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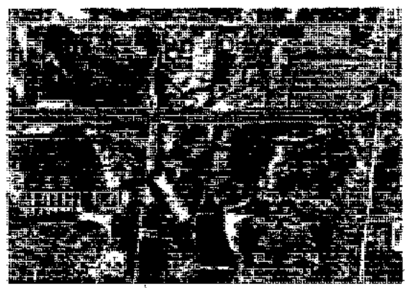
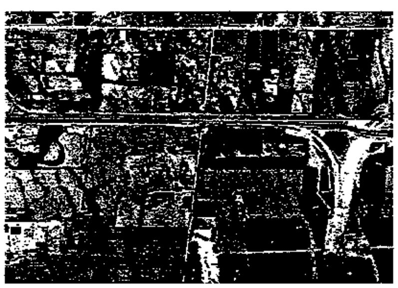
401 Corridor Integrated Planning Project
Town of Halton Hills


Scoped Subwatershed Plan

Final Report - March 2000

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1. INTRODUCTION

1.1 Study Overview

1.1.1 Background

The 401 Corridor has long be recognized by the Town of Halton Hills as a prime area for meeting the growing demand for industrial development. This was formally acknowledged in the 1985 Official Plan with the designation for low intensity "prestige rural industrial" and "rural industrial" land uses within this area.

The 401 Corridor encompasses a total area of 620 ha., which is mostly situated between Highway 401 and Steeles Avenue, and extending from the James Snow Parkway to Winston Churchill Blvd. At the western end, the northern boundary generally follows the alignment of the Middle Sixteen Mile Creek.

The potential for adverse environmental impacts due to urbanization is well documented. The resulting dramatic change in the hydrologic regime of the receiving streams can lead to flooding and erosion problems, deterioration of water quality, baseflow reductions, habitat degradation and groundwater effects. In addition, changes in land use without regard to the existing natural features and ecological functions can result in a loss of woodlands, wetlands, habitat and species diversity, as well as increase the risk to public safety and property.

In order to prevent and/or minimize such impacts and ensure future development proceeds in an environmentally sound manner, an integrated planing approach was adopted which includes the preparation of a Scoped Subwatershed Plan for the watercourses within the 401 Corridor. The purpose of the Plan is to recommend how water resources and related subwatershed features and ecological functions should be protected and enhanced to coincide with existing and changing land use.

Current land use planning practice and resource management philosophy embrace the principles of ecosystem-based planning using the subwatershed as the logical unit for environmental management. The overall goal of this approach is, to *"protect the quality and integrity of ecosystems, including air, land, water and biota, and to encourage restoration to healthy conditions where that quality has been diminished"* (OMMA, 1995). The objectives of this goal are to ensure that the long-term health of ecosystems and the continuing availability of natural resources are maintained, significant natural heritage and biological features are protected, and human life and property are protected from hazard under existing and future land uses. This goal and the underlying objectives have been adopted and integrated in this study.

1.1.2 Purpose and Scope of the Study

The purpose of this study is to prepare a Scoped Subwatershed Plan for the specific portions of Subwatershed 3, 4, 5, and 6, of Sixteen Mile Creek and that are located within the 401 Corridor boundaries. This plan will provide the broad framework and strategy for development, in a manner which harmonizes the community's need for development and services with the need for preservation and enhancement of the natural and human environment.

This study incorporates an ecosystem-based approach to land use planning and adheres to the principles, goals, objectives and procedures presented in the Sixteen Mile Creek Watershed Plan, the Gateway West (Mullett Creek) Subwatershed Study and the Provincial Policies regarding Natural Heritage, Water Quantity and Quality and Hazards.

Specifically, the purpose of this study is to undertake the following activities within the context of the 401 Corridor area:

- Establish the location, extent, significance and sensitivities of the existing natural features (e.g. streams, valleys, woodlands) and ecological functions/interactions (e.g., groundwater recharge/discharge, water use, habitats, movement corridors).

- Identify specific opportunities for protection, enhancement and rehabilitation of the environment, and identify constraints to development by setting subwatershed resource management objectives.

- Determine the potential impacts on natural systems and hydrologic processes resulting from proposed changes in land use, such as increased flooding and erosion, water quality impairment, baseflow reduction and habitat loss or disruption.

- Identify subwatershed management alternatives to mitigate the potentially adverse impacts of future development and develop a management plan that includes land use planning policies and controls; areas to be protected/enhanced; the size, type and location of storm water management facilities; and design guidelines.

- Develop an implementation strategy to guide development by identifying: recommended management works, responsibilities and commitments required at subsequent stages of the planning process, necessary future studies and required monitoring and maintenance.

The output of this study, the Scoped Subwatershed Plan, will provide input and guidance to the Secondary Plan to assist in the land use planning for the area in a manner that also achieves protection, preservation and enhancement of the local subwatershed environment. The Plan will also be useful for the review and regulation of individual development proposals at the Draft Plan of Subdivision levels.

The scope of work for the Study includes the following:

- Field studies and reconnaissance, including baseflow measurements and the installation of three continuous water temperature monitors.
- A field inventory of hydraulic structures (culvert size, type, and dimension).
- A hydrogeology study to develop an overall understanding of the groundwater regime and identification of significant groundwater recharge/discharge areas.
- A hydrology study to develop an overall understanding of the surface water regime of the subwatershed, including existing condition peak flow estimation.
- A water quality assessment including water quality sampling at eight locations to determine the existing water quality.
- A fisheries and benthic-invertebrate inventory to assess the existing aquatic habitat including recommendations for habitat protection, restoration and enhancement.
- A terrestrial biology inventory of vegetation, animals and habitat units (woodlands, shrublands, corridors) including recommendations for protection, restoration and enhancement.
- A comprehensive data assessment and identification of the significant natural heritage, environmental protection and hazard features; along with opportunities for protection, enhancement and rehabilitation, and constraints to development.
- Identification of Subwatershed goals and objectives for the protection, enhancement and restoration of significant natural heritage, environmental protection and hazard features.
- Comprehensive environmental impact assessment of the natural features and ecological functions based on the anticipated future land use.

- Establishment of environmental targets to protect/maintain, restore/enhance and monitor the various ecological facets of the study area.

- Preparation of a recommended Scoped Subwatershed Plan consisting of a series of management strategies/actions designed to protect and enhance the local natural features and ecological functions, and guide future development.

- Preparation of an Implementation Strategy outlining roles, responsibilities and mechanisms for implementing the recommended Subwatershed Plan components.

1.1.3 Study Approach

The study was conducted in two phases:

Phase I

Data Collection	Collect and review background information and identify specific regulatory requirements, objectives and policies/concerns.
Field Studies and Monitoring	Conduct field studies, reconnaissance and monitoring.
Data Assessment Synthesis	Identify the Subwatershed natural heritage features and ecological functions including the hydrologic, hydraulic and hydrogeologic processes.
Opportunities and Constraints	Identify opportunities for protection and enhancement of the natural heritage features and ecological processes, and identify constraints to development.
Goals and Objectives	Identify Subwatershed management goals and objectives for public health and safety, resource management (fish, wildlife, vegetation), and urban, agricultural and other land uses.

Phase II

Technical Assessments	Conduct technical assessments to establish how the natural systems and hydrologic processes of the Subwatershed will respond to land use changes within the 401 Corridor.

Targets and Constraints	Establish targets and constraints using information obtained from the Technical Assessments.
Management Strategy	Develop and evaluate management alternatives for the protection and enhancement of the natural features and ecological functions.
Implementation Strategy	Develop an implementation strategy to guide development that identifies recommended management works, responsibilities and commitments.
Documentation	Prepare a final Study Report summarizing all Phase I and II investigations, findings and recommendations.

As part of the overall project framework, an Environmental Sub-Committee was formed to guide the direction and scope of the this study, provide technical review and to ensure that the findings and recommendations were integrated into the Secondary Plan process. The members of this committee were:

Town of Halton Hills	A. Prasad K. Pianosi R. Henry
Region of Halton	R. Victor
Town of Milton	P. Antoniow
Halton Region Conservation Authority	G. Switzer
Ministry of Natural Resources	P. Hill C. Tschirhart
Department of Fisheries and Oceans	D. Ross.

1.1.4 Study Area Description

1.1.4.1 Regional Context

The following is a brief overview of the Sixteen Mile Creek and Credit River watersheds to provide an impression of the Regional setting of the 401 Corridor. The information was obtained primarily from the documentation contained in the Sixteen Mile Creek Watershed Report and Technical Appendices and the Gateway West Subwatershed Study, which should be referenced for a detailed discussion of the watershed features and attributes.

The 401 Corridor is situated centrally within the eastern part of the Sixteen Mile Creek watershed, which encompasses a total area of 377 km^2 primarily within the Region of Halton. The Corridor also covers a small portion of the Credit River watershed at its north-eastern corner. The watershed includes a small area of land within the Region of Peel along its' eastern boundary between Steeles Avenue and Lower Baseline Road. Area municipalities included within the watershed include the Towns of Halton Hills, Milton, and Oakville and the City of Mississauga.

The watershed maintains an average length and width of 35 km and 20 km respectively, and has an average gradient of 0.8% from its' headwaters near Highway 7 to its' outlet at Lake Ontario. Along its' length, the watershed extends across four main physiographic regions: the Niagara Escarpment, the South Slope, the Peel Plain, and the Iroquois Plain. Accordingly, a prominent feature of the watershed is the presence of the Niagra Escarpment in the north-westerly headwater areas, with an average drop in elevation of 35 to 40m.

The Sixteen Mile Creek system is comprised of four main watercourses branches: the West, the Middle and East Branches and the Lower (Main) Branch. The main stem of the West Branch, together with numerous small tributaries originates on the Niagara Escarpment and flows in a southerly direction to the Kelso reservoir, which is located south of the Niagara Escarpment; the watercourse then continues southerly and flows through the Town of Milton. The West Branch joins with the Middle Branch below Lower Baseline Road, east of Highway 25. The portion of the Corridor within the Credit River system drains eastward across Winston Churchill Blvd, joining Mullett Creek upstream of Highway 407.

Also rising on the Niagara escarpment is the Middle Branch, which travels down the escarpment and enters the Scotch Block Reservoir. South of the reservoir the watercourse and its' associated tributaries flow in a south-easterly direction to the confluence with the East Branch near the intersection of Britannia and Trafalgar Road.

The Main Branch is formed by the confluence of the West and Middle, which occurs south-east of the Highway 25-Lower Baseline Road area. The Main Branch flows through a deeply incised valley through the Town of Oakville to it's outlet at Oakville Harbour.

Land use within the Sixteen Mile Creek watershed is predominately agricultural with localized urban development located throughout the watershed. The urban development is centred around the area municipalities noted above, and in the east central part of the watershed in the Region of Peel (i.e., Lisgar Area). The urban development consists primarily of residential use, but also includes some industrial, commercial and institutional uses. Within the Mullett Creek subwatershed, the primary land use in the upstream areas is agriculture including fruit farming, row crops and dairy farming. Downstream areas within the City of Mississauga are becoming urbanized.

Available water quality data indicates that the Provincial Water Quality Objectives (PWQOs) are frequently exceeded for fecal coliforms, nitrates, total Kjedldahl nitrogen, total phosphorus and iron within the Sixteen Mile Creek watercourses. Exceedances have occurred most frequently on the Main branch downstream of Milton and near the outlet of the East Branch near Omagh. Impairment of water quality in these locations can be attributed to waste effluent from the Milton WWTP as well as urban storm water runoff. Improved water quality is experienced upstream of these locations but remains impacted by rural non-point sources such as agricultural and livestock activities as well as failing sceptic systems. No historical sampling information exists for Mullett Creek, however results of the recent Gateway West Subwatershed Study indicated that quality in the southern and central portions, beyond the 401 Corridor, is generally poor as a result of upstream agricultural activities (e.g., high nutrient and bacterial levels). Within the upper portions of the Mullett Creek subwatershed, dry conditions precluded sampling.

Historic information indicates that coldwater fishery habitat occurred extensively across the Sixteen Mile Creek headwater areas, extending down to the Town of Milton on the west Branch, and Derry Road on both the Middle and East Branches. Due to the effects associated with agricultural and urban development, coldwater fisheries are now generally limited to the upstream reaches of the West and Middle Branches, north of Steeles Avenue. The lower reaches of all the main watercourses support warmwater sport fisheries and provide a migration corridor for salmonids to reach the upstream spawning habitat. A notable exception is a segment of the West Branch, below Milton, that has been identified as potential coldwater stream. Historical information referenced in the Gateway West report indicates that Mullett Creek supports a coldwater species downstream of Mississauga Road. Monitoring performed during that study confirmed that warmwater species are supported up to Britannia Road despite poor quality habitat and water quality.

The Sixteen Mile Creek watershed contains vegetation that is representative of two broad forest regions: the Niagra and the Huron-Ontario Regions. There is no defined boundary which delineates the limits of these two Regions; rather the change from one region occurs as a gradual transition in south to north direction. The Niagara Region generally occupies the area of South-western Ontario defined by a line connecting Toronto to the southwest end of Lake Huron, and extending southerly into the United States.

Within the Sixteen Mile Creek Watershed, vegetation communities representative of the Hurion-Ontario region can be found throughout, but are mostly concentrated along and above the Niagara Escarpment. Within the upper portion of the Mullett Creek subwatershed, most of the vegetated areas are confined to the valley corridors (e.g., Reed Canary Grass marshes confined within flood plains). There are no table land forests.

The Sixteen Mile Creek watershed contains a diversity of notable environmental attributes that are of Provincial, Region or local interest, including:

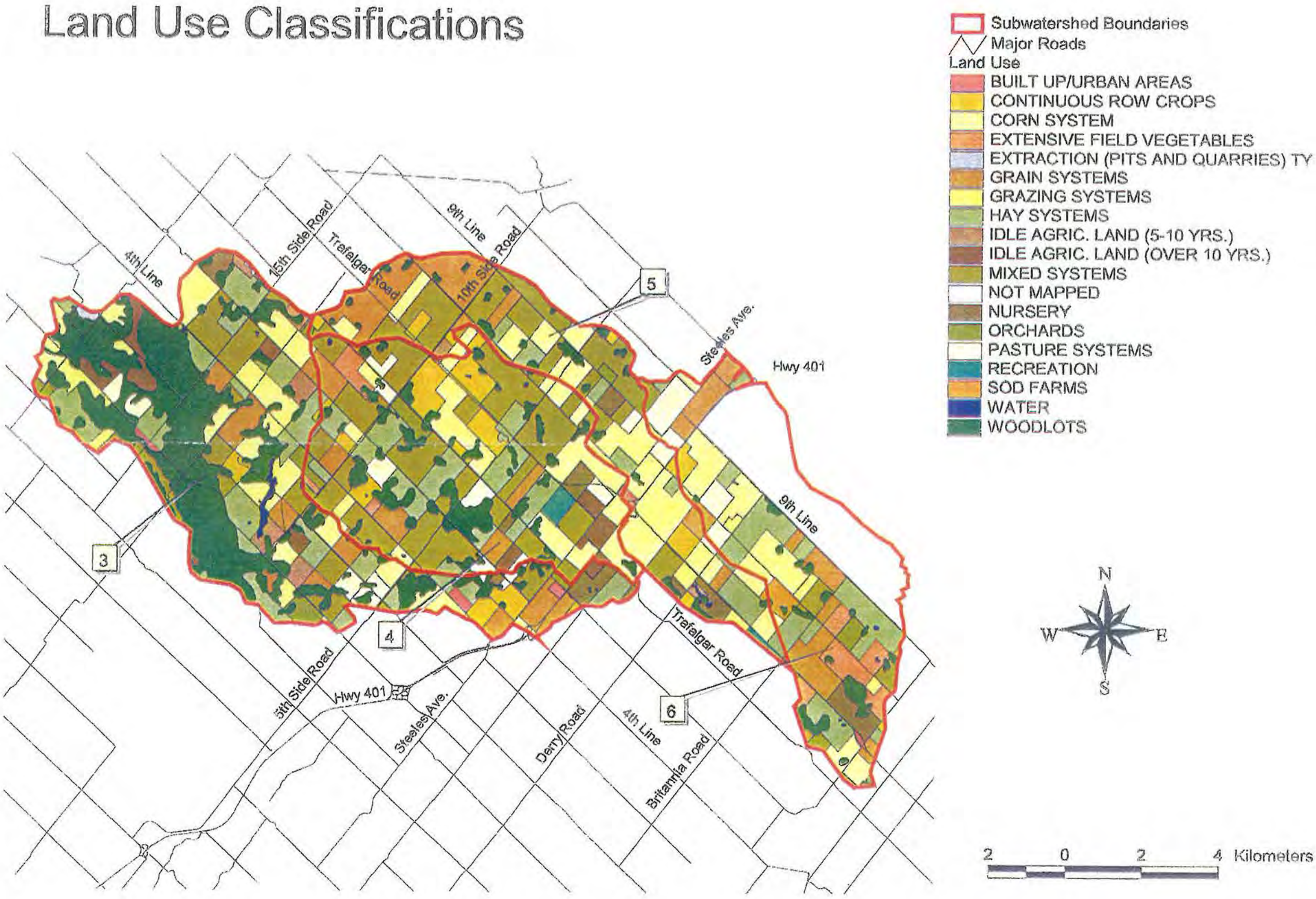
- the Niagara Escarpment;
- two identified Areas of Scientific and Scientific Interest (ANSI);
- eight identified, and two candidate Environmentally Sensitive Areas (ESAs); and
- a Provincially Significant Wetland Complex above the Escarpment.

These features are concentrated in the north-west area of sector of the watershed above the escarpment; south of the escarpment identified ESAs and/or ANSIs are generally confined to the East Branch, both above and below the Town of Milton, the Main Branch, and a short reach of the lower East Branch. No ANSI's or ESA's have been identified within the Mullett Creek subwatershed.

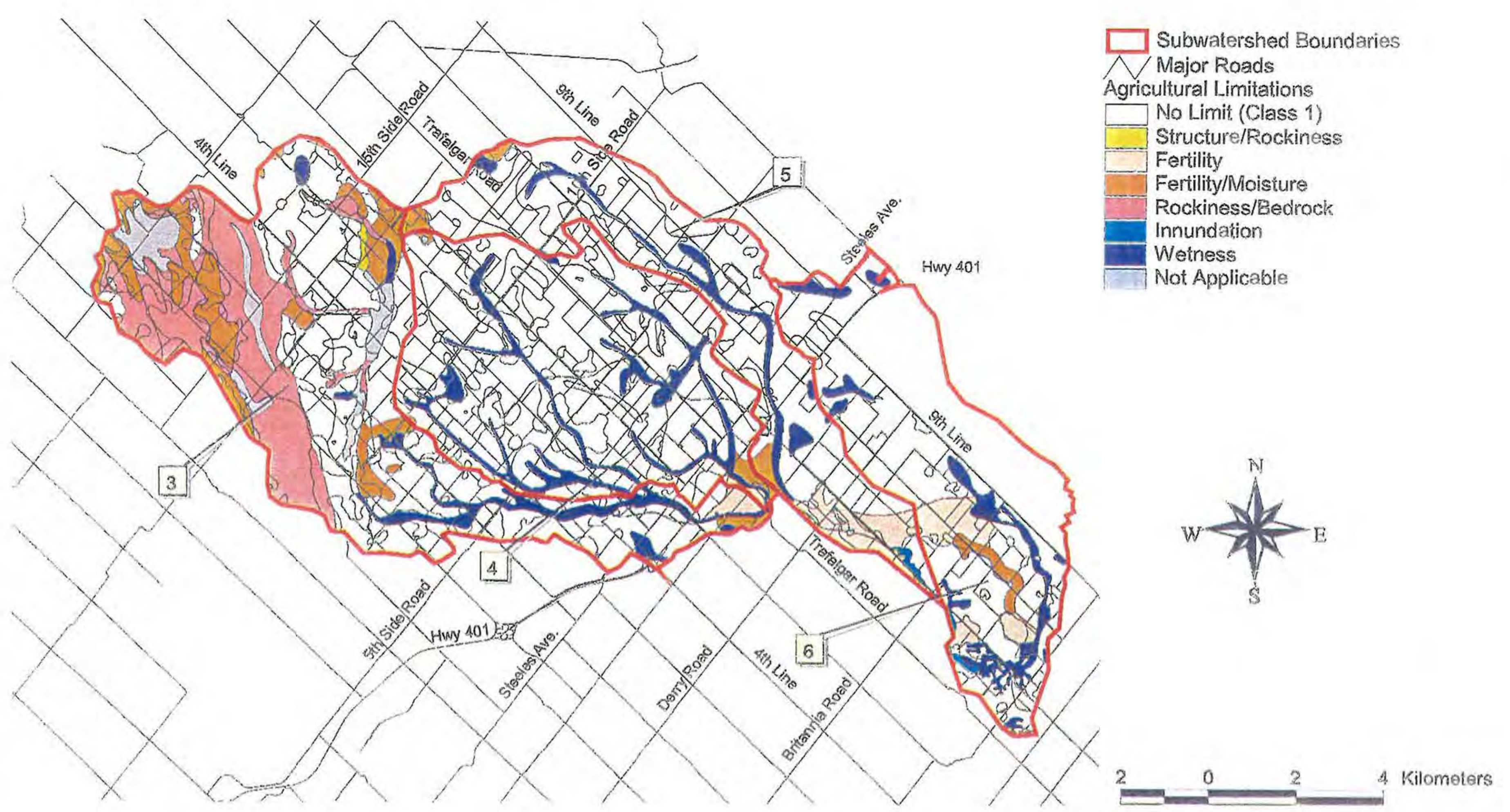
Land use characteristics throughout the various study Subwatersheds (3,4,5, and 6) have been previously classified by OMAFRA as part of their Agricultural Resource Inventory program during the 1980's. Results of the inventory for the study Subwatersheds within the Region of Halton are indicated on **Map No. 1** which has been created using ARC/INFO coverages created by OMAFRA's former GIS Unit. It is noted that no data is available for the eastern portion of Subwatershed 6 which lies within the Regional of Peel. Since the time of the resource inventory, this area has undergone appreciable land use changes in the form of urban residential development and therefore the inventory is not current. Land uses within the 401 Corridor (including Subwatersheds 3,4,5,6 and Mullett Creek subwatershed), which have also undergone land use changes and which is the focus of the Scoped Subwatershed Studies, have been updated as a result of field investigations presented in **Section 3**.

The following table summarizes the proportion of various OMAFRA land use classes within the Subwatersheds as shown on Map No. 1. These tables reflect the dominance of agricultural land uses throughout the subwatersheds and, with the exception of Subwatershed 3, the relatively low proportion of wooded areas, especially so in Subwatersheds 5 and 6. It is noted that the recently built-up area within the Region of Peel has been factored into the table. This extensive agricultural use may be expected given the relatively low incidence of limiting factors as indicated on the lower figure on Map No.1. With the exception of the upper portion of Subwatershed 3, above the escarpment, lands are generally characterized as class 1 agricultural lands. The Mullett Creek subwatershed within the Corridor consists of agricultural uses.

Land Use Classifications



Agricultural Limitations



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Scoped Subwatershed Studies

Subwatershed Land Use Characteristics

Map No.1

Table 1.1 - Subwatershed 3 Land Use Characteristics		
Land Use Designation	**Area (ha)**	**Percentage of Total Area**
Built Up/Urban Areas	42.4	0.8%
Continuous Row Crops	136.2	2.5%
Corn System	742.0	13.4%
Extensive Field Vegetables	20.7	0.4%
Extraction (Pits and Quarries)	20.1	0.4%
Grain Systems	386.0	7.0%
Grazing Systems	98.4	1.8%
Hay Systems	859.0	15.5%
Idle Agric. Land (5-10 Yrs.)	121.7	2.2%
Idle Agric. Land (Over 10 Yrs.)	187.0	3.4%
Mixed Systems	564.0	10.2%
Nursery	121.3	2.2%
Orchards	69.5	1.3%
Pasture Systems	139.0	2.5%
Water	38.9	0.7%
Woodlots	1,988.0	35.9%
TOTAL	**5,536.0**	**100.0%**

Table 1.2 - Subwatershed 4 Land Use Characteristics		
Land Use Designation	**Area (ha)**	**Percentage of Total Area**
Built Up/Urban Areas	32.1	0.1%
Continuous Row Crops	328.0	7.8%
Corn System	624.0	14.8%
Extensive Field Vegetables	82.8	2.0%
Grain Systems	252.4	6.0%
Grazing Systems	19.8	0.5%
Hay Systems	532.9	12.7%
Idle Agric. Land (5-10 Yrs.)	4.5	0.1%
Idle Agric. Land (Over 10 Yrs.)	113.6	2.7%
Mixed Systems	1,401.0	33.3%
Nursery	60.0	1.4%
Orchards	63.7	1.5%
Pasture Systems	168.9	4.0%
Recreation	47.8	1.1%
Water	6.3	0.2%
Woodlots	493.7	11.7%
TOTAL	**4,204.0**	**100.0%**

Table 1.3 - Subwatershed 5 Land Use Characteristics		
Land Use Designation	**Area (ha)**	**Percentage of Total Area**
Built Up/Urban Areas	11.5	0.4%
Continuous Row Crops	123.2	4.3%
Corn System	831.0	29.0%
Extensive Field Vegetables	0.03	0.0%
Grain Systems	510.0	17.8%
Grazing Systems	45.0	1.6%
Hay Systems	225.3	7.9%
Idle Agric. Land (5-10 Yrs.)	24.8	0.9%
Mixed Systems	752.0	26.3%
Nursery	91.4	3.2%
Orchards	18.2	0.6%
Pasture Systems	56.3	2.0%
Recreation	18.2	0.6%
Sod Farm	4.8	0.2%
Water	5.4	0.2%
Woodlots	148.1	5.2%
TOTAL	**2,864.8**	**100.0%**

Table 1.4 - Subwatershed 6 Land Use Characteristics		
Land Use Designation	**Area (ha)**	**Percentage of Total Area**
Built Up/Urban Areas	1,056.0	30.8%
Continuous Row Crops	38.8	1.1%
Corn System	455.5	13.3%
Extensive Field Vegetables	208.5	6.1%
Grain Systems	438.7	12.8%
Grazing Systems	44.9	1.3%
Hay Systems	542.3	15.8%
Mixed Systems	123.3	3.6%
Nursery	80.1	2.3%
Orchards	36.5	1.1%
Pasture Systems	200.0	5.8%
Sod Farms	48.8	1.4%
Water	4.5	0.1%
Woodlots	152.6	4.4%
TOTAL	**3,430.0**	**100.0%**

1.1.4.2 401 Corridor

The Sixteen Mile Creek Watershed Plan established seven subwatershed areas for the assessment of existing conditions, the determination of potential impacts associated with future land use changes, and the development of appropriate management strategies. As noted on **Figure 1.1**, the 401 Corridor is located in the east central part of the watershed, and stretches across Subwatershed 3, 4, 5, and 6, and the Mullett Creek Subwatershed. While the total area of the 401 Corridor encompasses 620 hectares of the land, it occupies only a small portion of the 5 Subwatersheds on both an individual and collective basis.

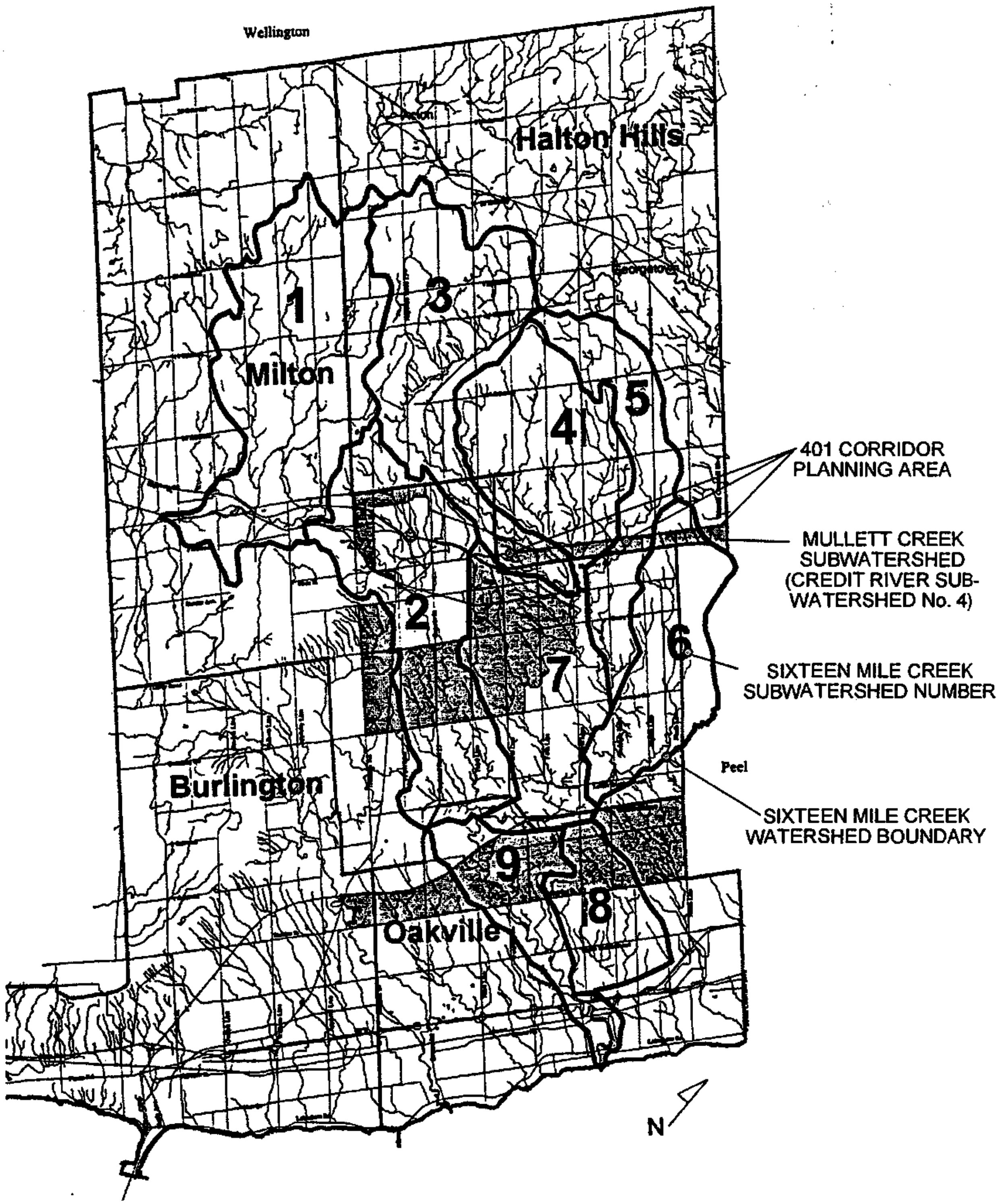
Subwatershed 3 comprises an area of approximately 5540 ha, and extends over a length of 18 km, from its' headwaters on the Niagra Escarpment to its' downstream limit in the vicinity of Sixth Line and the CPR Line. Extending through this subwatershed is the main branch of the Middle Branch of Sixteen Mile Creek and numerous small tributaries. The dominant land uses within the subwatershed involve agricultural activities for crop production generally below the escarpment, and natural areas above the escarpment; there is no major urban development in the area; population centres are limited to small rural pockets through the subwatershed.

Approximately 185 hectares of the western part of the 401 Corridor are situated within the boundaries of this subwatershed, near its southern limits. The 401 Corridor area included extends from the James Snow Parkway easterly for a distance of 2 km to east of Fifth Line.

The Middle Branch enters the 401 Corridor via an existing culvert under Steeles Avenue, immediately west of Fifth Line, travels a short distance in a southerly direction, and then flows easterly via an existing crossing under Fifth Line. From this point, the watercourse travels southerly and exits the 401 Corridor through an existing bridge under Highway 401.

Another notable watercourse within the 401 Corridor is the Mansewood Tributary, which converges with the Middle Branch north east of Fifth Line and Steeles Road. An unnamed tributary also extends through the south-west quadrant of the study area; this drainage feature presently collects and conveys storm drainage from an industrial park in the Town of Milton and the Cashway development within the 401 Corridor.

The principal land use within the 401 Corridor is related to agricultural activities for the production of field crops including corn, soybean, winter wheat, hay and pasture. However, some commercial development has occurred within this area including the Cashway Distribution Centre, the Truck Town Terminals, and the Landscape Ontario/VBI Distribution.



SOURCE: REQUEST FOR PROPOSAL. 401 INTEGRATED PLANNING PROJECT. FIGURE 1.

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401 CORRIDOR INTEGRATED PLANNING PROJECT
SCOPED WATERSHED STUDIES

STUDY AREA AND WATERSHED CONTEXT

FIGURE 1.1

Given the agricultural land use, areas of significant forest cover are confined to the north-west quadrant of the 401 Corridor, along the Mansewood Tributary and in the vicinity of the Middle Branch. A small remnant forest area is located adjacent to the south side of Steeles Avenue, and west of Fifth Line, and a minor wetland area adjoins the east side of this forest and extends southerly along the watercourse valley.

The Sixteen Mile Creek Watershed Plan indicates that the Middle Branch is categorized as a coldwater stream (Type I) above of the 401 Corridor (approximately 1km north), and as warmwater habitat through the study area. Field investigation completed as part of this study revealed the presence of rock bass and rainbow darters, which suggests that the habitat is suitable to accommodate the migration of rainbow trout through the area, and accordingly is representative of coldwater habitat.

The field investigations confirmed that the Mansewood tributary is indicative of a warmwater habitat. Given the previous disturbance and realignment of the unnamed tributary, combined with he intermittent flow conditions, this drainage feature is not considered to constitute fish habitat.

Subwatershed 4 encompasses a total area of 4200 ha of land and forms part of the overall drainage system associated with the Middle Branch. The subwatershed is approximately 10 km in length and a maximum width of 6 km. The headwaters of this subwatershed originate below the Niagara Escarpment and flow in a generally southerly direction.

Similar to the lower areas of Subwatershed 3, agricultural production remains the major land use activity.

This subwatershed includes approximately 148 ha of the central portion of the 401 Corridor. The main watercourses through the study area include a major tributary of the Middle Branch (Middle Sixteen Mile Creek Tributary) and the Hornby Tributary, both of which maintain continuous flow conditions. These two watercourses converge within the study area immediately north of Highway 401.

The Middle Branch Tributary enters the 401 Corridor via a 2m high by 9m wide bridge under Steeles Avenue, and then immediately passes through a 2.6 m wide by 9.1m high bridge structure under Sixth Line. Immediately upstream of Highway 401, this watercourse joins the Hornby Tributary, and the combine flow then passes under the highway through a 4m wide by 12.2 m wide concrete bridge.

Agricultural activity is also the dominant land use within this portion of the 401 Corridor; residential development is generally limited to a few residences on the south side of Steeles Avenue near the community of Hornby.

The terrestrial vegetation within this portion of the study area consists of remnant forest and hedgerow communities. The largest forest community is approximately 1.5 hectares in size and abuts Steeles Avenue, west of Sixth Line. The remaining areas are smaller in size, less than one hectare, and are scattered throughout the central and eastern part of the study area within Subwatershed 4.

In addition to the review of previous documentation in regards to the nature of the fish habitat in this portion of the study area, field investigations were carried out at five fish sampling locations. The sampling sites included locations upstream, downstream and within the study to fully characterize the nature of the habitat. Previous results indicated that both the Middle Sixteen Mile Creek Tributary and Hornby Tributary are representative of warmwater sportfish designation, while this study's results suggest that a coldwater designation may be appropriate for the Sixteen Mile Creek Tributary. The small swale to the west of the Middle Branch Tributary extends through agricultural fields, with no defined bed and banks. The field inspections confirmed that this drainage feature does not constitute fish habitat.

Subwatershed 5 extends a distance of 16 km from its' headwater area below the escarpment, in the vicinity of the CPR line, to its' southern boundary near Britannia Road. The main watercourse through this subwatershed is the East Branch of Sixteen Mile Creek, which rises in the vicinity of 10th Side Road and flows in a southerly direction to the confluence with the Middle Branch. Approximately 96 hectares of the 401 Corridor are situated within the lower half of this subwatershed whose total area is 2870 ha.

The land use characteristics of this subwatershed are similar in nature to Subwatersheds 3 and 4; predominantly agricultural with small local areas of rural development.

The 401 Corridor area within this subwatershed extends from approximately Trafalgar Road to Ninth Line in the east. The only watercourse traversing the study area is the East Branch, which is conveyed under Steeles Avenue by an existing 2.3m by 12.3 m concrete bridge just west of Eighth Line; the watercourse is conveyed offsite at the downstream study limit via a 3.4m high by 13m wide bridge structure. There area two minor swales which provide local drainage, and join the East Branch within the study area.

Given the extensive conversion to agricultural land use in the area, natural terrestrial vegetation is limited. However, a notable feature is the large forest located along the floodplain of the East Branch; it extends from Steeles Avenue to Highway 401 and covers an area of approximately 7 hectares, which is the largest within the 401 Corridor. A smaller stand of forest also remains north of Highway 401 near Eighth Line, and stands of existing hedgerows extend across the centre of this area in an east-west direction.

The aquatic environment is documented in the Sixteen Mile Creek Watershed Plan as being potential coldwater upstream of Steeles Avenue and warmwater sportfish south of Highway 401. While the East Branch is provided with high quality riparian cover by the existing forest, the fish species captured as part of this study indicate a warmwater baitfish community. Field observations of the drainage swales to the west and east revealed no defined bed or channel bank, and that intermittent flow conditions prevail. Based on these findings it was concluded that the swales do not represent fish habitat.

Subwatershed 6 encompasses an area of approximately 3430 hectares of land and comprises the most easterly subwatershed of the Sixteen Mile Creek system. This subwatershed extends from just north of Steeles Avenue southerly for distance of 12 km to Lower Baseline Road, and has an average width of approximately 3 km.

While agriculture remains a major land use activity, significant urban development has occurred and is continuing along the eastern boundary south of Highway 401 within the Region of Peel (Lisgar Area). A prominent feature within this subwatershed is the Highway 407 corridor which was recently completed in 1996, and which extends through the study area.

The 401 Corridor extends through 169 hectares of the headwater areas of Subwatershed 6. The total subwatershed area north of Steeles Avenue is limited to approximately 156 hectares. Given the small catchment areas there are no defined watercourses within this area. Storm drainage is conveyed by a series of five small intermittent swales that convey flows southerly through the Highway 407 and Highway 401 corridors.

The natural vegetation within this area has been extensively disturbed and removed, and only very small and limited features remain. The field investigations confirmed the results of previous studies completed as part of the Highway 407 Project, which found that the existing swales have been heavily impacted by agricultural activities.

Further changes would not result in a harmful alteration to fish habitat downstream. It is noted that these swales do contribute to downstream fish habitat through seasonal flow and nutrient conveyance.

Mullett Creek Subwatershed encompasses approximately 22 hectares of land in the north east corner of the study area, adjacent to Winston Churchill Blvd. Drainage from this area is conveyed easterly via an existing culvert. Again, given the small catchment areas, no watercourse is defined in this area and storm drainage is conveyed by intermittent swales. The Gateway West Subwatershed Study identified downstream watercourses as having primarily a stormwater conveyance function with limited ecological function.

1.1.5 Report Organization

This Report is arranged into eight chapters, which are summarized below.

Chapter 1	Introduction	Includes the purpose and scope of the study, the study goals, objectives and approach, and a description of the Subwatersheds and Watershed. This section also discusses the regulatory requirements, and the direction and procedures established by the Sixteen Mile Creek Watershed Plan.
Chapter 2	Background	Outlines the information sources used and the data collected, and includes a description of the field monitoring programs, as well as the hydrometric and climatic stations in proximity to the Subwatershed.
Chapter 3	Field Investigations and Technical Analyses	Provides a comprehensive description of the Subwatershed environment, including specific references to the sources of information, collected data and monitoring results. This chapter identifies the location, extent, sensitivity and significance of all components of the natural systems.
Chapter 4	Subwatershed Characterization	Summarizes the significant natural heritage, environmental protection and hazard features in the Subwatershed and discusses opportunities for protection, enhancement and rehabilitation of the environment, as well as identifying constraints to development.
Chapter 5	Technical Assessment of Hydrologic Processes and Natural Systems	Provides a comprehensive environmental impact study of the hydrologic processes and natural systems within the Subwatershed and their response to proposed changes in land use.
Chapter 6	Environmental Targets for Subwatershed Management	Establishes appropriate Subwatershed targets and constraints for the protection, enhancement and restoration of sensitive environmental features and ecological functions.

Chapter 7	Scoped Subwatershed Plan: Recommended Management Strategies	Presents the development of the overall Subwatershed Plan for the protection, enhancement and restoration of the Subwatershed natural features and ecological functions.
Chapter 8	Implementation Strategy	Presents an overall implementation strategy to guide development in an environmentally sustainable manner.

1.2 Planning Framework

1.2.1 <u>Provincial Policy Statement</u>

1.2.1.1 General

In 1997, the Province released a *Provincial Policy Statement* under Section 3 of the *Planning Act* upon proclamation of Bill 20. Table 3.1 provides a summary of the various policy components contained within the *Provincial Policy Statement*. Specific to this Study are the policies under Section 2, "Resources" and Section 3, "Public Health and Safety". Specifically, these policies pertain to <u>Natural Heritage</u> (Section 2.3), *Water Quality and **Quantity*** (Section 2.4), *Natural Hazards* (Section 3.1), and *Human-Made Hazards* (Section 3.2).

The provincial policies pertaining to Natural Heritage, and Water Quality and Quantity are related to the protection (or enhancement) of the Province's natural resources such as significant wetlands, endangered and threatened species, woodlands, valleylands, habitats, ground water and surface water. The provincial policies pertaining to Natural Hazards are related to protection of public health and safety by directing development away from areas of natural hazard.

1.2.1.2 Application of Natural Heritage, Water Quality and Quantity, and Hazard Policies

The section describes the provincial policies and direction used in the investigations and analyses to gain an understanding of the environment: its ecosystem features, processes and linkages, and hazards, and in the development of appropriate strategies for ensuring its long term sustainability.

