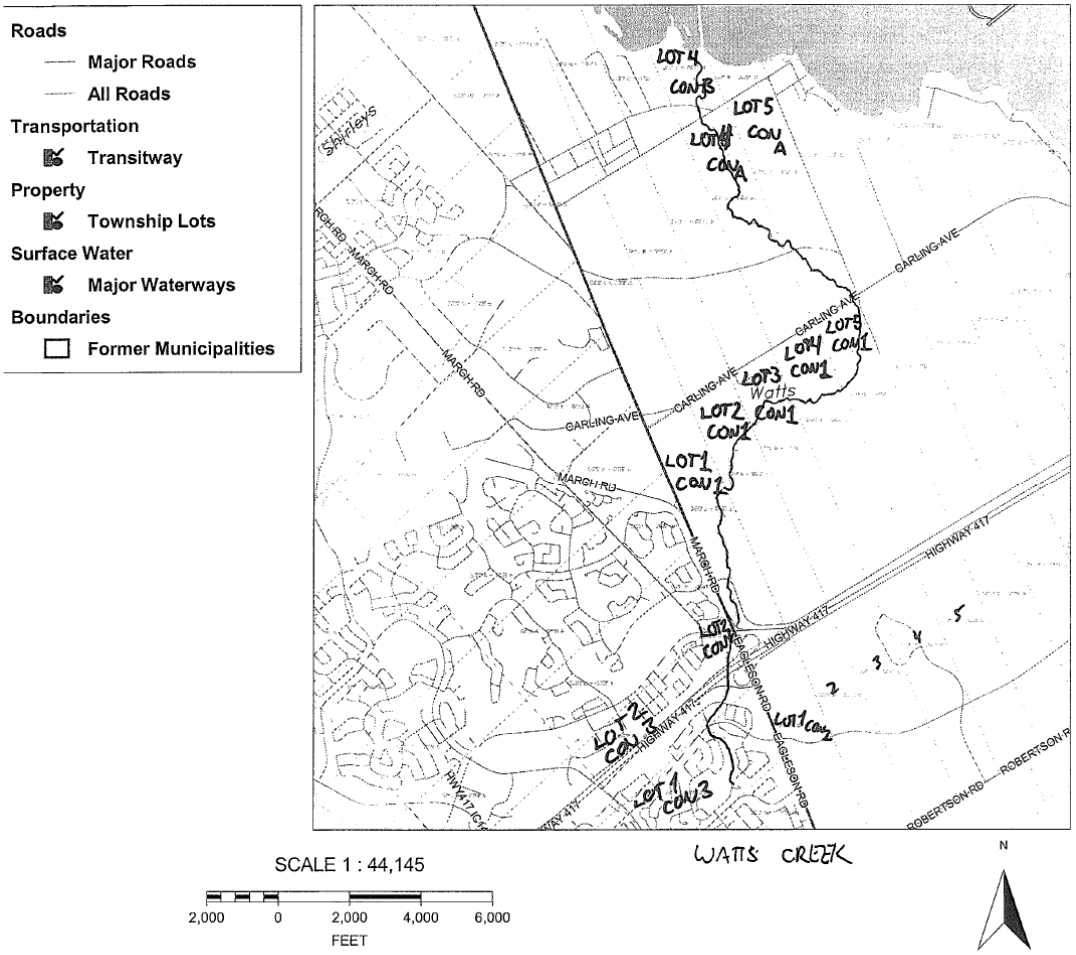
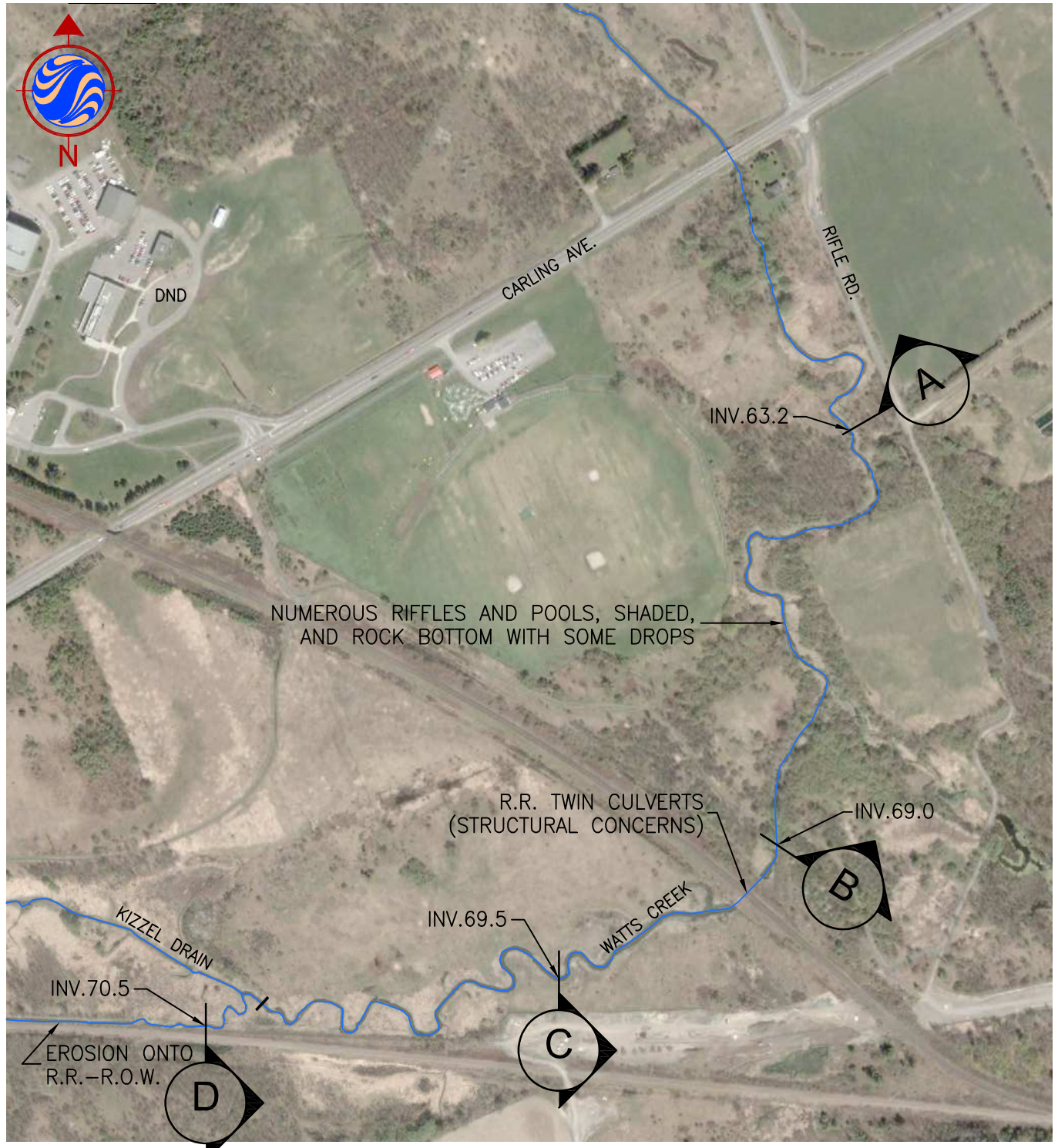


Figure 3 - Lots and Concessions

The Watts Creek watershed has area of approximately 2500Ha (including the Kizzel Drain of 1000ha).

A large area of the Watts Creek Subwatershed is contained within the National Capital Commission (NCC) Greenbelt (1000ha). This area features agricultural lands and government offices as well as considerable portions of undeveloped lands. The remaining 500ha is located in the City of Kanata and is primarily low and medium density residential with smaller areas of commercial and office usage.



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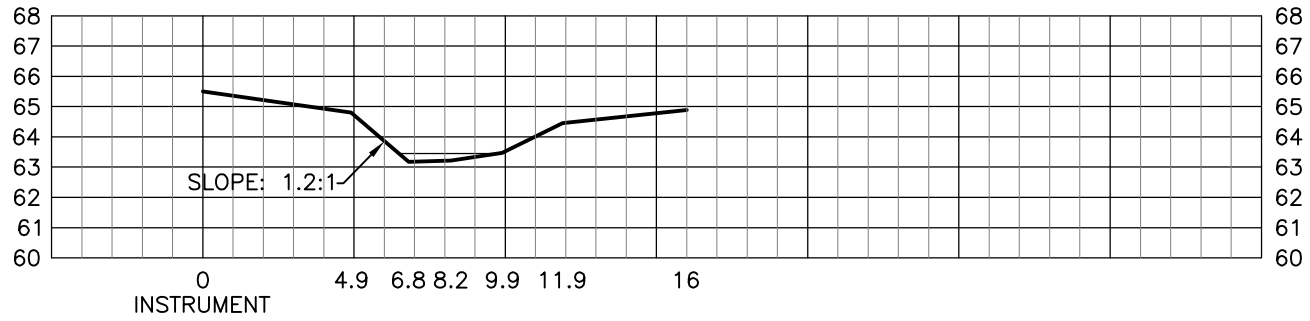
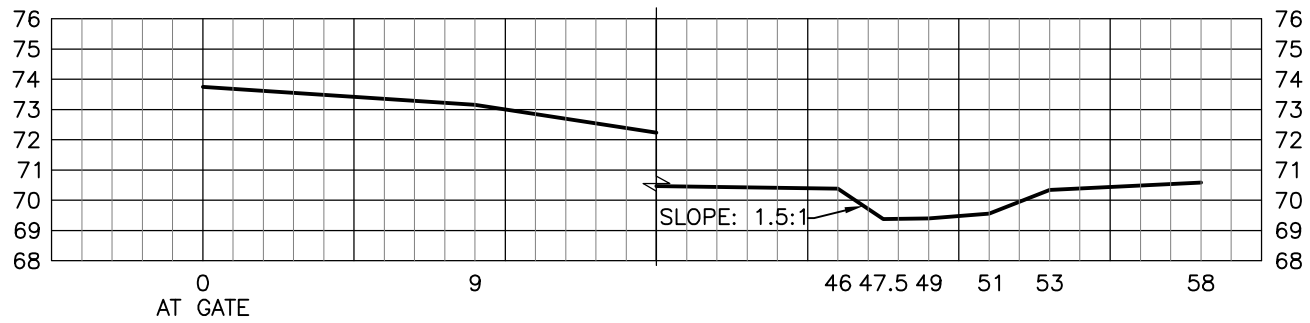


SECTION A

SECTION B



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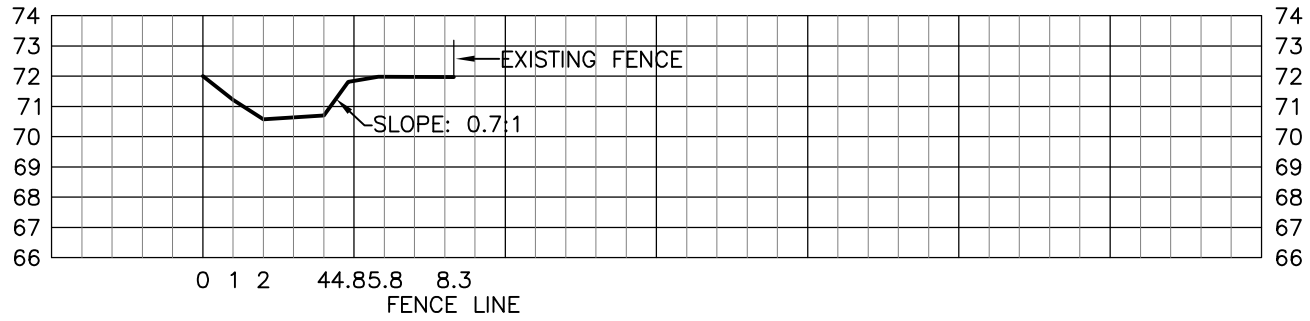

SECTION D

SECTIONS

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2010-08-25 10:23AM By: ecalberry