Table 1.5 - Provincial Policy Statement Components

Policy Number	Policy Component
1 - Efficient, Cost-Effective Development and Land Use Patterns	
1.1	Developing Strong Communities
1.2	Housing
1.3	Infrastructure • Sewage and Water Systems • Transportation • Transportation Corridors and Infrastructure Corridors • Waste Management
2 - Resources	
2.1	Agricultural Policies
2.2	Mineral Resources: Mineral Aggregates, Minerals, Petroleum Resources
2.3	Natural Heritage • Significant Wetlands • Significant Portions of the Habitat of Endangered and Threatened Species • Fish Habitat • Significant Woodlands • Significant Valleylands • Significant Wildlife Habitat • Significant Areas of Natural and Scientific Interest
2.4	Water Quality and Quantity • Sensitive Water Quality and Quantity Areas
2.5	Cultural Heritage and Archaeological Resources
3 - Public Health and Safety	
3.1	Natural Hazards • Great Lakes - St. Lawrence River System and Large Inland Lakes Impacted by Flooding, Erosion and/or Dynamic Beach Hazards • River and Stream Systems Impacted by Flooding and/or Erosion Hazards • Hazardous Sites
3.2	Human-made Hazards • Mine Hazards • Contaminated Sites

Note: Toned areas indicate specific *Policy* sections relevant to this Study.

For clarity, the following terms quoted from the *Provincial Policy Statement* (Province of Ontario, 1997) are defined.

Development is the creation of a new lot, a change in land use, or the construction of buildings and structures, requiring approval under the *Planning Act*; but does not include activities that create or maintain infrastructure authorized under an environmental assessment process; or works subject to the *Drainage Act* (*e.g.*, maintenance of existing municipal and agricultural drains).

Site Alteration include activities, such as fill, grading and excavation, that would change the landform and natural vegetative characteristics of a site.

Significant is defined as follows:

- in regard to wetlands and areas of natural and scientific interest, an area identified as *provincially significant* by the Ministry of Natural Resources;
- in regard to other features and areas in Policy 2.3, ecologically important in terms of features, functions, representation or amount, and contributing to the quality and diversity of an identifiable geographic area or natural heritage system;
- in regard to other matters, important in terms of amount, content, representation or effect.

Ecological Functions are the natural processes, products or services that living and non-living environments provide or perform within or between species, ecosystems and landscapes. These may include biological, physical and socio-economic interactions.

Negative Impacts is defined as follows:

- in regard to fish habitat, the harmful alteration, disruption or destruction of fish habitat, except where it has been authorized under the *Fisheries Act*, using the guiding principle of no net loss of productive capacity.
- in regard to other natural heritage features and areas, the loss of the natural features or ecological functions for which an area is identified.

Adjacent Lands includes those lands contiguous to a specific natural heritage feature or area, where it is likely that development or site alteration would have a negative impact on the feature or area.

Environmental Impact Study (EIS) is a study that identifies and assesses the impacts of development on a specified feature or system. Generally for development and site alteration to be permitted, the study will need to demonstrate that there will be no negative impacts on the natural features or the ecological functions for which the area is identified.

1.2.1.2.1 Natural Heritage

Natural heritage features and areas are defined as natural landforms, ecosystems and habitats, which are important for their environmental and social values as a legacy of the natural landscapes of an area (Province of Ontario, 1997). They include natural features and areas such as:

- significant wetlands;
- significant portions of the habitat of endangered and threatened species;
- fish habitat;
- significant woodlands;
- significant valleylands;
- significant wildlife habitat, and
- significant areas of natural and scientific interest.

Significant Wetlands - Wetlands are defined as lands that are seasonally or permanently covered by shallow water, as well as lands where the water table is close to the surface. In either case, the presence of abundant water has caused the formation of hydric or saturated soils and has favoured the dominance of either hydrophytic or water-tolerant plants. In many cases, wetlands provide important ecological functions related to biological and hydrological processes, such as fish and wildlife habitat, surface and groundwater connection, flood storage, and nutrient retention and removal. Periodically soaked or wet lands used or agricultural purposes which no longer exhibit wetland characteristics are not considered to be wetlands according to the *Provincial Policy Statement* (Province of Ontario, 1997). It is provincial policy that all planning jurisdictions protect wetlands identified to be provincially significant by the Ministry of Natural Resources.

Significant Portions of the Habitat of Endangered and Threatened Species - Significant portions of the habitat of endangered and threatened species include the portion(s) of habitat that is essential to sustaining or expanding the species' population. Endangered species are native species listed in the Regulations under the *Endangered Species Act*, that are at risk of extinction throughout all or a significant portion of their Ontario range if the limiting factors are not reversed. Threatened species are native species that are at risk of becoming endangered if the limiting factors are not reversed (Province of Ontario, 1996).

No development is permitted within the significant portions of the habitat of endangered and threatened species.

Fish Habitat - Fish habitat is defined as the 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 include fish, shellfish, crustaceans, and marine animals at all stages of their life cycle (Province of Ontario, 1996).

No development or site alteration is permitted that results in the harmful alteration, disruption or destruction of fish habitat, in cases where compensation (habitat restoration, enhancement and/or creation) is not feasible or is considered unacceptable according to the *Fisheries Act*. A vegetated buffer of at least 15 m can be considered part of fish habitat because fish depend on this buffer and it forms part of significant wildlife habitat (Section 4.2.1.6).

Development or site alteration may be permitted within some fish habitat if it does not harmfully alter, disrupt or destroy fish habitat, such that there will be no net loss of the productive capacity. This may require that development proposals investigate and identify protective measures such as relocation, redesign, mitigation and compensation in instances where there is a potential loss of fish habitat. Likewise, where a person proposes work that is likely to result in the alteration, disruption or destruction of fish habitat or in the deposit of a deleterious substance in water frequented by fish, the person shall provide to the Minister of Fisheries and Oceans, plans and specifications, studies or other information relating to the water, fish and fish habitat in accordance with the *Fisheries Act*.

Significant Woodlands - Woodlands are defined as treed areas that provide environmental and economic benefits such as erosion prevention, water retention, provision of habitat, recreation and the sustainable harvest of woodland products. Woodlands include treed areas, woodlots or forested areas and vary in their level of significance (Province of Ontario, 1997).

Woodlands are complex ecosystems. Their assessment requires application of appropriate expertise. Significant woodlands are identified on the basis of a number of criteria including: size, association with other natural heritage features, composition, age, site quality, linkage, buffering and hydrological flow.

Development and site alteration may be permitted in or adjacent to significant woodlands if it has been demonstrated that there will be no negative impacts on the natural features or ecological functions for which the area is identified. No development should generally be permitted within significant woodlands situated within significant valleylands or the vegetative buffer of fish habitat.

No mandatory restrictions are identified for other woodlands, shrublands and hedgerows not identified as significant and situated outside of significant valleylands or fish habitat buffers, although retention and expansion through connection to other woodlands is encouraged to meet the long-term objective of 25% forest cover. Hedgerows are quite variable in tree content. Other woodlands and hedgerows may be important in local situations as a genetic source for woodland expansion.

Significant Valleylands - Valleylands are defined as natural areas that occur in a valley or other landform depression that has water flowing through or standing for some period of the year (Province of Ontario, 1996). Valleylands include naturally vegetated or potentially revegetated areas of ravine, river and stream corridors situated within the physical boundaries of the valley landform.

No development should generally be permitted within significant valleylands that also contain significant woodlands.

Development and site alteration may be permitted in or adjacent to significant valleylands if it has been demonstrated that there will be no negative impacts on the natural features or ecological functions for which the area is identified.

Significant Wildlife Habitat - Wildlife habitat includes areas where plants, animals and other organisms live, and find adequate amounts of food, water, shelter and space needed to sustain their populations. Specific wildlife habitats of concern may include areas where species concentrate at a vulnerable point in their annual or life cycle; and areas which are important to migratory or non-migratory species (Province of Ontario, 1996).

Significant Areas of Natural and Scientific Interest - Areas of Natural and Scientific Interest (ANSIs) are defined as areas of land and water containing natural landscapes or features that have been identified as having life science or earth science values related to protection, scientific study, or education (Province of Ontario, 1996). Significant ANSIs are identified as provincially significant by the Ministry of Natural Resources.

1.2.1.2.2 Water Quality and Quantity

Water quality and quantity incorporates consideration of all forms of water within the hydrologic cycle; the features within which water exists and those sustained by it, its movement, the functions it performs and the benefit it provides. The quality and quantity of surface and groundwater resources and their interrelationships are recognized as essential to the overall ecosystem health.

Implementation of Provincial Policy 2.4.1 requires that the quality and quantity of surface and groundwater and the function of sensitive groundwater recharge/discharge areas, aquifers and headwaters be protected or enhanced.

Shallow Aquifer, Groundwater Recharge/Discharge Areas - Surface water infiltrating into the subsurface recharges the underlying aquifer systems; most importantly the shallow aquifer system, which in turn contributes to shallow groundwater flow and discharge that helps maintains baseflow in streams and rivers. The maintenance of baseflow (*i.e.*, water quantity) is essential for sustaining the fish and aquatic communities and associated ecological processes in the stream tributaries.

No development is permitted that will negatively impact on the quality and/or quantity of surface and groundwaters associated of the principal watercourses, groundwater recharge/discharge areas, headwaters and aquifers which have been identified as sensitive areas.

Development may be permitted only if the quality and quantity of surface waters and groundwaters (including their functions), groundwater recharge/discharge areas, aquifers and headwaters are protected or enhanced. Proposed development and/or site alteration that may alter the quality and/or quantity of surface and ground waters (*e.g.* the functioning of recharge/discharge areas), may necessitate that an impact assessment be conducted. In such instances, the development proponent may be required to prepare hydrologic, hydrogeologic or other required studies, in order to demonstrate that no significant impacts will occur and/or that appropriate mitigation will is provided.

1.2.1.2.3 Natural Hazards

Section 3.1 of the Provincial Policy Statement defines hazardous lands as property or lands that could be unsafe for development due to naturally occurring processes, and hazardous sites as property or lands that could be unsafe for development and site alteration due to naturally occurring hazards (Province of Ontario, 1996). According to Policy 3.1, these areas include:

(i) hazardous lands adjacent to the shorelines of the Great Lakes - St. Lawrence River System and large inland lakes which are impacted by flooding, erosion and/or dynamic beach hazards;

(ii) hazardous lands adjacent to river and stream systems which are impacted by flooding and/or erosion hazards; and

(iii) hazardous sites including unstable soils (sensitive marine clays, organic soils) or unstable bedrock (karst topography).

Development and site alteration may be permitted in the less hazardous portions of hazardous lands and hazardous sites, if all of the following can be achieved:

- the hazards can be safely addressed (this may require that development proposals investigate and identify protective measures such as relocation, redesign (*e.g.* flood proofing) and remediation (*e.g.* hydraulic structure improvements);
- new hazards are not created and existing hazards are not aggravated;
- no adverse environmental impacts will result;
- vehicles and people have a way of safely entering and exiting the area during times of flooding, erosion and other emergencies; and
- development does not include institutional uses or essential emergency services or the disposal, manufacture, treatment or storage of hazardous substances.

1.2.1.2.4 Human-Made Hazards

Section 3.2 of the *Provincial Policy Statement* includes development restrictions related to human-made hazards, in addition to the range of natural hazards covered in Policy Statement 3.1. Specifically, Policy Statement 3.2.2 pertains to contaminated sites which should be *"...restored as necessary prior to any activity on the site associated with the proposed use such that there will be no adverse effect"*.

1.2.2 Sixteen Mile Creek Watershed Plan

The Halton Urban Structure Review process was a comprehensive integrated planning process aimed at managing the urban growth over the next 20 year planning horizon and beyond that is anticipated to occur within Halton Region. For the most part, the urban growth will be located within the Sixteen Mile Creek watershed, and accordingly, an integral component was the development of a Watershed Plan to address the potential environmental impacts of future development and to formulate strategies to promote the orderly and sustainable management of activities that affect the natural and human environment.

The Mission Statement adopted as the basis for the preparation of the Watershed Plan was as follows:

> ***to achieve the sustainable management of activities in the Sixteen Mile Creek watershed that will result in the preservation and enhancement of the natural and human environment.***

Based on the Mission Statement and the regulatory requirements, a number of Environmental Principles were developed to guide the nature of the Watershed Plan, direct the scope of the supporting technical analyses, and provide context for the identification of specific goals and objectives for the watershed. The six Environmental Principles are as follows:

Principle No. 1: *Ensure that significant vegetation and wildlife habitat resources are maintained in a natural and sustainable condition, and encourage restoration and enhancement where feasible and appropriate.*

Principal No. 2: *Ensure that waters and water-related features that support aquatic habitat are maintained in a clean, natural and sustainable condition and encourage restoration and enhancement where feasible.*

Principle No. 3: *Ensure that ground and surface water resources are protected at a level which ensures sustainability of both natural resources and economic and social uses, and encourage restoration and enhancement where feasible and appropriate.*

Principle No 4: *Ensure that soil, property and land resources are protected from deterioration and losses due to excessive flooding and erosion process, and encourage restoration where feasible and appropriate.*

Principle 5: *Ensure, where possible, that the aesthetic qualities and values of the natural environment are protected and accessible for use compatible with protection of sensitive features.*

Principle 6: *Ensure that cultural heritage resources are protected.*

With these principles as the underlying foundation, extensive investigations were undertaken to evaluate the condition of the current environment, to assess the potential future impacts associated with changing land use, and to develop appropriate strategies for the preservation, protection and enhancement of the ecosystem. The investigations and technical analyses centred on five key and interrelated watershed resources: Aquatic Habitat; Terrestrial Habitat; Surface and Groundwater supplies; and Recreation and Aesthetics.

Arising from this activity was a set of Watershed Goals and Objectives for each of the resource category that have watershed wide application. The intent was to provide the framework and guidance for the development of overall strategies for the Watershed Plan. Specific criteria based on watershed conditions and analysis of potential impacts were derived on a subwatershed basis. The specific details for Subwatersheds 3, 4, 5, and 6 are summarized in **Tables 1.6** to **1.9**.

The Watershed Plan identifies management strategies for several different land use activities. Recommendations particular to future urbanization include:

- the need for subwatershed plans to be conducted in accordance with Provincial Guidelines
- ensuring that subwatershed studies remain consistent with the Goals, Objectives and Targets established by the Watershed Plan;
- the incorporation of appropriate policies in Secondary Plans to implement the results of the subwatershed studies;
- subwatershed plans are to review the recommended strategies identified in the Watershed Plan and develop appropriate stormwater management practices based on subwatershed specific characteristics and resources;

Table 1.6 - Summary of Subwatershed Resources, Objectives and Management Strategies
Subwatershed 3 - Middle Branch Headwaters to Hornby

Key Resources	**Aquatic:** migratory rainbow trout habitat Scotch Block to Fifth Line; upstream coldwater; redside dace; Scotch Block and Fifth Line to Hornby warmwater. **Terrestrial:** Escarpment edge/ESA 29, several core habitat areas and secondary woodlands, linkages to Escarpment, edge deer wintering range. **Water Supply:** good water quality, deteriorating moving downstream. Regionally significant recharge area (H). **Landform/Soils:** Escarpment edge. **Recreation:** Scotch Block Reservoir.
Key Issues	• protection of migratory coldwater near threshold conditions (temperature, local cover, structure, limitations) and upstream headwater coldwater fisheries and sustaining factors (e.g. groundwater). • protection of recharge area. • isolated woodlots. • local agricultural impacts on water quality and riparian habitat, and pasture access to woodlots, streams. • local rural development impacts on tributaries and woodlots.
Objectives/ Targets	• maintain upstream and migratory coldwater fish habitat and increase extent downstream of Fifth Line as feasible (maintain, reduce water temperatures downstream of Scotch Block; maintain baseflow; maintain, enhance water quality). • maximize infiltration and contribution to stream baseflow. • maintain existing hydrologic regime/water budget to extent feasible. • maintain migratory trout passage. • protect and enhance stream corridor and Natural Heritage System.
Key Management Strategies/Actions	• consider reconstruction to bottom draw on Scotch Block and restoration riparian habitat to wooded cover (bioengineering) versus gabions. • enhance local riparian cover as feasible to improve stream corridor and local linkages. • encourage restriction of pasture access to core and secondary habitats and streams, and encourage managed fertilizer and pesticide use. • manage rural development activity impact on local tributaries and woodlots. • collect and analyze additional data prior to any development. • protect core habitat areas and streams with buffers and other site specific measures as appropriate. • under future development, maximize flow dispersal and recharge, appropriate temperature controls.

Table 1.7 - Summary of Subwatershed Resources, Objectives and Management Strategies
Subwatershed 4 - Middle Branch Tributaries

Key Resources	**Aquatic:** potential coldwater habitat (healthy red side dace population in tributary 203.f and in small headwater streams). **Terrestrial:** well developed system of core habitat areas along tributary 203.f, other small core habitat and secondary habits areas and linkages. **Water Supply:** limited water quality data available. Regionally significant recharge area (H). **Landform/Soils:** **Recreation:**
Key Issues	• local agricultural impacts on water quality and riparian habitat, and pasture access to woodlots and streams. • protection of coldwater habitat and redside dace population (baseflow limitations, pasturing etc.). • isolated woodlots.
Objectives/ Targets	• maintain potential coldwater habitat and enhance if feasible (maintain, enhance baseflow, riparian cover, water quality, stream structure). • maintain existing hydrological regime/water budget. • protection of recharge area. • protect stream linkages between core habitat and secondary areas and enhance as feasible.
Key Management Strategies/Actions	• encourage OMAF and farmers to improve agricultural practices, controlling cattle access to small tributaries and woodlots, riparian enhancement as feasible. • enhance riparian habitat and stream linkages. • preclude on-stream pond construction and review small dam impacts, and removal opportunities. • collect and analyze additional natural system data prior to any development. • under future development, maximize flow dispersal, recharge, temperature control, riparian buffers, etc. • protect core habitat areas and streams with buffers and other appropriate site specific measures.

Table 1.8 - Summary of Subwatershed Resources, Objectives and Management Strategies
Subwatershed 5 - East Tributary

Key Resources	**Aquatic:** baitfish in the upstream reaches to warmwater fishery in the downstream reaches. **Terrestrial:** core habitat area until downstream reach; local, secondary habitat and linkage features and potential floodplain wetland. **Water Supply:** generally poor water quality (high nutrients, low DO).
Key Issues	• some severe local, agricultural impacts on aquatic habitat due to on-line irrigation ponds and water quality impacts. • isolated remnant woodlots.
Objectives/ Targets	• prevent further deterioration of water quality and enhance as feasible. • preclude additional on-line ponds and rehabilitate existing ponds to improve baseflow conditions. • maintain seasonal fish access to upper tributaries. • maintain and enhance riparian cover and secondary linkages.
Key Management Strategies/Actions	• work with MOE and stakeholders to improve water taking management. • preclude more on-line ponds; remove, re-structure or rehabilitate existing ponds. • maintain main tributary linkage and enhance if feasible, incorporating minor local habitat areas as feasible. • collect and analyze appropriate additional data prior to any development. • ensure corridor studies address fragmentation and cumulative impacts as appropriate. • protect core habitat areas and streams with buffers and other appropriate site specific measures.

Table 1.9 - Summary of Subwatershed Resources, Objectives and Management Strategies
Subwatershed 6 - Lisgar Area

Key Resources	**Aquatic:** upstream reaches altered baitfish, to downstream warmwater. **Terrestrial:** no core habitat area until downstream at junction with Middle Branch; local secondary habitat areas, wetlands and riparian linkages. **Water Supply:** generally poor water quality (high bacteria, nutrients, pesticides); may encompass locally important recharge area (M)). **Landform/Soils:** **Recreation:**
Key Issues	• local agricultural impacts on water quality, pasture, loss of riparian cover; local development impacts, tributary channelization and alteration (concrete), sedimentation, invert changes. • isolated, remnant woodlots.
Objectives/ Targets	• maintain existing fish habitat and enhance where feasible. • retain local woodlots and wetlands, as feasible, especially in conjunction with stream linkages. • maintain seasonal baitfish access to intermittent tributaries. • protect recharge area.
Key Management Strategies/Actions	• co-ordinate additional data collection, analysis and recommendations with those of Lisgar Water Quality Study. • preclude additional on-line ponds if barrier to fish movement. • protect core habitat area and streams with buffers and/or other site specific measures as appropriate. • encourage protection of secondary habitat areas in conjunction with stream linkages and in context of urban design. • assess minor tributaries for seasonal baitfish use or other functions and ensure protection of functions, or replacement with restoration and enhancement depending on urban design. • protect valley from erosion (geotechnical setbacks and runoff management).

- consideration should be given to modified urban forms that would reduce the amount of impervious area (e.g. modifications to the design of housing, servicing and roads that reduce potential impacts at source);
- subwatershed plans should address the general criteria for peak flow targets, low flows, flow duration characteristics and water quality specified by the Watershed Plan;
- the need for technical studies to be conducted as part of the subwatershed plan to refine/update the Natural Heritage System and incorporate the information into the Secondary Plan.

1.2.3 Gateway West Subwatershed Plan

The Gateway West Subwatershed Study (1999) developed a Subwatershed Plan for the Levi's Creek, Mullett Creek and a portion of the Credit River subwatersheds to guide the development a Secondary Plan for the Gateway West Area, located east of the 401 Corridor Planning Area within the City of Brampton. Recommendations of this plan relating to the Mullet Creek subwatershed provides direction for development within the north-east corner of the 401 Corridor Planning Area.

The subwatershed goals and objectives for the study were based on those of the Credit River Water Management Study. The goal for the Mullett Creek subwatershed was identified as follows:

To maintain and enhance the key environmental features, functions and linkages within the Mullett Creek subwatershed as land use changes occur through development.

Objectives were developed for hydrology, water quality, and aquatic and terrestrial health.

The study included a description of existing subwatershed characteristics based on historical information, field programs and technical studies. Characteristics included geology and groundwater, fluvial geomorphology, hydrology and hydraulics, surface water quality, and aquatic and terrestrial environment. This information was subsequently used to determine the functional interaction of the ecosystems elements. The following table summarizes the functional assessment.

Table 1.10 - Mullett Creek Subwatershed Characterization		
Mullett Creek	*The upper portions of Mullett Creek are ephemeral, and provide limited functional value in terms of aquatic of terrestrial resources. In the lower reaches, near the Credit River in Mississauga, the creel provides some habitat for migratory runs of salmonids and warmwater species.*	
Functions	**Attributes**	**Linkages**
Surface Water • conveyance of stormwater is main function in upper reaches • some storage in well-defined reaches • swale drainage may improve water quality through filtration **Vegetation** • some erosion control in swales and gullies • limited terrestrial habitat • limited aquatic habitat **Geomorphology** • meander belt geometry	No significant vegetation Refuge habitat for salmonids at base.	**Terrestrial** • poor conditions to upland areas in headwaters and through Brampton • some wildlife movement in stream corridors within Mississauga **Aquatic** • no connections in headwater of through Gateway lands • good connection in lower sections of Mullett although barriers restrict fish movement at Mississauga

Impacts of development on the ecosystem were analyzed through technical studies to determine appropriate mitigation measures for specific areas throughout the subwatersheds. These measures, including stormwater management criteria for erosion, water quality, and flood control and a greenland system to protect environmental features, formed the basis for the subwatershed plan. For details on technical analyses, readers are referred to the Gateway West Subwatershed Study documents, however, recommended criteria are summarized in this report where appropriate.

An implementation plan was developed to identify requirements and responsibilities for implementing the Gateway West Subwatershed Plan. Further details on implementation requirements are provided in Section 8 of this 401 Corridor report.

2. BACKGROUND

2.1 Hydrology

2.1.1 Sixteen Mile Creek Flood Line Analysis

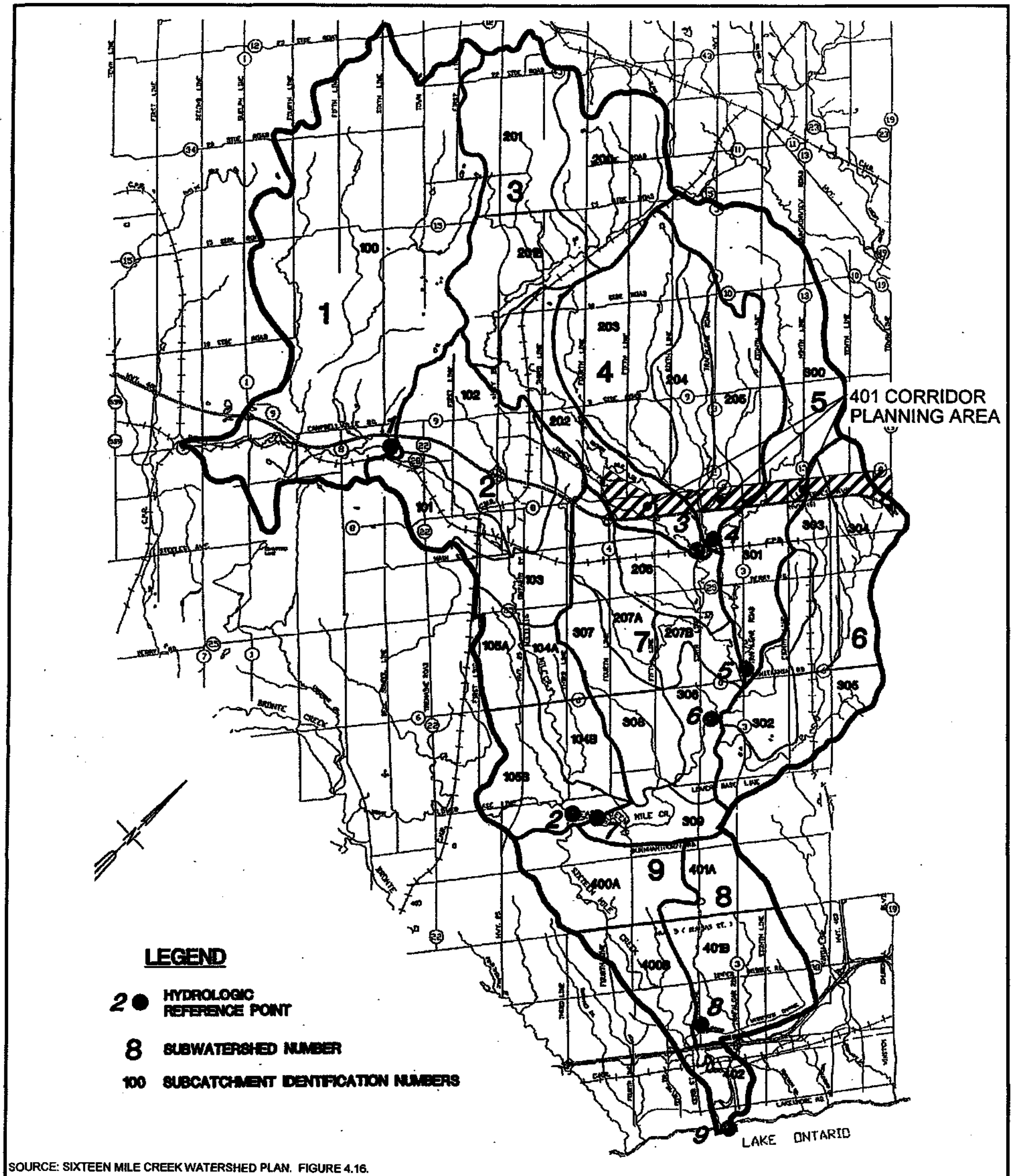
Flood hydrology for the entire watershed was completed in1988 to provide design flows for the preparation of flood plain mapping. A combination of flood frequency analysis for available stream flow gauges, and regional regression equations was applied to generate design flows for calibrating the HYMO simulation model for existing conditions. Proposed land use conditions, as designated in the Official Plans of Oakville, Halton Hills and Milton were used in the preparation of a future condition model to calculate design flows for flood plain mapping. Details of this analysis are provided in the Study Report, Halton Region Conservation Authority, Floodline Mapping Study of the Sixteen Mile Creek, Technical Report (The Proctor & Redfern Group, 1988).

Hydrologic analysis represented a key component of the Sixteen Mile Creek Watershed Plan (1996) studies and was used extensively in the evaluation of impacts of proposed urban expansion, and in the development of the watershed plan. QUALHYMO, a deterministic, continuous model, was adopted for its ability to analyze erosion characteristics and water quality loadings as well as year-round hydrology. This model was developed for the watershed based on existing land use conditions, and the proposed future and ultimate land use scenarios which differed from those used in previous modelling.

The subcatchment boundaries within each of the subwatershed are shown on **Figure 2.1**.

The QUALHYMO model, which had been calibrated to long-term, seasonal flow volumes and flow magnitude distributions, was used to review the previous HYMO design flows. The results for both the design storm simulations and the calibration event used in the HYMO model development were found to be in good agreement with the original modelling. Consequently, the QUALHYMO model was adopted for the assessment of land use changes on Regulatory Storm peak flows and flood lines (Sixteen Mile Creek Watershed Plan, Technical Report #2, Evaluation of Potential Development Impacts. (Gore and Storrie Limited, 1995)).

The following table compares design flows within selected scoped subwatershed areas as calculated using the two models under the various development conditions. The table indicates that ultimate condition peak flow rates do not significantly exceed the future condition rates used in the flood plain analyses. This



SOURCE: SIXTEEN MILE CREEK WATERSHED PLAN. FIGURE 4.16.

TOWN OF HALTON HILLS

DILLON CONSULTING

401 CORRIDOR INTEGRATED PLANNING PROJECT
SCOPED WATERSHED STUDIES

SUBWATERSHED AND SUBCATCHMENT BOUNDARIES

FIGURE 2.1

difference in flow rates was deemed to be within the accuracy range of the modelling process and, as a result, the original 1998 flow rates were accepted for use in determining flood plain limits.

Table 2.1 - Regional Storm Peak Flows

Location	Area (sq.km)	1988 Flood Hydrology		HUSP Flood Hydrology		
		Existing	Future	Existing	Future	Ultimate
IHD 201	38.9	216.7	216.7	179.9	179.9	183.3
IHD 203	115.3	474.5	475.2	441.3	430.2	494.2
IHD 204	28.7	129.4	129.4	114.7	114.7	124.3
Drumquin	144	587.9	587.9	548.1	537	603.8

Source: Sixteen Mile Creek Watershed Plan, Technical Report #2, Evaluation of Potential Development Impacts. (Gore and Storrie Limited, 1995), Table 3.4.

Table 2.2 presents design flow rates used in the flood plain analysis models in the vicinity of the Subwatershed under consideration.

Table 2.2 - Design Flows for Flood Plain Analysis

Watercourse	Crossing(s)	Design Flow Rate					
		Regional	100-Year	50-Year	25-Year	10-Year	5-Year
Middle Sixteen Mile Creek	Highway 401, Fifth Line (south), Steeles Avenue	264.66	50.24	44.86	37.72	29.93	24.42
Middle Sixteen Mile Creek Tributary	Highway 401 / Sixth Line Underpass	254.96	73.3	66.66	57.65	46.59	38.96
Middle Sixteen Mile Creek Tributary	Sixth Line, Steeles Avenue	185.24	52.4	46.98	40.2	32.29	26.86
Hornby Tributary	Steeles Avenue	262.16	75.87	67.96	57.41	44.98	37.26
East Sixteen Mile Creek	Highway 401, Steeles Avenue	122.15	31.84	28.52	24.22	19.28	15.79

Source: Halton Regional Conservation Authority HEC-2 models.

These main tributaries are shown on **Figure 2.2** which also illustrates minor watercourses and drainage features as defined on 10:000 scale Ontario Base Maps.

2.1.2 Sixteen Mile Creek Flood Line Extensions

In order to derive design flow rates for minor tributaries of Sixteen Mile Creek for use in the watershed studies, results of the original flood hydrology modelling were used to calculate a relationship between Regional Storm peak flow and the tributary drainage area. The following relationships were developed for naturally flowing watercourses located within the till plain:

$Q_{regional}$ (cms) = 6.714 $A^{0.886}$, for areas less than 15 square kilometres, and
$Q_{regional}$ (cms) = 5.785 A, for areas greater than 15 square kilometres.

These relationships were used to develop design flows for several minor tributaries within Subwatersheds 3, 4, 5 and 6. Two of these tributaries are located within the 401 Corridor study area.

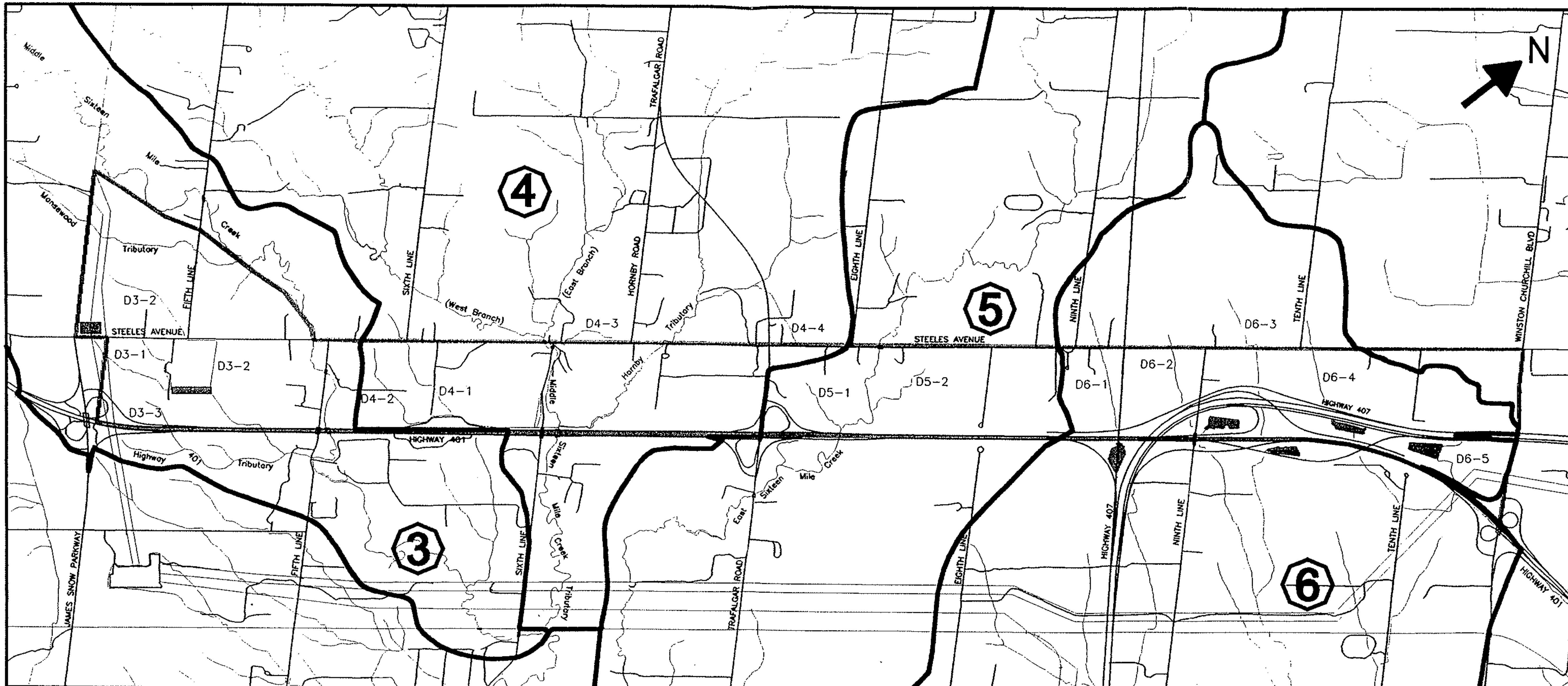
2.1.3 Subwatershed 6 - Lisgar Area

Due to the extensive amount of development within the area, the hydrology of Subwatershed 6 has been studied extensively in the past. The Lisgar Area is represented by subcatchments 304 and 305 on **Figure 2.1.** The various studies are discussed below.

Lisgar District Conceptual Stormwater Management Plan
(Paul Theil Associates Limited, 1983)

The Lisgar District, located in the City of Mississauga, encompasses lands bounded by Britannia Road to the south, Ninth Line to the west, Tenth Line to the east, and the CP Rail embankment to the north. It represents the easterly most portion of Subwatershed 6.

Along with plans for major urban development throughout the entire Lisgar District, a conceptual stormwater management plan was developed to address potential flooding concerns both within the development area, and downstream. To mitigate potential flooding problems, a minor/major system of storm sewers, foundation drains and continuous overland flow paths were recommended. In addition, a large stormwater management pond (for quantity control) was recommended at the outlet from the subdivision (i.e. east of Ninth Line and north of Britannia Road).



LEGEND

SCALE 1:25000

- WATERCOURSE
- (3) SUBWATERSHED NUMBER
- SUBWATERSHED BOUNDARY
- 401 CORRIDOR PLANNING AREA
- STORMWATER MANAGEMENT POND
- CPR RAIL LINE
- HYDRO LINE
- D5-1 SWALE IDENTIFICATION

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SCOPED SUBWATERSHED STUDIES

WATERCOURSE AND DRAINAGE FEATURES

FIGURE 2.2

Development upstream of the CP rail embankment, which includes the Highway 401 Corridor area was not considered in this study.

Impacts of Proposed Highway 407 on Highway/Hydraulic of the East Tributary of Sixteen Mile Creek (M.M. Dillon, 1984)

In 1984, Dillon Consulting Limited (formerly M.M. Dillon Limited) completed a Preliminary Design Report regarding the proposed Highway 407 on behalf of the Ministry of Transportation. This study focussed on the tributary located west of Ninth Line and within the area extending from south of Britannia Road to Highway 401 where the tributary coincided with the Highway 407 alignment. Hydrologic modelling, based on the future land use condition envisioned at the time, was used to develop design flows along the length of the highway for the purpose of determining channel crossing and realignment alternatives, and cut and fill requirements to address potential downstream impacts.

Future urbanization within the catchment area upstream of the CP rail embankment, including the Highway 401 Corridor area, was not considered in this study.

Master Drainage Plan, Sixteen Mile Creek Drainage Area, Winston Churchill Development District (Rand, 1989)

The Winston Churchill Development District is bounded by Ninth Line to the west, Tenth Line to the east, Britannia Road to the north, and the Erin Mills development to the south. This area is located directly south of the Lisgar District development, along the eastern boundary of Subwatershed 6.

A hydrologic assessment was carried out to determine the impacts of the proposed development on flows in the tributary of the Sixteen Mile Creek Tributary. The analyses and recommendations in this Master Drainage Plan Report indicate that storage for the purposes of flood control is not required in the development, by virtue of its downstream location in the subwatershed, and the non-coincident timing of peak flows from this area relative to the remaining watershed area.

Due to its downstream location, drainage from this area generally does not directly affect hydrologic conditions within the 401 Corridor.

Lisgar District Pre-Engineering Storm Drainage Report
(Paul Theil Associates Limited, 1989)

This report essentially is an update of the original conceptual stormwater management plan for the Lisgar area (see above). The document confirms that many of the works recommended in the 1983 report had been implemented, including:

- Servicing of 143 ha of Lisgar District land;
- 1800 m of channelization within the Lisgar area, as well 1100 m of channelization downstream from Ninth Line;
- A large SWM facility just east of Ninth Line to reduce 2-year to Regional Storm post-development flows to pre-development levels.

This report also recommends that all proposed development areas north of the Lisgar District (including the 401 Corridor), should implement water quantity control facilities similar to that implemented within the Lisgar area.

Lisgar Region Water Quality Study
(R.E. Winter Associates and Gore & Storrie Limited, 1993)

This study was initiated to address water quality concerns within the Lisgar Region which comprises virtual the majority of the Subwatershed 6 lands within the City of Mississauga. The objective of the study was to develop a water quality management plan that would protect existing environmental and water resource-related features, while incorporating anticipated land use changes.

Detailed hydrologic models were developed to generate design flows throughout the subwatershed for various development conditions and to develop a water quality management plan. The recommendations in the Lisgar Water Quality Study included source controls, improved conservation practices, retrofitting of the Lisgar water quantity pond (to also include quality control), and additional wet ponds to provide treatment to new development areas in the subwatershed.

The near-future land use scenario considered urban development in the form of residential development extending up to the CPR line. Under ultimate land use conditions, industrial development was included in two areas:

i) north of the CPR line extending to Highway 401, and
ii) west of the CPR Spur Line and south of Highway 401.

It was recognized, however, that development north of Highway 401 may occur and that, in this case, runoff controls would be implemented to control peak flow rates through the Highway 401 culverts.

Toll Highway 407, Sixteen Mile Creek Watershed, Stormwater Management Strategy Study Final Report (Dillon Consulting Limited, 1997)

The hydrologic model developed as part of the Lisgar Region Water Quality Study was used as the basis for stormwater management studies associated with the proposed highway development. It was determined that with only minor modification, this OTTHYMO model could be used for the Toll Highway 407 study. This would ensure consistency with the most recently approved hydrologic analyses for the subwatershed at that time, and would provide the necessary level of detail for the analysis required.

The model was obtained from the City of Mississauga, and the following changes were made:

i) The Regional Storm rainfall depth and duration were reduced from 252 mm and 14.4 hours, to 212 mm and 12 hours, as specified in the MNR Floodplain Management in Ontario Technical Guidelines.

ii) The subarea representing the entire north/south length of the proposed Toll Highway 407 right-of-way, was subdivided into three subareas (north of Derry Road, between Derry Road and Britannia Road and south of Britannia Road) to provide a more detailed, local assessment of potential impacts along the length of the Highway.

iii) The percentage impervious area for the Toll Highway 407 right-of-way was increased from 25% to 43%, reflecting the ultimate (paved median) highway cross-section.

iv) Quantity control ponds were incorporated into the model where external drainage areas (proposed for development) would discharge into the Toll Highway 407 right-of-way (i.e. Winston Meadows Planning Area located east of Ninth Line and south of Britannia Road, and proposed industrial area west of CPR Spur Line and south of Highway 401). Quantity controls for these development areas were proposed to ensure that peak flows within the Highway right-of-way would not be increased.

In general, the reduction in Regional Storm rainfall volume (from 252 mm in the Lisgar Study to 212 mm for this study) resulted in a decrease in Regional Storm peak flows of about 10%. Peak flows for the more frequently occurring events were virtually identical to the peak flows in the Lisgar Study.

Additional modelling in the vicinity of the Highway 407 - Highway 401 interchange was required to provide the necessary level of detail to address hydrologic issues at several headwater swales whose drainage areas had been aggregated in the Lisgar model.

Analysis indicated that within the context of the Lisgar Region, the ultimate 8-lane Highway 407 development would not appreciably affect peak design flow rates under extreme conditions. This is due to the Highway impervious area representing a very small portion of the total watershed area. Within smaller local areas of the Lisgar region, such as at the Highway 407 - Highway 401 interchange, any increases in peak flow rate were determined to be minor. Given that storm water management facilities would be implemented for the purpose of water quality, it was recognized that quantity control could be readily integrated into these facilities, and consequently, all detention facilities proposed as part of the highway storm water management strategy incorporate quantity control.

A series of stormwater and flood plain management measures recommended by the study have since been implemented to control potential impacts of the highway development. These include:

- extensive flood plain recontouring in the Britannia Road area to compensate for fill associated with the highway embankment;
- an on-line flood storage compensation / quality detention facility located south of Derry Road;
- five wet ponds for the purpose of water quantity and quality within the Highway 407 - Highway 401 interchange.

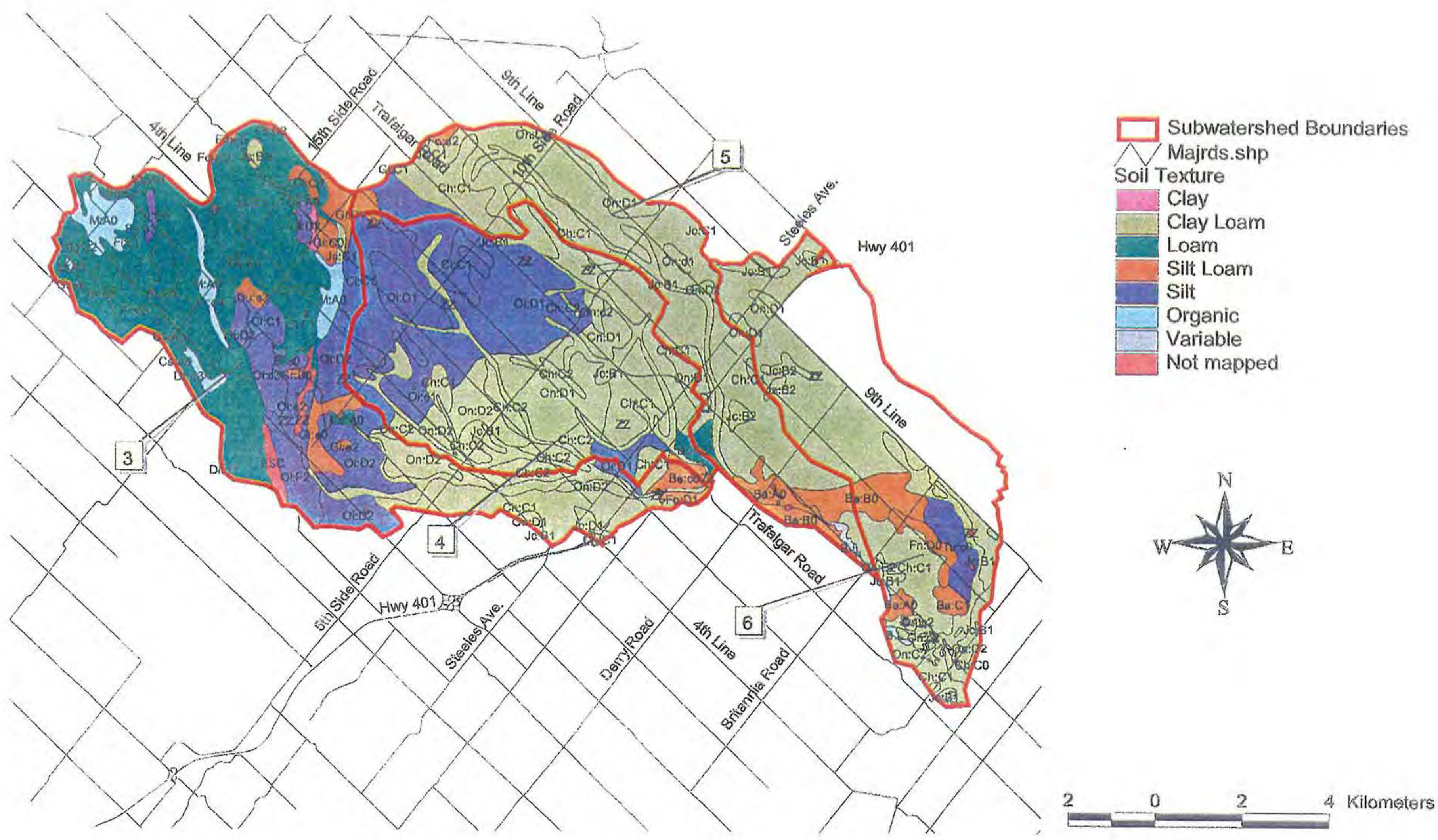
2.1.4 Middle Sixteen Mile Creek Tributaries

Several hydrologic analyses have been carried out in the past with regard to several minor tributaries of the Middle Sixteen Mile Creek in order to address local storm water management impacts associated with proposed development. These analyses are described below.

Milton Business Parks Industrial Subdivision, Milton/401 Industrial Park, Stormwater Management Study (F.J. Reinders and Associates Canada Limited, Revised 1988)

The Milton Business Parks Industrial Subdivision, located on 28.8 ha of land north of Steeles Avenue and East of Fourth Line, forms part of the larger 62 ha Milton/401 Industrial Park within Subwatershed 3 (see **Figure 2.3**). The lands drain to a tributary of the Middle Branch of Sixteen Mile Creek which flows southward across Steeles Avenue and the 401 Corridor Planning Area to its confluence with the Middle

Surficial Soil Types



Drainage Characteristics

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401 Corridor Integrated Planning Project
Scoped Subwatershed Studies

Subwatershed Soil and Drainage Characteristics

Map No.2

Branch, south of Highway 401. Immediately downstream of Steeles Avenue, this tributary is referred to as Swale 1 (shown as D3-1 on **Figure 2.2**) in subsequent reports.

Hydrologic analysis using the MICROHYMO model was used to assess water quantity impacts of the Industrial Park and to design a pond to control post-development flows to pre-development values. Control up to the 100 year event has been provided in the facility which has been built within the Ontario Hydro corridor, north of Steeles Avenue.

Scoped Sub-Watershed Study, Panacea Redevelopment Corporation, Middle Sixteen Mile Creek Watershed, Town of Halton Hills (MTE Consultants Inc. in association with Howes-Jones & Associates, 1997)

Hydrologic analysis for Swale 1 and an adjacent tributary named Swale 2 (D3-2 on **Figure 2.2**) was expanded during the above study in order to address storm water management issues associated with a proposed building supply distribution centre and its surrounding area, located within the 401 Corridor study area. The MIDUSS modelling package was used for the analyses.

A storm water management strategy was developed consisting of two consecutive on-line facilities located at the confluence of Drains 1 and 2. The first facility, which has since been built, is intended to provide i) ultimate water quality control capacity for the local and upstream area, and ii) interim water quantity and erosion control for the local area. The second facility is intended to provide centralized water quantity and erosion control benefits to the entire development area.

The study notes that for hydrologic modelling of the upstream 401 Industrial Park, the natural condition drainage area and percentage impervious were assumed due to the unavailability of the pond outlet details for the industrial park facility. This assumption will likely affect the accuracy of the study results due to the higher actual runoff volumes which will be generated by the industrial park.

Storm Water Management Report, Cashway Distribution Centre, Town of Halton Hills, for Panacea Redevelopment Corporation (MTE Consultants Inc. in association with Howes-Jones & Associates, 1997)

Hydrologic analysis presented in the discussion of the previous Scoped-Sub-Watershed Study was reiterated in the above report.

2.2 Flood Plain Analysis

2.2.1 Major Tributaries

The 1988 flood plain analysis identified the communities of Hornby, Mansewood and Drunquin as being subject to periodic flooding due to high runoff and ice jamming. Within Hornby, the study identified one building within the Regional flood line; within Mansewood, two dwellings were identified within the flood lines; within Drumquin, no dwellings or structures were identified within the flood lines, however, a significant length of Britannia Road West (approximately 110 m) would be inundated.

The suitability of the 1988 flood lines was reviewed as part of the Sixteen Mile Creek Watershed Plan technical studies. Using design flows derived from QUALHYMO modelling described in the previous section, the original flood plain model were updated and results were compared with those of the original analysis. Higher flood elevations were calculated along the watercourse from the lower reaches of East Sixteen Mile Creek southward to Lake Ontario. Within the 401 Planning Area, the technical analyses confirmed the validity of the original flood levels determined as part of the 1988 study.

Flood and fill lines associated with the main tributaries have been digitized from the original 1:2000 mapping and are presented on **Figure 2.4**.

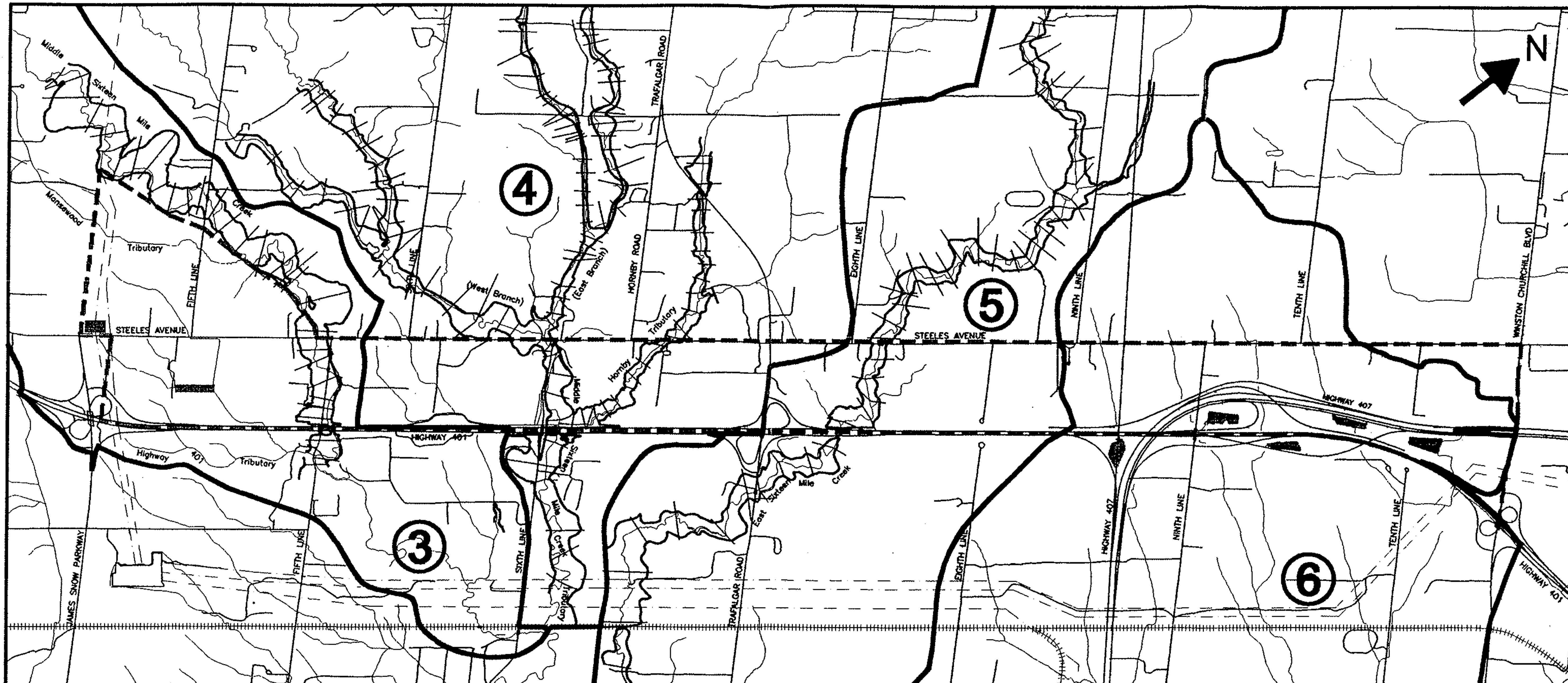
2.2.2 Minor Tributaries

Extensions of flood line mapping to cover minor tributaries within Subwatersheds 3, 4, 5, and 6 were determined as part of the Sixteen Mile Creek Watershed Plan technical studies. The purpose of this mapping was to provide estimates of flood limits for unmapped tributaries with drainage areas over 125 ha.

Cross sections for the HEC-2 computer models were based on 1:10,000 scale base mapping and were modified to reflect low flow channel characteristics as measured in the field. Tributary crossings were surveyed and added to the models. Design flow rates were based on the flow-area relationships derived from the design flows used for original flood line mapping, as described previously.

2.2.3 Highway 407 Corridor - Subwatershed 6

Flood line mapping in the Lisgar Region has been prepared as part of several of the studies discussed in the previous section on hydrology. The most current analysis was completed as part of the Toll Highway 407 Sixteen Mile Creek Stormwater Management Strategy Study (Dillon Consulting Limited, 1997) in order to:



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LEGEND

SCALE 1:25000

WATERCOURSE	STORMWATER MANAGEMENT POND
SUBWATERSHED NUMBER	CPR RAIL LINE
SUBWATERSHED BOUNDARY	HYDRO LINE
401 CORRIDOR PLANNING AREA	REGIONAL FLOOD LINE

401 CORRIDOR INTEGRATED PLANNING PROJECT
SCOPED SUBWATERSHED STUDIES

REGIONAL FLOOD LINES

FIGURE 2.4

i) develop water surface elevations to aid in setting the Highway top-of-road profile, and

ii) establish flood plain limits so that Highway/flood plain conflicts can be identified and the amount of fill (and hence, the amount of compensating cut) required within the flood plain determined.

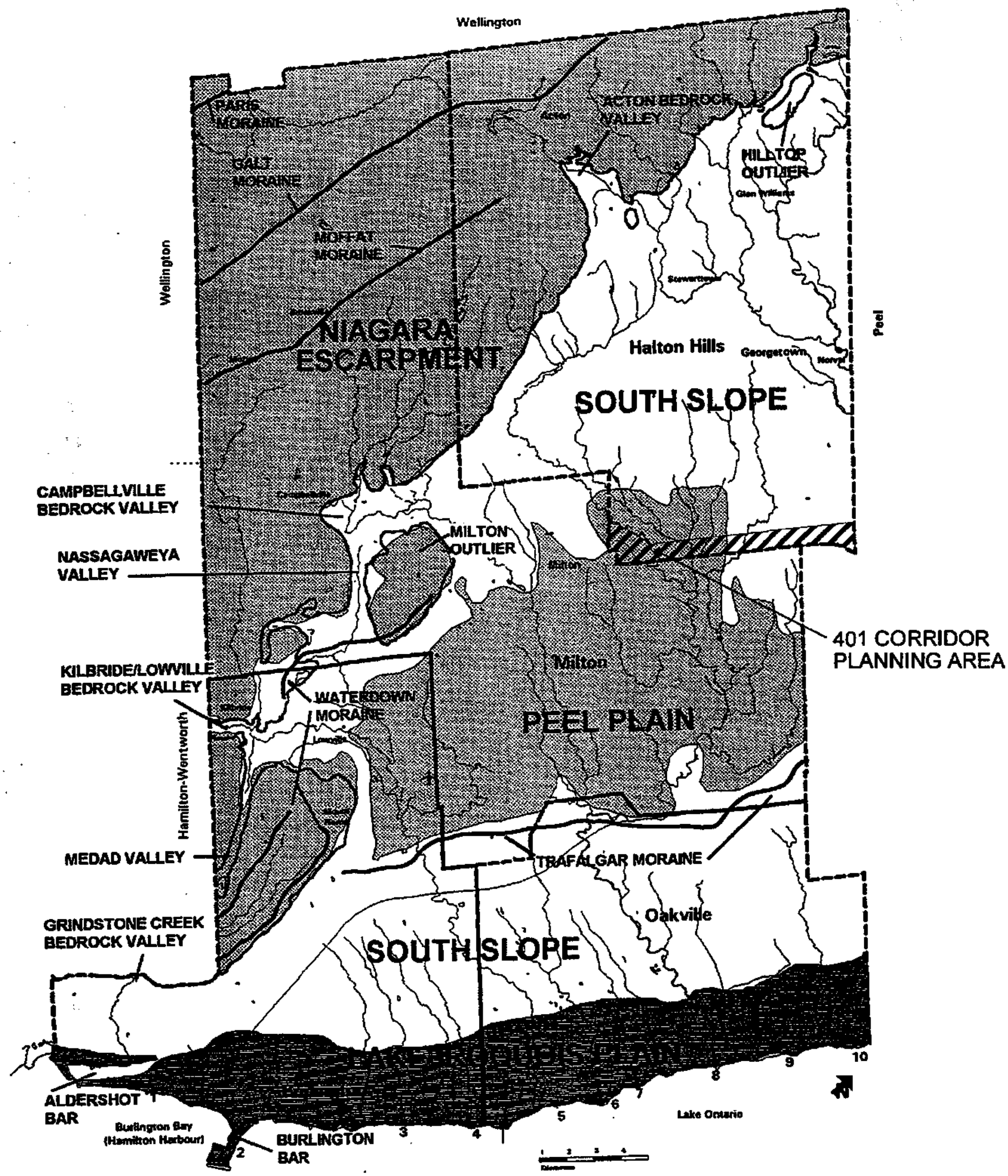
Cross-section data for the model was obtained from detailed 1:1000 scale topographic mapping, which was produced specifically for the Toll Highway 407 project (1994 aerial photography). The existing conditions backwater model comprises a total of 110 cross-sections extending from downstream of the CPR Spur Line to Highway 401. Existing bridges and culverts which were incorporated into the model were field surveyed for invert, obvert, length, geometry and top-of-road elevation. The future condition model includes the highway embankment, proposed crossings, channels, the Derry Road facility, and extends to the Highway 407/ Highway 401 Interchange.

2.3 Hydrogeology

2.3.1 <u>Regional Hydrogeological Context</u>

Physiography

The study area is split between two physiographic regions known as the Peel plain and the South Slope (**Figure 2.5**). The Peel Plain, which covers the western part of the study area, is a level to undulating tract of clay soils that covers 300 square miles in Halton, Peel, York, Durham Regions and the City of Toronto. Elevations within the physiographic region vary from 150 to 230 masl. The Peel plain is shale and limestone till with a veneer layer of varved clay. This clay was presumably carried by meltwater from limestone regions to the east and north and deposited in a temporary lake in the Ontario basin. Drainage is consistent within the region due to topography, although the soils are characteristically of low permeability. The eastern portion of the study area is underlain by the South Slope, a region of glacial tills with varying surface features. In the area of study, the soils are exhibit low morainic relief (*The Physiography of Southern Ontario*, Chapman and Putnam, 1984). Regional physiography is illustrated on **Figure 2.5**.



SOURCE: HALTON AQUIFER MANAGEMENT PLAN. PHASE I REPORT. BACKGROUND HYDROGEOLOGY. FIGURE 4.

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SCOPED WATERSHED STUDIES

REGIONAL PHYSIOGRAPHY

FIGURE 2.5

Surficial Soils

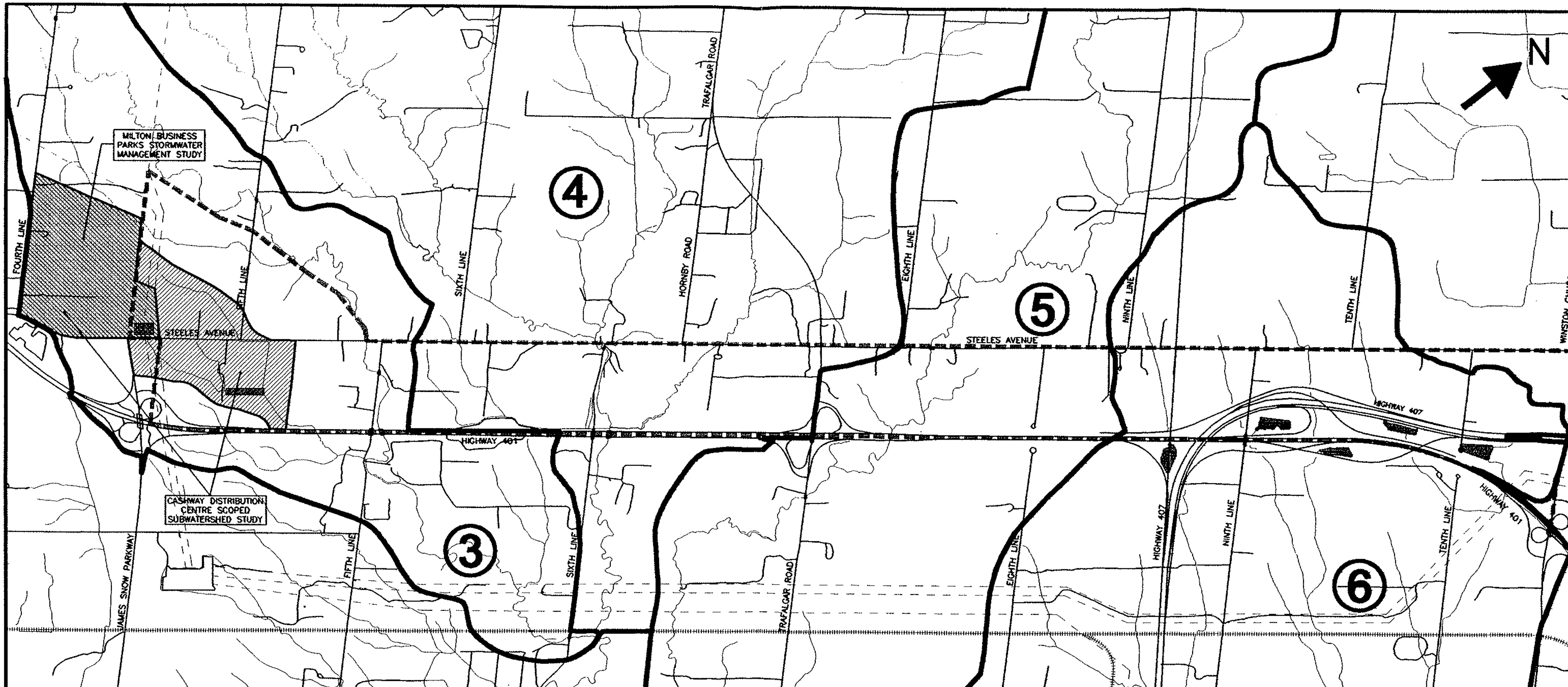
Map No. 2 provides an overview of surficial soil types throughout the Subwatersheds according to the Ontario Soil Survey mapping for the Region of Halton. Mapping was derived from ARC/INFO coverages created by OMAFRA's former GIS Unit.

Both Subwatersheds 5 and 6 are characterized primarily by imperfectly-drained Chinguacousy clay loam throughout the upstream and central areas and Berrien, Font and Brady sandy loam in central to downstream areas. Localized areas of well-drained Oneida clay loam are also found in these subwatersheds. It is noted that no GIS data is available for the eastern portion of Subwatershed 6 which lies within the Regional of Peel. Soils within this portion of Subwatershed 6 are primarily imperfectly-drained Chinguacousy clay loam. Well-drained Oneida silt loam is found throughout the majority of Subwatershed 4 while imperfectly-drained Chinguacousy clay loam is located over the headwater area, along the eastern subwatershed divide and throughout the downstream lands. Subwatershed 3 is characterized by imperfectly-drained Chinguacousy clay loam downstream of Fifth Side Road. Upstream of Fifth Side Road and extending to the headwater areas, well-drained soils are generally found including Oneida silt loam below the escarpment and Guelph, Farmington and Burford loams above the escarpment.

The surficial soils in the 401 Corridor Planning Area are predominated by glacial till, consisting primarily of clay-dominated matrices. Till soils in this area contain various fractions of silt, sand and gravel. Ground surface is relatively smooth and slightly rolling. This is typical of unaltered till plain areas. The till soils range in thickness, but are typically greater than 10 m thick, with a few exceptions where the thickness of till is on the order of 7 to 9 metres.

In the central portion of the study area, there are some soils differentiated by the method of original placement, in this case water-laid soil. These soils range from clay-dominant deposits to sand-dominated deposits. These represent the northern portion of a larger water-laid deposit. These soils, in this area, are expected to be relatively thin, limited to a few metres in thickness.

Specifically, there are three soil types within the 401 Corridor Planning Area. The Chinguacousy loam to clay loam is found throughout most of the study area. This is an imperfectly drained soil that is developed in clay and silty clay glacial till deposits. Chinguacousy loam to clay loam tends to be found in gently sloped areas and is an important soil for general farming (*The Soils of Halton County. Report No. 43 of the Ontario Soil Survey.* Gillespie, J.E., R.E. Wickland and M.H. Miller, 1955).



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LEGEND

SCALE 1:25000

WATERCOURSE	STORMWATER MANAGEMENT POND
③ SUBWATERSHED NUMBER	CPR RAIL LINE
SUBWATERSHED BOUNDARY	HYDRO LINE
401 CORRIDOR PLANNING AREA	

401 CORRIDOR INTEGRATED PLANNING PROJECT
SCOPED SUBWATERSHED STUDIES

MIDDLE SIXTEEN MILE CREEK
HYDROLOGIC STUDY AREAS

FIGURE 2.3

The second most common soil is an Oneida clay loam/Dumfries loam. This soil is found in four locations in the study area: between 8th and 9th Line, along both sides of 5th Line, Trafalgar Road and 9th Line, all extending from Steeles Avenue to the Highway 401. This soil is moderately well drained and often occurs within imperfectly drained Chinguacousy and poorly drained Jeddo soils. Most of the Dumfries soils are used for pasture but some areas have been used to produce hay and grain crops whereas the Oneida soils are good agricultural soils (Gillespie *et al.* 1955).

The least common soil type in the study area is a Jeddo clay loam/Brisbane loam. This soil type is soil found in six locations in the study area (west of 5th Line North - north and south of Steeles Avenue, both sides of 5th Line, east side of 6th Line, east of Trafalgar Road, south of Steeles Avenue at 10th Line North, and east of 10th Line south of Steeles Avenue and north of Highway 401). Brisbane loam tends to occur on flat topography and has dark surface soil (Gillespie *et al.* 1955). This soil type is good for general farming. Jeddo soil is poorly drained and occurs in depressional areas. The surface soil is dark brown and there is a medium level of organic matter.

Bedrock Geology

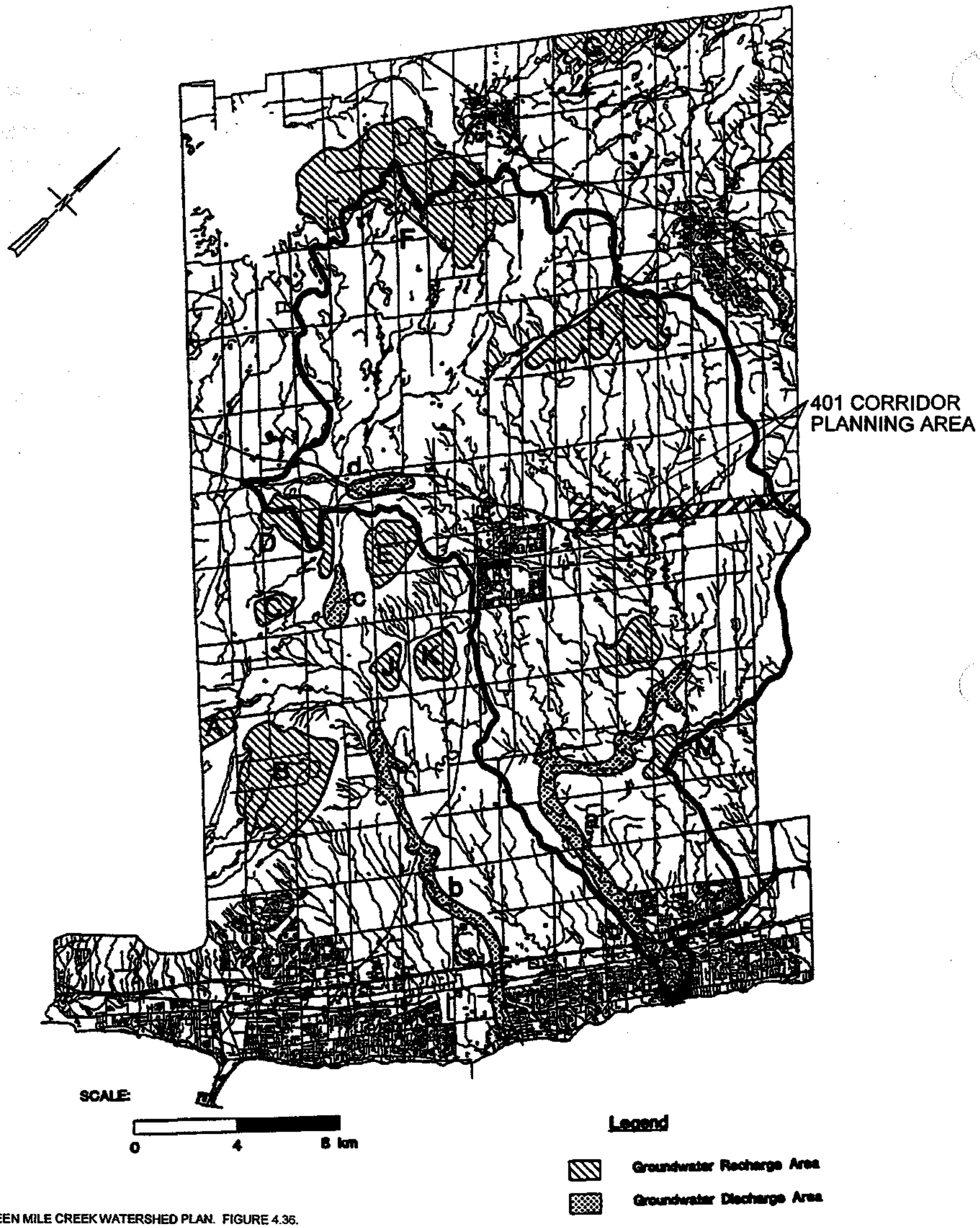
The area is underlain by red Queenston Shale, typically 15 to 30 m below grade within the study area.

The shale bedrock is reported to be low-yielding for water wells, although it is used extensively for residential water supply in and around the study area.

Regional Hydrogeology

Ground water flow in a regional context follows a north to south pattern in the area of study. Regional ground water recharge has been documented to occur north and northwest of the study area (Sixteen Mile Creek Watershed Study). Regional discharge occurs to Sixteen Mile Creek to the south of the study area. There is also some evidence, based on converging ground water flow lines and stream density, that discharge occurs to Sixteen Mile Creek tributaries north of Steeles Avenue, although this cannot be confirmed at this time (Gore & Storrie, 1995). Regional recharge and discharge areas are indicated on **Figure 2.6.**

A comprehensive study of Halton Region's ground water resources, conducted by Region staff, identifies that there are no major sand and gravel layers in the corridor, greater than approximately 1.5 m thick. Mapping of the area indicates the greatest potential for water supply wells of significant yields to be in the central portion of the study area between Trafalgar Road and Sixth Line (greater detail below). Otherwise, the area is generally considered a poor water yielding area.



SOURCE: SIXTEEN MILE CREEK WATERSHED PLAN. FIGURE 4.36.

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SCOPED WATERSHED STUDIES

REGIONAL RECHARGE AND DISCHARGE AREAS

FIGURE 2.6

Several areas of groundwater sensitivity have been identified throughout the study subwatersheds as part of the Halton Aquifer Management Plan (1995). Small portions of the headwater region of Subwatershed 3, above the Escarpment, within the Amabel Formation have been identified as being sensitive due to deeper static water levels (**Figure 2.7**). Other sensitive areas, due to the presence of sand or gravel aquifers, have been identified within the boundaries of Subwatersheds 3, 4, 5, 6. These areas are generally located north of the Fifth Side Road, beyond the proposed 401 Corridor Planning Area (see **Figure 2.8**).

2.3.2 Local Hydrogeology

The specific hydrogeologic characteristics of the 401 Corridor Planning Area are discussed segment-by-segment below.

Fifth Concession; James Snow Parkway to Fifth Line

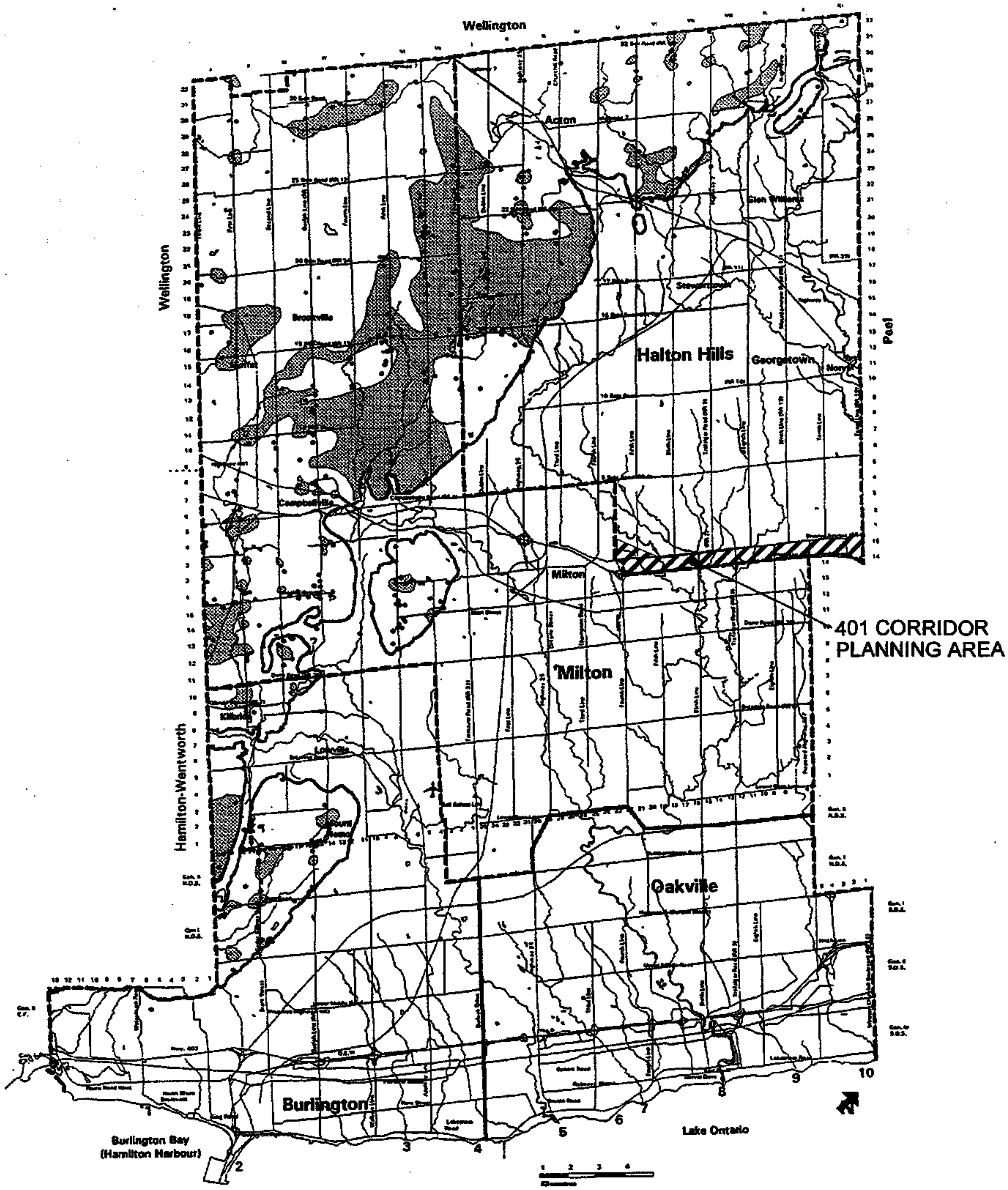
In the western portion of the study area, the soil lithology consists of clay till overburden overlying red shale bedrock. The bedrock in this area is relatively shallow, at approximately 192 to 197 masl, or 10 to 15 m below grade. There is no evidence of any significant water bearing zone within the overburden. Static water levels in the bedrock are typically about 3 m below grade. As such, vertical gradient are small and downward. Recharge of ground water is very low, estimated at 50 to 100 mm/yr.

Sixth Concession; Fifth Line to Sixth Line

The top of bedrock trends deeper through the Sixth Concession, with an elevation of approximately 180 masl representing the upper surface of bedrock in this area. The surface soil is clay till throughout, and it is typically greater than 10 metres thick. Between the clay till and the bedrock, inconsistent unit(s) of sandy soil are reported in water well records, and these are sources of water in the area. Static water levels are in the range of 2 to 3 metres below grade. Recharge of ground water would be very low, typically 50 to 100 mm/yr.

Seventh Concession, Hornby Area; Sixth Line to Trafalgar Road

A significant hydrogeological study of the Hornby area was undertaken in the early 1980s for the Regional Municipality of Halton. The study concentrated on the availability of ground water as a resource, the suitability of the area for septics and the capacity for development of the area. The study confirmed that the surface soil in the area is clay till, with low recharge capacity (estimated at 80 to 110 mm/yr.). This till is typically 20 metres thick, but contains thin seams (likely isolated) of sandy soil which produce very small



SOURCE: HALTON AQUIFER MANAGEMENT PLAN. PHASE I REPORT. BACKGROUND HYDROGEOLOGY. FIGURE 11.

TOWN OF HALTON HILLS

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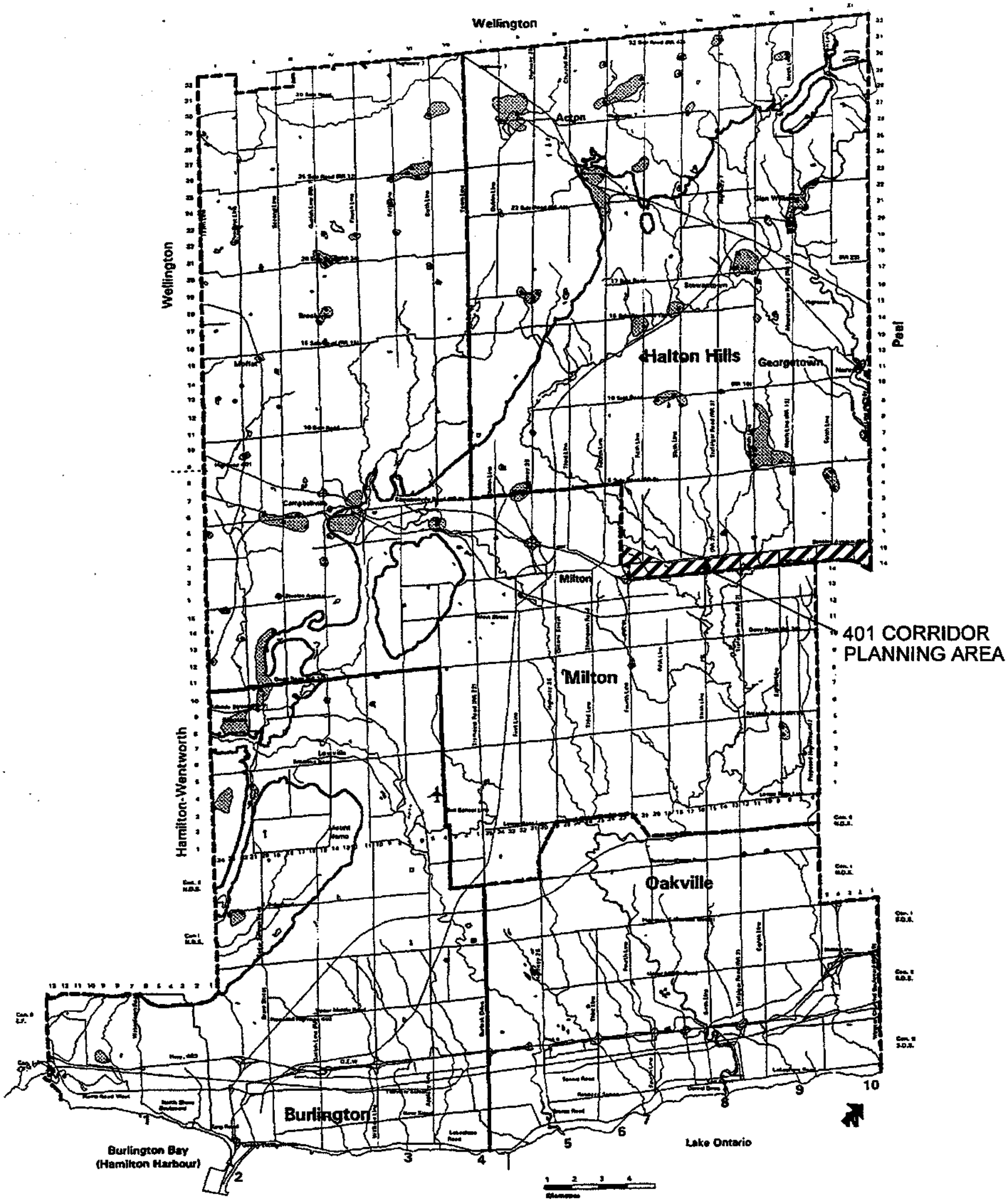
401 CORRIDOR INTEGRATED PLANNING PROJECT
SCOPED WATERSHED STUDIES

SENSITIVE AREAS - AMABEL FORMATION

FIGURE 2.7



SOURCE: HALTON AQUIFER MANAGEMENT PLAN. PHASE I REPORT. BACKGROUND HYDROGEOLOGY. FIGURE 13.