July, 2010
163400982

ORIGINAL SHEET - ANSI B

Stantec Consulting Ltd.
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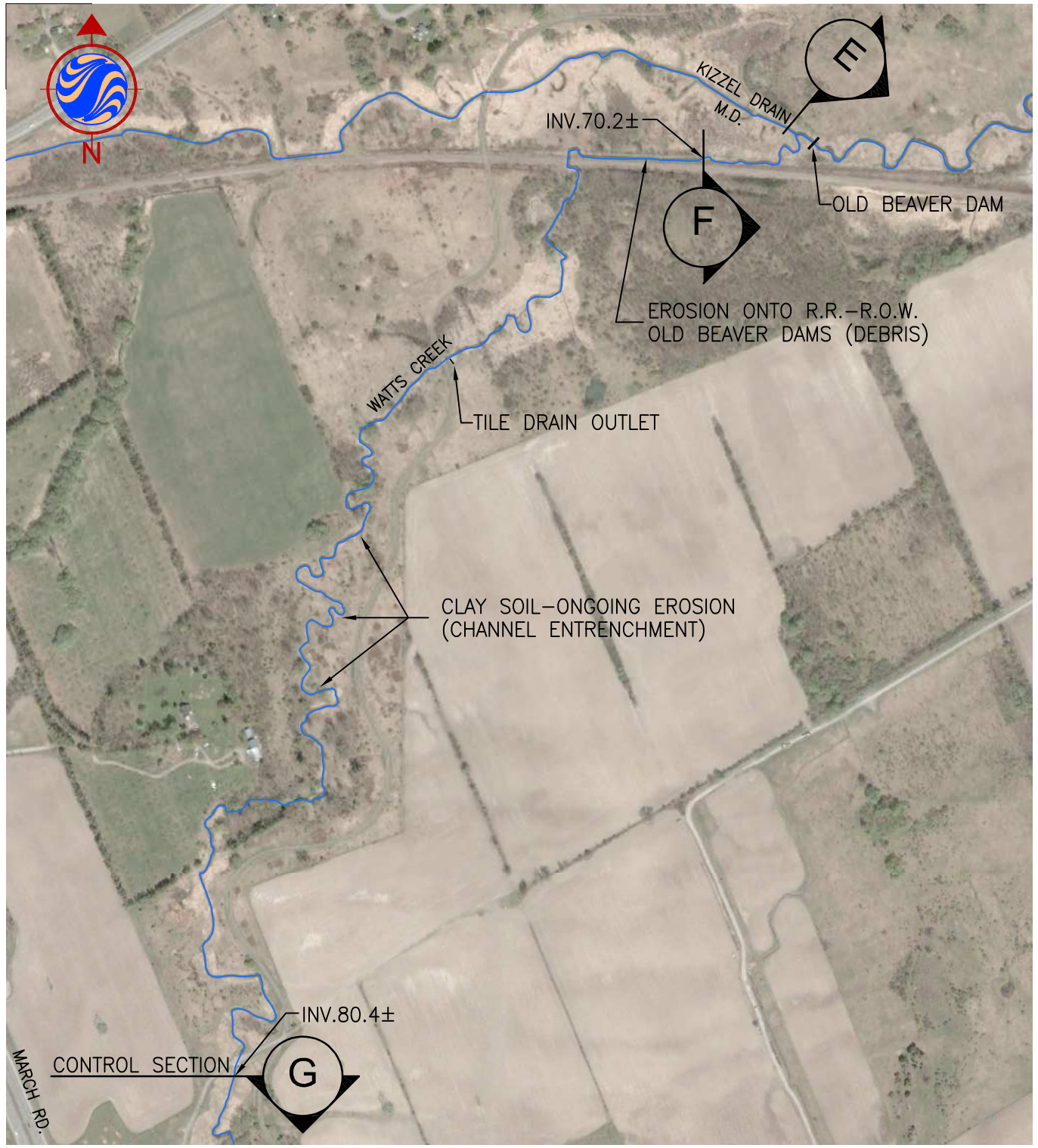
Notes

Client/Project
NATIONAL CAPITAL COMMISSION
WATTS CREEK AND
KIZZLE DRAIN

Figure No.
1

Title
WATER COURSE ALIGNMENT
AND SECTIONS I



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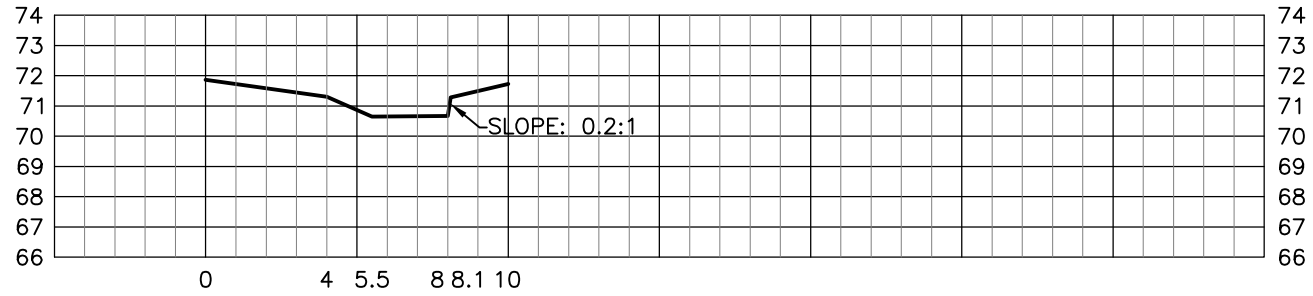
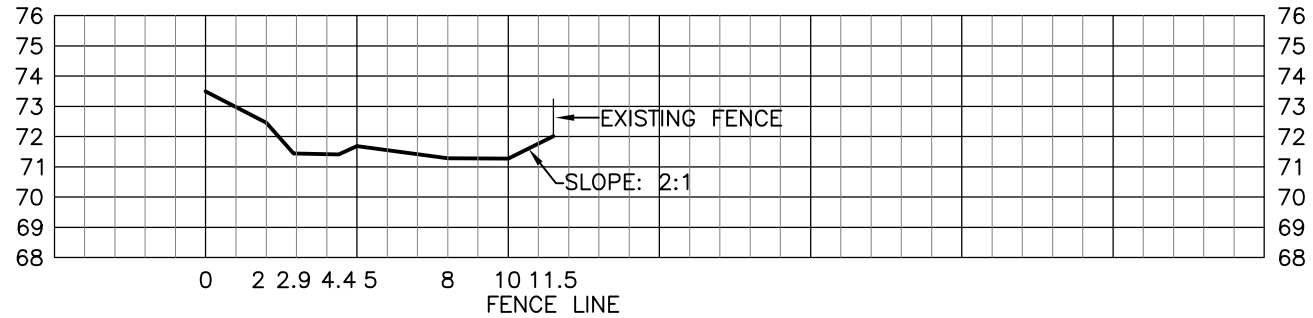


SECTION E
(KIZZEL DRAIN)



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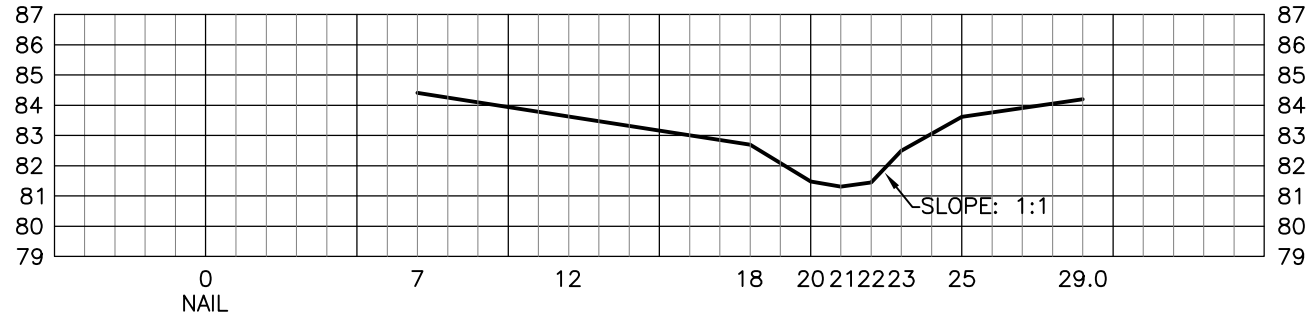

SECTION G

SECTIONS

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Client/Project
NATIONAL CAPITAL COMMISSION
WATTS CREEK AND
KIZZEL DRAIN

Figure No.
2

Title
WATER COURSE ALIGNMENT
AND CROSS SECTIONS II

3.1.1 Kizzel Drain

The Kizzel Drain, on the North side of Highway 417, is a major tributary to Watts Creek (1000ha), while Shirley's Brook forms a separate neighbouring subwatershed. Approximately 800ha of the Kizzel Drain watershed lies within the City of Kanata. Except for 70 ha of undeveloped Natural Environment area most of the area is developed or is scheduled for development in the future. Included in this area is the Kanata Lakes golf course of approximately 70-ha. The balance of the Kizzel Drain subwatershed area, approximately 200ha is NCC Greenbelt, currently used for and designated rural and agriculture.

The upper 2/3's of the Kizzel Drain is within the City of Kanata. The lower 1/3 is within the NCC Greenbelt.

The Kizzel drain begins Lanata lakes Storm water Management facility which consists of a Kizzel Cell wet pond/wetland area located west of Goulbourn Forced Road and Beaver Cell wet pond/wetland area located east of Goulbourn Forced Road. The Beaver Cell discharges pond flows via a concrete outlet structure into a vegetated ravine gully that has been channelized with quarried stone. From the pond, the Kizzel Drain flows north 350 m passing beneath the CNR line via an 1100 m ø CMP culvert. The Drain the continues northeasterly 1,700 m through the Kanata North Business Park passing beneath several roadway culverts that include: Station Road (first, via an 1,200 mm ø concrete pipe, then entering an 80 m enclosure via a 1,300 mm ø CMPA existing at March Road (via a 1.6 m x 2.45 m concrete box culvert and Legget Drive (first, via twin 1,250 mm ø concrete box pipe, then via twin 1,650 mm ø concrete pipe culvert). From Legget Drive, the Kizzel Drain flows eastward 250 m to Hertzberg Road where it is conveyed beneath the road via a 2.0 m x 3.0 m *HxW) concrete box culvert. The Drain continues eastward 500 m passing first under Carling Avenue.

The Kizzel Drain under NCC stewardship begins at Lot 1 Concession A at Hertzberg Road and 240meters north of Carling Avenue. The Drain then flows in an easterly direction for an approximate distance of 460meters to Carling Ave via a 1.2 m x 4.0 m (HxW) concrete box culvert that is in poor condition and currently under review for replacement. Through this reach the 1989 floodplain is noted to be approximately 220 meters wide. The drain including its 250 meter floodplain then crosses Carling Avenue proceeding in an easterly direction for an approximate distance of 600 meters, where it crosses the bicycle pathway, hence proceeding easterly for 320 meters where it outlets into Watts Creek. The lower portion of the Kizzel Drain watershed, includes a significant flood plain area, and a significantly larger agricultural land area that is affected by upstream increases in flow.

3.1.2 Soil Characteristics

Soils in the subwatersheds are identified as Precambrian and Paleozoic bedrock overlain by silt/clay till less than a 1m thick in the upper reaches, deposits of clay, silty clay and silt in the middle and lower reaches of Watts Creek and throughout the Kizzel Drain.

4.0 Impact of Land Use Changes

As with most urban creeks, Watts Creek has been and continues to be the subject of significant development pressures. The NCC is routinely being approached with regards to development and/or alterations that may impact on the creek and they do not have the proper tools at hand to provide input to the process.

A significant portion of the residential and commercial/industrial development within the Watts Creek catchment has taken place before the advent of modern stormwater management measures.

4.1 LANDUSE

The change in land uses within Watts Creek watershed is summarized as follows:

	September 1999	**2010**
• Agricultural	1180ha/47.1%	1180ha/47.1%
• Developed	760ha/30.4% and	870ha/34.7%
• Undeveloped	560ha/22.5%	450ha/18%

Figure 4 provides a general depiction of the additional land use developments within the watershed since 1999.

Urban Land Use Changes

Since the “Shirley Brook and Watts Creek Subwatershed Study” report was released, there has been a small additional commercial development in the WC-1 sub watershed. In comparison to the development prior to 1999, land use within the Watt’s Creek (WC) watershed has not substantially changed.