TOWN OF HALTON HILLS

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401 CORRIDOR INTEGRATED PLANNING PROJECT
SCOPED WATERSHED STUDIES

SENSITIVE AREAS - SAND OR GRAVEL AQUIFERS

FIGURE 2.8

amounts of water (insufficient for residential supply). Below the clay till, there is a localized basal sand aquifer, sitting within a local bedrock depression (**Figure 2.9**). This basal aquifer extends from just north of Steeles Avenue southward beyond Highway 401, but is limited to less than one concession width around the original community of Hornby (at Hornby Road). This aquifer does not appear to extend eastward to the "new" Hornby area at Trafalgar Road. The basal sand aquifer is capable of yielding 40 L/min., which is approximately twice the yield of wells elsewhere in the Hornby area.

Ground water flow in the aquifer is generally from north to south. A main tributary of Sixteen Mile Creek passes through an incised valley in this area, directly above the basal aquifer. There is evidence of upward vertical gradients from the basal aquifer in the vicinity of the valley, from Sixth Line to halfway to Trafalgar Road. The intervening clay between the basal aquifer and the Creek will limit movement of ground water, however, suggesting that the most significant discharge likely occurs south of Highway 401. Nonetheless, there is likely a net gain in flow in the Creek in this area.

Eighth Concession; Trafalgar Road to Eighth Line

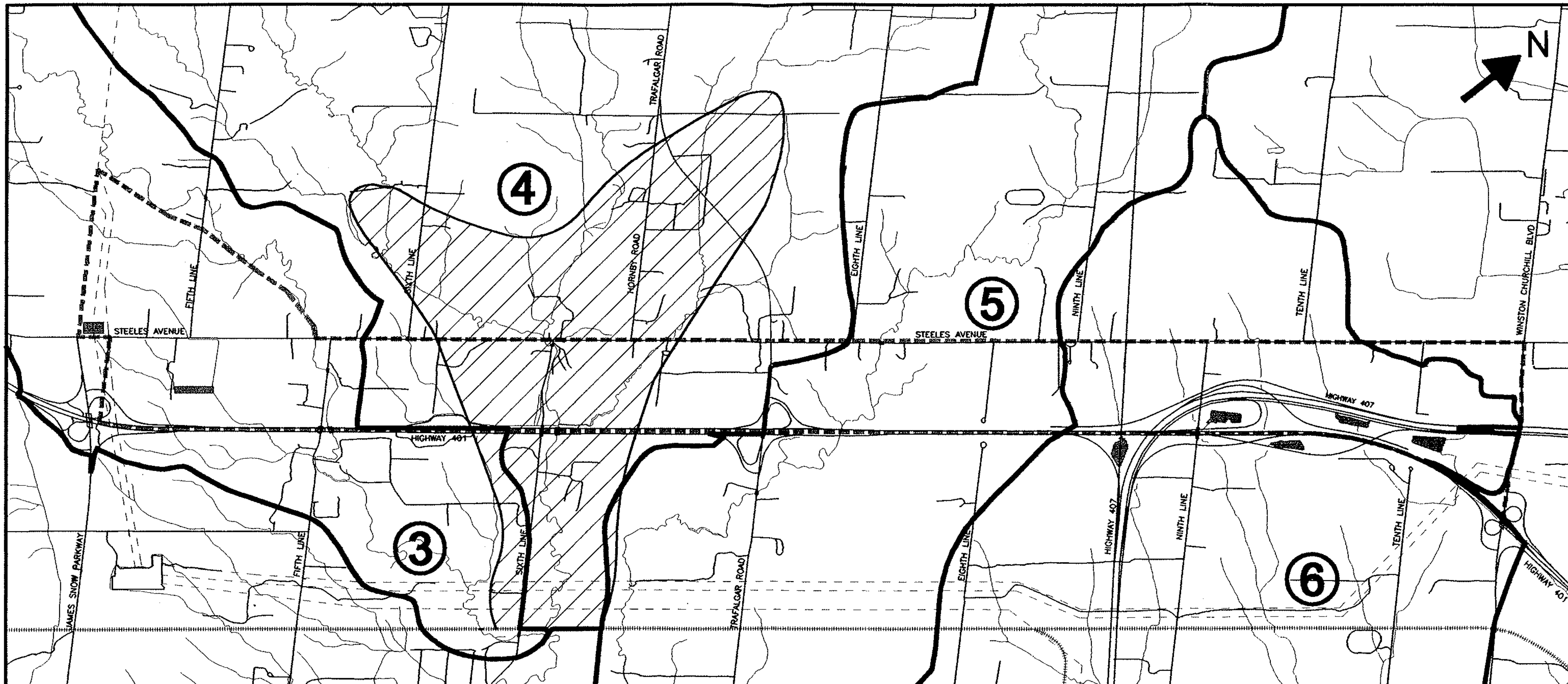
The lithology in this area consists of clay till overlying bedrock. The overburden is approximately 18 to 24 m thick. There is no indication in well records of overburden aquifer deposits in this area. Static water levels in bedrock wells are typically several metres below grade, indicating downward gradients throughout the table land area. Recharge is very limited in this area (less than 100 mm/yr).

Ninth Concession; Eighth Line to Ninth Line

The lithology consists of surface clay till overlying sand and gravel deposits at 9 to 10 metres below grade. Static water levels are typically in the range of 2 to 5 metres below grade, and indicate a north to south flow pattern for ground water in the confined sand aquifer. Recharge is very limited by the clay till to less than 100 mm/yr. Due to the lack of any deeply incised water courses, discharge is not a significant occurrence in this area.

Tenth and Eleventh Concessions; Ninth Line to Winston Churchill Boulevard

The lithology in this area is similar to the ninth concession, with clay till at surface. In this area, the clay till extends to between 8 to 14 metres below grade. Sand and gravel units underlie the clay till, providing residential ground water supplies. In one location, near Highway 407, a sand unit was encountered at shallower depth (7m). Static water levels are typically 4 to 6 metres below grade, with some variation



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LEGEND

SCALE 1:25000

WATERCOURSE

SUBWATERSHED NUMBER

SUBWATERSHED BOUNDARY

401 CORRIDOR PLANNING AREA

STORMWATER MANAGEMENT POND

CPR RAIL LINE

HYDRO LINE

BASAL SAND AQUIFER BELOW TILL (APPROXIMATE BOUNDARY)

401 CORRIDOR INTEGRATED PLANNING PROJECT
SCOPED SUBWATERSHED STUDIES

LOCAL HYDROGEOLOGIC FEATURES

FIGURE 2.9

throughout the area. Recharge in this area is limited to less than 100 mm/yr. There is no opportunity for any significant discharge to occur in this area.

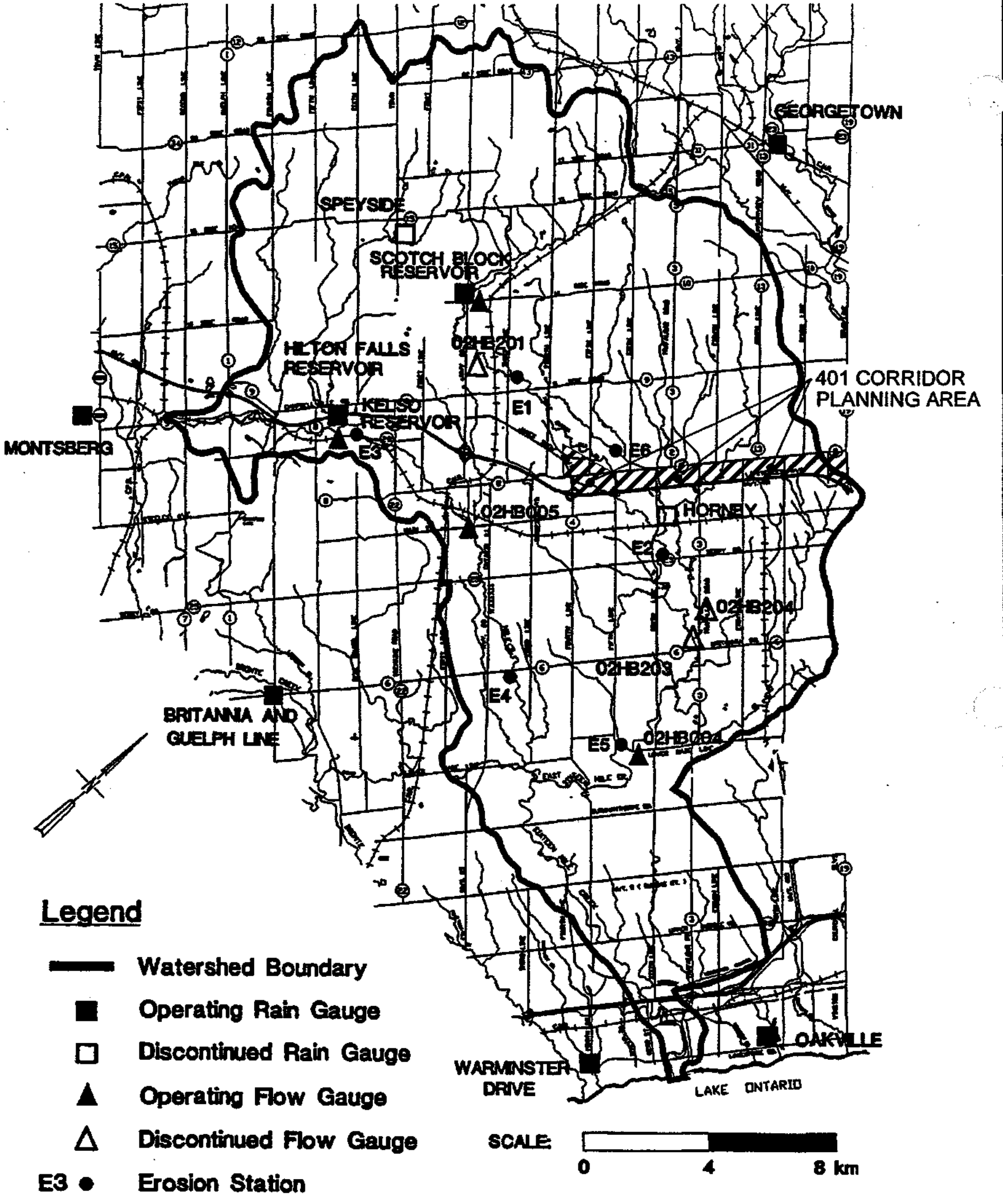
2.4 Stream Geomorphology

2.4.1 Regional Geomorphologic Context

A field survey of Sixteen Mile Creek was conducted as part of the Sixteen Mile Creek Watershed Plan (1996) to characterize existing channel geomorphology and to identify the nature and extent erosion problems in the watershed. For this purpose, stream bank materials were collected and cross sections were surveyed at six sites located in relation to proposed development areas. Information was collected for middle and upper reaches of the watershed as opposed to downstream reaches since these reaches were deemed to be more sensitive to potential flow changes and would therefore govern control requirements for the watershed.

Four of these sites would be influenced by drainage from Subwatersheds 3, 4, 5, and 6. The first site E1 is on the escarpment beyond the limit of ultimate development and, therefore, would not be subject to increased erosion potential following development without appropriate controls in the subwatersheds; the second site E6 is located on the till plain, upstream of the 401 Corridor Planning Area and west of Sixth Line. This site would be subject to increased erosion potential only under ultimate development conditions. The third site, E2, is located downstream of the confluence of Subwatersheds 3 and 4, upstream of Derry Road. This site will be subject to increased erosion potential under both future (i.e., 401 Corridor) and ultimate development scenarios. The fourth site, E5, is located on the East Branch upstream of Baseline Road. These locations are indicated on **Figure 2.10**.

The geomorphologic survey at these sites included a field assessment of the erodibility of various stream bank strata at the section to determine the most erodible soil unit. In addition, laboratory tests were performed to determine physical parameters which were used to then classify the soils and to estimate the critical shear stresses - these are defined as those values at which erosion is initiated. Assuming uniform flow conditions, mean shear stress at each section was calculated for a range of flow rates to determine the corresponding threshold flow rate for erosion. The following table excerpt from the Sixteen Mile Creek Watershed Plan, Technical Report #2, Evaluation of Potential Development Impacts summarizes the erosion characteristics of the most erodible soil units at each site.



SOURCE: SIXTEEN MILE CREEK WATERSHED PLAN. FIGURE 3.6.

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WATERSHED EROSION MONITORING SITES

FIGURE 2.10

Table 2.3 - Characteristics of Erosion Stations						
Site	**Location**	**Tributary Area (ha)**	**Soil Type (Most Erodible)**	**τ Critical (Pa)**	**Q Threshold (L/s/ha)**	
					At Site	**At Critical D/S Site**
E2	Middle Branch D/S of CPR	9596	Loamy Sand	2	0.156	0.103
E4	West Branch D/S of Britannia Road	11634	Sandy Loam	5	0.155	0.155
E5	East Branch U/S of Lower CPR	18426	Silt Loam	8	0.103	0.103
E6	Middle Branch U/S of Fifth Line Road	2158	Sand	2	0.139	0.103

The study noted that in order to effectively control erosion within the watershed, over-control at the subwatershed level is required in order to protect more sensitive downstream areas. Particularly, over-control in the Middle Branch is required to protect the more sensitive East Branch at site E5. The more stringent unit area threshold rate has been added as the last column in the table.

No erosion assessment sites were selected within Subwatershed 6 as part of the Watershed Plan. Previous studies, including Master Drainage Plan, Sixteen Mile Creek Drainage Area, Winston Churchill Development District (Rand, 1989) and Lisgar Region Water Quality Study (R.E. Winter Associates and Gore & Storrie Limited, 1993), noted that there was no significant watercourse erosion in the subwatershed. However, surficial erosion from agricultural and construction practices was reported.

2.4.2 Local Geomorphology

Background

The geology of any area exerts an important control on the characteristics of watercourses and on the relation between watercourses and their floodplains. Within the Highway 401 Corridor study area, there are two different surficial geology deposits (Ontario Ministry of Northern Development and Mines, 1991; 1:1,000,000). The western half of the study area is characterized by glacio-lacustrine sediment while the eastern half is characterized by glacial till. Both deposits tend to be cohesive and fine grained in texture although coarse clasts may be found within each of them. Given that there is spatial variation of the surficial geology, it follows that the corresponding drainage pattern and channels may exhibit slightly different characteristics between the eastern and western sections of the study area. Specifically, this is evident in the difference in drainage pattern: west-end watercourses exhibit a dendritic-type pattern while that of east-end watercourses is parallel.

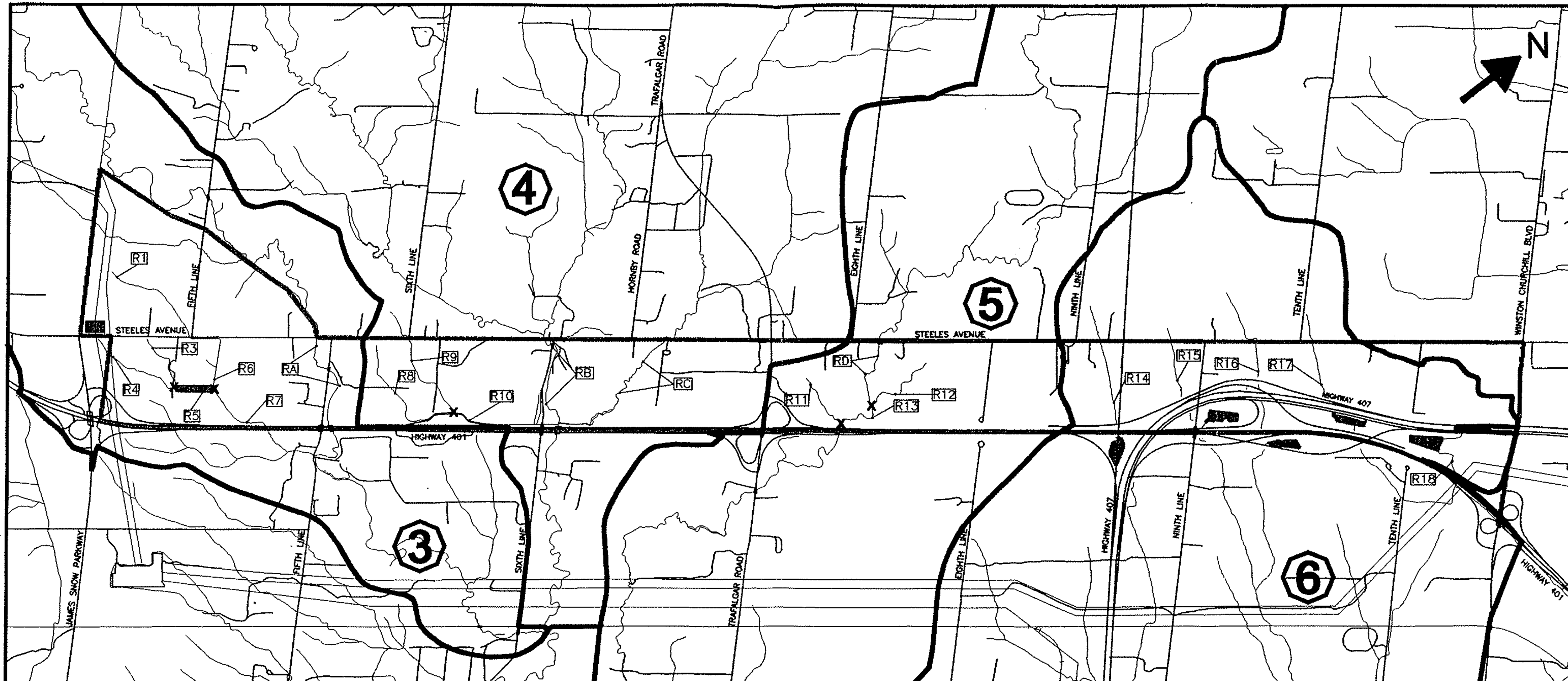
Humans, wildlife and vegetation modify the control that geology exerts on watercourses. For example direct channel alteration for structural crossings or agricultural practices interrupt existing physical processes thereby, compromising the stability of the channels. Some human modifications have occurred within the study area. Wildlife can modify the channel through removing riparian vegetation, forming local dams or accessing the watercourse. Riparian zone vegetation affects the volume of sediment delivered to the channel and bank stability.

Reach Morphology

A detailed review of available topographic maps was performed to allow physical properties of watercourses (e.g. planform, stream order) to be quantified and to establish the spatial relation between channels and their floodplains. In addition, using the topographic information, potential sites of floodplain/valley-wall erosion were identified. At a coarse scale, this information is used to identify watercourse tendencies and processes.

The morphologic analyses for this study were completed using 1:10,000 scale mapping of the study area. At this scale, not all features or channels (e.g. ephemeral and low-order) can be mapped. For this reason morphometric measurements represent only the characteristics of the area that is observable on the maps. Each of the tributaries and main channels within the study area was assigned a reach number **(Figure 2.11 - please note that reach boundaries refer to field reaches described in section 3.3)**. Reaches 9 and 10 were measured both individually and combined because, combined, the reaches represent the main branch of the watercourse. This combination is only possible when the two reaches display similar characteristics and are divided only due to the addition of a tributary channel (i.e. no other reach-defining characteristic). Specific measurements that were made of each reach includes channel gradient (based on topographic contour data) and sinuosity (see **Table 2.4**). The morphometric measurements are used to later classify the reaches according to Level I of Rosgen's classification system so that comparisons with other channels (within and outside of the study area) can be made.

The stream order of each of the reaches **(Table 2.4)** within the 401 Corridor Planning Area was determined using Horton's stream order classification system. The reaches that are situated towards the west part of the 401 Corridor Planning Area possess a range of stream orders (1^{st} to 4^{th}) while in the east part, the stream orders are consistently low (i.e. 1^{st}).



SCALE 1:25000

LEGEND

- WATERCOURSE
- 3 SUBWATERSHED NUMBER
- SUBWATERSHED BOUNDARY
- 401 CORRIDOR PLANNING AREA
- STORMWATER MANAGEMENT POND
- CPR RAIL LINE
- HYDRO LINE
- R10 REACH IDENTIFICATION
- X REACH BREAK POINT

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GEOMORPHOLOGIC REACH LOCATIONS

FIGURE 2.11

Table 2.4 - Morphometric Parameters of Reaches Within the Study Area				
Reach	**Watercourse or Drain (Figure 2.2)**	**Sinuosity**	**Gradient (%)**	**Stream Order**
1	D3-2	1.07	0.75	1
3	D3-1	1.17	0.49	1
4	D3-1	1.13	0.32	1
5	D3-2	1.09	0.83	N/A (SWM Pond)
6	D3-1 + D3-2	1.08	0.77	2
7	D3-1 + D3-2	1.13	0.48	3
7 (past 401)	D3-1+ D3-2	1.12	0.69	N/A
A	Middle Sixteen Mile Creek	1.09	0.46	>4
8	D4-2	1.15	0.60	1
9	D4-1	1.11	0.60	1
10	D4-1 + D4-2	1.25	0.25	2
9 & 10	D4-1 + D4-2	1.13	0.53	N/A
B	Middle Sixteen Mile Creek Tributary	1.13	0.59	>4
C	Hornby Tributary	1.15	0.45	>3
11	D5-1	1.13	1.58	1
D	East Sixteen Mile Creek	1.11	0.32	>3
12	D5-2	1.16	1.05	1
13	East Sixteen Mile Creek	1.22	0.89	2
14	D6-1	1.05	0.54	1
15	D6-2	1.15	0.58	1
16	D6-3	1.12	0.51	
17	D6-4	1.08	0.33	1
18	D6-5	1.05	N/A	1

Sinuosity, a measure of the degree of meandering of a river is low for many of the streams within the study area. Low sinuosity values (e.g. 1.0 – 1.1) are frequently associated with high gradient or headwater streams. For this reason, the sinuosity of the 1st and 2nd order streams (i.e. headwater) was expected. Low sinuosity may also be attributable to previous activities such as channel straightening for agricultural practices. The high sinuosity of reaches 10 and 13 is attributable to the increased water volume from the joining of two upstream tributaries (i.e. reach 8 with 9, and D with 12).

Reaches 11 and 12 have the steepest gradients of all channels within the study area. These reaches are 1st order streams that are actively downcutting into the floodplain, and therefore the high gradients are expected.

Historical Analyses

An examination of historical air photos provides insight into the channel response to land use changes that have occurred in its watershed, and into the natural tendencies and trends of planform evolution. Thus, general information regarding the form and function of the channels was obtained. Included in the historical analyses for this study were photos taken in 1954 (1:15,840), 1979 (1:20,450), and 1996 (1:8,889 – digital imaging). Due to the scale and quality of the airphotos, and the small size of the channels, historic changes in channel width could only be estimated. Specific areas of channel erosion and deposition could not be readily identified at these scales. Furthermore, given the increase in maturity of vegetation within the riparian zone along several reaches, the channel pattern was sometimes obscured. In these areas, observations and measurements of channel planform could not be made. Although historical land use and channel changes were evaluated for all reaches within the study area (**Table 2.5**), quantitative measurements (e.g. channel length or width, migration rates) were limited to those reaches (A-D) in which detailed fieldwork was completed.

Table 2.5 - Qualitative Observations of Land Use and Channel Characteristics and Changes Noted on 1954, 1979 and 1996 Aerial Photography

Area	Land Use Characteristics and Changes	Channel Characteristics and Changes
James Snow Parkway to 5th Line	'54 agriculture '79 and '96 no change	'79 increase in surficial drainage network '96 no change
Reach A: between 5th and 6th Lines	'54 agriculture '79 and '96 no change	'54 deposit in channel upstream of bridge '79 channel straightening in lower end of reach '96 increase in sinuosity
5th Line to 6th Line	'54 agriculture, small woodlots '79 and '96 slight increase in rural residential housing, especially upstream	See reach B
Reach B: between 6th Line and Hornby Road	'54 dense forest , agriculture '79 parkland instead of forest/agriculture '96 no change	'79 deposition in channel near bend '96 decrease in sinuosity

Table 2.5 - Qualitative Observations of Land Use and Channel Characteristics and Changes Noted on 1954, 1979 and 1996 Aerial Photography		
Area	**Land Use Characteristics and Changes**	**Channel Characteristics and Changes**
Reach C: S. of Hornby Rd.	'54 agriculture '79 no change, but addition of track near Steeles Avenue '96 no change	'54 meandering river, no riparian vegetation '79 sinuosity increase in the middle of reach '96 sinuosity increase in upper ½ of reach. Channel appears straightened around the 401
6th line to Trafalgar Road	'54 agriculture '79 and '96 slight increase in residential housing, especially upstream	See reach C
Trafalgar Road to 8th Line	'54 agriculture '79 and '96 no change	See reach D
Reach D: 8th Line	'54 dense forest surrounds channel, agriculture beyond trees '79 no change in landuse, Trafalgar Rd has been extended '96 no change	'54 meandering '79 obscured by vegetation '96 obscured by vegetation
8th Line to 9th Line	'54 agriculture '79 and '96 slight increase in residential housing, especially upstream	'54 low sinuosity streams '79 and '96 no change observed
9th Line to 10th Line	'54 agriculture '79 and '96 slight increase in residential housing, especially upstream	'54 low sinuosity streams '79 and '96 no change observed

The current land use of the 401 Corridor Planning Area and its surrounding areas is dominated by agriculture in all airphotos. The main alteration of land use that occurred in the study area was the construction of Highway 401 between 1954 and 1979. A slight increase in rural residential housing was noted to have occurred both within and upstream of the 401 Corridor Planning Area during the 42 years of the historical analysis. Adjacent to Reach B, parkland replaced agricultural land by 1979.

Several observations concerning channel planform of the main tributaries can be made. That is, Reach A has decreased in length due to channel straightening activity that removed one meander bend from the planform prior to 1979; reach B decreased in sinuosity between 1954 and 1979; the sinuosity of reach C increased markedly in the same time period (likely a function of a change in hydrologic regime attributable to an upstream development); reach D appears to have changed the least throughout the 42-year historical air photo record.

The stream channels that are situated within the study area tend to exhibit a low sinuosity planform as noted in previous sections. At the Highway 401 watercourse crossings, all channels have been modified.

Migration rates were calculated for all reaches. From these calculations it becomes apparent that Reach C is most actively migrating across its floodplain and that the migration rate is larger between 1979 and 1996 than between 1954 and 1979. The migration rate calculated for reach C, between 1954 and 1979 was low (~ 0.12 m/yr) and has increased between 1979 and 1996. Exact quantification of the recent migration rate is not possible due to the quality of the available photos; the rate, however, likely does not exceed 1 m/yr. The increase in migration rate is expected since the planform has increased in sinuosity through the growth and development of meanders. The average migration rate for reach B is also high (~ 0.50 m/yr between 1954 and 1979) and has increased between 1979 and 1996. Similar to reach C, the high migration rate for reach B is attributable to the active planform modification that has been taking place (i.e. increase sinuosity). The lowest migration rate was observed for reach A (1979 – 1996: 0.25 m/yr), which has decreased since the 1954 – 1979 time period. This rate reflects the natural migration rate of a channel that has not been impacted by a change in hydrologic regime. Migration rates could be calculated for Reach D, only between 1954 – 1979. During this time, the rate was moderate (~ 0.35 m/yr) and has likely decreased given the increase in forest density.

2.5 Erosion

The Sixteen Mile Creek Watershed Plan developed a methodology for erosion control throughout the watershed based on the principle that erosion potential increases when the duration of flows that exceed the erosion threshold increases. If the duration of the erosive flows does not increase, then the potential for additional stream channel erosion after development will be greatly reduced, if not eliminated. The method recommended in the watershed plan for erosion control is to use stormwater storage facilities to mitigate changes in the stormwater discharges to maintain pre-development flow regime conditions as much as possible. The flow regime is defined by the long term flow duration exceedance relationship.

In the watershed plan, the pre-development flow regime was defined by using the QUALHYMO model for the long term simulation of each subcatchment. Flow duration exceedance relationships for subcatchment outlets were developed by the model for both existing and ultimate development conditions. Detention storage facilities were then simulated for each subcatchment to control the post development flow duration relationship to the pre-development conditions for all flow rates above the erosion threshold, as defined by the results of the field measurements. As a final step, the detention storage facilities were then enlarged and the rating curves extended to accommodate flood control requirements.

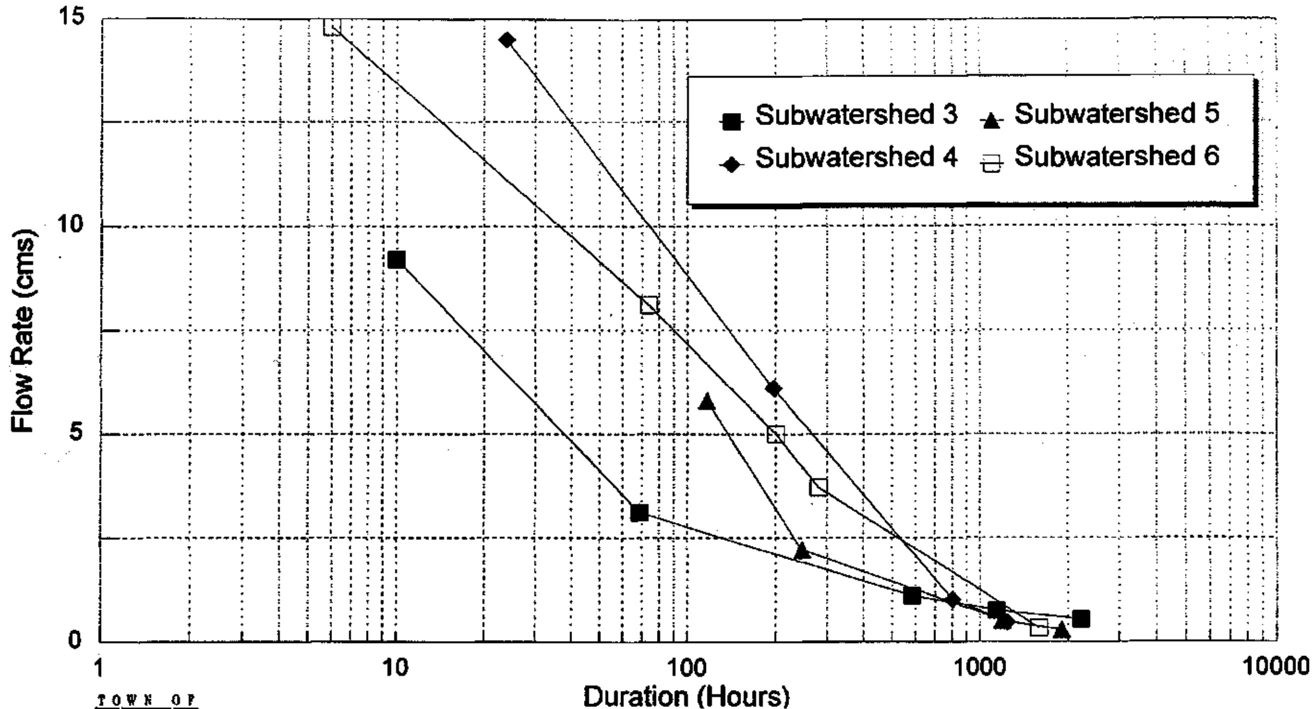
The control of erosion by this method requires large volumes of storage and small release rates. This leads to very long draw-down times for the detention facilities and, as a result, the hydrograph routing effects and time delays in the watershed become negligible and the system will tend to operate as a steady-state condition in which all discharges are additive. Because of this effect, the allowable discharge rates and detention storage volumes required for erosion control are governed by the most sensitive downstream location. In addition, this effect allows estimates of local control rates to be made based on a proportional basis according to factors such as local area or impervious area.

The Watershed Plan presented the simulated pre-development flow duration frequency curves for each sub-watershed and each sub-catchment in **Appendix D** of the plan. These curves for each of the subwatersheds in the current study are presented in **Figure 2.12.** This information may also be presented in an alternative form based on flows per unit area which may be adapted for use on smaller areas, such as the proposed development corridor (see **Figure 2.13**). Curves were based on an average year (November 1971 to October 1972) and are intended for preliminary planning only.

The Watershed Plan recommends that the erosion control analysis for subwatershed plans be verified with a minimum of 6 years of simulation.

The results of the watershed plan study demonstrated that detention storage can be used to control the post-development flow duration frequency curves to pre-development levels for erosion control. However, the results as shown in Figures 4.17 to 4.20 in the Watershed Plan report show that the simulated control facilities actually achieve over-control, with the post-development curve lower than the pre-development curve. Over-control can result in channel agradation (i.e. sedimentation) which can also lead to increased erosion in the stream. It is therefore important to achieve as close a match as possible to the pre-development flow regime.

The initial estimates for flow duration exceedance targets can be derived from the curves in the Watershed Plan for each sub-catchment. As in the previous **Figure 2.13,** these curves have been converted to unit discharge/hectare for application to the smaller catchment areas of the 401 Corridor Study (see **Figures 2.14 to 2.19**). However, the final design volumes and release rates will require confirmation with a long-term simulation.



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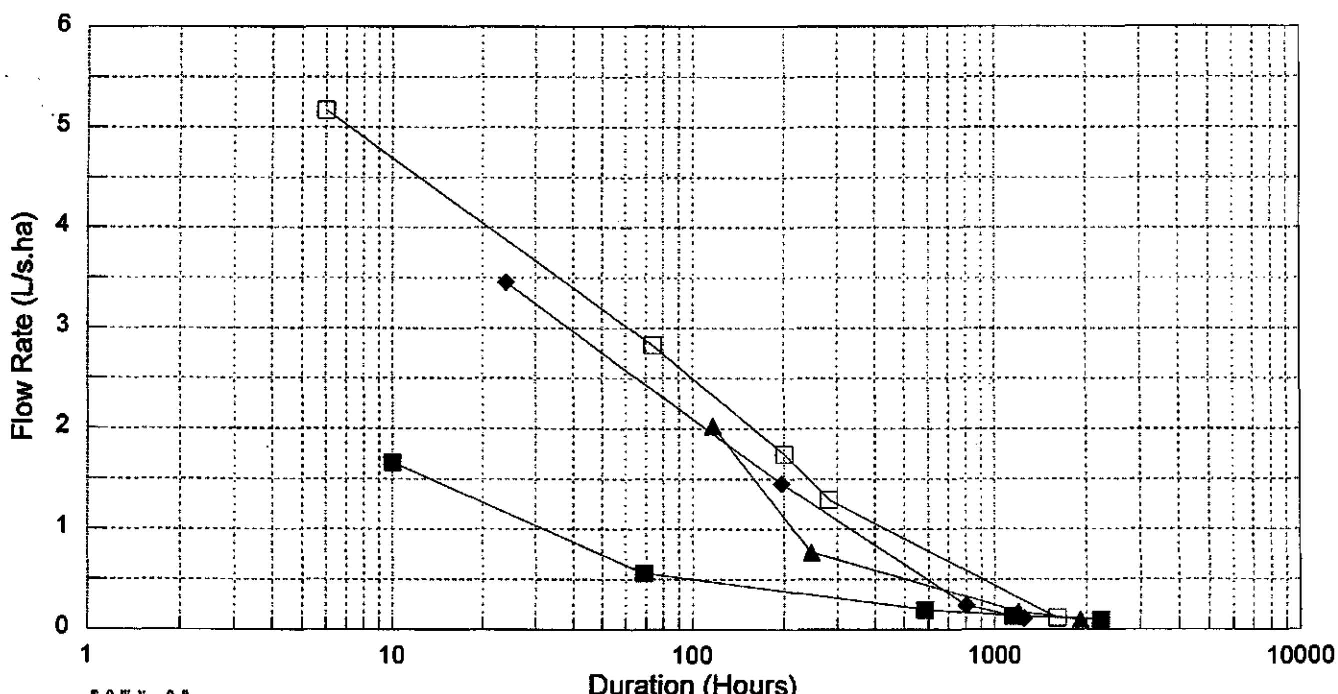
EXISTING SUBWATERSHED
FLOW-DURATION CURVES

FIGURE 2.12



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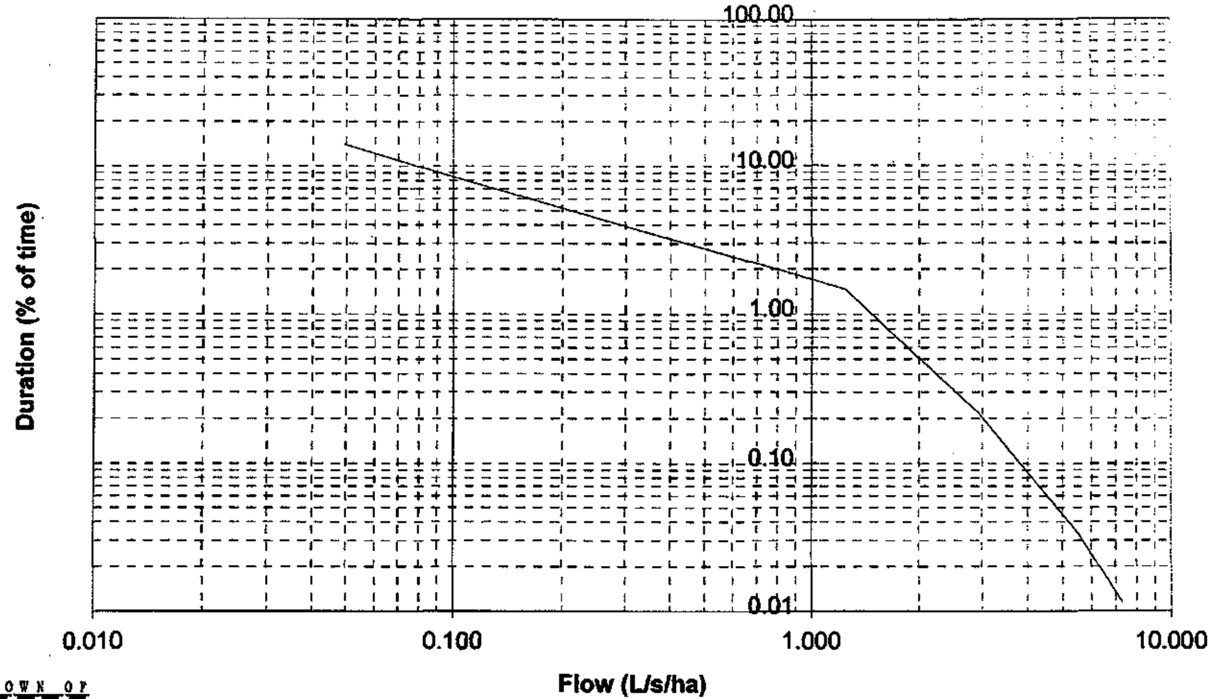
EXISTING SUBWATERSHED
UNIT FLOW-DURATION CURVES

FIGURE 2.13



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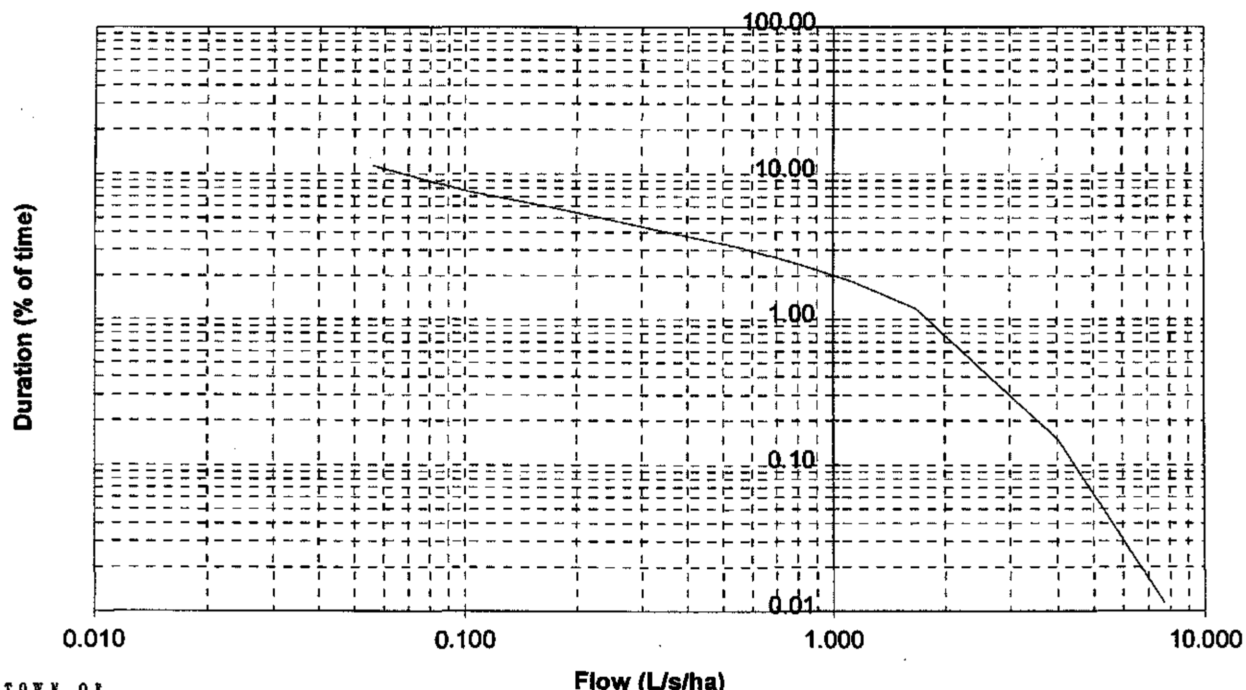
EXISTING SUBCATCHMENT 202
UNIT FLOW-DURATION CURVE