To date the Kizzel Drain (KD) watershed has experienced some additional development (i.e. within area KD-1), however the development since 1999 is relatively minor in comparison to the pre-1999 development.

Currently there is significant urban land development pressures within the Kizzel Drain watershed, plus additional pressure to divert part of the Shirley’s Brook watershed into the Kizzel Watershed.

The Shirley’s brook subwatershed has witnessed far more development than WC and the KD.

Agricultural Land Use

The type and degree of agricultural crops are a function of market and local demand conditions. From a review of the aerial mapping there has been no net change in the agricultural crop activity.

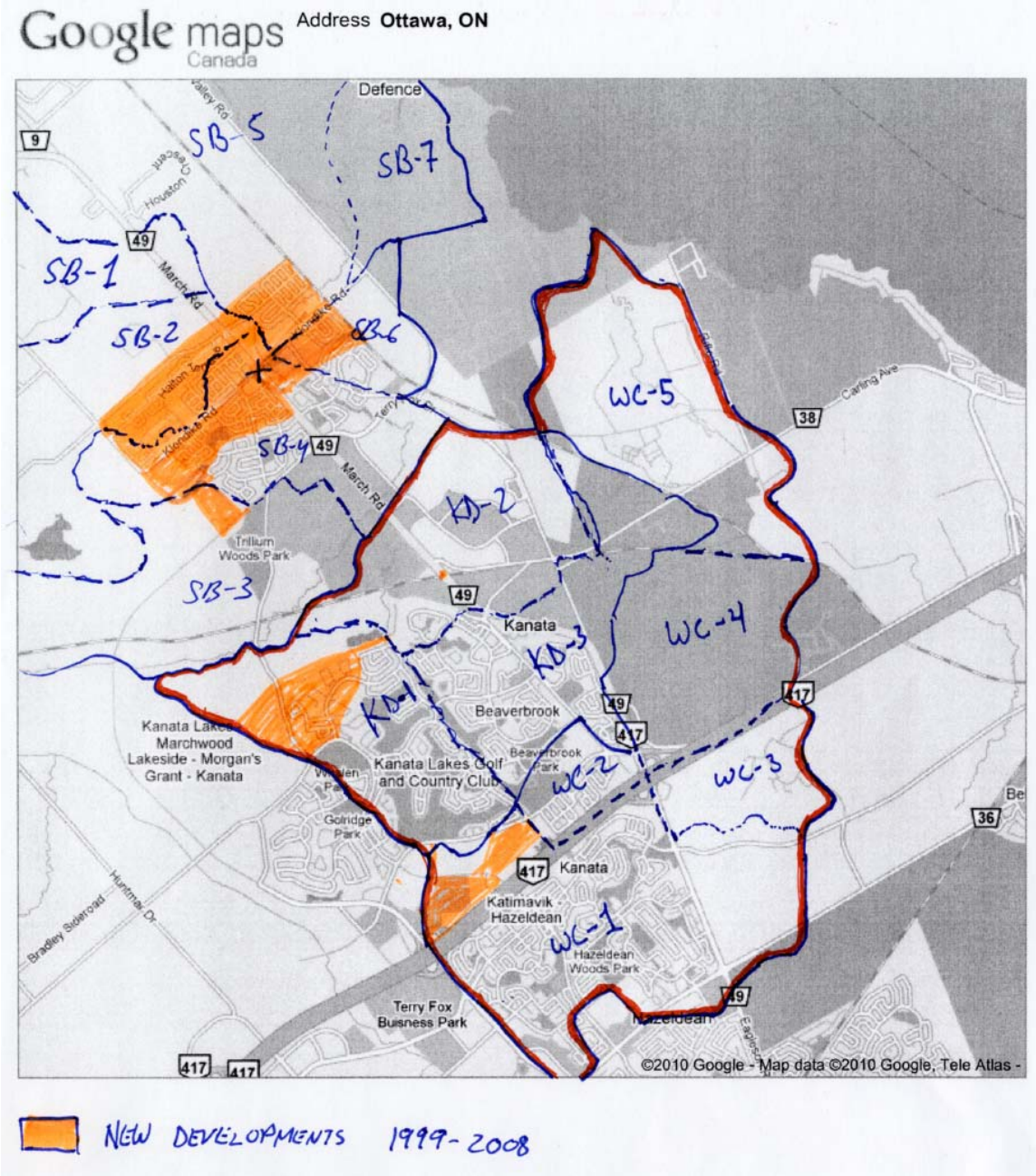

Figure 4: Land Use Change

4.2 EROSION IMPACTS

The bankful discharge of a natural stream usually corresponds to the flow from a one or two year design storm. As the rate of flow increases for these events the channel shape and profile will react accordingly. When this occurs, the system is referred to as being in a state of dynamic equilibrium.

A brief walkthrough of Watts Creek has confirmed that the banks of the creek are in the process of eroding in some locations while in others, the creek is further entrenching within its channel as visible by the sharp slopes of its banks.

It is noted that the stable parts of Watts Creek and the Kizzel Drain have limited available energy (i.e. slope) and/or have access to the floodplain, and/or have secure banks and bottom (i.e. bed rock or deep rooted vegetation).

Some of the more obvious changes over time relate to changes in the cross-sectional area as erosive forces from rainfall events are rapidly directed to the system. Also as the creek becomes gradually disconnected from its floodplain under frequent return storm events, the sediment regime of the creek is altered.

The exact nature of these changes, such as entrenchment, is in part a function of the altered hydrology and increased erosion in the system. Other erosive factors, include long-term alteration of the meander pattern of the system which, in itself, becomes a driving force for additional creek response in the future.

Examples of the creek undergoing some erosion are seen in **Figure 5** and **Figure 6**.

As shown in **Figure 7**, over the 1981-2008 timeframe, it is generally observed that the Watt's creek channel meander belt has not substantially changed its course. The current meandering path of the creek will likely remain as the creek seems to be eroding deeper in its current bed rather than moving away from its current path.

Figure 5: Erosion of the Banks

Figure 6: Entrenched Creek Bed

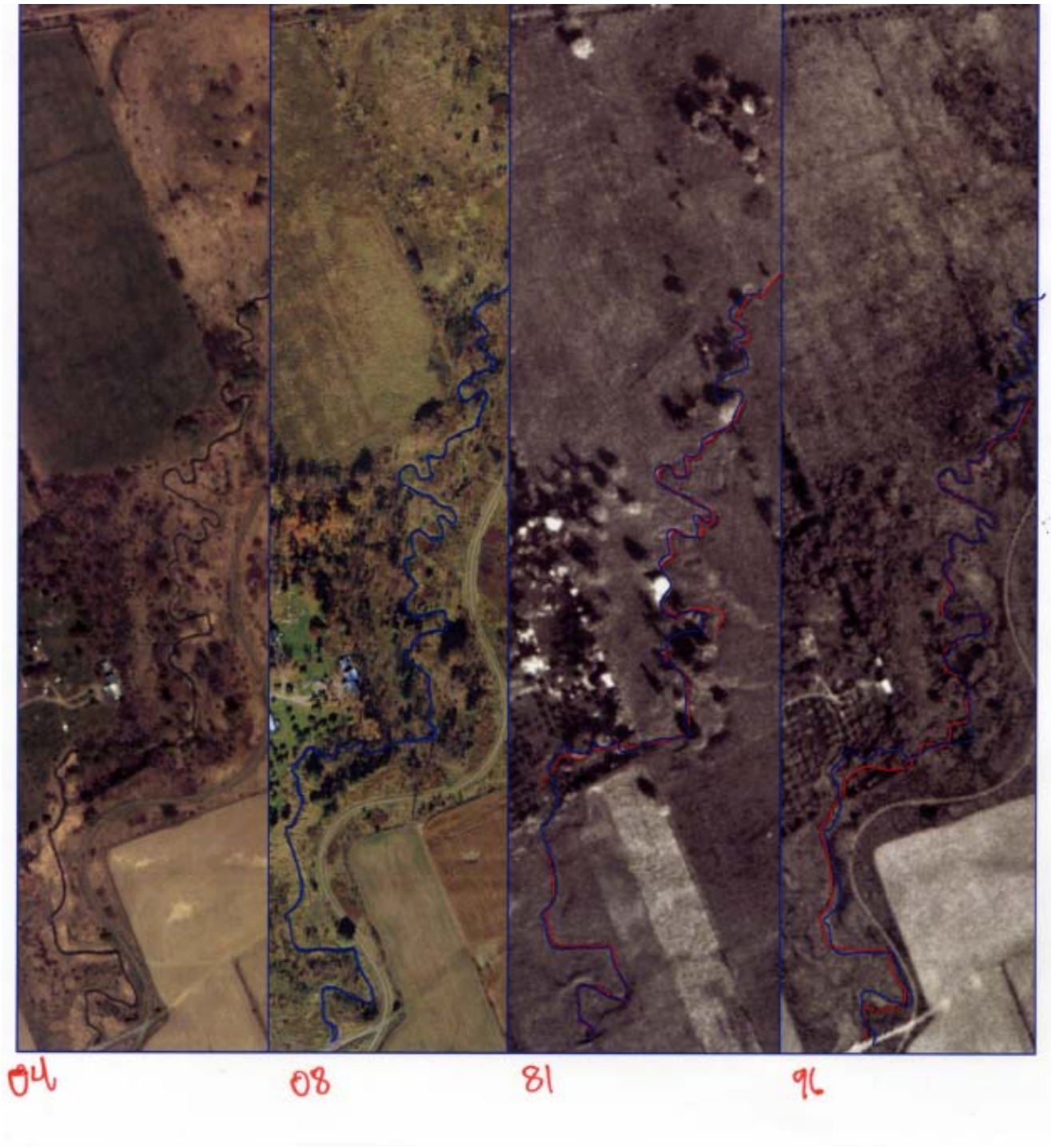

Figure 7: River Meander Path over Time (1981-2008)

4.3 HYDROLOGIC IMPACTS

In the context of water resources, degraded water quality, lost fish habitat, increased erosion and flooding problems are all associated with deforestation, agricultural cultivation, and urban development. Depending on soil types and topography, the degree of impact can vary from one land use change to another. For example an existing forest land use that is deforested and turned into an urban land use can be much more significant in total environmental impact than a land use change from existing agricultural crop production to an urban land use.

In urban or agricultural areas the runoff is directed and caused to flow in artificial conveyance systems to a water course. In urban areas the conveyance system includes surface swales, road gutters, tile drains and storm sewers. In agricultural crop production areas the conveyance system includes tile drains and open lateral drains to a water course.

In urban areas a Master Drainage and Storm Water Management Plan is a requirement to development. The development must show compliance to the plans and apply for a Ministry of Environment for a Certificate of Approval (C of A) to construct the works.

4.3.1 Base Flows

Field measurements of base flow at various locations along Watts Creek and the Kizzel Drain on July 20th 2010. The purpose of these measurements was to identify the source of baseflow.

The date was not considered a pure baseflow event, in so far as a 14mm rainfall had occurred on July 19th. However the flow measurements are significant in identifying relative flows and where base flow may originate from. Also they can used to compare the target base flow (i.e. sufficient base flow required to protect aquatic and terrestrial ecosystems) as established in the 1999 report. For specific Reaches the Base flow targets and July 20th 2010 flows have been established and are noted as follows:

TABLE 4.1
Flow Comparison Table - Base Flows

Specific Reach	Target Flow	July 20th 2010
Kizzel Drain at outlet of Beaver Pond	15 L/s	
Kizzel Drain at confluence with Watts Creek	20L/s	25L/s
Watts Creek at Corkstown Road	20L/s	45L/s
Watts Creek upstream of Kizzel Drain		55 L/s
Watts Creek downstream of Kizzel Drain	50L/s	
Watts Creek at Carling		90L/s
Watts Creek at Shirleys	60L/s	

Some general observations on baseflow patterns, as indicated by the data are as follows:

- In terms of the main stem of Watts Creek, the primary source of base flow appears to be the upstream urban areas. The Kizzel Drain watershed does appear to contribute as much flow as the Watts Creek watershed. It may be that the foundation drainage system within the residential area of Watts Creek watershed is more extensive and deeper than the subdrainage system from the commercial/office/residential developments in the Kizzel Drain watershed.
- Based on the July 19th 2010 flow measurements, the baseflow from the Kizzel Drain tributary accounts for roughly 30% of the base flow in Watts Creek upstream of Carling Avenue.
- There appears to be a modest 20% baseflow within Watts Creek coming from ground water sources between the Siphon crossing and Carling Avenue.
- A significant 50% of the baseflow occurs from lands upstream of the siphon crossing. In part, this appears to be from the urban subdrainage system in the City of Kanata.