FIGURE 2.14



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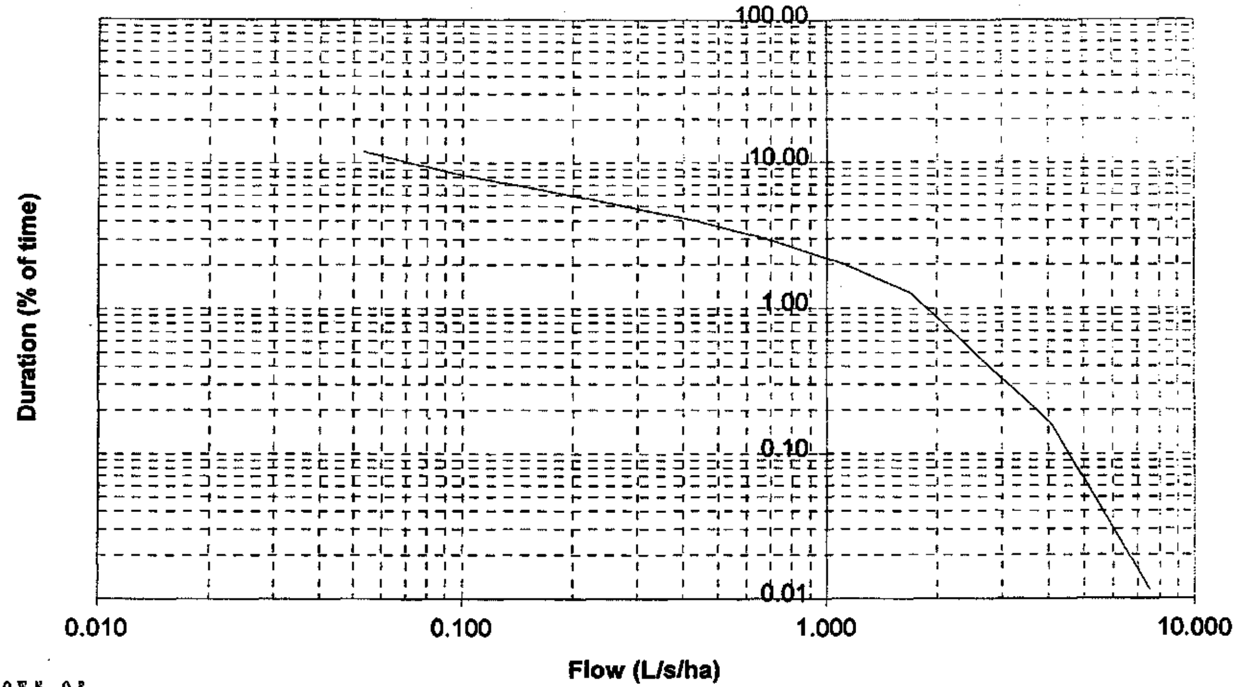
EXISTING SUBCATCHMENT 204
UNIT FLOW-DURATION CURVE

FIGURE 2.15



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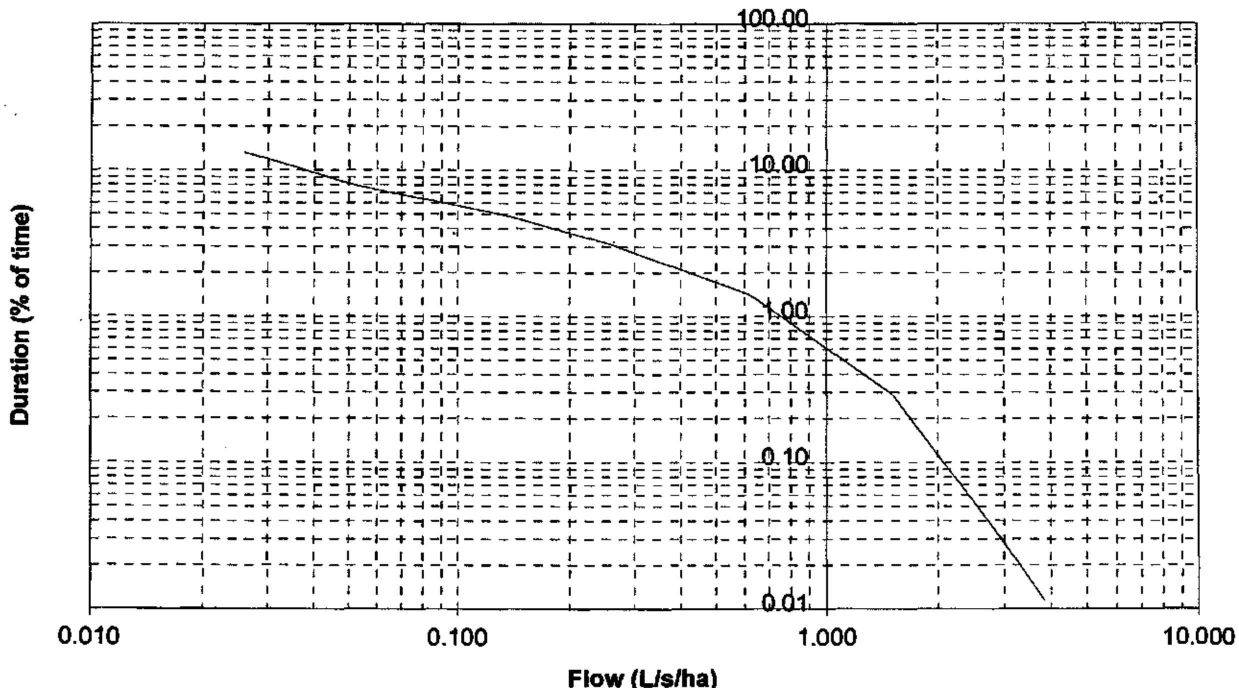
EXISTING SUBCATCHMENT 205
UNIT FLOW-DURATION CURVE

FIGURE 2.16



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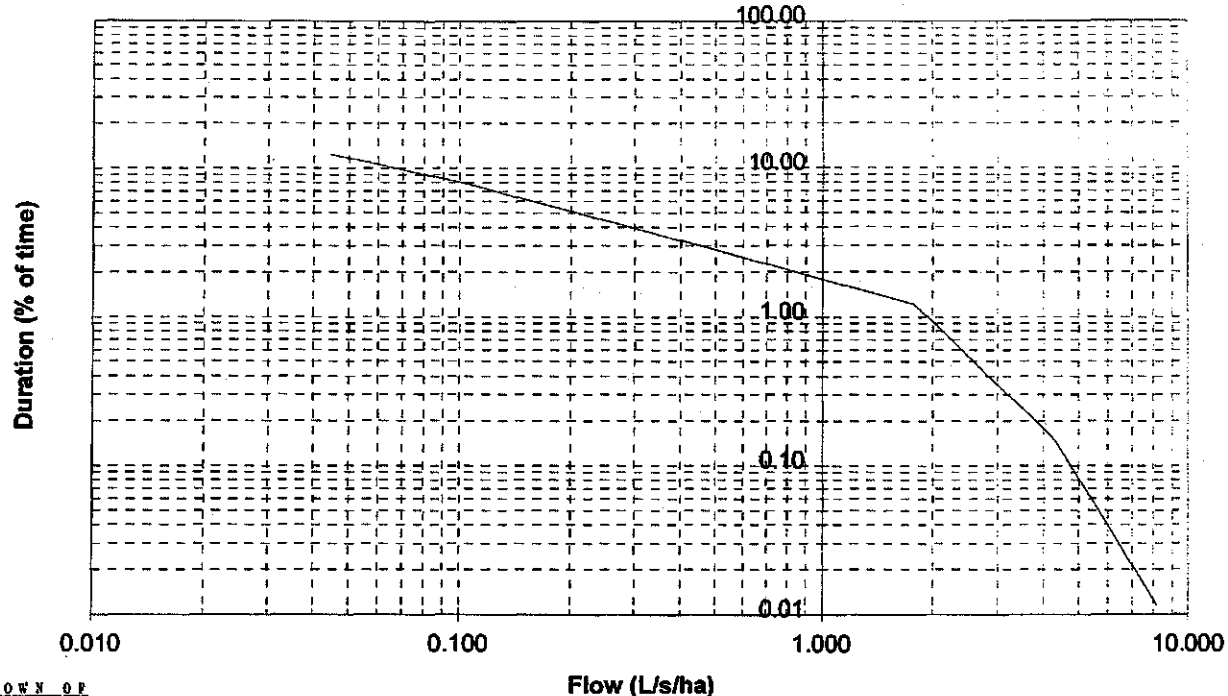
EXISTING SUBCATCHMENT 301
UNIT FLOW-DURATION CURVE

FIGURE 2.17



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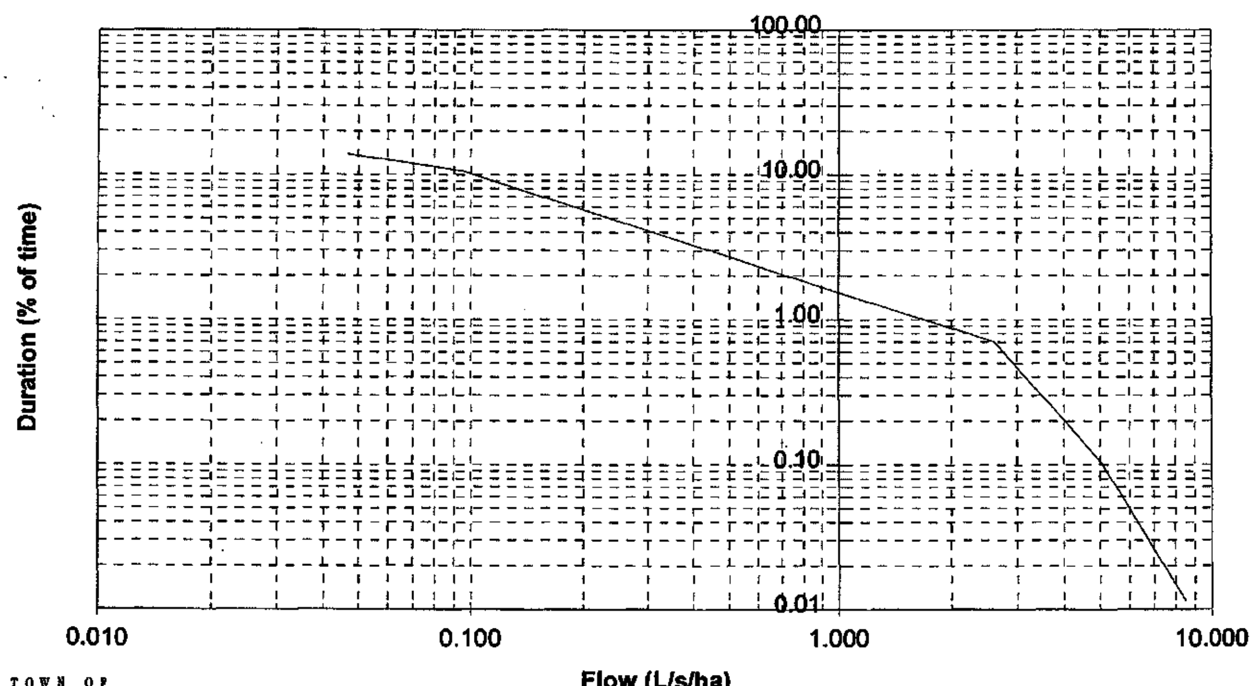
EXISTING SUBCATCHMENT 303
UNIT FLOW-DURATION CURVE

FIGURE 2.18



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EXISTING SUBCATCHMENT 305
UNIT FLOW-DURATION CURVE

FIGURE 2.19

Initial rating curves for the detention facilities have also been derived from the watershed study, as shown in **Figures 2.20 and 2.21**. Primarily those subcatchments with high (>30 %) future impervious percentages are shown as these will be characteristic of the proposed development within the corridor. Subcatchment 203, which has a lower impervious percentage, has also been included since it represents an area for which a significant amount of refinement of the rating curve was performed to meet the target predevelopment flow duration curve (**Figure 2.22**). These rating curves will be refined during the detailed analysis for both the erosion control targets and the flood control targets using the long-term QUALHYMO simulation and the OTTHYMO design event simulation respectively.

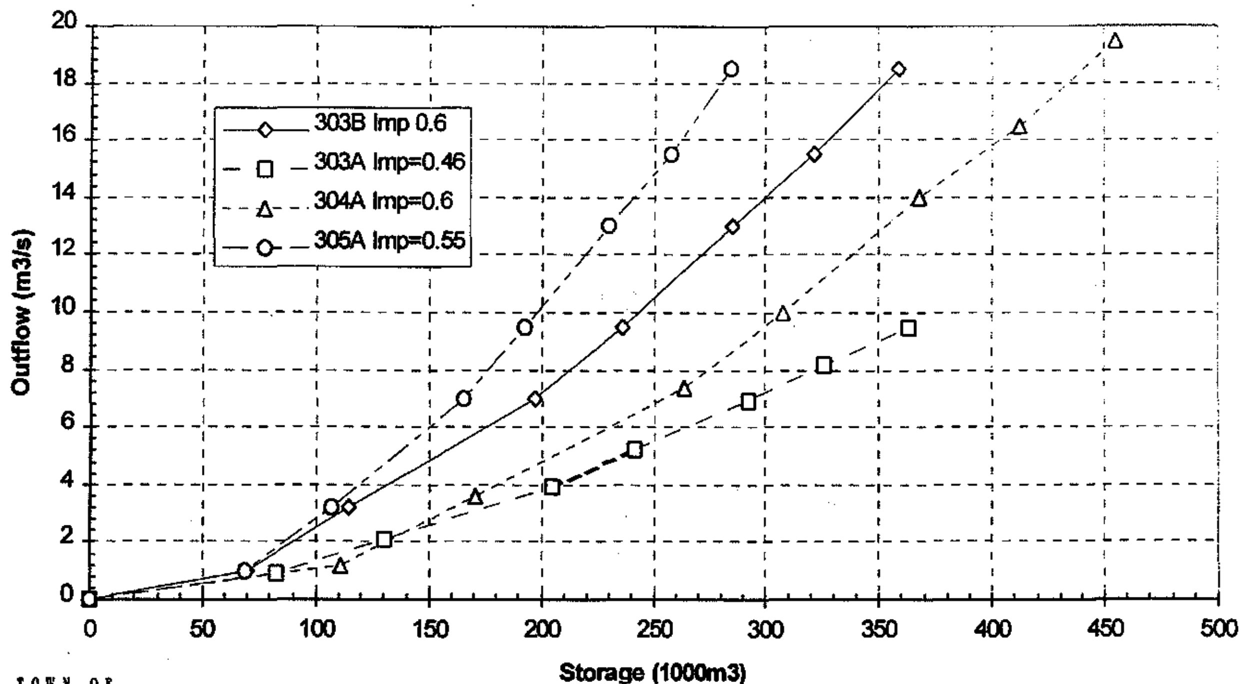
2.6 Water Quality

The Sixteen Mile Creek Watershed Plan identified and reviewed all available data and reports on the water quality of Sixteen Mile Creek. The sources of data included:

- Ministry of Environment, Provincial Water Quality Monitoring Network (PWQMN) data, 1964 to present;
- Ministry of the Environment, "Oakville Creek Water Quality Study", 1973;
- Ministry of Health, Regular fecal coliform monitoring - Kelso Reservoir and upstream, 1988-89;
- Halton Region Conservation Authority, Rural Beaches Program, 1990-91;
- R.E. Winter & Associates Limited, "East Sixteen Mile Creek Study", 1990;
- R.E. Winter & Associates Limited/Gore and Storrie Limited "Lisgar Water Quality Study", 1993.

The review included statistical analyses where possible and comparisons with available guidelines. Results related to the scoped subwatershed areas are presented below.

Figure 2.23 illustrates the PWQMN stations throughout the entire watershed. MOE stations 3, 4, 5, 6, and 7 lie along the Middle Sixteen Mile Creek in subwatershed 3. Station 11 is located downstream of the confluence of the Middle and East systems, including drainage from all scoped subwatersheds (3, 4, 5, and 6). Sampling results at station 3 often exceeded provincial objectives for fecal coliform, iron, nitrite, TKN and phosphate (i.e., over 30% of the time) and consistently exceeded the objective for nitrate (i.e., over 60 % of the time). Phenols and copper guidelines were occasionally exceeded. Similar results were reported for stations 4, 5, 6, and 7, with the exception that not all trace constituents were evaluated at these last sites. At station 11, guidelines for fecal coliform, iron, nitrogen compounds, and phosphorus were often exceeded while those for copper and phenols were occasionally exceeded.



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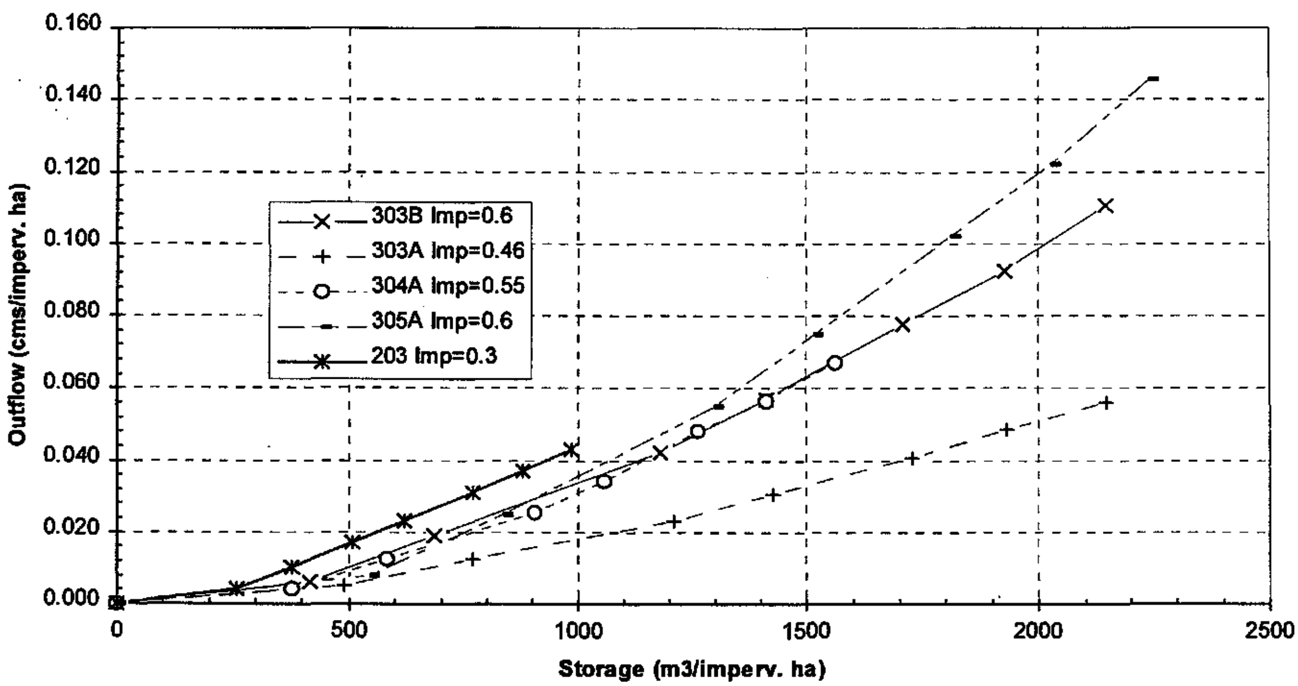
EROSION CONTROL POND RATING CURVES
(FUTURE IMPERVIOUS > 30 %)

FIGURE 2.20



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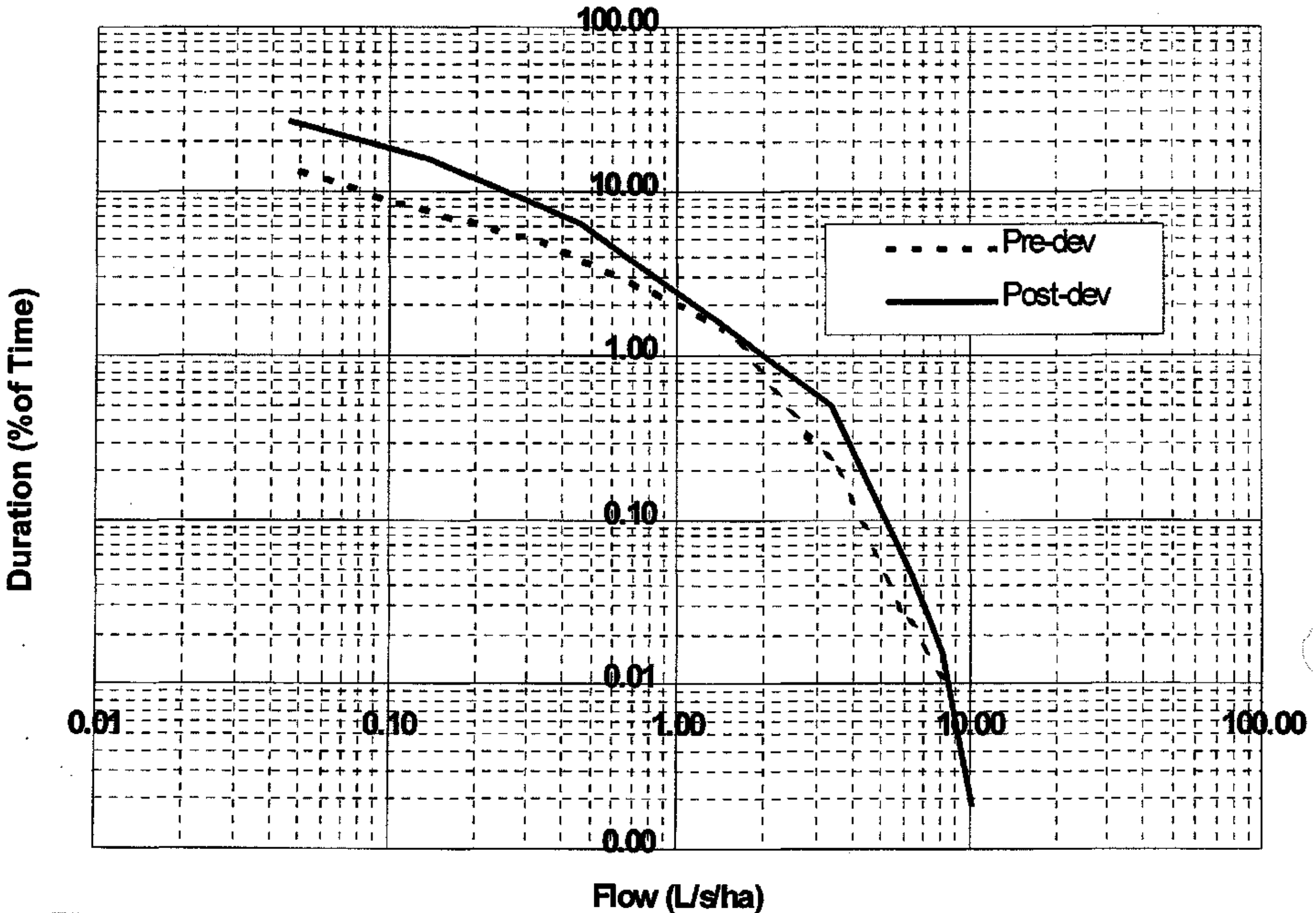
EROSION CONTROL POND RATING CURVES
(NORMALIZED)

FIGURE 2.21



Post-dev - Six year simulation
Pre-dev - One year simulation

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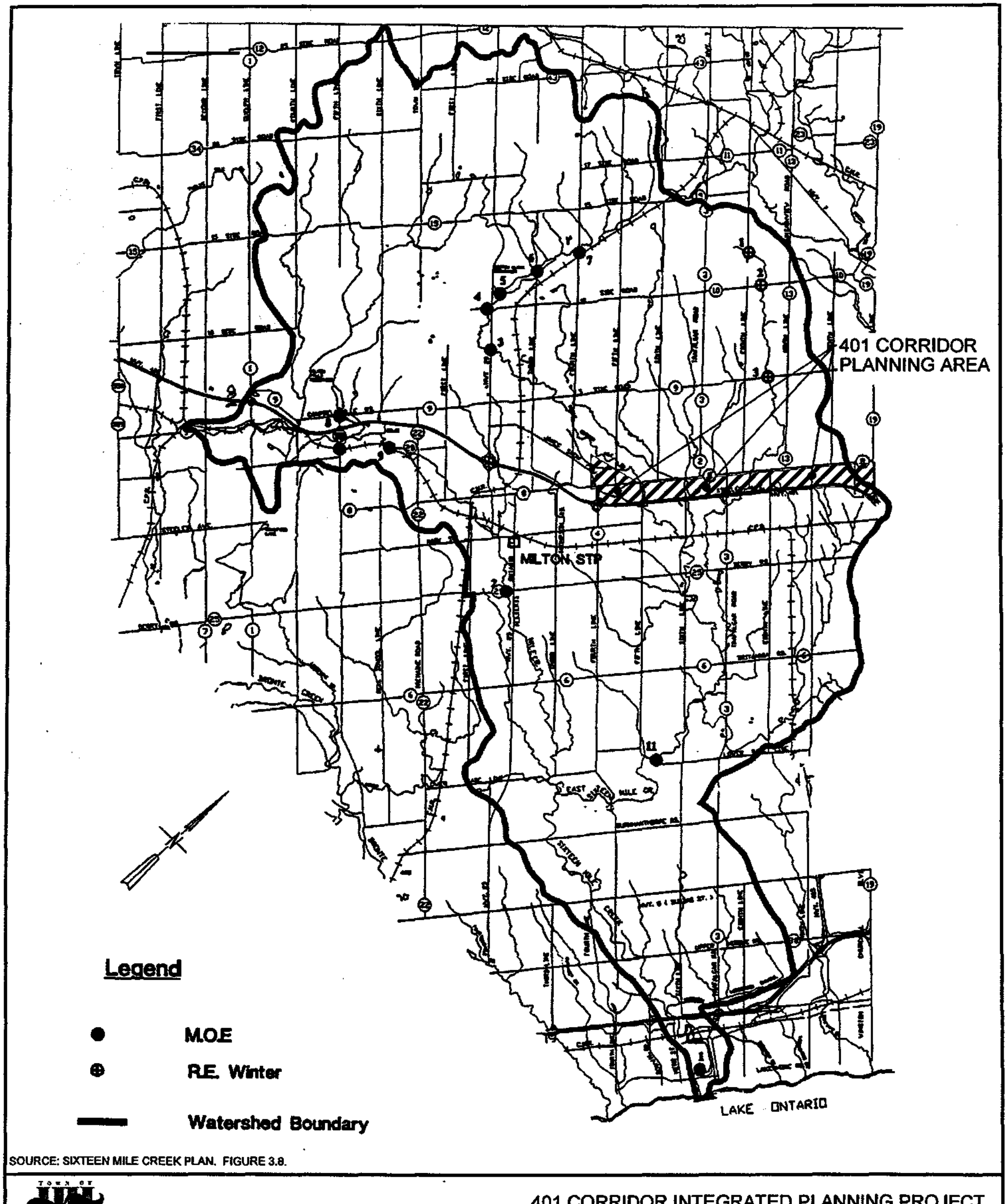
EXISTING AND PROPOSED SUBCATCHMENT 203
UNIT FLOW DURATION CURVES

FIGURE 2.22



SOURCE: SIXTEEN MILE CREEK PLAN, FIGURE 3.8.

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SCOPED WATERSHED STUDIES

WATERSHED WATER QUALITY MONITORING SITES (PRE-1992)

FIGURE 2.23

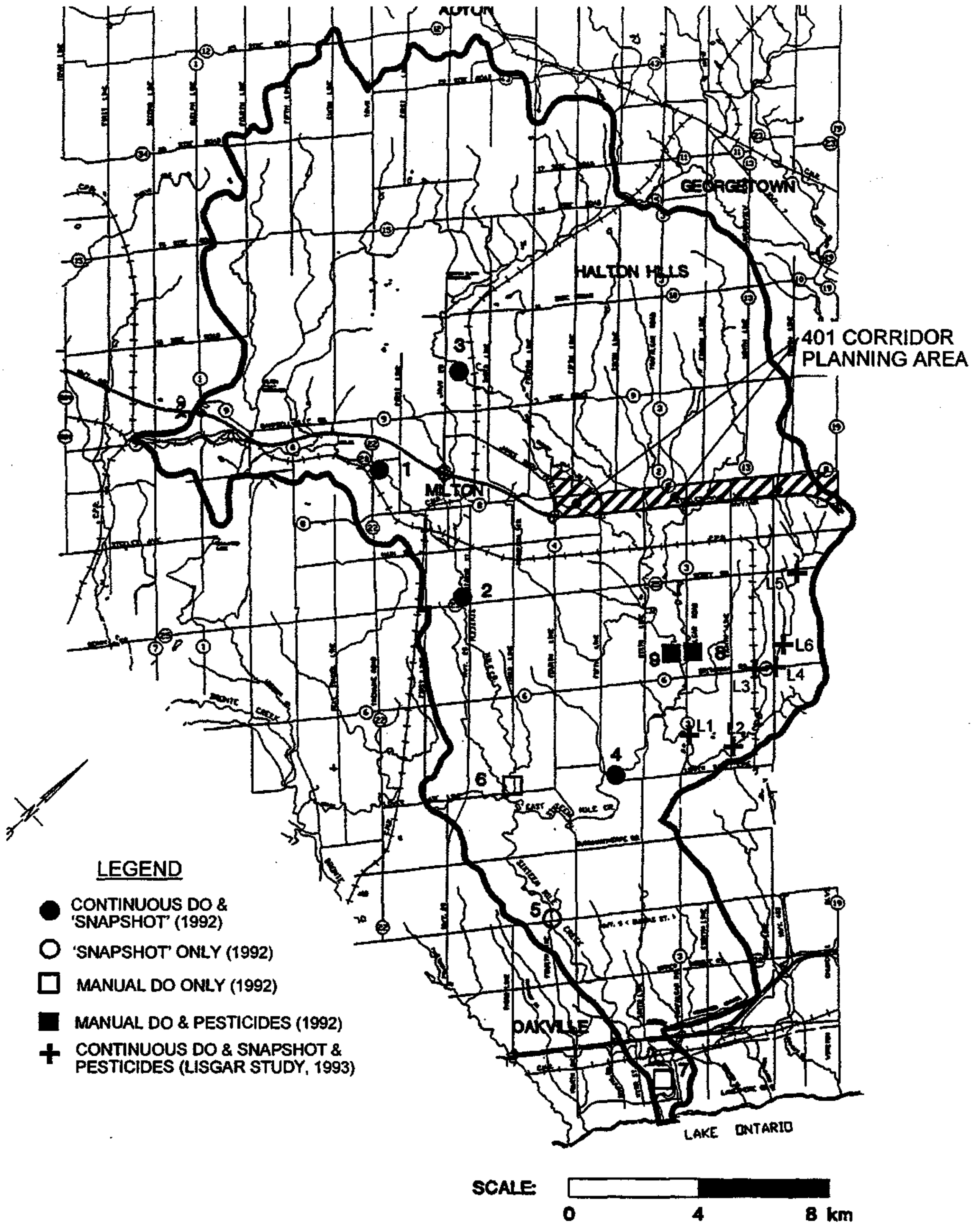
Figure 2.23 illustrates three stations along East Sixteen Mile Creek, upstream of the 401 corridor, which were the subject of the four-season monitoring by R.E. Winter in 1990. The study found high levels of total phosphorus, total dissolved solids and "very high levels" of fecal and total coliforms. The bacteria levels were particularly high in the fall and summer monitoring periods. Results were found to be similar to other locations throughout the watershed, where similar constituents have been tested. The only potential source of these parameters was identified as agricultural operations in upstream catchment areas.

Additional water quality monitoring was performed in 1992 to supplement the previous study results. The monitoring stations for this program are shown on **Figure 2.24.** Dissolved Oxygen DO monitoring in the Middle Sixteen Mile Creek system (station 3 upstream, and station 9 downstream of the 401 corridor) indicated that the PWQO of 5 mg/L for coldwater fisheries was satisfied in both summer and fall periods, likewise for station 8 on the East Sixteen Mile Creek. Minimum values were found during the summer period, likely a result of the decreasing solubility of oxygen at higher summer temperatures.

Temperature monitoring was conducted during the critical summer period to evaluate fish habitat. Cooler temperatures and lower diurnal variations were found at upstream stations where groundwater discharges were considered to have influenced results. It was concluded that reaches in the central and downstream reaches of the creek do not receive significant groundwater input.

Discrete dry and wet weather sampling was conducted at station 3 while pesticide sampling was conducted at stations 8 and 9. Results confirmed generally high levels of nutrients reported from the MOE monitoring program. As expected, suspended solids loads increased during wet weather conditions. Results of the pesticide analysis revealed few instances where measurable levels were reported. The exceptions were 2,4-D, found in two samples at station 3, and Methoxychlor, found in one sample at station 3, however, all below objective concentrations. These results were in contrast to those of the Lisgar Region study described below.

Extensive water quality monitoring was conducted as part of the Lisgar Region Water Quality Study. Sampling was conducted on both the west and east branches of the East Sixteen Mile Creek Tributary which drains the majority of subwatershed 6 lands. As shown on **Figure 2.24**, the majority of sampling stations were located near the downstream portion of the subwatershed, located near or south of Britannia Road. One station (SW5), located on the east branch at Derry Road, provides the most insight into existing conditions from the study corridor as it reflects agricultural land uses which extend upstream past the study corridor and to the headwaters.



SOURCE: SIXTEEN MILE CREEK WATERSHED PLAN. FIGURE 3.9.

401 CORRIDOR INTEGRATED PLANNING PROJECT
SCOPED WATERSHED STUDIES

WATERSHED WATER QUALITY MONITORING SITES (1992-1993)

FIGURE 2.24

The east branch was consistently more polluted than the west branch, as station 5 showed the highest concentrations, indicating a source of contamination in the upper eastern reach. Guidelines were exceeded at station 5 for aluminum, copper ("unusually high" values), iron, manganese, TKN, ammonia, nitrate, phosphorus, potassium, and zinc. In contrast to the Watershed Plan monitoring results, the PWQO for gamma-BHC, 4-4'-DDE and Methoxychlor was exceeded and elevated levels of Endosulfan 1 and 2 were reported. Dry weather samples, however, resulted in pesticide levels all below the detection limit.

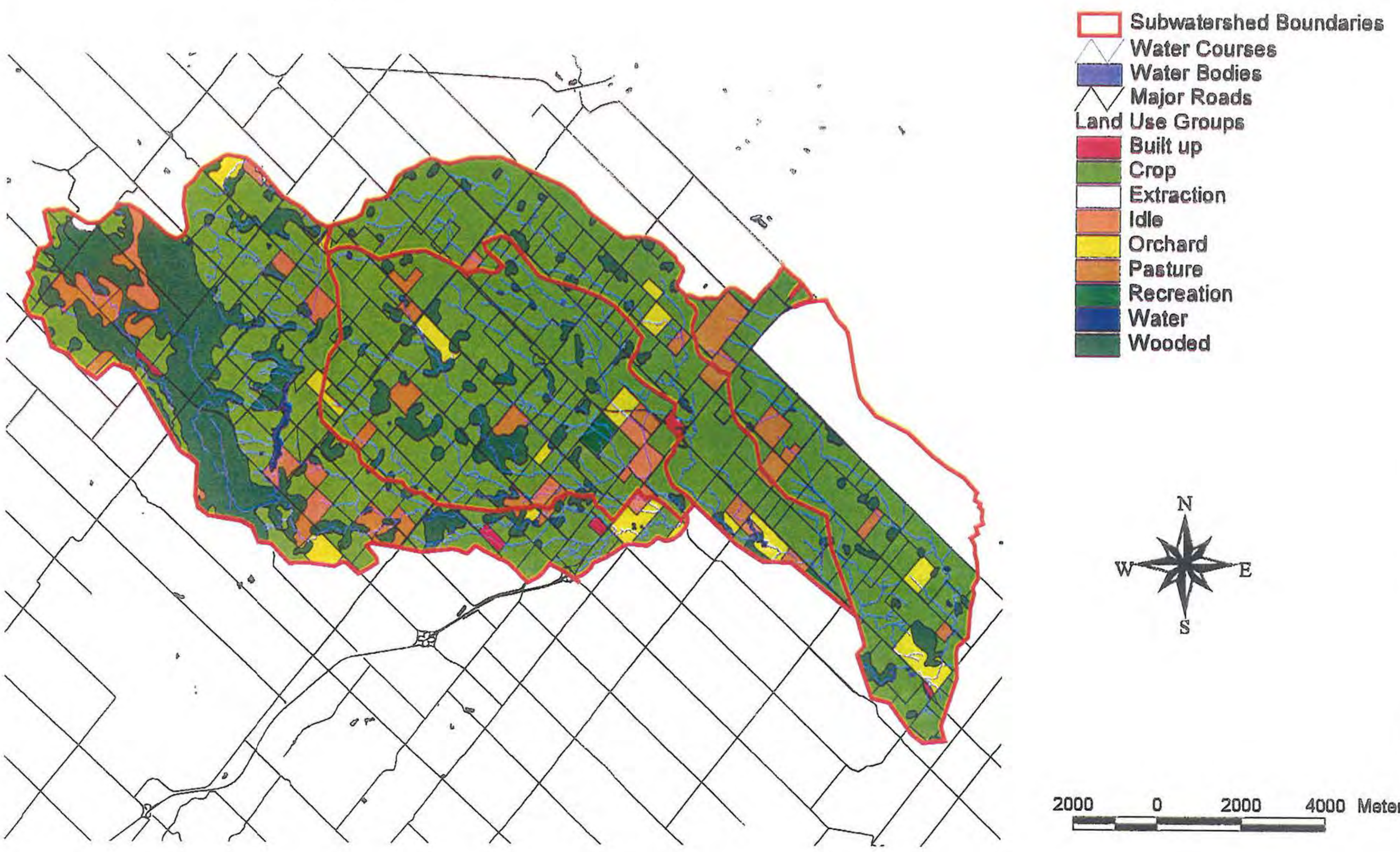
Additional monitoring included bacteria, with the upper eastern reach being the most contaminated, likely due to animal waste being deposited/discarded directly into or nearby the watercourse. DO monitoring at Station 5 revealed minimum concentrations at the PWQO for aquatic life (i.e., 4.0 mg/L). Temperatures of the small tributaries were found to vary according to ambient air temperature, largely as a result of deforestation.

2.7 Aquatic Environment

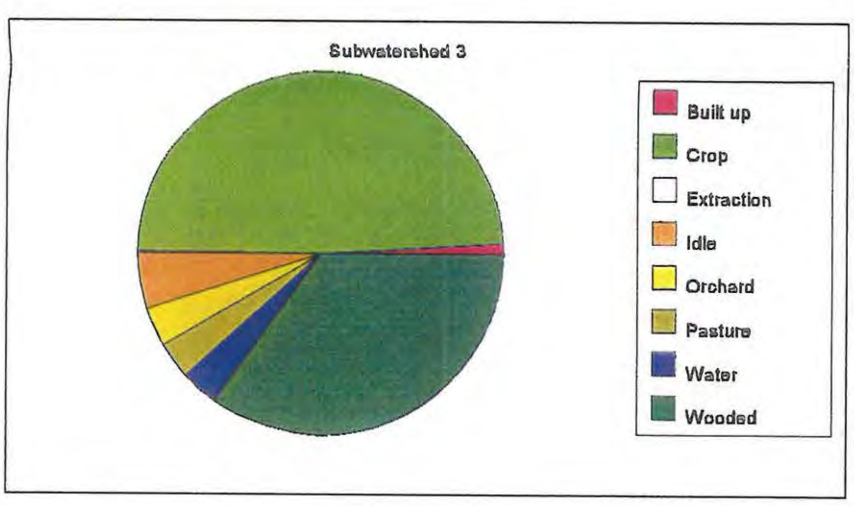
The main branch of Middle Sixteen Mile Creek (refer to watercourse **Figure 2.2**) and its eastern tributaries flow through the study area. The east branch of Sixteen Mile Creek and several of its tributaries also flow through the study area.

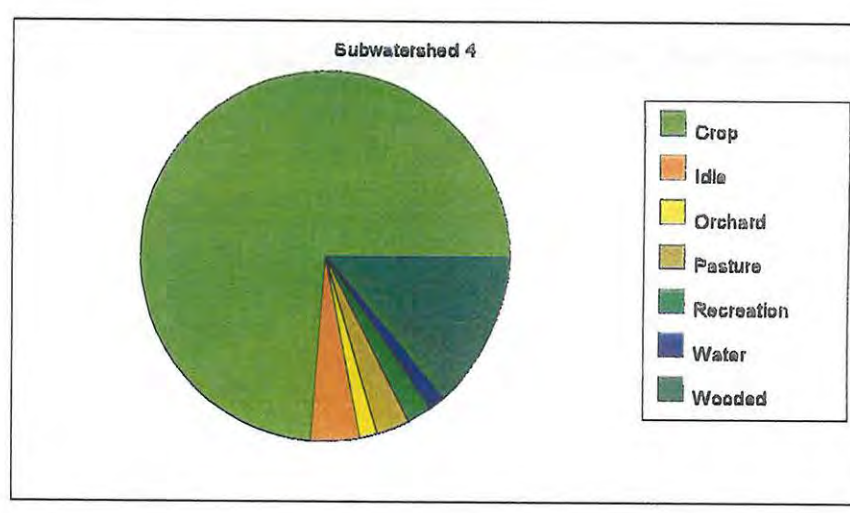
A general overview of riparian vegetation along watercourses in the Subwatersheds provides a general indicator of habitat potential. To derive summaries of these vegetation types, Halton Region's watercourse mapping (based on 1:10,000 OBM) was superimposed on general grouping of OMAFRA land use types presented in **Map No. 1**. Topologic intersection of these layers was performed using GIS to provide the total lengths of watercourse throughout each land use group and within each Subwatershed. The land use groups along with summary charts are presented on **Map No. 3**. The summary charts indicate a clear difference in the distribution of riparian vegetation (land use) types within the Subwatersheds: Subwatershed 3 is characterized by a relatively low proportion of cropping and other agricultural practices (which relates to agricultural limitations above the escarpment) and a relatively high proportion of wooded and idle land. The remaining Subwatersheds all exhibit a high proportion of cropping activities and a significantly lower proportion of wooded riparian conditions. These conditions can be related to background information regarding habitat and species found within the 401 Corridor Planning Area, as discussed below.