4.3.2 Channel Conveyance

The main function of all watercourses is the efficient movement of water and sediment through the system. This function entails both conveyance and storage components. A stream will find a shape, form or pattern that permits the necessary movement of water and sediment, with the energy available (i.e. slope).

Surface Flooding

There are a number of flood susceptible areas along portions of Watts Creek and the Kizzel drain where a floodplain has been identified on the zoning plans and land use is restricted.

Most of the flooding problems appear to be related to the portion of Watts Creek upstream of the CN Railway line to the Kizzel Drain and then along the Kizzel Drain upstream to Hertzberg Road. There are no significant floodplains identified within the urban area upstream of Hertzberg Road.

As noted earlier, the Kizzel Drain is a Municipal Drain and there can be requests for agriculture drainage improvements for this watercourse.

The 1989 floodplain mapping may not be accurate today. The combination of increased flows from urbanization and improved modeling capabilities may show that the current floodlines have changed. Also may have been changes to the stream characteristics (i.e. increases in culvert sizes, erosion, sedimentation, floodplain infilling and obstructions) and these changes could impact the floodplain delineations.

Subsurface Drainage

The NCC Greenbelt has invested in agricultural tile drainage that must function properly for a long period of time.

In the design of tile drainage, under normal surface drainage conditions, the tile drains are expected to remove 12mm of water over a 24 hour period and the outlet into the water course is expected to be free draining within 24 hours of each event. The carryover of events and slow release storm water discharge may extend the channel flow time, thus impacting the effectiveness of the tile drainage system to remove soil drainage.

4.4 WATER QUALITY

Urban pollution combined with the rapid accumulation and transport of the urban runoff will add additional pollution loads to the Kizzel Drain and Watts Creek. These additional pollutants will negatively impact fish habitat, and degrade the overall health of the water course. “End of pipe” Storm water management can help to mitigate the impacts of urban storm water runoff, however it is not the complete answer. Past issues with anaerobic decay within the Kanata Lakes SWM facility wetland, and increasing urban development within the watershed introduces concerns with the capacity of the wetland to continuously provide current/preexisting levels of water quality treatment. Without continuous monitoring, over the long term, it is difficult to ascertain the working capacity.

BMP source controls (i.e. street sweeping, roof top ponding, roof runoff infiltration, upstream wetlands, stricter zoning etc.) may also be necessary. Even the complete Storm water management package may not be sufficient to completely eliminate the water quality impacts of urbanization. Water temperature changes along with increases in soluble pollutants like salt and nitrates are difficult issues to correct

The NCC Greenbelt manages the agricultural lands that drain into Watts Creek. Some of these lands are tile drained and these drains may potentially contribute organics and nutrients from the fields they drain. The Nutrient Management Act, revised in 2002, changes how nutrients are managed on agricultural lands. Section 6(2) (v and w) states:

> *“requiring that materials containing nutrients be managed in an environmentally responsible manner as specified in the regulations by persons who are engaged in the purchase, acquisition, resale or disposal of materials containing nutrients or who are otherwise engaged in the trading of materials containing nutrients; and, governing the use of innovative technologies in the management of materials containing nutrients used by and on agricultural operations, including specifying conditions for the use of those technologies and respecting the manner and the circumstances in which they may be used”*

Agricultural practices must comply with the Nutrient Management Act.

In addition to the agricultural lands, the NCC Greenbelt, has some institutional and commercial land uses within their land stewardship. Institutional landuses are required to implement storm water management policies that are specific to the Watts Creek watershed.

4.5 FISH AND AQUATIC HABITAT

Alteration of flow regimes or diversion of flows have the potential to negatively influence the availability of sensitive or moderate fish habitats and invite unintended consequences to existing fish communities through a reduction in habitat quantity and quantity. Impact on fish habitat could arise from:

- maintenance, construction, and decommissioning of road crossings
- road widening
- utility easements
- development
- agriculture
- recreational activities

The unintended consequences of these activities can include:

- uncontrolled releases of stormwater runoff
- increases in peak flows
- alteration of streamflow conditions
- streambank erosion
- loss of substrate diversification
- loss of in-stream and riparian vegetation
- increased flushing of pollutants Resulting in decreased water quality (e.g., warmer water temperatures, lower oxygen levels, turbidity, increased light attenuation), loss of critical habitats, suffocation of fish, fish eggs and microinvertabrates, and contamination, ultimately resulting in reduced species diversity and a fish community comprised of fishes tolerant to change.

Fish habitat is defined in Section 34 of the Act as “spawning grounds and nursery, rearing, food supply and migration areas on which fish depend directly or indirectly in order to carry out their life processes.” Fish habitats are classified by their significance in supporting a fish community. Critical habitats (formerly Type 1) have high productive capacity and are rare, highly sensitive to development, or have a critical role in sustaining a fishery (e.g., spawning and nursery areas for some species, and ground water discharge areas). Important habitats (formerly Type 2) are moderately sensitive to development and, although important to the fish population, are not considered critical (e.g., feeding areas and open water habitats of lakes). Marginal habitats

(formerly Type 3) have low productive capacity or are highly degraded, and do not currently contribute directly to fish productivity. Marginal, and to a degree Important habitats have the potential to be improved. The results of the fish habitat assessment presented in the "Shirley's Brook and Watts Creek Sub watershed Study" indicates that Watts Creek contains only Important habitats.

A preliminary investigation of Watts Creek on July 20, 2010, suggests Watts Creek habitats are largely homogenous with a few exceptions. In general, substrates are dominated by clay with deposits of silt and muck with generally slow moving flows. In-stream cover is minimal with very little course woody debris, coarse substrate. In-stream vegetation is limited to small amounts of mosses and filamentous algae with no rooted vascular plants. The riparian areas are densely vegetated with grasses and very little canopy cover.

One exception to the homogenous habitat qualification include Watts Creek between Teron Road and March / Eagleson Road, where existing conditions appear to be engineered, containing riffle-pool sequences with varying flow velocities and diverse substrates ranging from fine materials to boulders and bedrock. In-stream vegetation was largely limited to moss and algae. In-stream shade is provided by overhanging vegetation and mature riparian trees providing abundant stream shading. The creek banks are steep with signs of erosion.

The other exception to homogenous habitat included a section of Watts Creek between the CN rail line and Carling Road. Existing conditions in this area contained a mixture of habitat types similar to the homogenous habitats inter-mixed with heavily forested areas with a diverse mix of substrates ranging from fine materials to boulders and bedrock. Water velocities varied significantly through natural riffle-pool sequences with abundant in-stream cover (e.g., coarse substrate, coarse woody debris), mosses, algae and rooted vascular plants. In-stream shade is provided by overhanging vegetation and mature riparian trees providing abundant stream shading.

Water temperature is considered one of the most important environmental variables in stream ecosystems due to its impact on growth, survival and distribution of aquatic organisms. Water temperature in streams is influenced by numerous factors such as per cent riparian forest, mean annual air temperature, per cent surface water, and groundwater discharge potential.

Water courses are generally classified into three categories (cold, <19°C; cool, 19–<22°C; and warm, ≥22°C) based on a variety of temperature data and calculation methods. Cold water systems are typically considered the most sensitive to change while warm water systems are generally considered tolerant of change. Mississippi Valley Conservation currently considers Watts Creek a warm water system.

Water temperatures were collected periodically throughout the day of the preliminary investigation. Water temperatures in Watts Creek ranged from 20.5 °C to 25.5 °C between the Carling Road crossing and the Tri Party sanitary sewer siphon, respectively.

Each fish species is tolerant of a range of water temperatures and they are classified similarly as cold, cool, and warm water species based on their preferred summer water temperature. The Watts Creek fish community was previously made up of a mix of cool and warm water species (Dillon 1999, Table ???), however is currently considered warm water. The current fish community in Watts Creek is unknown and likely has changed since 1999. In addition to impacting the physiological and biological functions of fish described above, increasing water temperatures provides greater opportunities for invasive species to colonize new areas.

Table ???. The following fish species have been observed in Watts Creek(Dillon 1999).

Common Name	Scientific Name	Common Name	Scientific Name
Banded Killifish	*Fundulus diaphanus*	Fathead Minnow	*Pimephales promelas*
Blacknose Dace	*Rhinichthys atratulus*	Finescale Dace	*Phoxinus neogaeus*
Blacknose Shiner	*Notropis heterolepis*	Freshwater Drum	*Aplodinotus grunniens*
Bluntnose Minnow	*Pimephales notatus*	Golden Shiner	*Notemigonus crysoleucas*
Bridle Shiner	*Notropis bifrenatus*	Logperch	*Percina caprodes*
Brook Stickleback	*Culaea inconstans*	Northern Pike	*Esox lucius*
Central Mudminnow	*Umbra limi*	Northern Redbelly Dace	*Chrosomus eos*
Common Shiner	*Luxilus cornutus*	White Sucker	*Catostomus commersonii*
Creek Chub	*Semotilus atromaculatus*	Yellow Perch	*Perca flavescens*
Fantail Darter	*Etheostoma flabellare*		

4.5.1 Species of Concern

Background information pertaining to species of concern within Watts Creek was requested and/or gathered from several sources, including the DFO, MNR, and the *Shirley's Brook and Watts Creek Subwatershed Study* (Dillon 1999). Distribution maps of fish Species at Risk produced by DFO suggest no federally designated Species at Risk occur in the Watts Creek system (DFO, 2010), however American Eel (Anguilla rostrata) and River Redhorse (Moxostoma carinatum) are noted in Shirley's Brook, the system immediately to the west of Watts Creek. Species at Risk information was requested from the MNR on April 12, 2010. A response has not been received to date.

No fish species of concern were noted in Watts Creek in the Shirley's Brook and Watts Creek Subwatershed Study (Dillon, 1999). However the status of the Bridle Shiner (Notropis bifrenatus) has changed since the production of the subwatershed study. The Bridle Shiner has historically occurred in Watts Creek, though it is not clear from the subwatershed study when Bridle Shiner was last observed in Watts Creek. Bridle Shiner is currently listed as a species of

Special Concern in Ontario, though there is no formal protection for this species provincially (Holm et al., 2009). Bridle Shiner was federally designated a species of Special Concern by the Committee on the Status of Endangered Wildlife in Canada in November 2001.

Bridle Shiner prefer quiet areas of clear, cool streams and are typically associated with abundant submersed aquatic vegetation and silt or sand and silt substrates. Bridle Shiner use the vegetation for cover, to locate food, and spawning (DFO, 2010). In Ontario, Bridle Shiner is only found in the St. Lawrence River and its tributaries (Holm et al., 2009). terrestrial habitat

4.6 TERRESTRIAL HABITAT

In the past, development and agricultural pressures have resulted in the loss of floodplain, reductions in buffer area, and fragmentation of the terrestrial linkages. This in turn results in water temperature variations, reduction in base flow, decreased wildlife biodiversity, and erosion. It is considered important and beneficial to the City, that the NCC maintains corridors that will benefit wildlife movement and provide recreational opportunities.

Also terrestrial habitats within the sub watershed area have been fragmented by human activities. Habitat fragmentation as a result of development is a significant threat to terrestrial fauna (e.g., birds, deer, turtles). Three migration corridors linking terrestrial habitats to the Ottawa River are identified in the sub watershed study. Large areas of protected natural areas are present within the sub watershed, particularly southwest of Second Line Road. Smaller areas of unprotected natural areas occur between the protected natural areas and the Ottawa River. The small unprotected natural areas are essential links in the migration corridors and should be protected.