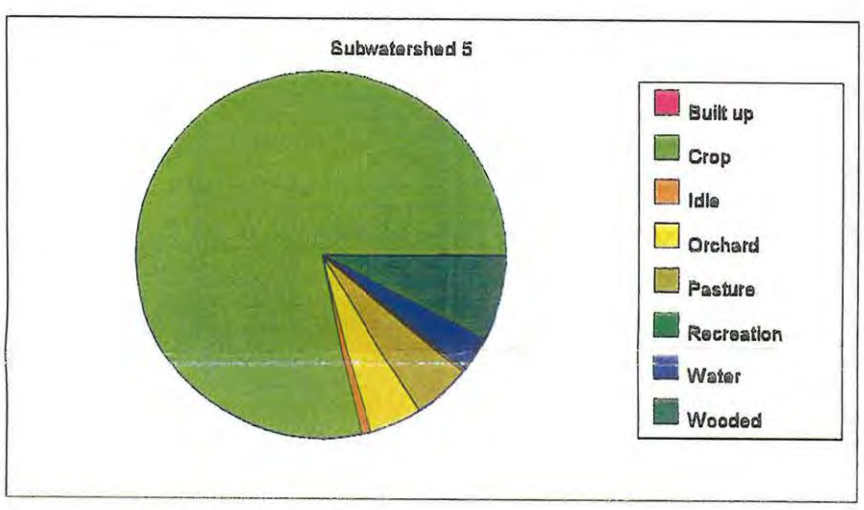
Land Use Groups

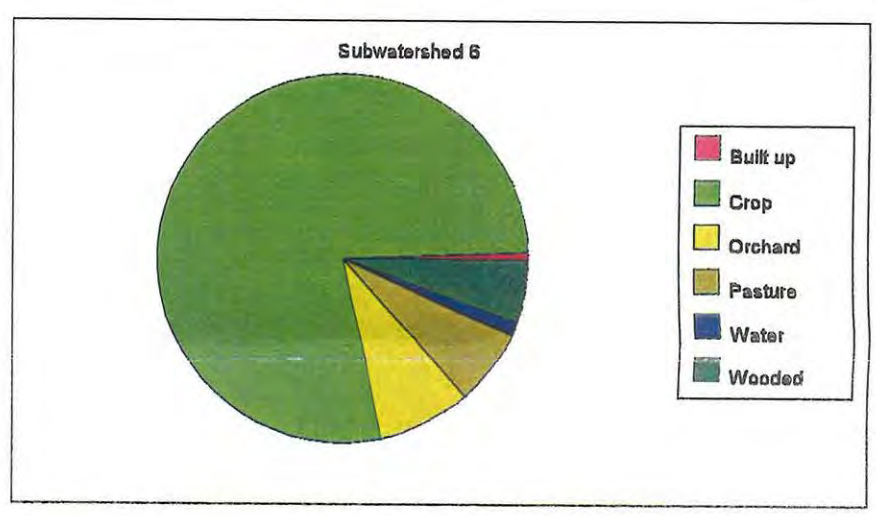


Subwatershed Riparian Vegetation Summaries









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401 Corridor Integrated Planning Project
Scoped Subwatershed Studies

Riparian Vegetation and Land Use Characteristics

Map No.3

Background information was obtained from various sources including Ministry of Natural Resources stream inventories, the Sixteen Mile Creek Watershed Plan prepared by Ecoplans (1995) and other studies prepared in advance of development within the Lisgar Region of Subwatershed 6 and construction of Highway 407.

East Sixteen Mile Creek and Tributaries

Most of the east branch of Sixteen Mile Creek has been characterized as a warmwater habitat with the exception of a 4 kilometre stretch north of Steeles Avenue (Ecoplans 1995). Due to low summer base flow temperatures, this area has been characterized as potential coldwater habitat. The reach which flows through the 401 Corridor Planning Area has been characterized as warm water baitfish habitat and downstream of Highway 401 has been characterized as warm water sportfish habitat. Fish communities that have been recorded for this area, however, are mainly representative of baitfish species such as creek chub (*Semotilus atromaculatus*), johnny darter (*Etheostoma nigrum*) and white sucker (*Catostomus commersoni*). All are spring spawning species, with a preference for gravelly areas.

Five headwater tributaries of the east branch of Sixteen Mile Creek are located at the east end of the 401 Corridor Planning Area. These watercourses are discussed in the Lisgar Region Water Quality Study (R.E. Winter Associates and Gore & Storrie Ltd. 1993) and the Toll Highway 407 Stormwater Management Strategy Study Final Report (Dillon Consulting Limited 1997). They are described as intermittent swales, highly altered by agricultural practices, with no defined baseflow channel. The most westerly watercourse flows into a west tributary of Sixteen Mile Creek (east branch). A defined baseflow channel is evident south of Derry Road, however, the watercourse is intermittent until south of Britannia Road. The remaining four eastern headwater tributaries converge into a second tributary of Sixteen Mile Creek (east branch) 500 metres north of Derry Road. This tributary has been channelized to its outlet into an on-line storm water management pond near Britannia Road. The outlet control of this pond constitutes a barrier to fish migration. The two tributaries of the east branch converge with other intermittent watercourses near Britannia Road, eventually flowing into Middle Sixteen Mile Creek, southwest of Drumquin.

Middle Sixteen Mile Creek Tributaries

Two branches (east and west) of the Middle Sixteen Mile Creek Tributary converge just upstream of the 401 Corridor Planning Area. Both watercourses flow through agricultural lands which lack overhead cover and, because of their small size, are likely areas of low productivity. A number of headwater tributaries flow into these branches MNR (1989), and Ecoplans (1995) have designated two of these headwater tributaries as potential coldwater areas because of low baseflow temperatures. There have been reports of brook trout captured in the headwater tributary northwest of Hornby, but these reports remain unconfirmed (Ecoplans 1995). The remaining two tributaries have been characterized as warmwater baitfish streams. Blacknose dace (*Rhinichthys atratulus*), creek chub (*Semotilus atromaculatus*), white sucker (*Catostomus commersoni*), and the vulnerable redside dace *(Clinostomus elongatus)*, have been caught in the headwaters of one of the tributaries which flows into the west branch (Ecoplans 1995). Clear gravelly riffles are preferred areas for these fish. The Hornby Tributary converges with the main branch of the tributary on the southern border of the study area (see **Figure 2.2**). As these two branches flow south of Steeles Avenue and through the study area, they are characterized as warmwater baitfish streams. Beyond Highway 401, which is south of the study area, the fish community is documented as warmwater sportfish.

Middle Sixteen Mile Creek

Middle Sixteen Mile Creek flows south constituting the northwestern edge of the study area in the vicinity of Fifth Line, north of Steeles Avenue. As this watercourse flows through the study area it has been characterized as warmwater sportfish habitat (MNR 1986, 1989) based on the presence of smallmouth bass *(Micropterus dolomieu)*. The reaches upstream of 5th Line have historically been brook trout habitat *(Salvelinus fontinalis)*, a late summer/fall spawning species, preferring gravelly areas and spring fed flow. In recent years this species has not been observed. However young-of-the-year rainbow trout (*Oncorhynchus mykiss*) have been captured, as well as older year classes, indicating successful spawning by migrating trout from Lake Ontario (Ecoplans 1995). This species is spring spawning and prefers gravel riffles and pools. This presence of this species has resulted in the coldwater characterization of these upper reaches.

2.8 Terrestrial Environment

As indicated in the Watershed Plan for Sixteen Mile Creek, the 401 Corridor Planning Area is in a transition area between the Niagara (or Carolinian) Forest and the Huron-Ontario Forest (Gore and Storrie 1996). The Niagara Forest covers parts of southern Ontario, south of a line that extends from Toronto to the southwestern end of Lake Huron. Trees characteristic of this forest type include beech, maple, black walnut, hickory and oak. The Huron-Ontario forest section is a part of the Great Lakes- St. Lawrence Forest Region, which covers most of Ontario and Quebec. This region contains associations of oaks and hickories, mixed hardwoods and white pine. Communities typical of this forest region, in the vicinity of the 401 Corridor Planning Area are most common along and above the Niagara Escarpment.

The Niagara Escarpment, which is to the west of the 401 Corridor Planning Area, is an important feature in the Regional context as it supports a variety of plant and animal species. Most of the forest cover within the region is concentrated on the escarpment and provincially significant Class 1-3 wetlands occupy areas to the north of this feature(Gore and Storrie 1996).

In the region directly adjacent to the 401 Corridor Planning Area, there are few natural areas of significant size. Furthermore, the few natural areas tend to be limited in diversity and are isolated in the agricultural landscape, often associated with deep downstream valleys (Toll Highway 407 - Stormwater Management Strategy Study, Dillon, 1997, Sixteen Mile Creek Watershed Plan, Gore and Storrie, 1996). Wetlands adjacent to the 401 Corridor Planning area are categorized as Class 5 to 7 and accordingly are not considered provincially significant.

Less than 10% of the area surrounding the 401 Corridor Planning Study is naturally forested (Lisgar Region Water Quality Study, Gore and Storrie 1993). The remaining land is active or abandoned agricultural land (Gore and Storrie 1996; Gore and Storrie 1993). In general, the existing species are typical of agricultural and urban settings and forest edges (Gore and Storrie 1993).

There are no ESAs within or directly adjacent to the 401 Corridor Planning Area. The nearest ESAs are the Hilton Falls Complex, (approximately 5.5 km to the west; north of Highway 401 at Highway 25), Milton Heights (approximately 4.0 km to the west; south of Highway 40, west of Tremaine Road) and Crawford Lake-Rattlesnake Point Escarpment Woods (approximately 4.0 km to the west; south of Highway 401, west of Tremaine Road).

3. FIELD INVESTIGATIONS AND TECHNICAL ANALYSES

Field investigations for the various study disciplines were carried out in order to provide a greater level of detail with regard to local conditions in the 401 Corridor and, where required, external areas within the study subwatersheds. The various field investigation programs and their results are presented in the following sections.

3.1 Hydrology

Internal Drainage Characteristics

Hydrologic analyses performed as part of the original flood line mapping study and the Watershed Plan employed a level of detail with respect to drainage area delineation which was sufficient for the purpose of defining flow rates in the major branches of Sixteen Mile Creek. For more detailed local analyses, however, a greater level of discretization is required. Accordingly, drainage characteristics of the 401 Corridor and external areas were confirmed during field investigations in the winter of 1998/1999. The primary purpose of these investigations was to:

- identify and inventory existing drainage structures (bridges and culverts);
- confirm the location of storm drainage systems;
- confirm the location and direction of swales and drainage ditches;
- confirm overland flow directions and drainage boundaries.

Confirmation of these drainage characteristics in the field was a necessity in order to compliment the exiting topographic mapping which is considered to be at a coarse scale (i.e., 2.5 m to 5.0 m contour interval). **Drawing 1** (fold out in back pocket) illustrates the subcatchment boundaries that have been refined in the vicinity of the proposed corridor development area. Areas were found to vary only marginally from those of the Watershed Plan.

Given the nature of the existing development within the corridor, i.e., predominantly agriculture, drainage within the area is conveyed primarily by a system of small local intermittent drains that collect and convey flows to the main watercourses. These have been identified previously on **Figure 2.2**. Drainage areas to these features range from approximately 25 to 125 ha.

Due to the small size of these drains, particularly in Subwatersheds 3 and 4, many have been diverted at Highway 401 and directed to common outlets. Original drainage paths continuing across the highway right-of-way are apparent on the mapping. Many of the headwater drains in Subwatershed 6 have been straightened to accommodate existing development.

The figure also identifies several larger tributaries which are relevant to the study. The Mansewood Tributary, named for the community at its headwater area within the Town of Milton, has a tributary drainage area of 166 ha at its confluence with the Middle Sixteen Miles Creek, downstream of Fifth Line. Another feature, referred to as the Highway 401 Tributary, is also a tributary of the Middle Sixteen Mile Creek, with its confluence downstream of the development corridor, east of Fifth Line. Its drainage area at the corridor boundary (drains D3-1 and D3-2 at Highway 401) is 138 ha, while at the confluence it is 216 ha, reflecting the additional drainage area collected south of the highway.

Inventory of Hydraulic Structures

An inventory of hydraulic structure within the study area was compiled during the fall of 1998 and winter of 1999. Measurements of hydraulic characteristics of culverts and bridges with the proposed development area were made in the field so that capacity assessments could be later performed (see **Section 4.0**). General condition assessments were also made. **Table 3.1** summarizes the results of the inventory. Structure locations are shown on **Figure 3.1**. More detailed results of the inventory can be found in **Appendix C**.

Table 3.1 - Bridge and Culvert Inventory/Assessment

Structure No. Refer to Fig. 3.1	Location	Size Diameter/HxW	Shape	Material	Length	Condition/ Comments
Steeles Avenue West						
1	Swale 3-1/Milton Pond, 126 m East of James Snow Parkway	Twin 900 mm	Circular	Corr. Steel	34	Good
2	Swale 3-2, 15 m West of Fifth Line North	970 x 1390 mm	Arch	Corr. Steel	42.5	Good
2B	Ditch Drainage, 375 m East of Fifth Line North	600 mm	Circular	Corr. Steel	25	Fair
3	Middle Sixteen Mile Creek, 97 m West of Fifth Line South	2.1 x 12.2 m	Bridge	Concrete	12	Good
4	Swale 4-1, 10 m West of Sixth Line North	900 mm	Circular	Corr. Steel	27	Poor, Inlet Crushed
5	Ditch Drainage, 44 m East of Sixth Line North	600 mm	Circular	Corr. Steel	41	Fair, Inlet Blocked
6	Middle Sixteen Mile Creek Tributary, 55 m West of Sixth Line South	1.98 x 9.0 m	Bridge	Concrete	12	Good
7	Swale 4-3, 100 m East of Sixth Line South	750 mm	Circular	Corr. Steel	23	Good
7A	Drian 4-3, Enclosure through park, outlet into Tributary D/S of Structure #25	750 mm	Circular	Corr. Steel	65	Fair
8	Hornby Tributary, 210 m East of Hornby Road	1.95 x 7.7	Bridge	Concrete	8.5	Good
9	Swale 4-4, 170 m East of Trafalgar Road	900 mm	Circular	Corr. Steel	25	Good, Inlet Dented
10	East Sixteen Mile Creek, 170 m East of Eighth Line North	2.3 x 12.3 m	Bridge	Concrete	8	Good
11	Ditch Drainage, 335 m East of Eighth Line	750 mm	Circular	Corr. Steel	24	Poor, Silted Up
12	Ditch Drainage, 15 m East of Ninth Line North	900 mm	Circular	Corr. Steel	27.5	Good
13	Swale 6-1, 150 m East of Ninth Line North	1200 mm	Circular	Corr. Steel	26	Good
14	Swale 6-2, 210 m West of Ninth Line South	970 x 1390 mm	Arch	Corr. Steel	21	Good
	Pond Outlet	Twin 600 mm	Circular	Corr. Steel	5	Fair, Rusted
15	Ditch Drainage, 95 m West of Ninth Line South	600 mm	Circular	Corr. Steel	24	Good
16	Ditch Drainage, 270 m East of Ninth Line South	900 mm	Circular	Corr. Steel	19.5	Fair, Blocked & Torn
17	Ditch Drainage, 219 m West of Tenth Line North	1000 mm	Circular	Corr. Steel	23.5	Fair, Inlet Dented
18	Ditch Drainage, 10 m West of Tenth Line North	Twin 740 x 1030 mm	Arch	Corr. Steel	23.5	Fair, Inlet Silted Up
19	Swale 6-4, 75 m East of Tenth Line North	Twin 970 x 1390 mm	Arch	Corr. Steel	20	Good, High Vegetation
19A	Ditch Drainage, 35 m West of Winston Churchill Boulevard	600 mm	Circular	Corr. Steel	25	Good

Table 3.1 - Bridge and Culvert Inventory/Assessment

Structure No. Refer to Fig. 3.1	Location	Size Diameter/HxW	Shape	Material	Length	Condition/ Comments
North/South Side Roads, Winston Churchill Boulevard to James Snow Parkway						
20	Ditch Drainage, Winston Churchill Boulevard, 76 m South of Steeles Ave.	Twin 600 mm	Circular	Corr. Steel	16.1	Good
21	Ditch Drainage, Tenth Line South at Steeles Ave.	600 mm	Circular	Corr. Steel	23	Good
22	Ditch Drainage, Ninth Line South at Steeles Ave.	600 mm	Circular	Corr. Steel	23.7	Good
23	Ditch Drainage, Ninth Line North at Steeles Ave.	800 mm	Circular	Corr. Steel	34	Good
24	Ditch Drainage, Eighth Line South at Steeles Ave.	600 mm	Circular	Corr. Steel	25	Good
25	Middle Sixteen Mile Creek Tributary, Sixth Line South at Steeles Ave.	2.6 x 9.1 m	Bridge	Concrete	8.7	Good
4A	Ditch Inlet Drainage, Sixth Line North at Steeles Ave.	300 mm	Circular	Corr. Steel	23	Fair
26	Middle Sixteen Mile Creek, Fifth Line 210 m South of Steeles Ave.	2.1 x 18.3 m	Bridge	Concrete	8.6	Good
2A	Ditch Drainage, Fifth Line North at Steeles Ave.	600 mm	Circular	Corr. Steel	19.1	Poor, Crushed/Blocked
27	Tributary, Middle Sixteen Mile Creek, Fifth Line 550 m North of Steeles Ave	2.13 x 2.40 m	Box	Concrete	11.6	Good
28	Ditch Drainage, James Snow Parkway at Steeles Ave.	750 mm	Circular	Corr. Steel	38	Fair, Outlet Damaged
29	Swale 3-1, Fifth Line, South of Hwy. 401	1.95 x 2.95 m	Box	Concrete	17.3	Fair, Old
30	Swale 4-1, Sixth Line , North Side of Hwy. 401	900 mm	Circular	Corr. Steel	48	Fair, 1.85/2.05 m to E.P.
Highway 401/407						
31	Hwy. 401 Ditch Drainage, 125 m East of James Snow Parkway	1.22 x 1.22 m	Box	Concrete	n/a	Good, 1.7 m to E.P.
32	Swale 3-1/Cashway Pond, Hwy. 401, 550 m West of Fifth Line	1.55 x 3.10 m	Box	Concrete	n/a	Good, 1.75 m to E.p.
33	Middle Sixteen Mile Creek, Hwy. 401, 50 m East of Fifth Line	7.9 x 21.3 m	Bridge	Concrete	48	Good
34	Middle Sixteen Mile Creek Tributary, Hwy. 401, 100 m East of Sixth Line	4.0 x 12.2 m	Bridge	Concrete	40	Good
35	East Sixteen Mile Creek, Hwy. 401, 500 m East of Trafalgar Road	3.4 x 13.0 m	Bridge	Concrete	60	Good
36	Hwy. 401 Ditch Drainage, 870 m East of Trafalgar Road	n/a	Inlet	n/a	n/a	Outlet to Tributary
37	Hwy. 401 Ditch Drainage, 1500 m East of Trafalgar Road	1.22 x 2.44 m	Box	Concrete	n/a	Good, 1.7 m to E.P.
38	Swale 6-1, Hwy. 401 and Ramp 407E-401W, 485 m West of Ninth Line	1.22 x 1.5 m	Box	Concrete	n/a	New

Table 3.1 - Bridge and Culvert Inventory/Assessment						
Structure No. Refer to Fig. 3.1	**Location**	**Size Diameter/HxW**	**Shape**	**Material**	**Length**	**Condition/ Comments**
39	Swale/Pond 6-1, Hwy. 407 and Ramp 407W-401E	1.8 x 3.0 m	Box	Concrete	n/a	New
40	Swale 6-2, Hwy. 407 and Ramps 401E-407W & 407E-401W	1.8 x 3.0 m	Box	Concrete	n/a	New
41	Swale 6-2, Ninth Line, North Side of Hwy 401	1.8 x 3.0 m	Box	Concrete	n/a	New
42	Swale/Pond 6-2, Hwy. 401 and Ramp 401W-407E, 50 m East of Ninth Line	1.2 x 1.2 m	Box	Concrete	n/a	New
43	Swale 6-2, Hwy. 407 and Ramp 407W-401E	1.8 x 3.0	Box	Concrete	n/a	New
44	Swale 6-3, Ramps 407E-401W & 401E-407W	1.8 x 3.5 m	Box	Concrete	n/a	New
45	Swale 6-3, Hwy. 407, 400 m East of Ninth Line	1.8 x 3.5 m	Box	Concrete	n/a	New
46	Relief Flow Culvert for Pond 6-2, Ramp 407W-401W	Twin 1400 mm	Circular	Corr. Steel	n/a	New
47	Swale 6-3, Hwy. 401 and Ramp 407W-401E	1.2 x 1.5 m	Box	Concrete	n/a	New
48	Swale/Pond 6-3, Ramp 401W-407E	Twin 2400 mm	Circular	Corr. Steel	n/a	New
49	Swale 6-4, Hwy. 407 and Ramp 407E-401W	1.8 x 3.5 m	Box	Concrete	n/a	New
50	Swale/Pond 6-4, Hwy. 401 and Ramps 401E-407W & 401W-407E	0.91 x 1.52 m	Box	Concrete	n/a	New
51	Relief Flow Culvert for Pond 6-4, Ramp 401W-407E	1.4 x 3.5 m	Box	Concrete	n/a	New
52	Swale 6-5, Hwy. 407, 330 m West of Winston Churchill Boulevard	Twin 1500 mm	Circular	Corr. Steel	n/a	New
53	Swale/Pond 6-5, Hwy. 401, 375 m West of Winston Churchill Boulevard	1.2 x 3.0 m	Box	Concrete	n/a	New

Baseflow Monitoring

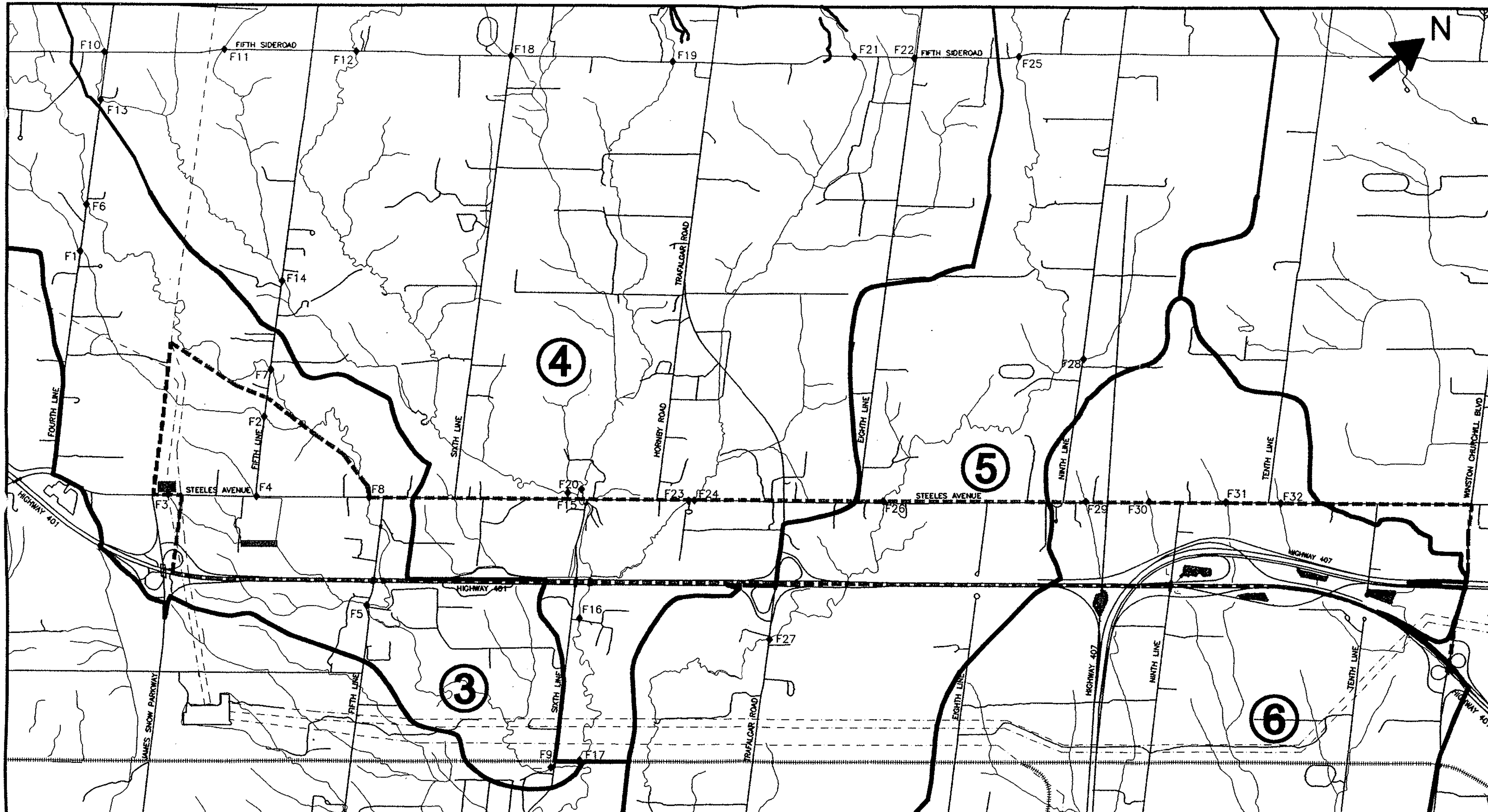
Baseflow measurements and estimates were made at a series of watercourse crossings during the spring of 1999. Monitoring sites included the main branches of Subwatersheds 3, 4 and 5 including larger tributaries, as well as the smaller drains. As indicated on **Figure 3.2a**, these sites were located upstream and downstream of the proposed development corridor, and many sites were located further upstream in the subwaterhseds where tributaries of the main branches crossed Fifth Side Road. In addition to flow observations, water depth and continuity in the upstream and downstream watercourses were noted. Results of the monitoring are presented in the following **Table 3.2a.**

Additional monitoring was carried out during the late spring of 1999 following a period of low precipitation **(Figure 3.2b)**. This second monitoring program focused on the Middle Sixteen Mile Creek Tributary and the Hornby Tributary in order to characterize potential baseflow groundwater contributions from the underlying basal aquifer. Flow monitoring was complimented by continuous temperature monitoring over a period of one month. Temperature recorders were located on the Middle Sixteen Mile Creek Tributary at the Hornby Tributary at Steeles Avenue and on the Middle Sixteen Mile Creek downstream of the confluence with the Hornby Tributary, downstream of Highway 401. Results of the flow monitoring are presented in **Table 3.2b** while results of the temperature monitoring are shown in **Figure 3.3.**

3.2 Flood Plain Analysis

The Mansewood and the Highway 401 Tributaries, both located within Subwatershed 3, were identified for flood line extension mapping in the Watershed Plan. In order to provide a sufficient level of detail to prepare flood line mapping in flood line extension areas, necessary valley cross sections and hydraulic structures were surveyed.

The Highway 401 Tributary is included in the 1:2000 mapping coverage of the original flood line mapping of Middle Sixteen Mile Creek. As this mapping was used to establish the natural cross sections, only low flow channel geometries and culvert characteristics were surveyed. The Highway 401 culvert draining the 401 Corridor Planning Area was surveyed as part of MTO's culvert inventory in 1996.



TOWN OF HALTON HILLS

LEGEND

WATERCOURSE
SUBWATERSHED NUMBER
SUBWATERSHED BOUNDARY
401 CORRIDOR PLANNING AREA
STORMWATER MANAGEMENT POND
CPR RAIL LINE
HYDRO LINE
F17 BASEFLOW MONITORING SITE

SCALE 1:26000

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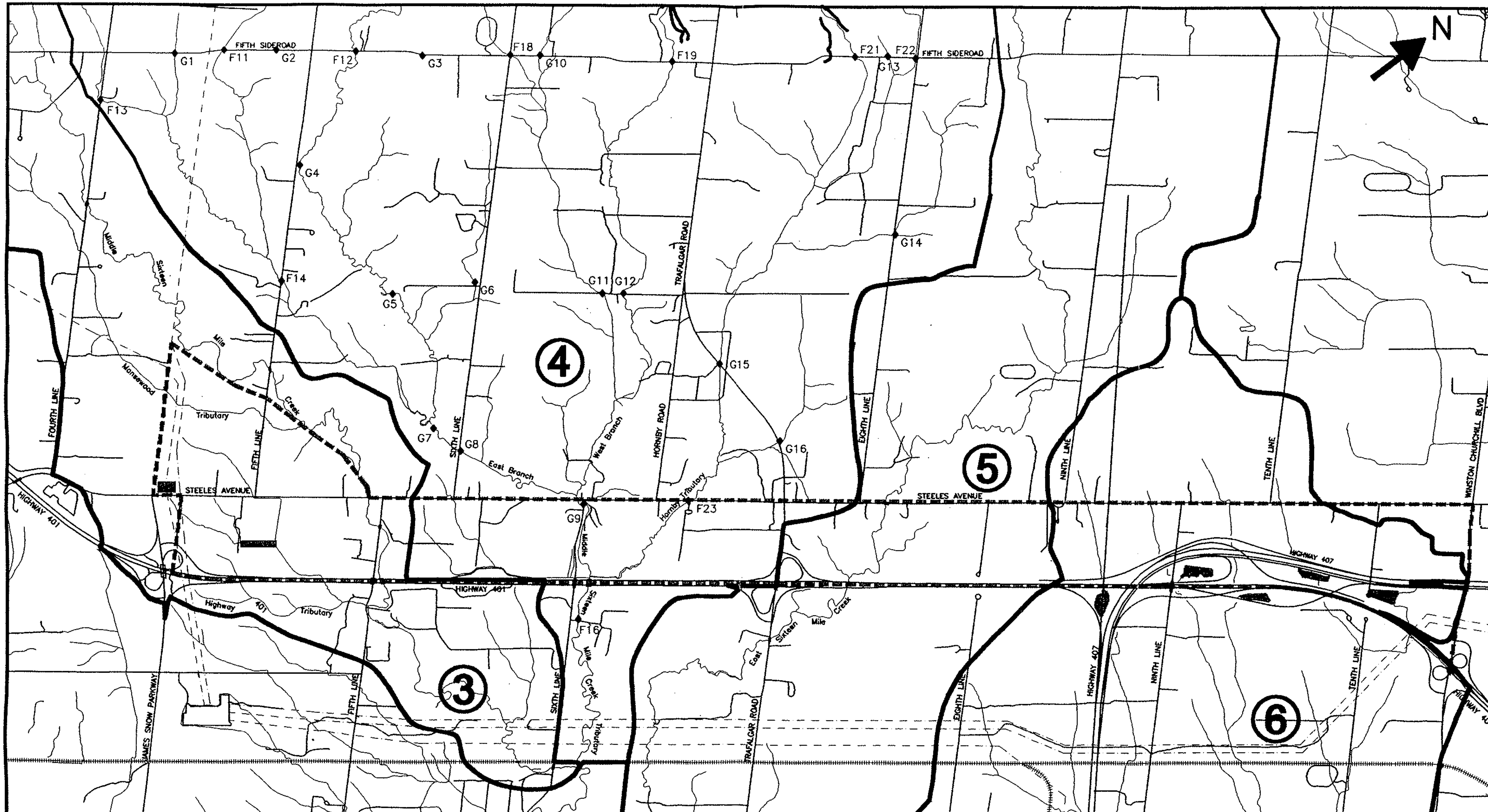
SCOPED SUBWATERSHED STUDIES

BASEFLOW MONITORING LOCATIONS (1)

FIGURE 3.2a



LEGEND

- WATERCOURSE
- ③ SUBWATERSHED NUMBER
- SUBWATERSHED BOUNDARY
- 401 CORRIDOR PLANNING AREA
- STORMWATER MANAGEMENT POND
- CPR RAIL LINE
- HYDRO LINE
- G9 ◆ F16 ◆ BASEFLOW MONITORING SITE

SCALE 1:25000

TOWN OF HALTON HILLS

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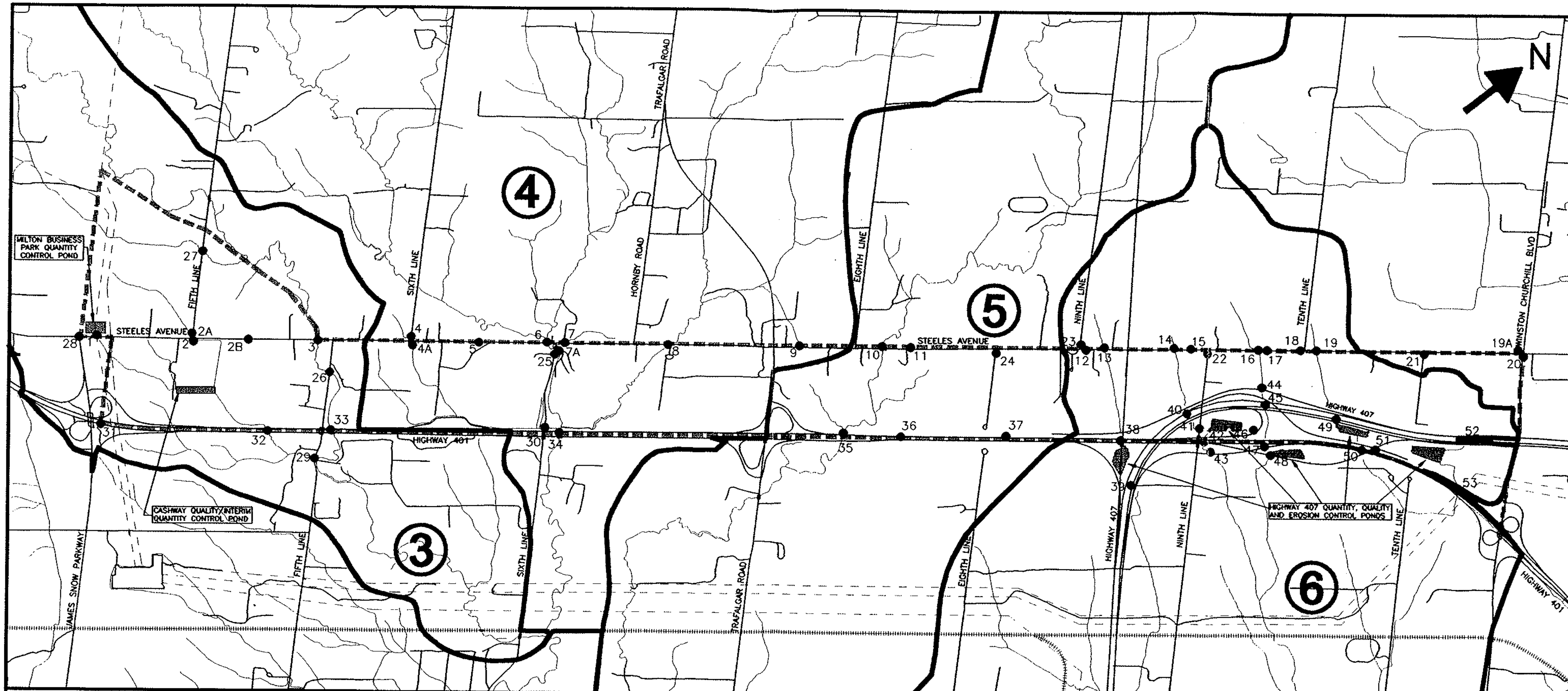
401 CORRIDOR INTEGRATED PLANNING PROJECT
SCOPED SUBWATERSHED STUDIES

BASEFLOW MONITORING LOCATIONS (2)

FIGURE 3.2b



LEGEND

SCALE 1:25000

- WATERCOURSE
- 3 SUBWATERSHED NUMBER
- SUBWATERSHED BOUNDARY
- 401 CORRIDOR PLANNING AREA
- STORMWATER MANAGEMENT POND
- CPR RAIL LINE
- HYDRO LINE
- 36 CULVERT/BRIDGE

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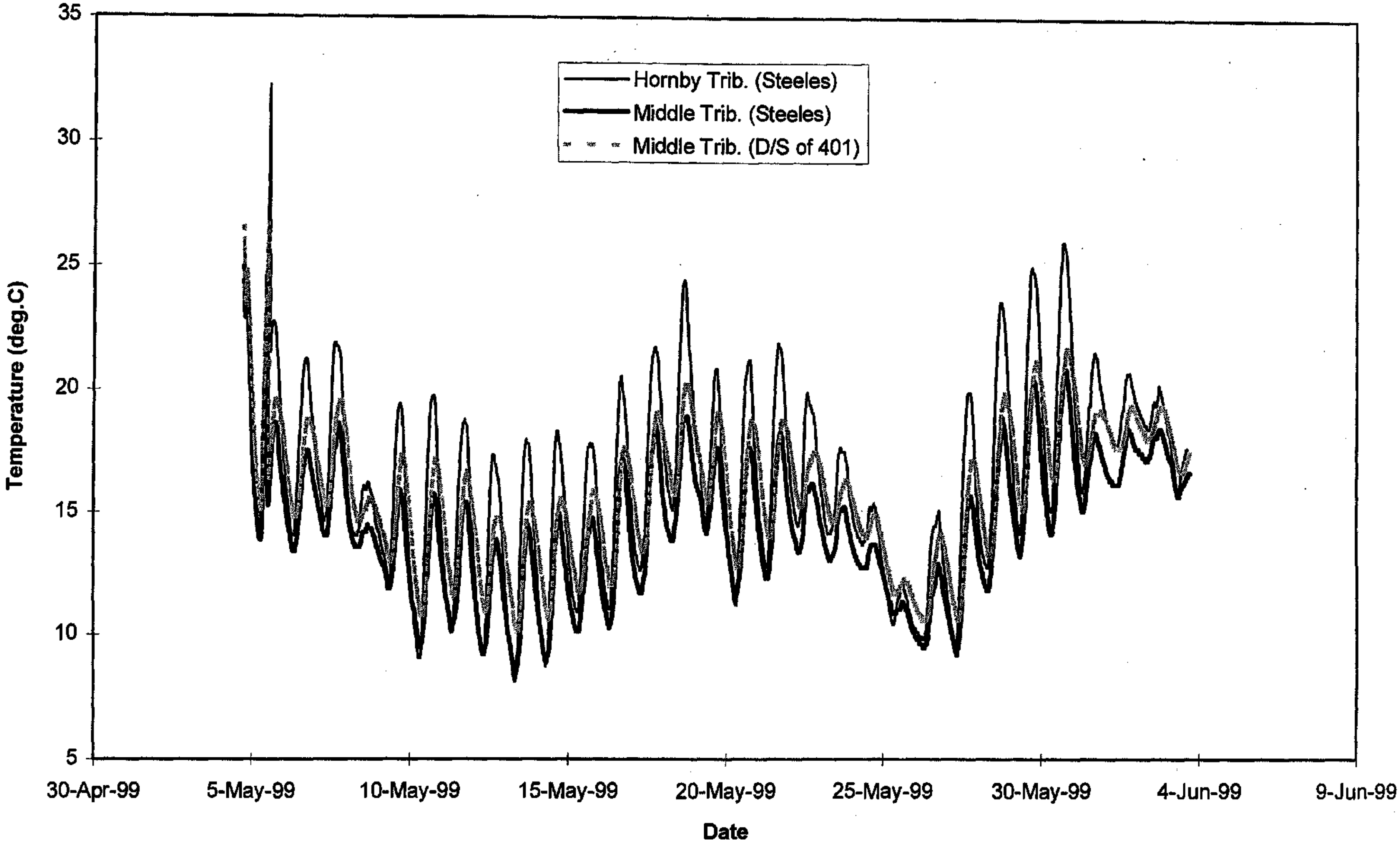
SCOPED SUBWATERSHED STUDIES

HYDRAULIC STRUCTURE LOCATIONS

FIGURE 3.1



HALTON HILLS

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401 CORRIDOR INTEGRATED PLANNING PROJECT
SCOPED SUBWATERSHED STUDIES

MIDDLE SIXTEEN MILE CREEK
STREAM TEMPERATURE

FIGURE 3.3

Table 3.2a - Baseflow Monitoring Summary (Spring 1999)					
Site ID (Refer to Fig. 3.2a)	**Watercourse**	**Site Location**	**Flow Measurement Location**	**Flowrate (m^3/s)**	**Comments**
F1	Mansewood Tributary	Fourth Line, 1400m south of 5th Sideroad	upstream end of 900mm CSP	<0.001	estimated flow
F2	Mansewood Tributary	Fifth Line, 500m north of Steeles Ave.	upstream end of 2.40x2.13m box culvert	0	standing water, 35cm deep
F3	Drain 3-1	Steeles Ave., 600m west of Fifth Line	upstream end of twin 900mm CSP	0	standing water, 15cm deep
F4	Drain 3-2	Steeles Ave. at Fifth Line	upstream end of 1390x970mm CSPA	0	dry
F5	Drain 3-2	Fifth Line, 100m south of Hwy 401	upstream inlet of 2.95x1.95m box culvert	0	standing water, maximum 26cm deep
F6	Middle Sixteen Mile Creek	Fourth Line, 1000m south of 5th Sideroad	20m upstream of concrete bridge	0.83	velocity profile section completed
F7	Middle Sixteen Mile Creek	Fifth Line, 850m north of Steeles Ave.	upstream of concrete bridge	0.84	velocity profile section completed
F8	Middle Sixteen Mile Creek	Steeles Ave., 600m west of Sixth Line	upstream of 12.2x2.1m bridge	0.5	estimated flow, maximum flow depth 56cm, 36cm on east footing
F9	Middle Sixteen Mile Creek	Sixth Line, 1200m south of Hwy 401	15m upstream of concrete bridge	1.03	velocity profile section completed
F10	West Branch of Middle Sixteen Mile Creek Tributary	5th Sideroad at Fourth Line	upstream of 2.45x1.15m box culvert (new)	0.01	estimated flow, gabion headwall, water depth of 33cm in culvert
F11	West Branch of Middle Sixteen Mile Creek Tributary	5th Sideroad, 500m west of 5th Line	upstream of 1.90x1.40m box culvert	0	standing water in culvert 25 to 35cm deep

Table 3.2a - Baseflow Monitoring Summary (Spring 1999)

Site ID (Refer to Fig. 3.2a)	Watercourse	Site Location	Flow Measurement Location	Flowrate (m^3/s)	Comments
F12	West Branch of Middle Sixteen Mile Creek Tributary	5th Sideroad, 300m east of Fifth Line	upstream end of 1.80x3.60m box culvert (poor condition)	0.02	estimated flow, 12cm water depth at exposed footing, maximum water depth of 50cm at creek invert
F13	West Branch of Middle Sixteen Mile Creek Tributary	Fourth Line, 300m south of 5th Sideroad	private pond control structure	0.01	flow based on weir equation
F14	West Branch of Middle Sixteen Mile Creek Tributary	Fifth Line, 1500m north of Steeles Ave.	downstream end of culvert	0.05	water 30 to 50 cm deep in culvert, estimated flow
F15	West Branch of Middle Sixteen Mile Creek Tributary	Steeles Ave., 600m west of Hornby Road	upstream of confluence with east branch	0.02	estimated flow, maximum water depth 37cm at Steeles Ave. culvert
F16	Middle Sixteen Mile Creek Tributary	Sixth Line, 200m south of Hwy 401	15m upstream of steel bridge (private drive)	0.54	velocity profile section completed
F17	Middle Sixteen Mile Creek Tributary	CPR 150m east of Sixth Line	7m upstream of railway bridge	0.5	velocity profile section completed
F18	East Branch of Middle Sixteen Mile Creek Tributary	5th Sideroad at Sixth Line	upstream of 1700x900mm CSPA	0	1cm depth of silt, pond depth of 1cm
F19	East Branch of Middle Sixteen Mile Creek Tributary	5th Sideroad, 300m west of Trafalgar Road	upstream of 1200mm CSP culvert	0	dry channel
F20	East Branch of Middle Sixteen Mile Creek Tributary	100m north of Steeles Ave., 500m west of Hornby Road	upstream of confluence with east branch	0.02	estimated flow, maximum water depth 37cm at Steeles Ave. culvert

Table 3.2a - Baseflow Monitoring Summary (Spring 1999)					
Site ID (Refer to Fig. 3.2a)	**Watercourse**	**Site Location**	**Flow Measurement Location**	**Flowrate (m^3/s)**	**Comments**
F21	Hornby Tributary	5th Sideroad, 400m west of Eighth Line	upstream of 1200mm CSP culvert	<0.001	estimated flow, standing water at upstream end, 30cm deep
F22	Hornby Tributary	5th Sideroad at Eighth Line	upstream of 450mm CSP culvert	0	standing water, 9cm deep
F23	Hornby Tributary	Steeles Ave., 200m east of Hornby Road	storm sewer, Steeles Ave. east of creek	0.01	estimated flow
F24	roadway drainage to Hornby Tributary	Steeles Ave., 200m east of Hornby Road	upstream of Steeles Ave. 7.7x1.9m bridge	0.01	estimated flow, maximum water depth 14cm
F25	East Sixteen Mile Creek	5th Sideroad, 700m east of Eighth Line	upstream of 5.5m wide box culvert	0.01	estimated flow, maximum depth of water is 27cm
F26	East Sixteen Mile Creek	Steeles Ave., 200m east of Eighth Line	upstream of culvert	0.1	velocity profile section completed
F27	East Sixteen Mile Creek	Trafalgar Road, 400m south of Hwy 401	10m downstream of concrete bridge	0.15	velocity profile section completed, maximum water depth 20cm
F28	Tributary of East Sixteen Mile Creek	Ninth Line, 1000m north of Steeles Ave.	upstream of 3.00x1.35m box culvert	<0.001	estimated flow, water depth 0 to 42cm, culvert in poor condition
F29	Drain 6-1	Steeles Ave., 200m east of Ninth Line	upstream end of 1200mm CSP	<0.001	estimated flow
F30	Drain 6-2	Steeles Ave., 600m east of Ninth Line	upstream end of 1390x970mm CSPA	0	standing water upstream, 9cm deep and downstream, 10cm deep
F31	Drain 6-3	Steeles Ave., 300m west of Tenth Line	upstream end of 900mm CSP	0	standing water, 5cm deep
F32	Drain 6-4	Steeles Ave., 100m east of Tenth Line	upstream end of twin 1390x900mm CSPA	0	standing water upstream, 8cm deep and downstream, 2 to 5cm deep

Table 3.2b - Baseflow Monitoring Summary (Late Spring 1999)					
Site ID (Refer to Fig. 3.2b)	Watercourse	Site Location	Flow Measurement Location	Flowrate (m^3/s)	Comments
G1	West Branch of Middle Sixteen Mile Creek Tributary	5th Sideroad, 500m east of 4th Line		0	dry
F11	West Branch of Middle Sixteen Mile Creek Tributary	5th Sideroad, 600m west of 5th Line	upstream of 1.90x1.40m box culvert	0.0015	standing water 30cm deep
G2	West Branch of Middle Sixteen Mile Creek Tributary	5th Sideroad, 250m west of 5th Line		0	dry
F12	West Branch of Middle Sixteen Mile Creek Tributary	5th Sideroad, 300m east of 5th Line	15m upstream of bridge at start of riffle	0.015	velocity profile section completed
G3	West Branch of Middle Sixteen Mile Creek Tributary	5th Sideroad, 600m west of 6th Line		0	dry
F13	West Branch of Middle Sixteen Mile Creek Tributary	4th Line, 300m south of 5th Sideroad	private pond control structure	0.006	flow based on weir equation
G4	West Branch of Middle Sixteen Mile Creek Tributary	5th Line, 800m south of 5th Sideroad		0.025	velocity profile section completed
F14	West Branch of Middle Sixteen Mile Creek Tributary	5th Line, 1500m north of Steeles Ave.		0.011	velocity profile section completed

Table 3.2b - Baseflow Monitoring Summary (Late Spring 1999)

Site ID (Refer to Fig. 3.2b)	Watercourse	Site Location	Flow Measurement Location	Flowrate (m^3/s)	Comments
G5	West Branch of Middle Sixteen Mile Creek Tributary	600m west of 6th Line and 1400m north of Steeles Ave.		0.019	velocity profile section completed
G6	West Branch of Middle Sixteen Mile Creek Tributary	6th Line, 1500m north of Steeles Ave.	900mm CSP	0	estimated flow, standing water 34cm deep, 16cm of silt on bottom
G7	West Branch of Middle Sixteen Mile Creek Tributary	200m west of 6th Line and 500m north of Steeles Ave.		0.031	flow estimated to be equal to that of G8
G8	West Branch of Middle Sixteen Mile Creek Tributary	6th Line, 300m north of Steeles Ave.	2m downstream of bridge	0.052	flow estimated to be equal to that of G8 + G11 + G12
G9	Middle Sixteen Mile Creek Tributary	Steeles Ave. and 6th Line (south)	2m downstream of bridge	0.037	velocity profile section completed
F16	Middle Sixteen Mile Creek Tributary	6th Line, 200m south of Hwy 401	6m upstream of bridge	0.69	velocity profile section completed
F18	East Branch of Middle Sixteen Mile Creek Tributary	5th Sideroad at 6th Line	2cm downstream of 1700x900mm CSPA	0	estimated flow, standing water
G10	East Branch of Middle Sixteen Mile Creek Tributary	5th Sideroad, 200m east of 6th Line		0	dry, no downstream channel, shallow ponded water downstream
F19	East Branch of Middle Sixteen Mile Creek Tributary	5th Sideroad, 300m west of Trafalgar Road	upstream of 1200mm CSP culvert????	0	dry

Table 3.2b - Baseflow Monitoring Summary (Late Spring 1999)					
Site ID (Refer to Fig. 3.2b)	**Watercourse**	**Site Location**	**Flow Measurement Location**	**Flowrate (m^3/s)**	**Comments**
G11	East Branch of Middle Sixteen Mile Creek Tributary	550m west of Hornby Road and 1400m north of Steeles Ave.		0.001	estimated flow, upstream flow is discontinuous, 25cm standing water upstream, algae growth
G12	East Branch of Middle Sixteen Mile Creek Tributary	400m west of Hornby Road and 1400m north of Steeles Ave.	3m downstream of small bridge on gravel riffle	0.020	velocity profile section completed, clear, clean water
F21	Hornby Tributary	5th Sideroad, 400m west of 8th Line	upstream of 1200mm CSP culvert?????	0	estimated flow, standing water continuous upstream, 31cm deep, discontinuous downstream, algae
G13	Hornby Tributary	5th Sideroad, 200m west of 8th Line		0	estimated flow, standing water east of culvert, discontinuous downstream, no channel upstream, ditch north of road and west of culvert is wet
F22	Hornby Tributary	5th Sideroad at 8th Line	concrete box culvert	0.001	estimated flow, flowing downstream, standing water upstream, algae in ditch along 5th Sideroad
G14	Hornby Tributary	8th Line, 1200m south of 5th Sideroad	twin CSPA	0	discontinuous downstream, algae, north CSPA blocked by soil and grass, standing water in south CSPA
G15	Hornby Tributary	Trafalgar Road, 900m north of Steeles	6m upstream of twin cell box culvert	0.016	velocity profile section completed, algae
G16	Hornby Tributary	Trafalgar Road, 400m north of Steeles		0	ponded water 50cm upstream end, downstream dry, occasional puddle downstream of culvert
F23	Hornby Tributary	Steeles Ave., 200m east of Hornby Road	2m downstream of bridge	0.014	velocity profile section completed, seepage from septic tank into creek

Only the most downstream portion of the Mansewood Tributary is covered by the 1:2000 mapping limits and therefore complete surveying of channel cross sections and the Fifth Line culvert was required. Additional detail was required in terms of cross section spacing (typically every 60-100 m) so that the planimetric limits of the flood line could be established. Section locations are presented along with analysis results in Section 4.0.

3.3 Stream Geomorphology

Field Program Overview

Background morphometric and historical air photo analyses provide insight into the general characteristics of channels with respect to the local environment, and the controls that affect channel morphology and function. To provide additional insight into channel form and into the actual processes that are operative within the watercourses detailed field investigations were undertaken. The selection of reaches for inclusion into the field investigation is based on the results of the previously completed morphometric and historical analyses. These reaches should represent a range of conditions, and extend throughout the spatial extent of the study area.

The field assessment was performed in late 1998 and consisted of the following:

- cross section measurements at over ten locations along each branch, over two meander wavelengths or 20 times the average bankfull width;
- measurements of bank full and low flow dimensions, and channel entrenchment;
- characterization of substrate based on pebble counts of the pavement and point measures of the subpavement layer;
- description of bank properties including height, root depth, in-situ strength, and amount of undercut;
- flow velocities measurements to calculate volumetric flow rates;
- establishment of a monitoring cross section to facilitate future monitoring.

As part of the field investigation, data pertaining to the cross-sectional dimensions, substrate materials, and bank properties were collected at ten cross-sections within each reach. A survey, from which the reach planform and bed morphology was mapped and through which the cross-sections are spatially linked, was completed for each reach. Data summaries identifying the variables that were measured, and the corresponding quantities for each of the reaches, are provided in **Appendix A.**

These data are used in subsequent analyses to identify channel thresholds (e.g. sediment movement) and to identify processes operative within the channel. A brief description of the field sites is provided below, followed by a brief discussion of preliminary results from the detailed field investigation.

Field Site Descriptions

The four main branches were selected for the detailed field investigation, all of which are higher-order streams (>3). Higher order streams were selected which are generally affected by processes that occur within a large upstream drainage area rather than by local conditions. These, high-order streams tend to be better developed than low-order streams given the larger volume of water that is conveyed in them. The concentration of rural residential housing is greatest upstream of Reaches B and C.

Salient characteristics of the reaches are provided in each of the brief site descriptions that follow. This information provides a general context of the physical characteristics of the reaches in the 401 Corridor Planning Area for subsequent analyses.

Reach A, a meandering creek, is situated downstream of Steeles Avenue between 5th and 6th Line (**Photo No. 1**); specific features of this reach include:

- Surrounding land use: pasture and scrubland;
- Riparian zone: herbaceous plants and grasses; goats graze on the bank top;
- Banks: consist of clays, silt and fine sand; undercut banks;
- Substantial erosion (i.e. slumping) of the higher downstream left-bank occurs throughout the reach;
- Channel-bed: well-defined pool and riffle sequences; substrate varies from clay to cobbles; fine sediment is found in pools, coarse clasts are found in riffles;
- During high discharge events, water in the channel can spill only onto the downstream right-bank floodplain.

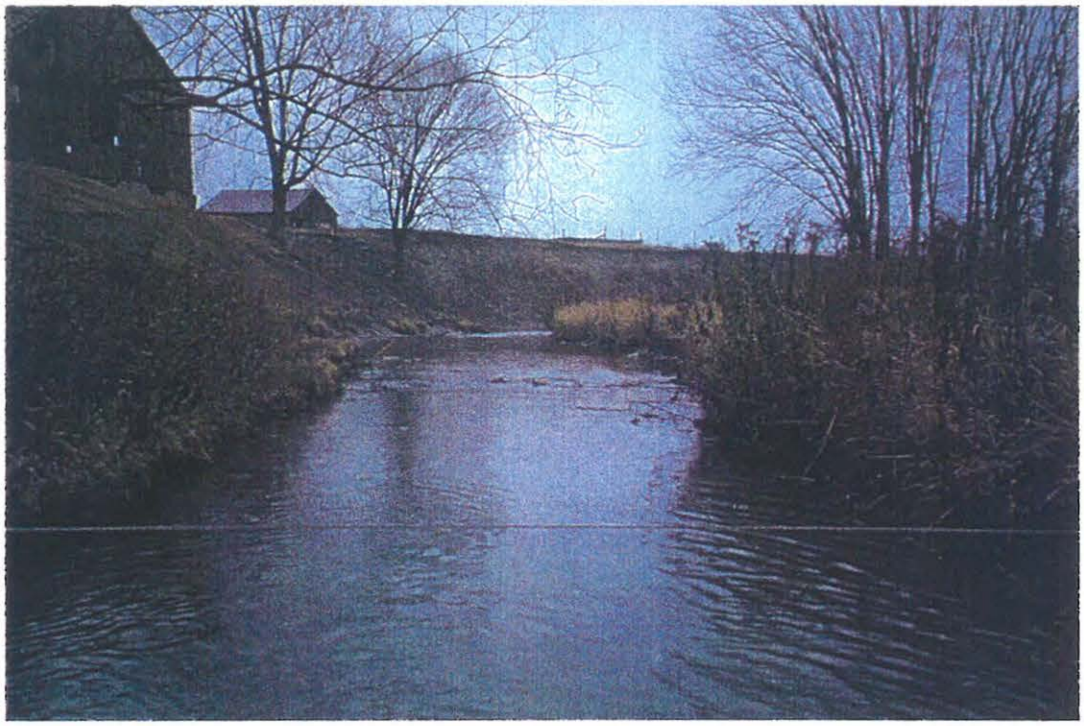

Photo No. 1. : Reach A - Middle Sixteen Mile Creek. General setting, valley wall erosion, grazing.

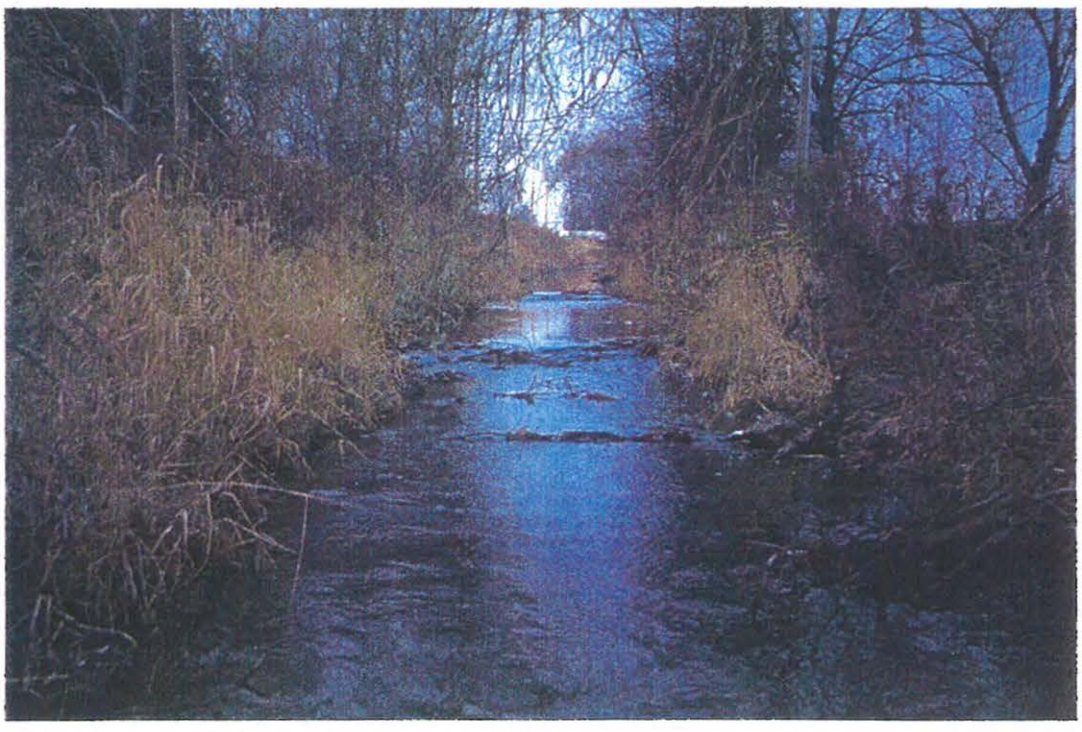

Photo No. 2. : Reach B - Middle Sixteen Mile Creek Tributary. General setting.

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GEOMORPHOLOGY REACH A AND B

PHOTO NO.s 1 AND 2

Reach B, a slightly meandering creek, is situated downstream of Steeles Avenue between 6th Line and Hornby Road (**Photo No. 2**), and is characterized as follows:

- Surrounding land use: park and scrubland;
- Riparian zone: herbaceous plants, grasses, and the occasional deciduous tree;
- Banks: consist of silt and fine/medium sand (i.e. non-cohesive); upper half of reach is lined with large cobbles to protect the bank materials from erosion; where bank is not lined, it is undercut;
- Channel bed: pool, riffles and extensive transitional areas; substrate is dominated by large cobbles, a function of the material lining the banks – fine sediment fills the voids.

Reach C, a sinuous creek, is situated downstream of Steeles Avenue, south of Hornby Road (**Photo No.3**); specific characteristics are:

- Surrounding landuse: scrubland;
- Riparian zone: dense herbaceous plants and grasses;
- Banks: 60% of the banks are undercut; material is mainly clay, silt, fine and medium sand;
- Substantial erosion along the downstream right-bank sat several locations along the surveyed reach;
- Channel bed: well-defined pools and riffles; substrate is variable in size but consists mainly of fine-grained sediment (i.e. silt and sands), and some pebbles/small boulders;
- Channel width is small..

Reach D, a slightly meandering creek, is situated downstream of Steeles , near 8th Line (**Photo No. 4**) and is described as follows:

- Surrounding land use: deciduous forest;
- Riparian zone: dense herbaceous plants, grasses and trees;
- Banks: only 30 % of the channel banks (consisting of clay, silt and fine sand) are undercut
- Several banks are eroded;
- Large woody debris serves a functional role in the channel;
- Channel bed: pool and riffle morphology; one large scour pool; substrate materials consist of fine grained sediment (i.e. clay, silt, sand) in both pools and riffles.

Overview of Reach Properties

Tables 3.3 and **3.4** provide a brief summary of the significant geomorphic parameters measured during the detailed field investigation of the study reaches. These represent the general characteristics of watercourses within the study area, and provide insight into the spatial diversity of the reaches. As noted above, the surficial geology within the study area consists of two deposits: glacio-lacustrine sediment and glacial till. Accordingly, the general characteristics and floodplain controls on the reaches within each deposit are similar and therefore data for reaches A and B (glacio-lacustrine) are discussed separately from data for reaches C and D (glacial till). Further, as noted above, the reaches towards the east end of the study area tend to have a lower order and have headwater regions within or immediately upstream of the study area. Also from **Table 3.3** it is evident that the drainage area for reaches A and B are larger than they are for reaches C and D.

Table 3.3 - Summary of Several Geomorphic Parameters for Each Reach Included in the Detailed Geomorphic Field Investigation

Variable	Reach A	Reach B	Reach C	Reach D
Drainage Area (km^2)	52.3	32.02	10.02	19.7
Avg. Bankfull Width (m)	6.44	5.48	3.43	7.69
Avg. Bankfull Depth (m)	0.55	0.54	0.45	0.44
Width:Depth	11.8	10.3	7.9	17.5
Avg. Bankfull Velocity (m/s)	1.26	0.78	1.41	1.47
Entrenchment Ratio	5.68	0.27	2.12	4.56
Substrate D50 (cm)	0.98	2.21	0.30	0.10
Average Roughness (n)	0.038	0.053	0.031	0.026
Bankfull Gradient	0.0046	0.0039	0.0056	0.0044

Photo No. 3. : Reach C - Hornby Tributary. General setting.

Photo No. 4. : Reach D - East Sixteen Mile Creek. General setting.

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GEOMORPHOLOGY REACH C AND D

PHOTO NO.s 3 AND 4

Table 3.4 - Significant Bank Properties Measured in Each of the Reaches				
Variable	**Reach A**	**Reach B**	**Reach C**	**Reach D**
% undercut	70	35	60	30
Dominant bank material	clay, silt, fine sand	silt, fine sand	clay, silt, fine and medium sand	clay, silt, fine sand
Rooting depth (cm)	17	11	20	30
Bank angle (degrees)	50	40	48	36

Properties of the cross-sectional shape (i.e. bankfull width and depth) and of the substrate materials of reaches A and B reflect the resistance of the channel boundary materials to erosion. Reach A is situated in a valley, causing its entrenchment ratio to be lower, and limiting the land area onto which flood waters can spill. Given that the banks of reach B banks are lined with boulders, the number of undercuts that may be incurred on the banks is reduced, regardless of the rooting depth of bank vegetation. The similarity in width/depth ratio of reaches A and B reflects the similarity in floodplain materials and bank vegetation.

The substrate materials, bankfull depths, and roughness values are similar for reaches C and D, likely a function of the surficial geology (i.e. glacio-lacustrine). The small bankfull width of reach C is a function not only of geology but also of the structural strength that dense grasses and herbaceous plants provide to the channel bank. The larger width/depth ratio of reach D is likely attributable to the difference in bank vegetation (i.e. trees versus grasses). Bank vegetation is also an important control of the extent of bank undercutting that occurs within a reach. In general, rooting depth is inversely proportional to the percentage of undercuts along a reach. The entrenchment ratio for both reaches is small, indicating that they are actively incising into the floodplain.

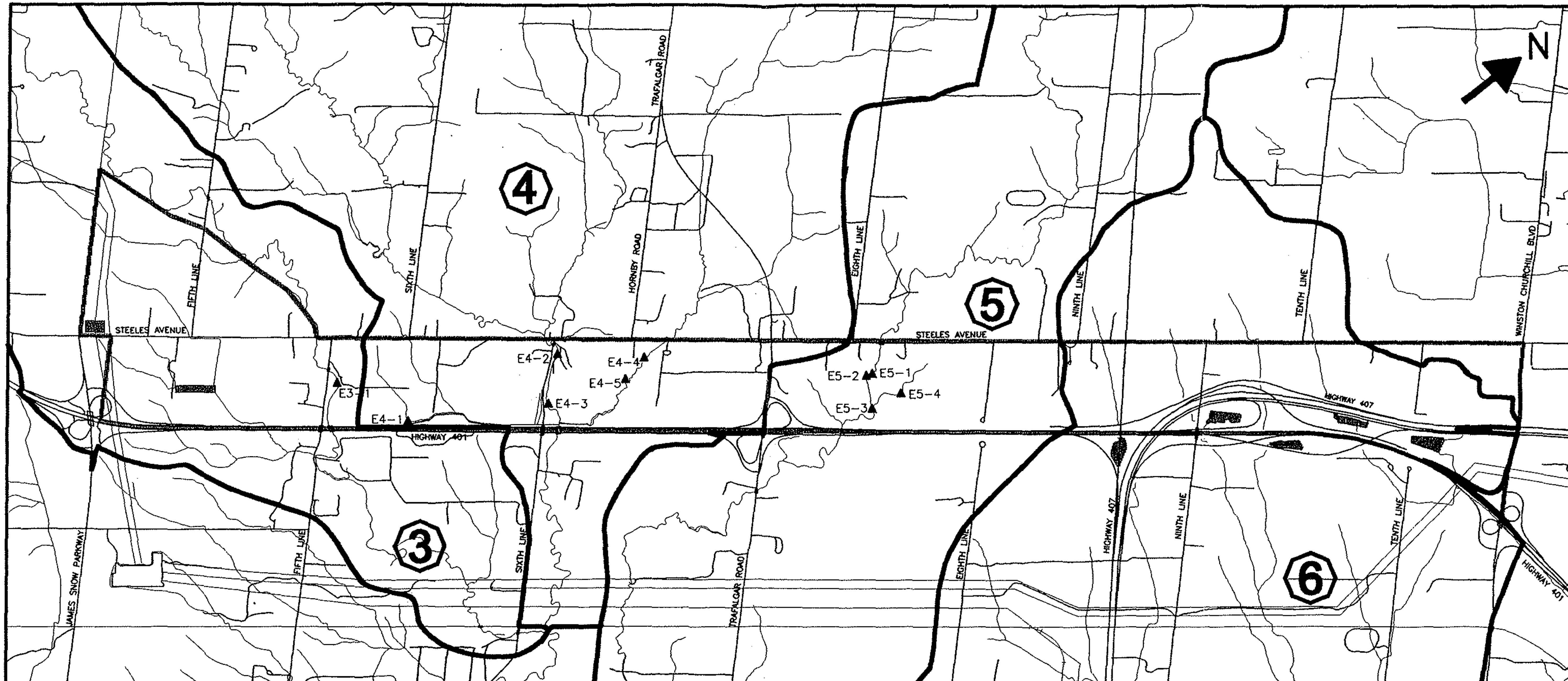
Results from the detailed field investigation provide further information regarding the form of the reaches within the study area. The insight gained from the field investigation is useful for identifying controls of channel form and providing background information for subsequent data analysis. In summary, the geomorphic characteristics of each reach within the study area are influenced not only by physical controls (i.e. geology) but also by modifying controls such as vegetation. The surficial geology controls channel cross-sectional shape, bank and substrate material, channel roughness and channel incision. Bank strength and the percentage of undercuts within a reach area function of bank vegetation. The hydrologic regime of each of the watercourses within the study area also influences not only the cross-sectional shape of the reaches, but also channel planform. Although all reaches are controlled by similar factors, differences in floodplain materials, upstream drainage area, land use and bank vegetation are sufficient to cause spatial variation in channel properties.

3.4 Erosion

In all natural channels, erosion and deposition of the channel boundary (bed and banks) occurs as part of an equilibration process wherein the channel works towards transporting both water and sediment efficiently downstream. The rate at which erosion and deposition occurs is influenced by bank properties (sediment, vegetation), flow regime (magnitude, duration and frequency), and sediment regime (supply, particle size, and volumes of both suspended load and bedload) to which the river adjusts its form. Erosion may also occur as a function of bank stabilization processes and physical (e.g. wet-dry) or geochemical weathering of the boundary materials.

Each of the reaches within the study area was assessed to identify areas where natural erosion rates have been exacerbated. Examination of topographic maps provided a first approximation that was confirmed through a reconnaissance visit in the field. None of the low-order headwater streams situated in the east-end of the study area displayed evidence of erosion. Given the gradient and meandering planform of these reaches, one can infer that the stream power in the reaches is low, reducing the likelihood of excessive erosion along its banks.

Several erosion sites have been identified (**Figure 3.4**), most of these are situated at locations where the meander bends impinge on a valley wall (e.g. Reach A, Photo No. 1). Although the valley wall impedes the lateral movement of watercourses, erosion of the valley wall will proceed as long as the creek needs to move laterally to attain a stable configuration. Associated with the lateral movement are bank toe erosion and valley-wall slumping. Dissipation of flow energy upstream of the valley wall will slow the erosion rate down. Similarly, re-reinforcement of the valley walls will also reduce the rate of erosion. Additional evidence of erosion is presented on **Photos 5 and 6.**



SCALE 1:25000

LEGEND

- WATERCOURSE
- 3 SUBWATERSHED NUMBER
- SUBWATERSHED BOUNDARY
- 401 CORRIDOR PLANNING AREA
- STORMWATER MANAGEMENT POND
- CPR RAIL LINE
- HYDRO LINE
- E4-3 EROSION SITE

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LOCAL EROSION LOCATIONS

FIGURE 3.4

3.5 Water Quality

A surface water quality monitoring program was developed in order to provide local detailed information which would complement existing data sources. To date the program consists of dry weather discrete sampling at eight locations located on each of the main branches and two of the main tributaries. These locations are indicated on **Figure 3.5**. Samples were collected in the early spring of 1999 and were analyzed for a range of parameters including, bacteria, metals, pesticides, herbicides and metals. Detailed laboratory results are presented in **Appendix B**. Summaries of results are compared to a series of guidelines and standards in **Tables 3.5** to **3.8**.

Results shown in **Table 3.5** indicate that Provincial Water Quality Objectives (PWQO's) for surface water are met in East Sixteen Mile Creek, as represented by site 5. With the exception of total phosphorus and iron at site 4A, objectives for all other parameters are met at the remaining sites within the Middle Sixteen Mile Creek Tributary system. Given the relatively low concentrations of total phosphorus within the tributary system upstream of Steeles Avenue (represented by site 4A on the East Branch of the Middle Sixteen Mile Creek Tributary, 4C on the West Branch, and 4D on the Hornby Tributary), a source of phosphorus from within the study corridor is suggested by the data. Elevated levels of phosphorus can result in eutrophication of watercourses, causing excessive algae or aquatic plant growth. While significant sources of phosphorus in surface waters include fertilizers, domestic and industrial effluents, domestic detergents, agricultural and urban drainage, the origin of phosphorus within the corridor is likely due to agricultural practices.

High concentrations of iron within the Middle Sixteen Mile Creek Tributary system downstream of the corridor appear to originate within, as opposed to upstream of, the corridor. While relatively high concentrations of iron were found in the West Branch upstream of the corridor, this could only marginally contribute to the high downstream concentrations, which are nearly an order of magnitude higher. Iron is typically introduced to surface water systems through the weathering of rocks, sewage and industrial waste discharges. High concentrations within the system may possibly be introduced by runoff from Highway 401.

Within the Middle Sixteen Mile Creek system, the total phosphorus objective was exceeded on the main branch downstream of the corridor as well as on the Mansewood Tributary near the upstream corridor boundary. Site 3B on the Highway 401 Tributary had nearly the lowest concentration for all sites which may indicate the effectiveness of the water quality treatment facility on drains D3-1 and D3-2.

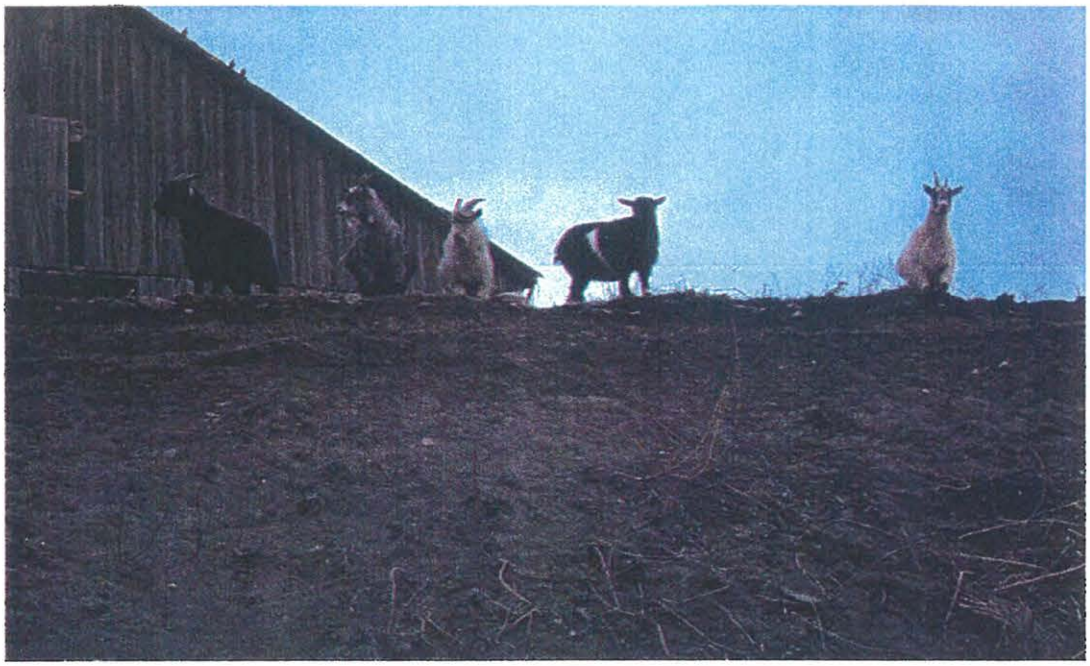

Photo No. 5.

Photo No. 6.

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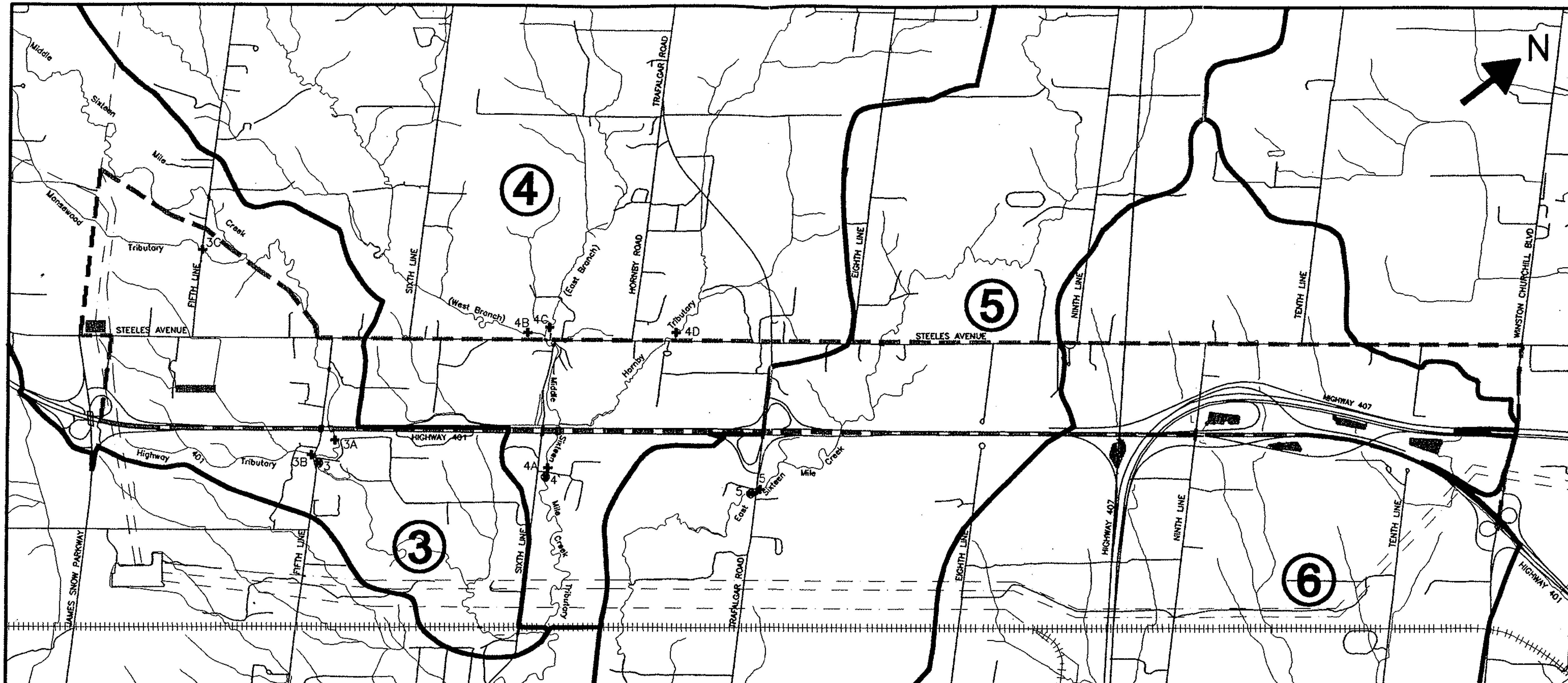
LOCAL EROSION

PHOTO NO.s 5 AND 6



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LEGEND

SCALE 1:25000

WATERCOURSE	STORMWATER MANAGEMENT POND
③ SUBWATERSHED NUMBER	CPR RAIL LINE
SUBWATERSHED BOUNDARY	HYDRO LINE
401 CORRIDOR PLANNING AREA	SAMPLING SITE: 3B✚ DRY WEATHER DISCRETE; 4 ⊕ DRY WEATHER CONTINUOUS

401 CORRIDOR INTEGRATED PLANNING PROJECT
SCOPED SUBWATERSHED STUDIES

LOCAL WATER QUALITY SAMPLING LOCATIONS

FIGURE 3.5

401 Corridor Integrated Planning Project
Scoped Subwatershed Studies
Town of Halton Hills

Dry Weather Flow Water Quality Analysis (April 6, 1999)

Table 3.5 - Evaluation of Selected Parameters - PWQO

Parameter	Units	PWQO		Laboratory Results at Station								Evaluation of Laboratory Results at Station - PWQO							
		Min.	Max.	3A	3B	3C	4A	4B	4C	4D	5	3A	3B	3C	4A	4B	4C	4D	5
Lab. pH	-	6.5	8.5	8.36	8.58	8.06	8.40	8.33	8.30	8.45	8.47		Above						
Total Dissolved Solids	mg/L			320	1736	338	386	334	261	421	489	-	-	-	-	-	-	-	-
Total Phosphorus	mg/L		0.03	0.045	0.010	0.052	0.171	0.023	0.011	0.009	0.012	Above		Above	Above				
Chloride	mg/L			45.0	905.0	93.5	61.9	40.5	37.8	79.7	133.0	-	-	-	-	-	-	-	-
Nitrate (as N)	mg/L			1.0	*0.2*	*0.2*	2.2	1.1	3.8	3.6	0.6	-	-	-	-	-	-	-	-
Silver	mg/L		0.0001	*0.0001*	*0.0001*	*0.0001*	*0.0001*	*0.0001*	*0.0001*	*0.0001*	*0.0001*								
Aluminum	mg/L			0.370	0.031	0.075	0.367	0.117	0.050	0.021	0.059	-	-	-	-	-	-	-	-
Beryllium	mg/L		0.011	*0.001*	*0.001*	*0.001*	*0.001*	*0.001*	*0.001*	*0.001*	*0.001*								
Cadmium	mg/L		0.0002	*0.0001*	*0.0001*	*0.0001*	*0.0001*	*0.0001*	*0.0001*	*0.0001*	*0.0001*								
Cobalt	mg/L			0.0003	*0.0001*	*0.0001*	0.0003	*0.0001*	*0.0001*	*0.0001*	*0.0001*	-	-	-	-	-	-	-	-
Chromium	mg/L		0.1	*0.005*	*0.005*	*0.005*	*0.005*	*0.005*	*0.005*	*0.005*	*0.005*								
Copper	mg/L		0.005	0.0025	0.0034	0.0025	0.0025	0.0016	0.0009	0.0015	0.0030								
Iron	mg/L		0.3	0.56	*0.03*	*0.03*	0.65	0.23	*0.03*	*0.03*	0.11	Above			Above				
Manganese	mg/L			0.086	0.023	0.01	0.083	0.062	0.029	0.022	0.057	-	-	-	-	-	-	-	-
Molybdenum	mg/L			*0.001*	0.002	*0.001*	*0.001*	*0.001*	*0.001*	*0.001*	*0.001*	-	-	-	-	-	-	-	-
Nickel	mg/L		0.025	*0.001*	0.001	*0.001*	*0.001*	*0.001*	*0.001*	*0.001*	*0.001*								
Lead	mg/L		0.025	*0.0005*	*0.0005*	*0.0005*	0.0007	*0.0005*	*0.0005*	*0.0005*	*0.0005*								
Vanadium	mg/L			*0.0005*	*0.0005*	*0.0005*	*0.0005*	*0.0005*	*0.0005*	*0.0005*	*0.0005*	-	-	-	-	-	-	-	-
Zinc	mg/L		0.03	0.005	0.007	0.003	0.011	0.023	*0.002*	0.003	0.010								
Fecal Coliform	CFU/100		100	35	48	*1*	24	50	27	86	29								
Total Coliform	CFU/100		1000	2600	230	150	200	70	50	220	80	Above							

Notes: PWQO = Provincial Water Quality Objective
ODWO = Ontario Drinking Water Objective
CLW = Criteria for Livestock Watering
CIW = Criteria for Irrigation Waters
SW3A was tested twice, the results are averaged.
Results shown in italics represent measurements below detection limit shown.