4.6.1 Shirley's Bay Wetland

Restoration of the form and natural regime of the wetland should be pursued. Water quality in Shirley’s Bay is greatly influenced by upstream conditions. Improvement of water quality in both watercourses will improve the quality in Shirley’s Bay. Reductions in sediment and nutrient load will reduce overall inputs into the bay, increasing water clarity and decreasing water temperature. This leads to aquatic vegetation growth at greater depths, further reducing the temperature. An added benefit is an increase in cover for fish.

5.0 Storm Water Management Targets of Future Development

5.1 ENVIRONMENTAL TARGETS

The Shirley's Brook and Watts Creek report developed targets to manage the impact of future development on water quality and quantity, and to provide a basis to monitor the effectiveness of the management strategies. These are desired end points that should be implemented for all developments within the watershed.

The report noted that once these targets are adopted as City policy, they can be used as a measuring stick against proposed developments as well as forming a basis for long term watershed monitoring.

5.1.1 Water quality

The water quality targets where based on literature sources pertaining to the protection of aquatic and terrestrial habitats, and Subwatershed specific data.

The following summary of water quality targets has been established, and was accepted as reasonable through input from the associated Project Steering Committee and the public. Because it represents a combination of objectives and accounts for the streams constraints, we see no reason not to carry it forward.

Table 5.1
Recommended Key Surface Water Quality Conditions
For the Protection of Aquatic Life

Parameter	Recommended Criteria Level	Discussion
Dissolved Oxygen	>3.0mg/L	For the protection of warm water fish habitat
Temperature	<2^{o} change	The thermal addition of storm water runoff should not exceed 2^{o}.
pH	6.5 to 9.0	Historical value
TSS	< 10 mg/L	The 10mg/L is a background value
UN-ionized NH^4	<0.02mg/L	PWQO
Total Phosphorus	0.03mg/L	PWQO
Aluminum	0.3mg/L	PWQO
Cadmium	0.0005mg/L	PWQO
Copper	0.005mg/L	PWQO
Lead	0.025mg/L	PWQO
Zinc	0.03mg/L	PWQO

The more stringent of eighter the above noted water quality targets or the Level 1 (enhanced) treatment target given in the Kanata Lakes SWM facility CofA be used as water quality criteria for future developments within the watershed.

5.1.2 Water Quantity

Streamflow targets are based on maintaining as close as possible, the entire range of flows. . The statistical description of streams flow regime is presented by a frequency, magnitude and duration curve. This statistical curve can be calculated for changing landuses using continuous simulation modeling.

Flows were calculated by Dillon in their September 1999 Shirley's Brook and Watts Creek Subwatershed Study report using a calibrated QUALHYMO computer model both on a continuous and single event bases. The landuse conditions, together with the methods used to derive the flow values are discussed in detail in Appendix C of that study.

Base flows

Sufficient base flow is required to protect aquatic and terrestrial ecosystems. For specific reaches the base flow targets were established by Dillon in their above noted study (re page 6-9) in as follows:

Kizzel Drain at outlet of Beaver Pond ……..15 L/s

Kizzel Drain at confluence with Watts Creek…….....20L/s

Watts Creek at Corkstown Road……..20L/s

Watts Creek downstream of Kizzel Drain…….50L/s

Watts Creek at Shirleys…….60L/s

Flooding and Erosion

Stream flow targets related to flooding and erosion are not specifically given in the aforementioned Dillon study. Regardless the concerns with increased flow rates and durations were identified and it was recommended that

1. The target level of quantity control would be to control post development peak flows to their corresponding pre-development levels for the 100 year return period event".

2. To control stream bank erosion, stormwater management (quantity controls) are recommended to minimize the potential for stream bank erosion in planned development areas.

3. When selecting targets for stream bank erosion, it is important for the proponent and reviewer to be cognizant of the risks involved in the release of post development runoff from the storage facility. Due to the increased volume of post development runoff, the duration of the uncontrolled outflow will be longer than predevelopment flows. This increase in duration can create potential erosion, in excess of the pre-development rate. Furthermore, if the rate of erosion and the volume of sediment contributed to the channel are note regulated, then the suspended sediment load of the water courses within will increase turbidity, impair water quality, and degrade aquatic ecosystems.

In light of the above noted erosion control concern, it is a recommendation of this report that the hydrological targets associated with urban drainage should be on a prescriptive bases, thus the entire flow regime is to be maintained at existing conditions. It is recognized that additional detailed studies may supersede this recommendation.

For reference purposes, existing Flows (in m3/s), were calculated in the aforementioned study (see Table 5.5 page 5-14) for the 2 year, 10 year and 100 year event as follows:.

Target Sites	2 year	10 year	100 year
Kizzel drain downstream of the beaver Pond	0.31	0.56	0.81*
Kizzel drain at Carling Ave.	2.2	4.2	7.2
Kizzel drain at confluence of Watts Creek	4.4.	8.8.	15.7
Watts Creek north of Highway 417	6.1	11.6	20.5
Watts creek at Corkstown Road	6.7	12.8	22.9
Watts Creek at Confluence with Kizzel Drain	6.2	13.7	28.1
Watts Creek at CNR	10.6	22.6	40.2
Watts Creek at Ottawa River	9.9	21.5	41.6

* According to the CofA 100 year discharges from the outlet structure “at a controlled rate of 0.96m3/s”.

5.2 WATERSHED INITIATIVES

Landuses within the Watts Creek and Kizzel Drain watershed is a mix of rural and urban. Urban expansions occurring over the next decade will be primarily within the Kizzel Drain watershed. With respect to these developments the City should work with the MVCA and the NCC on the following watershed initiatives.

- For watercourses within the urban areas the City/MVCA should work with developers, to naturalize the water course. Reaches susceptible to erosion should be stabilized, and new fish habitats added to reaches of degraded aquatic habitat.
- For downstream reaches and other priority areas, the City/MVCA/NCC should develop site specific action plans with the assistance of local interest/community groups. These action plans will need cost estimates and a cost plan.

- The City/NCC should embark on a program to secure priority woodland/wetland areas[1].
- The City/MVCA should update and extend floodplain mapping for both Shirley's Brook and Watts Creek and the City should update the OP accordingly.
- There are a number of bridge/culverts that are hydraulically or structurally inadequate (i.e. Carling Ave at the Kizzel Drain and the Twin pipe culverts on the CNR at Watts Creek). *In using the "Cities Structure Renewal Options Analysis Guidelines" for Watts Creek and Shirley's Brook twin structures should be avoided.*
- The meander belt area is to be considered a natural hazard area and regulated appropriately. The City should ensure that developers are aware of the recommended aquatic development setbacks (i.e. 30 meter and 15 meters, both sides of the watercourse, for type 1 and type 2/3 fish habitat respectively.). Though the NCC lands, the meander belt and water course will require detailed study, preliminary designs should be prepared, along with costs and a cost sharing formula with urban lands.
- In accordance with the ground water management recommendations of the Official Plan* develops should be required to implement lot level ground water infiltration BMP's.

5.3 MONITORING

It is recommended that a water quality/quantity and stream fluvial geomorphology monitoring plan be developed.

The goal of these stations is to provide up-to-date information on the creek status in terms of:

- Water quality/Temperature. Both urban and agricultural lands can contribute to poorer water quality and increases in water temperature. The Monitoring should include some indicator parameters at site that are representative of both types of land use.
- Distribution and diversity of aquatic life, including fish and aquatic invertebrates. It is suggested that the MVCA and DFO contribute in a co-operative effort to ensure that this monitoring component is implemented.
- Extent of on-going erosion, siltation and debris accumulation/obstructions. Routine visual inspection of the watercourse should be conducted annually to provide an on-going record of current status, including photographic records, permanent survey channel cross sections and analysis reports. The information on erosion and channel morphology status would act as a base for determining the need for a future flow control pond on the upper reach of Watts Creek and with gauging the effectiveness of upstream measures designed to assist with control of flow velocities.

In short, monitoring should be geared towards providing a comprehensive update on current status, so that the effects of implemented measures can be gauged.

[1] Please refer to Section 2.4.4 Groundwater Management for the City's policies on the protection of groundwater recharge areas and Section 2.4.5 Greenspaces for policies on the protection of forests in the City.

The monitoring term should be sufficient to confirm/establish trends in the overall health of the ecosystem (i.e. approximately 10 years). The plan should include specific sites that are accessible and provide a representation of how well the subwatershed criteria's and objectives are being achieved. The monitoring stations should be developed and maintained as part of the conditions to urban development.

6.0 Fluvial Geomorphology

6.1 CURRENT STATUS OF THE WATTS CREEK AND KIZZEL DRAIN STREAM MORPHOLOGY

6.1.1 Watts Creek upstream of Kizzel Drain:

Watts Creek is an actively meandering system that has its headwaters in the developed lands south of the intersection of Highway 417 and Eagleson Road.

Prior to crossing the 417, the Creek is a minor feature with few fluvial features, and it is fed primarily through stormwater discharge from the surrounding lands. As if flows through the highway interchange it picks up flow from roadside drainage and it is at this point that the creek starts to have distinctive features.

Almost immediately downstream of the junction of these two contributing branches the creek begins to take a meandering path, with a series of very tight meanders that have high amplitudes but rather short wavelengths.

Between the interchange and the Corkstown Road crossing there are at least 15 separate meander features, with up to 5 working their way to becoming eventual meander cutoffs over time. Riparian vegetation builds in diversity in this section and coverage of the creek starts to become significant.

Downstream of Corkstown Road the meandering continues in the same manner as upstream, with some tortuous menders interspersed among more gentle meander forms. Bank erosion along these reaches is significant as the creek continues to adjust to flows it receives from storms. There is one pedestrian trail crossing in the section between Corkstown Road and the Hydro transmission lines; that crossing appears to be rather stable and not currently under any significant risk. That said, the crossing should be monitored.

Downstream from what is referred to as the lower crossing the creek continues to access a wide section of the floodplain, however it would be a stretch to consider this meandering, considering the form of meandering upstream. It is more likely that the creek has been realigned in sections for some purpose or another, though I do not have any direct knowledge of this. Upon exiting this section (where there is little in the way of climax riparian cover) the creek enters a wooded area where the meandering again becomes active and tortuous, with high amplitude yet low wavelength. Again there are locations where cutoffs will eventually occur over time.

Upstream of the next trail crossing (which recently had its culvert replaced) the creek straightens. Bank erosion along this reach indicates the creek may be attempting to meander through here, but the time component of that activity would be slow given the nature of the ground vegetation and its ability to keep the banks relatively stable.

Downstream of the crossing meandering again begins to occur, until the rail line is reached. Upon passing beneath the rail, the creek follows the toe of slope for the rail bed for a distance of approximately 200 metres, where it is joined by the Kizzel Drain.

6.1.2 Watts Creek downstream of the Kizzel Drain:

The combined flow of the Watts and Kizzel systems moves through the landscape in a meandering pattern, however the meandering is somewhat more gentle than is seen upstream on Watts Creek. The Creek flows through open and wooded areas, straightening about 200 metres upstream of the Carling Avenue culvert.

The upstream side of the Carling culvert is somewhat of a mess. There is deposition of fines and a considerable amount of wood debris (and other debris as well) that is redirecting flow in such a way that the banks are eroding and the creek may be starting to flank the culvert. This is an area where intervention may be required, however that intervention could be limited to a clean-out and maintenance rather than a channel realignment. It is my understanding that a replacement culvert is being considered and the installation of that culvert, along with the removal of the existing one, provides a good opportunity for a clean-out.

Downstream of the Carling culvert the creek starts to meander again as the land gradient flattens out upstream of the Ottawa River. Tortuous meanders upstream of Malibar Rd/Shirleys Blvd are close to the existing culvert crossing and may require attention at some point in the future.

Overall the Watts and Kizzel systems are actively meandering with bank erosion along long stretches of creek length. That said, there is little if anything in the way of risk to infrastructure, with only two trail crossings, the low level crossing, and two road crossings to consider.

Therefore it can be concluded that while the systems are actively eroding, the erosion is natural as the creek continues to adjust to stormwater inputs (I was not able to find any SWM ponds along the system with the exception of one pond on the north west side of the Highway 417/ Eagleson interchange).

This erosion must be considered systemic in that the creek is adjusting along its length, and any attempt to stabilize or rehabilitate small sections would be wrought with long-term problems as the restored area would continue to have its upstream area adjusting, altering flow and sediment properties through the restored reach.

Further discussion is needed to determine what action, if any, is required for the road and trail crossings.

6.2 CHANNEL EROSION

All stable creek systems erode (i.e. eroding banks, bed scour). Erosion is natural process that helps deliver sediment to the system. Sediment supply, transport, and deposition is necessary to help the creek system dissipate stream energy and maintain a balance between flow and channel form.

6.2.1 Development of Erosion Thresholds for Stormwater Release Rates.

It would be prudent for the NCC to undertake work to determine erosion thresholds for sections of the Kizzel Drain and Watts Creek. These thresholds would be used to control stormwater pond release rates for upstream development with the intention of protecting the range of natural processes currently acting on these systems.

At times alterations to hydrologic processes will result from Proponent Applications. Changes in volumes and timing of flow require assessment of the impacts on receiving watercourses. This requires establishing erosion thresholds, through tractive force analysis, for bed and bank erosion potential.

The fundamental goal of fluvial ecosystem assessment, maintenance, restoration and monitoring is to maintain a condition that resembles its natural predisturbed state as closely as possible. Achievement of this goal entails maintenance of the target system's structure and function both locally and within its broader landscape or watershed context. To measure the degree of success in achieving such goals, physical, chemical, and biological evaluation data are necessary to verify that an ecosystem is performing as it should. To achieve long-term success, fluvial ecosystem maintenance should, where possible, address the causes and not just the symptoms of potential ecosystem disturbance. Sometimes these causes are obvious, and sometimes they are far removed in time and space from the ecological damage.

The changes that stress fluvial systems impair their value for both human use and environmental services. Stresses can arise from (1) water quantity or flow mistiming, (2) morphological modifications of the channel or riparian zone, (3) excessive erosion and sedimentation, (4) deterioration of substrate quality, (5) deterioration of water quality, (6) decline of native species, and (7) introduction of alien species. In most systems, these conditions arise from rapid or poorly-planned development where no predictive studies of channel adjustment have been undertaken.

6.2.2 Tractive Force Analysis

Tractive force analysis is an essential component of any development / environmental study in that it allows investigators to determine erosion-sensitive reaches and provides guidance for the delivery of flow volumes from stormwater management facilities.

The concept of tractive force analysis is relatively simple: a stream system or watercourse develops over many years with respect to the timing and volume of flow contributions by

groundwater (baseflow contributions) and overland flow (volumes greater than baseflow in streams), by the process of erosion and sediment transport. Therefore a watercourse develops a cross-sectional area and profile in the downstream direction that allows for the transfer of water and sediment from headwaters to mouth. When alterations to the hydrologic regime of a watershed occur, the response of the watercourse is to change either its cross-sectional area (via lateral or vertical erosion) or to modify its gradient (becoming steeper or more gentle depending on the conditions). These changes are not immediate in most cases nor are they limited to a particular temporal boundary as cumulative impacts usually prevent re-establishment of a natural flow regime.

Development of rural or agricultural lands to a more impervious surface is one such alteration which has in the past resulted in considerable change to stream systems. Paved surfaces and reduced infiltration result in two major impacts in streams: first, rapid delivery of flow to the watercourse causes increased flow competence and thereby sediment transport and erosion; second, a decrease in infiltration causes a potential decrease in baseflow contributions as subsurface hydropotential gradients are altered.

The preferred management strategy to the groundwater recharge issue is the development and maintenance of infiltration galleries within stormwater management ponds. However the problem of accelerated erosion by overflows during storm events is a more serious and complicated matter.

Stormwater management ponds will discharge excess water during periods of high input to surrounding stream systems. The delivery of that excess flow has the potential to cause erosion by either increased flow velocity or lower velocity over extended periods of time. Both conditions will result in channel alterations downstream of the structure, particularly in erosion-sensitive reaches. The challenge for managers is to effectively create stormwater management strategies which minimize impact to receiving watercourses and do not contribute to accelerated (faster than natural rate) erosion.

6.2.2.1 Methodology

Tractive force analysis (also known as excess shear, excess velocity, and excess stream power) allows geomorphologists to guide engineers as to the rate and timing of stormwater discharge from such ponds. The methodology to undertake such analyses includes the following:

1. A stream walk is undertaken at the start of the assessment to document overall watercourse conditions and to identify areas of potential erosion risk. During this walk notations of changes in soil type and bed characteristics are made and digital photographs are taken. A further purpose of the creek walk is to choose potential cross-sections for further study. The number of cross-sections chosen reflects the concerns of the study TOR.

2. A rapid reach assessment is undertaken which identifies particular concerns with respect to channel form, bank properties, riparian conditions, substrate and flow characteristics. A numerical score of out of 100 results which can be used comparatively to select reaches for further study.

3. Once all potential cross-sections have been identified choices are made as to which ones would require further analysis. This decision is based on relative stability to other reaches and the proximity to areas of concern or specific interest: in particular areas of differing soil type, proximity to structures, or proximity to catchment nodes with respect to the hydrological modeling which this work complements.

4. Each cross-section is monumented for future use. Cross-sectional measurements of channel and bankfull area are made at tight intervals to get a detailed indication of form. Local slope is determined using a leveling exercise. This cross-sectional data is input into a flow model along with information on channel roughness (Manning's 'n') to determine stage/discharge relationships and specific velocities.

5. Bed samples of pavement and subpavement are collected and returned to the lab for grain-size analysis, bank samples are also collected. The grain size distribution is used in the tractive force analysis.

6. Critical shear stress for the bank and bed material (pavement and subpavement) is determined using standardized methods for the D_{10}, D_{50} and D_{90} fraction of each sample.

7. Critical velocities for entrainment for the bank and bed material (pavement and subpavement) is determined using standardized methods for the D_{10}, D_{50} and D_{90} fraction of each sample.

8. Boundary shear stress is determined from the cross-sectional profile, slope and roughness components measured in the field. Comparisons are made between the critical and boundary shear at bankfull stage to establish erosion potential for each fraction.

9. Existing relationships between stage and velocity through the sections are determined using standard equations (e.g. Komar, 1987) and a stage/velocity curve is developed. This curve is validated through direct measurement in the field of flow velocity on a minimum of three different flow events.

10. Critical velocities for the erosion of bank and bed material (pavement and subpavement) is determined using standardized methods for the D_{10}, D_{50} and D_{90} fraction of each sample.

11. Critical discharge to match the critical/boundary shear relationship as well as the critical velocity relationship is then mathematically determined and reported to the engineer for placement in the hydrological model as a threshold value. The hydrological model is

then run against the threshold value to determine exceedance for the pre-development and post-development scenarios; this is input into the decision matrix for the sizing of the stormwater management pond.

12. Theoretical erosion and transport is based on ideal conditions; however ideal conditions in the field are not often found. Validation of the transport results are required and are achieved through direct bedload transport sampling at the cross-sections where calculated thresholds are determined, again using a minimum of three samples under different flow events. Field results are used to validate the erosion and transport model results; at time tweaking of the theoretical model is required.

13. Reporting includes critical shear, critical discharge, critical velocity, stream power and erosion potential for the selected cross-sections. These other critical thresholds are reported in case there are issues surrounding the use of shear stress as a decision-making tool.

14. Results are evaluated and the potential for impacts are determined for the post-development condition. Depending on the degree of impact, a mitigation plan is to be developed to deal with the erosion problems. This mitigation plan is to include an implementation plan as well as preliminary costing.

15. Recommendations are made from the perspectives of fluvial functioning of the watercourse as a component of the final report.

The determination of erosion thresholds using the tractive force/permissible velocity procedure does not require that an existing hydrologic model is in place. Thresholds and critical discharges can be established for any reach and then be available for input into the exceedance exercise upon development of the hydrologic model.

If thresholds have been developed for a reach and it has been more than 3 years before the hydrologic model is run, the thresholds need to be assessed to determine if they remain appropriate, as changes in the upstream area may have altered the sediment regime for the reach.

6.2.3 Location of Study Reaches for Erosion Threshold Analysis

Five reaches have been selected for erosion threshold analysis. These reaches are considered to be sensitive to changes in hydrology and as such, would act as controlling reaches for stormwater discharge.

The reaches are located as follows (Ref. Figure JTBES 1 below): Kizzel Reach 1is located upstream of Legget Drive within the vicinity of the golf course; Kizzel Reach 2 is located upstream and downstream of Herzberg Road; Watts Reach 1 is located downstream of the junction of Watts Creek and Kizzel Drain along an actively meandering reach; Watts Reach 2 is

located upstream and downstream of the Carling crossing; and Watts Creek 3 is located upstream and downstream of the Sandhill Road crossing.

In addition, a control reach has been added to Watts Creek upstream of the low crossing on an active meandering reach. The purpose of this control reach is to understand the degree of meandering and change to channel cross-sections in areas that are not expected to be affected by land use change.

Erosion threshold analysis should be undertaken as soon as is practical to ensure existing conditions are not affected by future land use change.

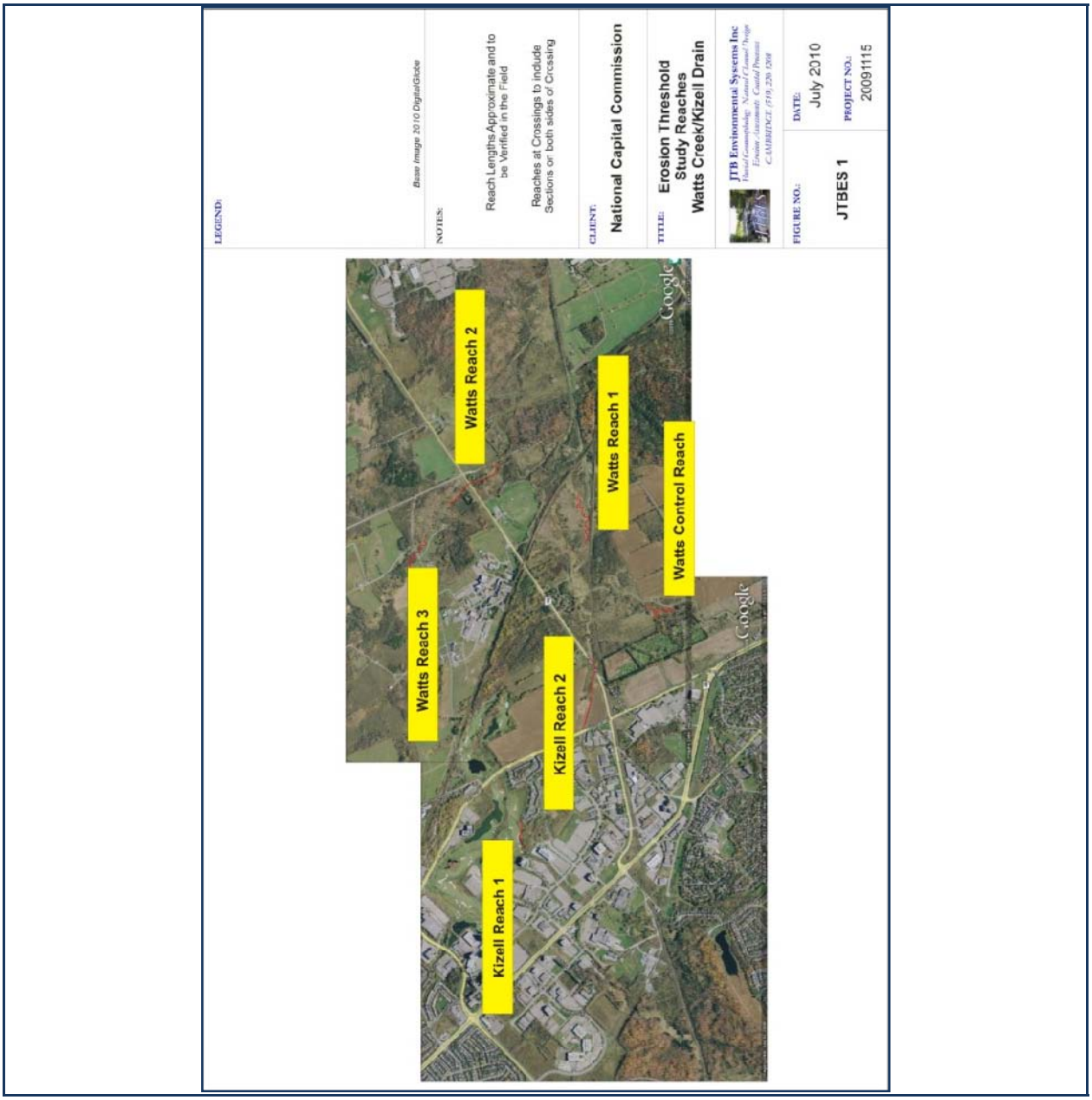

Figure JTBES1: Location of Erosion Threshold Reaches

6.3 FISH HABITAT PROTECTION/RESTORATION

The highest quality habitat in Watts Creeks occurs in the undeveloped upstream reaches. Protection should be afforded for these areas in the form of limited development. When development is permitted to occur, appropriate setback distances should be maintained with naturally occurring conditions within the riparian area undisturbed. Disturbed or manicured areas should be replanted with native herbaceous and woody plant species to provide bank stabilization and shade.

Efforts to improve habitats should include plans to simultaneously protect higher quality Critical and Important habitats while improving degraded Marginal habitats. Opportunities for fish habitat improvement should be exploited as they arise.

Regulation of water temperature is vital to the aquatic ecosystem. Controlling erosion and water course shading are two strategies for controlling water temperatures that can be accomplished by the same methods. Riparian naturalization efforts including planting of native plant species e.g., reed canary grass, red osier dogwood, willow) will help to stabilize banks and provide much needed shade. Vegetative buffer (e.g., native grasses, shrubs, and trees) on both sides of all watercourses is recommended as follows:

Critical Fish Habitat (formerly Type 1) should have a	-	30 m buffer
Important Fish Habitat (formerly Type 2) should have a		15 m buffer
Marginal Fish Habitat (formerly Type 3) should have a		15 m buffer

Instream work should include incorporate natural design principles to provide riffle-pool-run sequences. Common and homogenous habitat types should be diversified. For example, where substrates are dominated by soft/fine materials, a range of clean, coarse substrates (i.e. gravel, cobble, boulders) should be introduced. Naturally occurring organic debris such as fallen trees, rootwads, and leaf packs should be left undisturbed. Barriers to migration, such as beaver dams, weirs, etc., should be removed.

Agriculture has the greatest impact in Watts Creek and can be effectively mitigated by limiting access of livestock and farm machinery to the watercourses. Access should be restricted to limited access locations. Active agriculture lands within the riparian areas should be allowed to return to a natural state (e.g., no mechanical alteration or maintenance) with supplemental plantings of native herbaceous and woody plant species.

6.4 TERRESTRIAL HABITAT AND LINKAGES

Improving the in-water conditions and riparian area as noted above should significantly improve resources available in the immediate area for terrestrial species.

Migration corridors occurring in the Watts Creek Watershed linking terrestrial habitats to the Ottawa River are identified in the sub watershed study. Large areas of protected natural areas are present within the sub watershed, particularly southwest of Second Line Road. Smaller

areas of unprotected natural areas occur between the protected natural areas and the Ottawa River. The small unprotected natural areas are essential links in the migration corridors and should be protected.

7.0 Preliminary Design

Alternatives to this undertaking including the do nothing option were not explicitly examined but are discussed herein.

7.1 PROPOSED WATERCOURSE MANAGEMENT PLAN AND OPPORTUNITIES

The area within the meander width is critical to the health of the watercourse and its related ecosystem. A large and diverse this buffer area along the channel promotes significant enhancements to water quality and terrestrial activity within the watershed.

Managing this stream system can go two ways--one can either take what could be considered a heavy-handed approach and go in draining and trying to fix all the erosion areas, or one could take a more passive approach and allow the creek to continue its adjustment phase naturally while ensuring that potential risks at crossings, agricultural tile drainage systems, and threats to table land are monitored and acted upon if a problem starts to present itself.

Attempting to fix the erosion areas would be a monumental task and there is no guarantee that the fix would be stable over time. When a system is actively adjusting it is difficult to separate cause and effect for the erosion areas, and as such it becomes almost a guessing game as to what to fix and how. Additionally, because there are many areas where the creek is showing adjustment, restoring one area would likely not be successful over time as the upstream area would still be adjusting. That means a restoration plan would have to include ALL areas and the cost would be prohibitive.

That said, sitting back and letting the creek do what it wants to in order to fix itself is hard to do. The corridor is an active recreation area along the trails, and people are going to see the erosion and adjustment and some will call and complain that nothing is being done. If this is the preferred course of action by stakeholders then a public education component should be implemented that informs the public that there is awareness of what is happening and it is being carefully monitored, however it is in the best interest of the creek overall to allow it to do what it wants as long as there is no risk to persons or infrastructure. This would in fact make this a significant educational opportunity that could be taken advantage of by local schools to develop a long-term 'Creek Watch' program.

Figure 7-1b of the Dillon Report highlights potential restoration areas. Considering how little direct information that exists on channel behavior and fluvial process, it is not recommended at this time to undertake any restoration of this type as the benefits are not sufficiently understood.

In order for this to be properly undertaken, a detailed study of the creeks and their behavior in the vicinity of the crossings should be completed as soon as possible. These sites would then be continually assessed and change over time tracked, with the expectation that forward-thinking would be used to predict increasing risk.

7.2 CHANNEL IMPROVEMENTS AND RECOMMENDATIONS

For those reaches of the Kizzel and Watts Creek Water courses that are firstly within the NCC greenbelt and secondly which are part of the municipal drain we have conceptualized works that may occur as part of a Section 78 Municipal Drain engineers report.

It is recommended that the following design objectives from a base of design.

Design objectives:

- Enhance the ecological system by adding a fish habitat.
- Improve water quality by adding shading within the meander belt and along the Kizzel Storm Water management Pond.
- Maintain and improve on the hydraulic functions of the drain.
- Protect structures, table lands and the watercourse from further deterioration.
- Provide improved access to the water course for inspection, maintenance and public educational purposes (i.e. lookouts).
- Erosion protection incorporate bio engineered products.

The channel improvements proposed herein are related to works that may be done as part of an Engineer's Report initiated and prepared under Section 78 of the Drainage Act. The works are intended to improve the existing drain by making it more environmentally acceptable and current with the Drainage Act requirements.

A proposed preliminary concept plan is shown in Figure 8 and 9. These works are for preliminary costing purposes only, and set a benchmark on which costing sharing principals can be developed.

Preliminary Design Recommendations:

- Relocate parts of the drain away from the rail way embankment. The relocation sections would be excavated and allowed to establish. Once fully established with vegetation (i.e. 1or 2 years later) they can be utilized and the existing drain abandoned. The increased meander belt, currently being constrained by the railway embankment, should be reforested to provide shading and terrestrial linkage. It is noted that under the Drainage Act, works pertaining to the railway should be implemented by that public utility or can be charged back to that authority as a special benefit.
- To minimize water course contact with the CNR railway embankment, relocate the confluence of Watts Creek with the Kizzel Drain.
- Provide a shaded walking trail along the water course. This trial will be also provide the NCC with access to monitor the stream and when necessary remove beaver dams and other obstructions within the watercourse.

- Improve the watercourse hydraulics, by removing obstructions.
- Stabilize the channel from further entrenchment by adding bio engineered drop structures.
- Culverts that restrict the flow or are structurally deficient (i.e. Carling Ave at Kizzel Drain and CNR at Watts Creek should be replaced with new single barrel structures.
- Rip Rap with filter cloth should be placed at the ends of all culverts, at bends, tile outlets, lateral drains and channel drops, where erosion is observed to be a risk to structures, tile drainage systems or table lands. Bio engineering techniques such as root wads, live staking, brush layering, and coir logs can be used to retain the soils from further erosion.
- Tree shading and fish habitat enhancements should be added to the water course.
- The Mississippi Valley Conservation Authority on behalf of DFO will undertake a Fish Habitat and Class Authorization of the watercourse for its future maintenance. This will streamline the review and approval process related to impacts of watercourse maintenance activities on fish habitat.

7.2.1 Public use of Green Space

Public use focuses on the wooded and open areas alongside the creek and within the watershed. These areas see a variety of uses including casual walking, pet walking, bicycling and some winter sport activities including informal cross country skiing.

There are established pathways from the City of Kanata at Corkstown Road, northward to Carling Ave and from Carling to Shirley's Bay via Riffle Road. In general, it is obvious that there is substantial public use and appreciation of the Watts Creek corridor.

It was apparent from the water course inspection that additional informal Public Access linkages to the aesthetically and geomorphologic features of the water course are missing and could be added as part of the water course management plan. The water course management plan shows some pathways to the water course. These pathway locations are for discussion and costing purposes only.

7.3 FUTURE WATERCOURSE CONCERNS

In general, landuse changes that affect the vegetation, soil or drainage patterns will impact on the rate and volume of flow in a water course. Changes that increase the rate of flow or volume of surface water will have a negative impact on erosion and vice versa.

At this point in time we do not have sufficient information to determine with a high degree of confidence the extent of impact for any particular development application on the creeks within the watershed; however this report documents the concerns and points out that parts of the stream are undergoing erosion and environmental stresses.

Accordingly, it will be important that future developments in the watershed complete the appropriate Storm water management studies, subject to provincial and municipal approvals, on an ongoing basis as development applications come forward.

7.3.1 Kizzel Drain and Watt Creek Down Stream of Kizzel Drain

Within the Kizzel drain watershed, there are several land developments that are likely to occur in the shorter term. It is recommended that these developments adhere to the environmental targets set by the 1999 Shirley's Brook and Watts Creek Subwatershed Study, and as summarized herein.

With respect to a contemplated flow diversion from Shirley's Brook to the Kizzel drain, any alteration of flows is going to take that adjustment that has occurred and throw it out of kilter, initiating another adjustment phase that would be just beginning. In addition, a switching would affect base flow levels in both systems, and the associated differences in timing and duration of flows to the systems would be a catalyst for further change.

7.3.2 Watts Creek Upstream of Kizzel Drain

For Watts Creek upstream of the Kizzel Drain, erosion and water quality problems will continue and may accelerate due to climate change and development infill.

It is the opinion of this study, that the benefits of stream stabilization in Watts Creek upstream of Kizzel Drain, to correct for past neglects in water management, are questionable at best.

For this urban watershed alternative storm water management solutions may include site level water management, and/or inline storm water management pond. It is pointed out that this situation is similar to the Sawmill Creek and McEwan Creek circumstances wherein a pond was added after the fact.

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Legend

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- PROPOSED PATHWAY
- RURAL VACANT LAND
- PROPOSED LOOKOUTS
- PROPOSED CULVERT/TILE DRAINAGE EROSION PROTECTION
- ABANDON DRAIN

0 200 600 1000m

Client/Project
NATIONAL CAPITAL COMMISSION
WATTS CREEK AND
KIZZLE MUNICIPAL DRAIN

Figure No.
8

Title

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2010-08-25 09:56AM By: ecalberry

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ORIGINAL SHEET - ANSI B

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Legend

- EXISTING WATERCOURSE ALIGNMENT
- PROPOSED WATERCOURSE RELOCATION
- PROPOSED STRUCTURE
- RURAL VACANT LAND
- PROPOSED CULVERT/TILE DRAINAGE EROSION PROTECTION
- ABANDON DRAIN

0 200 600 1000m

Client/Project
NATIONAL CAPITAL COMMISSION
WATTS CREEK AND
KIZZEL MUNICIPAL DRAIN

Figure No.
9

Title

8.0 Costs and Cost Sharing

A coordinated multi-party effort will be needed for implementation of the major works recommended: the creek realignment away from the railway embankment, erosion protection at structures, fish habitat enhancements, public pathways, stream crossings, and a potential flow detention facility on Watts Creek.

The NCC should work closely with the City of Ottawa and the Regulatory agencies in proceeding with planning and design of the structural components.

- Discussions with the City to initiate the proposed watercourse management plan under Section 78 of the Municipal Drainage Act. A significant portion of proposed work is within the existing Municipal Drain and the Act provides an implementation method that covers all aspects, including design, approvals, costing cost sharing and future maintenance.
- Discussions with the City of Ottawa to discuss decommissioning and removal of the abandoned Watt Creek sewage treatment plant, and Shirley's Bay dyke.
- The NCC should obtain proposals to supply install and maintain Monitoring stations. The purpose of these stations is to provide information and report information Monitoring Stations to provide

Once a watercourse management plan is completed and costs of this plan have been established we see no reason why the NCC cannot enter into an agreement with the City to implement the plan and collect for the costs of the works.

8.1 COST ESTIMATES

Based on the preliminary design shown on Figures 9 and 10, and for the purposes of this study, a preliminary estimate of the proposed water course management costs has been determined. A combined engineering/contingency allowance of 70% has been included and there is no allowance for land, easements, or damages.

A cost estimate for the inline pond was purposely excluded and will not be considered further. This is very significant cost item that requires further verification in respect of need.

A cost estimate for the stream crossings was also excluded. These crossings are the responsibility of the directly affected utility (i.e. the Carling Ave Crossing is the City of Ottawa's responsibility and the railway embankment crossing of Watts Creek is a CNR responsibility).

Component	Estimated Construction Cost	Engineering and Contingencies	Total
Channel Realignments	$365,000	$255,000	$620,000
Erosion Protection (assume 15 sites)	$150,000	$105,000	$255,000
Fish Habitats (assume 10 sites)	$200,000	$140,000	$340,000
Public Path way and look outs	$210,000	$150,000	$360,000
Total	$925,000	$650,000	$1,575,000

8.2 DRAINAGE ASSESSMENTS

Assessments should recognize benefit and outlet responsibility. The percentage of cost allocated to each is the duty of the Engineer. The onus is on the landowners to prove that the land is not benefited or that the outlet/injury assessment is inappropriate.

It difficult at this time to address the issues of cost and charges to potential development of upstream lands, as there is insufficient detail on preexisting flow and proposed flow after SWM in either the Kizzel Drain or Watts Creek systems.

8.2.1 Direct Benefit

The habitat corridor development, water course erosion protection works and fish habitat enhancement sites proposed for Watts Creek and Kizzel Drain, is being initiated by the NCC. The NCC has made the decision that the proposed works will be of benefit to the public at large, and that the probable cost as noted in the previous section is lower than the anticipated benefits. The benefits to the NCC include, increased social and environmental value to the public, channel stabilization/protection of table lands, and aesthetic improvements for recreational users.

8.2.2 Outlet Liability

Because of the common law responsibility, the owner of each parcel of land in the watershed is generally charged for ‘outlet liability’ in other words he has to pay for the increase size or cost of the drain due to the volume of water which he collects on his property or discharges even though the drain does not provide a direct outlet or benefit for his artificial drainage or even remove all the surface water from his land.

Generally, the assessment for outlet liability is on a unit value per acre and varies due to varying landuses and the distance/use of the water course.

8.3 DEVELOPMENT CHARGES

The City uses Development charges to collect “assessments” from future lots for those works required to accommodate sustainable growth.

8.4 COST SHARING AGREEMENTS

A cost sharing agreement between the affected parties may require employment of a mutually acceptable negotiator.

A number of general principles that should be followed in formulating a cost sharing strategy:

- Replacement, retrofitting or improvements to existing drainage infrastructure is generally the responsibility of the owner/operator of the infrastructure (Section 26 of the Drainage Act)
- Benefits and special benefits or requests for works should be paid for in proportion to the benefit received. (Section 22 and 24 of the Drainage Act)
- Cost for drainage items that are not special benefit items for a single owner are allocated in proportion to the volume of runoff generated by tributary areas calculated on the basis of area multiplied by an estimated “runoff coefficient”. The runoff coefficient provided and estimate of the percentage of precipitation that will become direct surface runoff.

9.0 Conclusions and Recommendations

This report should provide the National Capital Commission with the tools it requires to make informed policy decisions on potential flood control or erosion prevention measures, a watercourse management plan on recommended maintenance and stream corridor restoration works, and an estimate of appropriate costs along with recommended method of collect back from the landowners within the watershed.

9.1 IMMEDIATE NEEDS

The following immediate needs can be identified at this point:

9.1.1 Drain Maintenance and Improvements

As noted, the Carling Ave culvert needs replacement, there are several obstructions along the drain, erosion of tile drains are a problem and there is a need for general maintenance of the Drain.

To deal with this work and perhaps improve the drain, the NCC Greenbelt Authority should request the City for a drainage improvement under Section 78 of the Act.

9.1.2 Current Development Proposals in the Kizzel Drain Watershed

The KNL developments are pursuing subdivision approvals for lands tributary to the Kizzel Drain. In reviewing the conditions to development, the water management requirements of the 1999 Shirley's Brook and Watts Creek Sub-watershed Study by Dillon, should be applied to the extent possible and practical.

In the context of the Water Management Strategy, strictly adhering to targets for flow, and to maintain annual and seasonal volumes of water table recharge, to maintain the contribution to creek base flows is considered necessary for the long term environment health of the creek.

9.1.3 Integrated Review of Development Proposals

To ensure the intent of the 1999 Shirley's Brook and Watts Creek Sub-watershed Study is met, the need for an integrated environmental impact review of land **develo**pment proposals is emphasized.

9.1.4 Agency Identification

As a necessary first step in the implementation of the proposed water course management plan there is an immediate need to identify the lead agency that will act as project proponent and steward for the water shed and water course.

9.1.5 Immediate Monitoring Needs

As has been explained the monitoring of the water course is considered an immediate need to ensure a firm basis for measuring the effectiveness of water control efforts.

Concurrent investigation of erosion including control sections is recommended to determine the need for and benefit of additional erosion control or a future in line flow control structure.

9.1.6 Erosion and Slope Stability Investigations

Geotechnical investigation of slope conditions and erosive processes at work along the Watts Creek water course upstream of the Kizzel drain should be undertaken as soon as possible.

9.2 SUMMARY OF ISSUES

The following Table provide a summary of the issues within the Watts Creek and Kizzel Drain Watersheds.

Issue	Recommended Actions	Lead Agency (Support Agency)	Notes	References
1 Trillium Forest and Kanata Lakes Beaver Pond	Consideration be given to an NCC land exchange. "Design with nature" approach and develop on the lands best suited for development. Give a high weighting to forest areas like the Trillium forest.	City of Ottawa, NCC & Developer	May require an appointed mediator to negotiate a fair exchange. Zoning changes may be time sensitive and will require cooperation with all 3 levels of government.	Section 1.1.4 and 4.3
	b Development is Subject to OMB Draft Conditions. Ensure tree clearing is not permitted until all the conditions are fulfilled.	City of Ottawa: WW&DS	The current City of Ottawa Resolution requiring the developer to clear all conditions prior to any tree clearing may be subject to an OMB hearing.	Draft Plan Conditions and Section 1.1.4
2 Carling Avenue Culvert Replacement	Culvert verified as needing replacement. Require City confirmation that it will be replaced with one in Kind. Specifically, a single barrel culvert with the same end area.	City of Ottawa	Channel Realignment on NCC/Greenbelt Lands requires an amendment to the current 1973 Municipal Drain By-law. Also consideration should be given to location long term monitoring station at this location.	Sections 1.1.5, 7.0, Drainage Bylaw, and Oct 2008 Carling Ave Culvert Structure Renewal Options Analysis Report, Subsequent City of Ottawa letter
3 DND Drainage Modifications	Retrofit existing drainage system to current standards in conjunction with new development. Water quality targets per the 1999 Shirley should be consistent with current provincial guidelines.	DND, NCC Greenbelt, City/MOE Approvals	DND is not legally required to implement SWM controls.	
4 Shirley's Bay Rehabilitation and Environmental Development	Conduct an EA study on opportunities for alternative environmental development within Shirley's Bay including possible breaching of the dyke.	Ottawa River Regularity Agency, MOE, DFO, and other		Section 4.6.1
	Do Nothing	City of Ottawa: DSD & CS-D (RVCA, DFO, MOE)		
5 Abandoned Watts Creek Sewage Treatment Plant	Plan to decommission and remove the existing buildings and infrastructure. Undertake a Property Condition Assessment Detail Report.	City of Ottawa and NCC	The Cities and NCC liability/responsibility requires a legal opinion.	
6 Erosion and Obstructions of and within Watts Creek	Address critical erosion areas including tile drain outlets, railway embankments, and culvert crossings. Remove obstructions including old beaver dams and control beaver population if necessary.	NCC (MVCA, DFO)	Permits are required, address fisheries issues, fluvial geomorphic considerations, and long-term maintenance issues/cost sharing	Section 7.0, 8.0 and 9.0
7 Review of Land Development Proposals	The NCC is circulated with and is given the opportunity to comment all development plans in the watershed. Apply updated guidelines for new development (through all stages of development approval process). Ensure City is aware of and is applying the 1999 Shirley Brook and Watts Creek Study recommendations	City of Ottawa: DSD/RVCA	Guidelines for development and impact assessments have been updated	Section 5.0 7.3 and 9.0
8 Integrated Monitoring Program	Develop an integrated monitoring program to assess the erosion process and to more accurately track the health of the watercourse. Develop water quality and Quantity stations at key locations. The locations should be accessible and representative of the water shed. 2 locations on the Kizell Drain and 2 on the Watts Creek.	City of Ottawa: (MVCA, DFO, MOE,NCC)	Monitoring program to include elements of fluvial geomorphology, biology, base flow measurement, etc.; will also incorporate assessment of the effectiveness of urban development Storm water Management and proposed Agricultural best management practices. The water quality monitoring program to be developed with the intent of increasing fish habitat and in lieu of effluent monitoring at the storm outfalls.	Section 5.3 and 7.3
9 Water course Management Plan	The watercourse should be maintained. Impediments to flow along the drain caused by, beaver dams, minor mud slides and culvert constrictions should be removed. Erosion protection at structures, including the Railway embankment and at tile outlets should be added. Fish habitat enhancements and shading are recommended. Provide access to aesthetically and geologically significant areas of interest. A regular (annual) inspection and maintenance program should be developed. Costs within the Municipal drain reach would be assessed in accordance with the procedures described in the Act.	City of Ottawa (WW&DS)	The Kizell Drain and Watts Creek, from the Kizell Drain to the twin culverts under the CNR tracks, is currently designated as municipal drain under Ontario Drainage Act	Section 7.2
10 Agricultural Landuse Controls	Consider a program of smaller properties and rentals to land stewards that promote environmentally sustainable agriculture/organic farming. Investigate the tile drainage outlets as potential sources of nutrient contamination. Modify agricultural landuse. Under take a cost benefit analysis to determine the costs of land use conversion to forest lands and hay fields and a reduced grain crop rotation (i.e. corn and soybeans).	NCC Greenbelt		Section 5.3
11 Cost Recovery	**a** Development Charges	City of Ottawa	Specific to projects that relate to development. Subject to City approval and could be disputed at OMB	Section 8.0
	b Municipal Drainage Act	NCC/City of Ottawa	Part of the Drain is already a Municipal Drain. Ideal mechanism for cost sharing related to watercourse management. Will require a Engineers report, Meeting to Consider, Court of Revision and could be disputed at a Tribunal Hearing.	Section 8.0
	c Mutual Cost Sharing Agreements	City/NCC/ Developers	Needs a cooperative attitude created by a tangible benefit to the parties involved.	Section 8.0
11 Public Awareness and Education	**a** Promote measures to reduce runoff from residential and commercial properties	City of Ottawa	Consider a program targeted to Watts Creek watershed, specifically using the recommendations in the 1999 Shirley's Brook Watts Creek Study	
	b Educational signage at strategic locations	Community Associations/NCC	Assistance to be provided by City of Ottawa / MVCA	Section 7.2.1
	c Creek clean-up and riparian planting days	Community associations/NCC	Assistance to be provided by City of Ottawa / MVCA; focus plantings within priority areas	

All of which is duly presented;

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