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Dry Weather Flow Water Quality Analysis (April 6, 1999)

Table 3.6 - Evaluation of Selected Parameters - ODWO

Parameter	Units	ODWO		Laboratory Results at Station								Evaluation of Laboratory Results at Station - ODWO							
		Min.	Max.	3A	3B	3C	4A	4B	4C	4D	5	3A	3B	3C	4A	4B	4C	4D	5
Lab. pH	-			8.36	8.58	8.06	8.40	8.33	8.30	8.45	8.47	-	-	-	-	-	-	-	-
Total Dissolved Solids	mg/L		500	320	1736	338	386	334	261	421	489		Above						
Total Phosphorus	mg/L			0.045	0.010	0.052	0.171	0.023	0.011	0.009	0.012	-	-	-	-	-	-	-	-
Chloride	mg/L		250	45.0	905.0	93.5	61.9	40.5	37.8	79.7	133.0		Above						
Nitrate (as N)	mg/L		1	1.0	*0.2*	*0.2*	2.2	1.1	3.8	3.6	0.6				Above	Above	Above	Above	
Silver	mg/L		0.05	*0.0001*	*0.0001*	*0.0001*	*0.0001*	*0.0001*	*0.0001*	*0.0001*	*0.0001*								
Aluminum	mg/L			0.370	0.031	0.075	0.367	0.117	0.050	0.021	0.059	-	-	-	-	-	-	-	-
Beryllium	mg/L		1	*0.001*	*0.001*	*0.001*	*0.001*	*0.001*	*0.001*	*0.001*	*0.001*								
Cadmium	mg/L		0.01	*0.0001*	*0.0001*	*0.0001*	*0.0001*	*0.0001*	*0.0001*	*0.0001*	*0.0001*								
Cobalt	mg/L			0.0003	*0.0001*	*0.0001*	0.0003	*0.0001*	*0.0001*	*0.0001*	*0.0001*	-	-	-	-	-	-	-	-
Chromium	mg/L		0.05	*0.005*	*0.005*	*0.005*	*0.005*	*0.005*	*0.005*	*0.005*	*0.005*								
Copper	mg/L			0.0025	0.0034	0.0025	0.0025	0.0016	0.0009	0.0015	0.0030	-	-	-	-	-	-	-	-
Iron	mg/L			0.56	*0.03*	*0.03*	0.65	0.23	*0.03*	*0.03*	0.11	-	-	-	-	-	-	-	-
Manganese	mg/L		0.05	0.086	0.023	0.01	0.083	0.062	0.029	0.022	0.057	Above			Above	Above			Above
Molybdenum	mg/L			*0.001*	0.002	*0.001*	*0.001*	*0.001*	*0.001*	*0.001*	*0.001*	-	-	-	-	-	-	-	-
Nickel	mg/L			*0.001*	0.001	*0.001*	*0.001*	*0.001*	*0.001*	*0.001*	*0.001*	-	-	-	-	-	-	-	-
Lead	mg/L		0.05	*0.0005*	*0.0005*	*0.0005*	0.0007	*0.0005*	*0.0005*	*0.0005*	*0.0005*								
Vanadium	mg/L			*0.0005*	*0.0005*	*0.0005*	*0.0005*	*0.0005*	*0.0005*	*0.0005*	*0.0005*	-	-	-	-	-	-	-	-
Zinc	mg/L			0.005	0.007	0.003	0.011	0.023	*0.002*	0.003	0.010	-	-	-	-	-	-	-	-
Fecal Coliform	CFU/100			35	48	*1*	24	50	27	86	29								
Total Coliform	CFU/100			2600	230	150	200	70	50	220	80								

Notes: PWQO = Provincial Water Quality Objective
ODWO = Ontario Drinking Water Objective
CLW = Criteria for Livestock Watering
CIW = Criteria for Irrigation Waters
SW3A was tested twice, the results are averaged.
Results shown in italics represent measurements below detection limit shown.

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Dry Weather Flow Water Quality Analysis (April 6, 1999)

Table 3.7 - Evaluation of Selected Parameters - CIW

Parameter	Units	CIW		Laboratory Results at Station								Evaluation of Laboratory Results at Station - CIW							
		Min.	Max.	3A	3B	3C	4A	4B	4C	4D	5	3A	3B	3C	4A	4B	4C	4D	5
Lab. pH	-			8.36	8.58	8.06	8.40	8.33	8.30	8.45	8.47	-	-	-	-	-	-	-	-
Total Dissolved Solids	mg/L	500	3500	320	1736	338	386	334	261	421	489	Below		Below	Below	Below	Below	Below	Below
Total Phosphorus	mg/L			0.045	0.010	0.052	0.171	0.023	0.011	0.009	0.012	-	-	-	-	-	-	-	-
Chloride	mg/L	100	700	45.0	905.0	93.5	61.9	40.5	37.8	79.7	133.0	Below	Above	Below	Below	Below	Below	Below	
Nitrate (as N)	mg/L			1.0	*0.2*	*0.2*	2.2	1.1	3.8	3.6	0.6	-	-	-	-	-	-	-	-
Silver	mg/L			*0.0001*	*0.0001*	*0.0001*	*0.0001*	*0.0001*	*0.0001*	*0.0001*	*0.0001*	-	-	-	-	-	-	-	-
Aluminum	mg/L		5	0.370	0.031	0.075	0.367	0.117	0.050	0.021	0.059								
Beryllium	mg/L	0.1	0.1	*0.001*	*0.001*	*0.001*	*0.001*	*0.001*	*0.001*	*0.001*	*0.001*	Below	Below	Below	Below	Below	Below	Below	Below
Cadmium	mg/L		0.01	*0.0001*	*0.0001*	*0.0001*	*0.0001*	*0.0001*	*0.0001*	*0.0001*	*0.0001*								
Cobalt	mg/L		0.05	0.0003	*0.0001*	*0.0001*	0.0003	*0.0001*	*0.0001*	*0.0001*	*0.0001*								
Chromium	mg/L		0.1	*0.005*	*0.005*	*0.005*	*0.005*	*0.005*	*0.005*	*0.005*	*0.005*								
Copper	mg/L	0.2	1	0.0025	0.0034	0.0025	0.0025	0.0016	0.0009	0.0015	0.0030	Below	Below	Below	Below	Below	Below	Below	Below
Iron	mg/L		5	0.56	*0.03*	*0.03*	0.65	0.23	*0.03*	*0.03*	0.11								
Manganese	mg/L		0.2	0.086	0.023	0.01	0.083	0.062	0.029	0.022	0.057								
Molybdenum	mg/L		0.01	*0.001*	0.002	*0.001*	*0.001*	*0.001*	*0.001*	*0.001*	*0.001*								
Nickel	mg/L		0.2	*0.001*	0.001	*0.001*	*0.001*	*0.001*	*0.001*	*0.001*	*0.001*								
Lead	mg/L	0.2	0.5	*0.0005*	*0.0005*	*0.0005*	0.0007	*0.0005*	*0.0005*	*0.0005*	*0.0005*	Below	Below	Below	Below	Below	Below	Below	Below
Vanadium	mg/L		0.1	*0.0005*	*0.0005*	*0.0005*	*0.0005*	*0.0005*	*0.0005*	*0.0005*	*0.0005*								
Zinc	mg/L	1	5	0.005	0.007	0.003	0.011	0.023	*0.002*	0.003	0.010	Below	Below	Below	Below	Below	Below	Below	Below
Fecal Coliform	CFU/100			35	48	*1*	24	50	27	86	29								
Total Coliform	CFU/100			2600	230	150	200	70	50	220	80								

Notes: PWQO = Provincial Water Quality Objective
ODWO = Ontario Drinking Water Objective
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SW3A was tested twice, the results are averaged.
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Table 3.8 - Evaluation of Selected Parameters - CLW

Parameter	Units	CLW		Laboratory Results at Station								Evaluation of Laboratory Results at Station - CLW							
		Min.	Max.	3A	3B	3C	4A	4B	4C	4D	5	3A	3B	3C	4A	4B	4C	4D	5
Lab. pH	-			8.36	8.58	8.06	8.40	8.33	8.30	8.45	8.47	-	-	-	-	-	-	-	-
Total Dissolved Solids	mg/L		3000	320	1736	338	386	334	261	421	489								
Total Phosphorus	mg/L			0.045	0.010	0.052	0.171	0.023	0.011	0.009	0.012	-	-	-	-	-	-	-	-
Chloride	mg/L			45.0	905.0	93.5	61.9	40.5	37.8	79.7	133.0	-	-	-	-	-	-	-	-
Nitrate (as N)	mg/L			1.0	*0.2*	*0.2*	2.2	1.1	3.8	3.6	0.6	-	-	-	-	-	-	-	-
Silver	mg/L			*0.0001*	*0.0001*	*0.0001*	*0.0001*	*0.0001*	*0.0001*	*0.0001*	*0.0001*	-	-	-	-	-	-	-	-
Aluminum	mg/L		5	0.370	0.031	0.075	0.367	0.117	0.050	0.021	0.059								
Beryllium	mg/L			*0.001*	*0.001*	*0.001*	*0.001*	*0.001*	*0.001*	*0.001*	*0.001*	-	-	-	-	-	-	-	-
Cadmium	mg/L	0.02	0.05	*0.0001*	*0.0001*	*0.0001*	*0.0001*	*0.0001*	*0.0001*	*0.0001*	*0.0001*	Below	Below	Below	Below	Below	Below	Below	Below
Cobalt	mg/L		1	0.0003	*0.0001*	*0.0001*	0.0003	*0.0001*	*0.0001*	*0.0001*	*0.0001*								
Chromium	mg/L		1	*0.005*	*0.005*	*0.005*	*0.005*	*0.005*	*0.005*	*0.005*	*0.005*								
Copper	mg/L	0.5	1	0.0025	0.0034	0.0025	0.0025	0.0016	0.0009	0.0015	0.0030	Below	Below	Below	Below	Below	Below	Below	Below
Iron	mg/L			0.56	*0.03*	*0.03*	0.65	0.23	*0.03*	*0.03*	0.11	-	-	-	-	-	-	-	-
Manganese	mg/L			0.086	0.023	0.01	0.083	0.062	0.029	0.022	0.057	-	-	-	-	-	-	-	-
Molybdenum	mg/L		0.5	*0.001*	0.002	*0.001*	*0.001*	*0.001*	*0.001*	*0.001*	*0.001*								
Nickel	mg/L		1	*0.001*	0.001	*0.001*	*0.001*	*0.001*	*0.001*	*0.001*	*0.001*								
Lead	mg/L	0.1		*0.0005*	*0.0005*	*0.0005*	0.0007	*0.0005*	*0.0005*	*0.0005*	*0.0005*	-	-	-	-	-	-	-	-
Vanadium	mg/L		0.1	*0.0005*	*0.0005*	*0.0005*	*0.0005*	*0.0005*	*0.0005*	*0.0005*	*0.0005*								
Zinc	mg/L	25	50	0.005	0.007	0.003	0.011	0.023	*0.002*	0.003	0.010	Below	Below	Below	Below	Below	Below	Below	Below
Fecal Coliform	CFU/100			35	48	*1*	24	50	27	86	29								
Total Coliform	CFU/100			2600	230	150	200	70	50	220	80								

Notes: PWQO = Provincial Water Quality Objective
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SW3A was tested twice, the results are averaged.
Results shown in italics represent measurements below detection limit shown.

The PWQO for iron was also exceeded on the main branch downstream of the corridor. As relatively little of the total runoff at this site originates from within the corridor, it is unlikely that the corridor contributes significantly to this high concentration.

The objective range for pH, which reflects the hydrogen ion concentration, was marginally exceeded at site 3B indicating a basic (pH > 7) character of the water. This range has been set for the protection of aquatic life. Values for most sites with the exception of 3C were found to be near the upper limit of this range.

Total coliform was exceeded at site 3A and was found to be an order of magnitude above other sites. Possible contributions of coliform could be poorly maintained septic systems and manure storage near watercourses.

Table 3.6 compares sampling results to Provincial Drinking Water Objectives (PDWO's). Only manganese was exceeded at site 5 in the East Sixteen Mile Creek.

Manganese was also exceeded within the Middle Sixteen Mile Creek Tributary system at 4A and 4B, sites at which high iron concentrations were also found. Nitrate levels were exceeded at all sites within this system, with highest concentrations found in the tributaries upstream of the study corridor. Nitrates are primarily derived from atmospheric nitrogen through a sequence of conversions that ultimately result in the complete oxidation of nitrogen compounds to nitrate. Nitrates are found in almost all natural waters at concentrations that do not exceed 5 mg/L (as N). However concentrations above 2 mg/L (as N) may be indicative of external sources of contamination that may include fertilizers, drainage from barnyards, feedlots, septic systems and cesspools.

Within the Middle Sixteen Mile Creek system, manganese was also exceeded at the 3A, again a site with high iron levels. Again, this constituent likely originates from upstream of the corridor. Chloride concentrations were greatly exceeded at site 3A downstream of the corridor - these concentrations also result in high total dissolved solids concentrations which also exceed recommended values. The source of this contamination is reasonably runoff from the Highway 401 where winter maintenance activities include the application of chloride compounds for de-icing purposes.

Table 3.7 compares monitoring results to Criteria for Irrigation Waters (CIW). In general, all watercourses tested are not ideally suited as irrigation sources due to deficiencies in chloride, beryllium, copper, lead, zinc, and total dissolved solids. Site 3A, discussed above, exceeds the recommended range for chloride concentration. Similarly, **Table 3.8** indicates that the watercourses are not ideally suited for livestock watering due to deficiencies in trace constituents such as cadmium, copper and especially zinc which is several orders of magnitude below the recommended range.

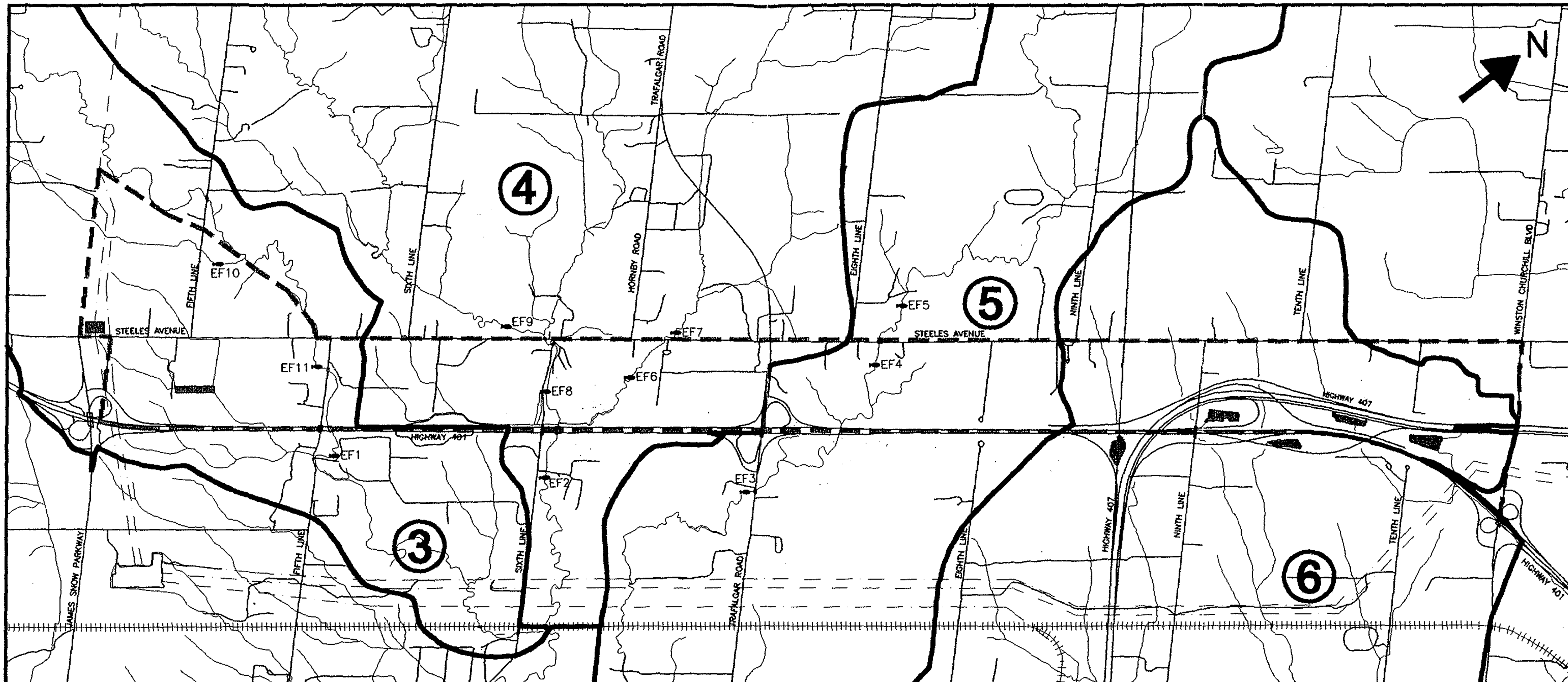
Organochlorine pesticide scans were performed on all samples. Results indicated levels well below provincial water quality objectives. This is consistent with dry weather sampling performed as part of the Lisgar water quality study (see **Section 2.6**).

In addition to the laboratory analysis described above, continuous dissolved oxygen, DO, and temperature measurements were taken at three locations, on the main branches of Subwatershed 3, 4, and 5. These monitoring site located immediately downstream of the proposed development corridor are also indicated on **Figure 3.5**. Ideally, DO monitoring is conducted in the summer season when extreme minimum values are observed, however the timing of the current study precludes monitoring in that period.

A summary of results for the monitoring performed in the spring of 1999 is provided in **Table 3.9**. Detailed results are provided in **Appendix B**. Generally, results indicate a high degree of oxygen saturation at all three sites.

Table 3.9 - Spring 1998/1999 Dissolved Oxygen Monitoring Summary

Location	Dissolved Oxygen Concentration (mg/L)			
	Average	Maximum	Minimum	Range
Middle Sixteen Mile Creek (Site 3)	12.6	13	12	1
Middle Sixteen Mile Creek Tributary (Site 4)	13.7	14.6	12	2.6
East Sixteen Mile Creek (Site 5)	11.4	12.1	10.8	1.3



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LEGEND

SCALE 1:25000

- WATERCOURSE
- 3 SUBWATERSHED NUMBER
- SUBWATERSHED BOUNDARY
- 401 CORRIDOR PLANNING AREA
- STORMWATER MANAGEMENT POND
- CPR RAIL LINE
- HYDRO LINE
- EF1 ELECTROFISHING LOCATIONS (APPROX. 50m REACHES)

401 CORRIDOR INTEGRATED PLANNING PROJECT
SCOPED SUBWATERSHED STUDIES

AQUATIC SAMPLING LOCATIONS

FIGURE 3.6

3.6 Aquatic Environment

Field investigations were conducted on December18, 1998, January 5 and February 26, 1999 to determine the status of the streams (i.e., flowing, intermittent, drainage). Electrofishing was conducted on April 10th and 12th and benthic sampling will be conducted in the May 1999 when conditions are conducive to this type of investigation. Results of the field investigations are presented below for each creek and tributary.

East Sixteen Mile Creek

The main tributary of East Sixteen Mile Creek enters the study area from the north, west of Eighth Line. Upstream reaches (north of Steeles) flow through agricultural fields. South of Steeles Avenue, the creek flows through a woodlot. Channel width is approximately 6m and substrate is a mix of gravel, sand and silt. Two small tributaries empty into this stream, from the east and west. Channels are not well defined and there was no observable flow in either of these tributaries at the time of the survey. There is a considerable amount of habitat diversity throughout the study area. Bankfull width is approximately 10m, with active channel width ranging from 4 m to 6 m. There is good overhead and instream cover in the form of trees and deadfall, and a few areas of undercut banks, although some channel braiding is also occurring, As the creek approaches Highway 401, substrate consists of gravel and silt, with some emergent vegetation. Bankfull width in this area is approximately 5 m, with an active channel width of 1-3m. There are several riffle areas, with cobble, gravel and aquatic plants. As it enters the Highway 401 crossing, which consists of two 10m box culverts, the channel widens to 5-8m. The stream flows in a 0.5m channel in the eastern box and as it passes through, the flow meanders immediately to the west opening of the culvert. Bankfull widths are 1-1.5 m with an active channel width of 0.5 m, over primarily cobble substrate.

Three reaches of this tributary were sampled with electrofishing equipment. One site was located within the study area (EF4) (see **Figure 3.6** for locations), the other two sites were upstream, north of Steeles Avenue (EF5) and downstream, south of Highway 401 (EF3). Results of the sampling program are listed in **Table 3.10.** The fish community observed within these sites was composed entirely of pollution tolerant species such as creek chub (*Semotilus atromaculatus*), blacknose dace (*Rhinichthys atratulus*), white sucker (*Catostomus commersoni*), brook stickleback (*Culaea* inconstans) and johnny darter (*Etheostoma nigrum*). All of the species are abundant throughout southern Ontario and are found in a wide range of habitats. Biodiversity was low with only two species captured at each of EF4 and EF5 and four species captured at EF3.

Table 3.10 - Electrofishing Results

Common Name	Scientific Name	Site Number										
		EF1	EF2	EF3	EF4	EF5	EF6	EF7	EF8	EF9	EF10	EF11
rainbow trout	*Oncorhynchus mykiss*	-	-	-	-	-	-	-	-	-	-	7
brook trout	*Salvelinus fontinalis*	-	1	-	-	-	-	-	-	1	-	-
white sucker	*Catostomus commersoni*	4	9	-	-	2	5	2	14	2	5	1
northern hogsucker	*Hypentelium nigricans*	2	2	-	-	-	-	-	1	-	-	4
common shiner	*Luxilus cornutus*	1	9	-	-	-	-	2	5	-	1	1
bluntnose minnow	*Pimephales notatus*	5	5	1	-	-	9	2	4	2	-	-
blacknose dace	*Rhinichthys atratulus*	15	5	-	5	-	28	2	20	4	28	18
creek chub	*Semotilus atromaculatus*	12	4	6	5	11	6	8	6	18	5	11
brook stickleback	*Culaea inconstans*	1	-	5	-	-	4	1	1	1	1	-
rock bass	*Ambloplites rupestris*	1	3	-	-	-	-	1	-	-	-	-
smallmouth bass	*Micropterus dolomieu*	-	-	-	-	-	-	1	-	1	-	-
rainbow darter	*Etheostoma caeruleum*	2	3	-	-	-	-	-	4	-	-	4
johnny darter	*Etheostoma nigrum*	30	27	3	-	-	9	11	14	5	-	12
Total number of species		10	10	4	2	2	6	9	9	8	5	8
Total number of fish		73	68	15	10	13	61	30	69	34	40	58

The Sixteen Mile Creek Watershed Plan designated this branch of Sixteen Mile Creek as potential coldwater and warmwater sportfish upstream of Steeles Avenue and downstream of Highway 401, respectively. Given the thickness (18 to 24 m) and low permeability of the clay till overburden in this area and the absence of overburden aquifer deposits, groundwater seepage to support coldwater species is unlikely. The fish species captured during this sampling program are indicative of warmwater baitfish communities.

Water depth on the sampling date ranged from .11-.20 metres and in-stream morphology consisted mainly of slow riffles and pools through the site.

Five watercourses, which are tributaries of the east branch of Sixteen Mile Creek, are located at the east end of the study area. Field investigations of these watercourses indicated that each one has been severely impacted by agriculture in the area. These watercourses are intermittent drainage swales with no defined channel present. One of the drains was lined with rip rap. All of these swales were dry at the time of field surveys and in most cases their location was confirmed only by the presence of a culvert crossing Steeles Avenue.

Middle Sixteen Mile Creek Tributaries

The Middle Sixteen Mile Creek Tributary includes the west and east branches, which converge just upstream of the study area and the Hornby Tributary which converges with the main tributary just upstream of Highway 401. The Hornby Tributary enters the study area through a highly channelized section, which flows between two residences. There is a complete lack of overhead/riparian cover and lawn mowing to the stream edges causing significant erosion and bank slumping. The creek flows southwest toward Highway 401 and its confluence with the Middle Sixteen Mile Creek Tributary. Bankfull width in this upper portion is approximately 3-4 m, with an active channel width of 1-1.5m. Substrate consists of a mix of boulders, cobble, gravel and some silt. There is little overhead cover throughout this reach but a few areas of instream woody debris were observed. There are also several sections where stands of trees provide overhead cover and shade. Bankfull width, active channel width and substrate do not appear to change significantly in the southern/ downstream reaches of the creek. As it approaches Highway 401, the creek meanders to the west, parallel to the highway. Active channel width was 2-3 m, and water depth in this area was 10-30 cm. This tributary continues to flow west until converging with the main branch of the tributary.

As mentioned previously, the west and east branches, as well as two first order tributaries converge at the northern end of the study area, to form the Middle Sixteen Mile Creek Tributary. The area to the north of the study area is heavily impacted by agriculture, and the watercourse is confined. The lack of vegetative cover has resulted in erosion in this area. As the tributaries converge and pass under Steeles Avenue, the resulting active channel width is approximately 8m and depth is 0.1m. Substrate in this area consists of silt, large cobbles, and submerged aquatic vegetation. A short distance from the Steeles Avenue crossing the creek meanders sharply east and is joined by another small tributary. This flows under Steeles Avenue through a 500 mm diameter culvert. A 0.5m dropoff at its downstream end may constitute a barrier at low flow. The creek then meanders south and passes through a park/picnic area. The steep eastern bank is covered with rip-rap, and substrate consists primarily of large (10cm) cobble. It flows south in a straight 2-3m wide channel and two riffles have been created with the large cobble. As the creek begins a meander to the east, out of the park, wooded overstorey vegetation becomes more abundant. Substrate in the lower reaches, toward Highway 401 consists primarily of cobble, approximately 5cm in diameter, with some silt. Bankfull width is approximately 8 m, with an active channel width of 6-8 m. The creek flows under the highway through an 8m x 8m wide box culvert. Fish passage through the culvert appears good.

Five fish sampling sites were randomly selected on the Middle Sixteen Mile Creek Tributary and the Hornby Tributary. Two sites (EF7 and EF9) were upstream of the study area, one site (EF2) was downstream of the study area and the remaining two sites (EF8 and EF6) were within the study area. The warmwater baitfish community designated for these areas in the Sixteen Mile Creek Watershed Plan was represented by the presence of white sucker, bluntnose minnow, blacknose dace and creek chub. However, in addition to these species, a single brook trout (*Salvelinus fontinalis*) and several rainbow darter (*Etheostoma caeruleum*) were captured at two of the sites (EF2 and EF9). Both of these species, particularly brook trout, are indicative of coldwater habitat. While reports of brook trout exist, to date presence of this species has not been confirmed through this portion of the Sixteen Mile Creek Watershed. As the tributary lies directly above the basal aquifer, some limited contribution of groundwater (as indicated by baseflow and temperature monitoring) may contribute to necessary conditions for brook trout survival. Single rock bass (*Ambloplites rupestris*) and smallmouth bass (*Micropterus dolomieu*) were also captured at EF7 and EF9. The presence of these species is generally indicative of a warmwater sportfish designation. Further details of the fish species captured at these sites are presented in **Table 3.10**.

Middle Sixteen Mile Creek

The main branch of Middle Sixteen Mile Creek constitutes the edge of the study area west of Fifth Line and north of Steeles Avenue. The creek flows through wooded areas, and there is some deadfall and pools that likely provide in-stream cover. The land south of the creek has been heavily impacted by agricultural use and large areas of exposed soil and poor bank stability are present. Channel width through this area is approximately 5 m. As the Creek passes under Fifth Line, the bankfull width was approximately 10 m, with an active channel width of 4 m on the day of the field survey. Riffle/pool complexes are present and riparian vegetation provides a degree of overhead cover. East of Fifth Line the channel is eroding an area of steep, exposed soil before flowing through agricultural fields again. Active channel width through this reach was also 4 m. Through the study area the channel is characterized by bank instability, slumping and significant erosion. Riparian vegetation is limited to grasses and overhead cover is sparse. Stream morphology was dominated by pools, however, in several locations concrete blocks, large cobble and other debris had apparently been placed in the stream to create riffles. Substrate was mainly silt and clay.

Two sites were electrofished during the sampling program, one within the study area (EF11) and one south of Highway 401 (EF1). Fish species captured at EF1 were indicative of a warmwater baitfish community, as mentioned above, with the exception of a single rock bass and a pair of rainbow darters. Biodiversity was moderate. Species captured at site EF11 included most of the species previously mentioned as well as several rainbow trout (*Oncorhynchus mykiss*). The trout were clearly from two separate year classes as evidenced by two distinct length groups (13 cm and 20 cm). Middle Sixteen Mile Creek has been designated as coldwater habitat approximately 1 km north of Steeles Avenue. The size of the creek, abundant riparian vegetation and the potential for groundwater inflows north of the site likely contribute to create these conditions. South of this area, warmwater sportfish species have been identified. This recent sampling program is likely an indication that habitat is suitable for rainbow trout to move downstream through the southern reach, at least during spring conditions.

Other Tributaries

Mansewood Tributary

This tributary converges with Middle Sixteen Mile Creek north of Steeles Avenue and east of Fifth Line.

The section west of Fifth Line is surrounded by agricultural lands. The bankfull width is approximately 2m, with an active channel width of less than 0.5m. The creek passes through a concrete box culvert, approximately 2.5 m x 2.5 m, with no apparent barriers to fish passage. Upstream, the channel morphology consists of pools, small riffles and some overhead cover, however, it is heavily overgrown with grasses. Approximately halfway between Fifth Line and the western boundary of the study area, there is an old circular concrete culvert. This is in poor condition, and may block fish passage. A round corrugated metal culvert occurs approximately halfway between the previous culvert and the western side of the study area. Although at grade, this culvert does not appear to block fish passage. Downstream/east of the Fifth Line crossing, the creek enters a wide floodplain. Active channel width through this reach was about 1 m. The creek passes through a mature wooded area with little visible understorey. Substrate was a mixture of clay, silt and sand. Fish species captured at Site EF10 were warm water baitfish species including creek chub, blacknose dace and common shiner.

Highway 401 Tributary

This tributary consists of three branches which converge prior to entering a stormwater management pond immediately upstream of Highway 401. The two western branches which comprise Swale D3- 1 on **Figure 2.2** can be characterized as drainage swales. Each branch drains an expanse of agricultural fields through which it arises and then flows through a truck yard in the area. During field investigations, the westerly most branch which also drains the Milton industrial lands was flowing through a poorly defined channel. Some sparse riparian vegetation was present along its course. The other branch was dry.

The northern branch of this tributary arises approximately 500 metres north of Steeles Avenue and flows southeast before reaching Steeles. Here, the watercourse has been realigned to flow straight east and then south, accommodating the Cashway building and grounds. This watercourse was also flowing during field investigations in February but was dry during the April field survey. Active width was consistently 1.0 metres and water depth averaged 0.2 metres. An attempt to create riffles and meanders was made during realignment but it is unlikely that any branches of this tributary contribute to fish habitat because of the barriers created by the storm water management facility downstream.

3.7 Terrestrial Environment

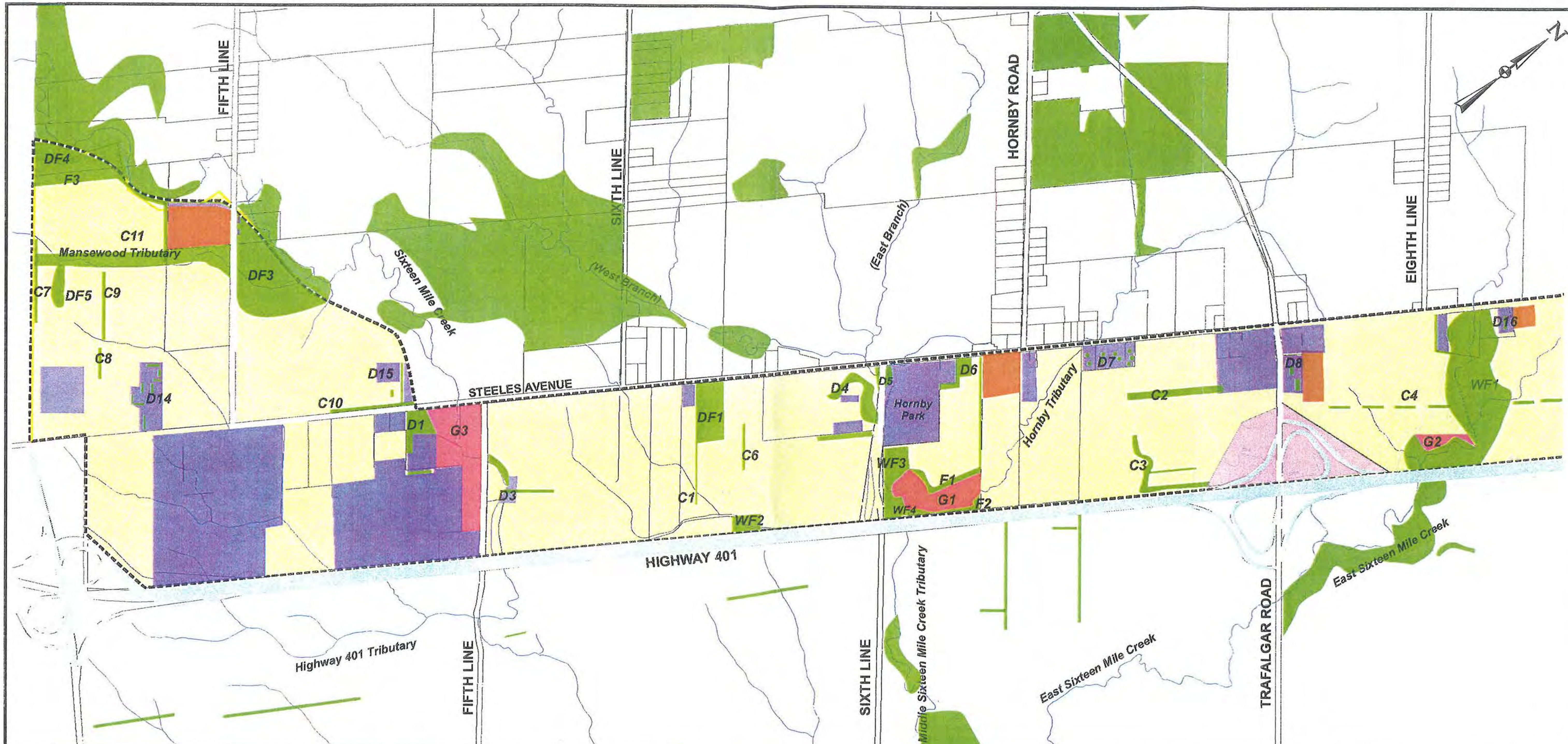
3.7.1 Vegetation

Agricultural Fields and Hedgerows

The description of the vegetation communities is based on recent boundary source information including 1995 air photography and field investigations.

The dominant vegetation community in the area is agricultural in nature and includes crop fields that are used for a rotation of corn *(Zea mays)*, soybean *(Glycine max)*, winter wheat *(Triticum aestivum)*, hay and pasture. Some fields have been abandoned near the Highway 407 area or have been developed for commercial purposes. Most of the fields are still in active agricultural use and some have well established hedgerows one to four trees thick. Dominant species include bur oak *(Quercus macrocarpa)*, hawthorn *(Crataegus spp.)*, white spruce *(Picea glauca)* and Norway spruce *(Picea abies)*. **Table 3.11** and **Figures 3.7a** and **3.7b** give a location and brief description of these hedgerow communities.

Table 3.11 - Description of Hedgerows in the Highway 401 Study Area	
Identification (see Figure 3.7)	**Description**
C1	Hedgerow of white spruce *(P. glauca)*, bur oak *(Q. macrocarpa)*, sugar maple *(Acer saccharum)*, white willow *(Salix alba)* and white cedar *(Thuja occidentalis)*. Some mature trees. Most trees ≥25 cm dhb.
C2	Hedgerow of (2-3 trees wide) of hawthorn *(Crataegus spp.)*, white elm *(Ulmus americana)*, Manitoba maple *(Acer negundo)*, staghorn sumac *(Rhus typhina)*, red oak *(Quercus rubra)*, basswood *(Tilia americana)*. Most trees approximately 25-30 cm dbh.
C3	Hedgerow of hawthorn *(Crataegus spp.)*, red oak *(Q. rubra)*, white elm *(U. americana)*, Manitoba maple *(A. negundo)*, sugar maple (*A. saccharum*) and Norway spruce *(P. abies)*. Most trees approximately 25-30 cm dbh.
C4	Hedgerow of hawthorn *(Crataegus spp.)*, white elm *(U. americana)*, red oak *(Q. rubra)*, basswood *(T. americana)*, bur oak *(Q. macrocarpa)*, black cherry *(Prunus serotina)*, Manitoba maple *(A. negundo)*. Few mature trees; most approximately 25 cm dbh.
C5	Hedgerow of mature deciduous trees
C6	Hedgerow of ten mature white spruce trees (approximately 90 cm dbh) as well as one bur oak *(Q. macrocarpa)* tree.
C7	Hedgerow of white pine *(Pinus strobus)* and Norway spruce (*P. abies*)
C8	Hedgerow of mature Norway spruce *(P. abies)* and bur oak *(Q. macrocarpa)*.
C9	Hedgerow of bur oak *(Q. macrocarpa)*, basswood *(T. americana)* and hawthorn *(Crataegus sp.)*. Many large mature trees.
C10	Hedgerow of white spruce *(P. glauca)* (3-4 m high).
C11	Riparian hedgerow Manitoba maple *(A. negundo)*, hawthorn *(Crataegus spp.)* white elm *(U. americana)*, bur oak *(Q. macrocarpa)*, basswood *(T. americana)*, sugar maple *(A. saccharum)*. Sparse clustering. Few mature trees.



LEGEND

Wooded	WF Wet Forest
Old Field	DF Deciduous Forest
Agricultural	C Hedgerow
Developed	D Plantings Around Residential, Commercial & Industrial Development
Wetland	F Conifer Forest
Right-of-Way	G Wet meadows/fields
	Example: DF1 = Deciduous forest #1

0 100 500 m

Approximate Scale: 1: 13,000

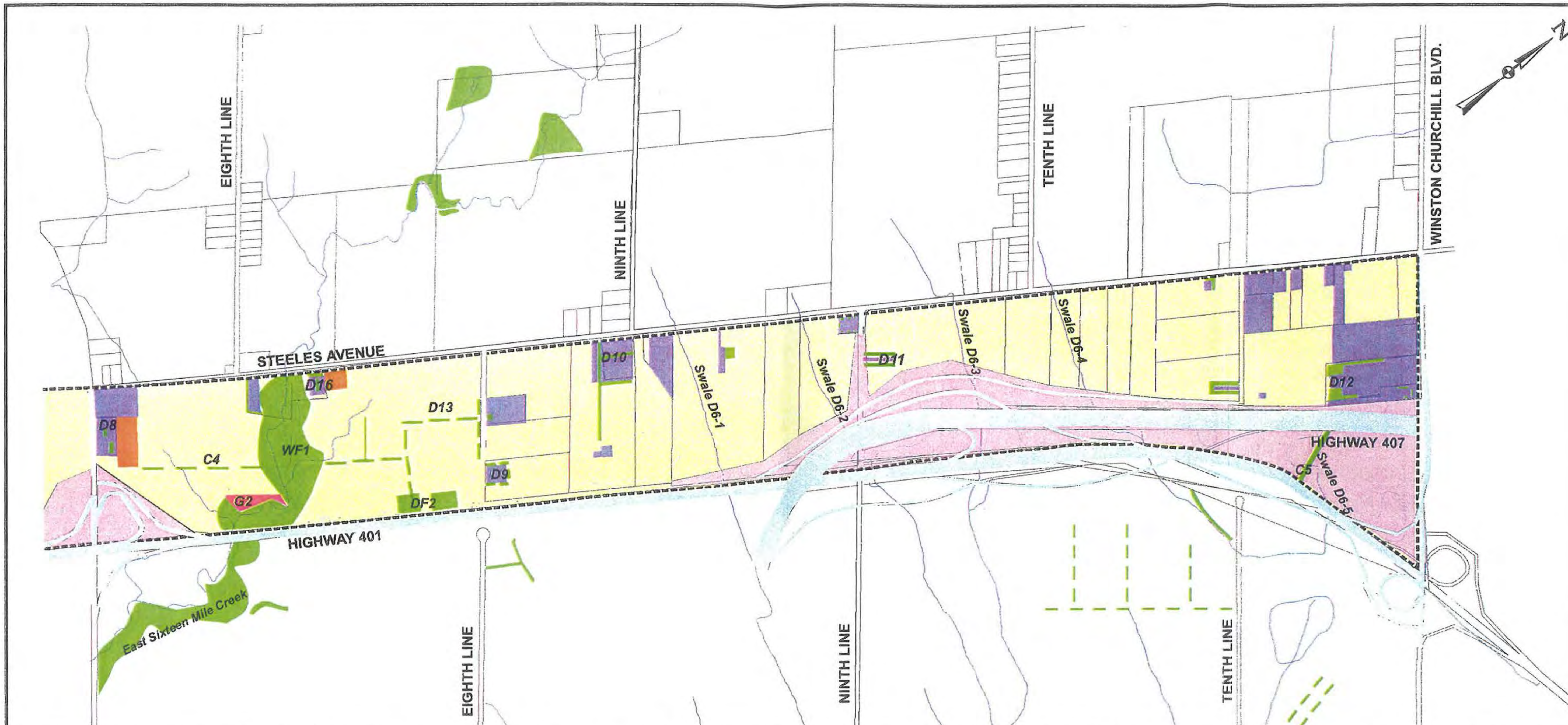
TOWN OF HALTON HILLS

DILLON CONSULTING

401 CORRIDOR INTEGRATED PLANNING PROJECT
SCOPED SUBWATERSHED STUDIES

EXISTING TERRESTRIAL BIOLOGY (WEST PORTION)

FIGURE 3.7A



LEGEND

Wooded		WF	Wet Forest
Old Field		DF	Deciduous Forest
Agricultural		C	Hedgerow
Developed		D	Plantings Around Residential, Commercial & Industrial Development
Wetland		F	Conifer Forest
Right-of-Way		G	Wet meadows/fields
			Example: DF1 = Deciduous forest #1

TOWN OF HALTON HILLS

DILLON CONSULTING

401 CORRIDOR INTEGRATED PLANNING PROJECT
SCOPED SUBWATERSHED STUDIES

EXISTING TERRESTRIAL BIOLOGY (EAST PORTION)

FIGURE 3.7B

Woodlots

Despite the long term agricultural activity that has occurred throughout the area, some remnant forested areas still remain and do provide habitat for the local areas wildlife protection. Most of these forests are within the creek or valley lands that cross through the study area. Several of the woodlands within the study area may be 'significant woodlands', as described in the Provincial Policy Statement. Size of woodland, in relation to the percentage of forest cover in the planning area and/or the regional landscape, is a factor used to determine the significance of a woodlot. Because of the low proportion of forest cover in the general study area, larger forests would be considered significant. These woodlots are shown on **Figures 3.7a** and **b** and are described below.

Although not categorized as significant areas, based on the Provincial Policy Statement, many of the small wooded areas and hedgerows provide benefits to the study area and the subwatersheds as a whole. These benefits include ecological stability, wildlife, economic value and aesthetics. Because of the low percentage of forest cover, these areas are particularly valuable to wildlife in the area; e.g., some of the hedgerows link small wooded areas to larger ones, while others link natural terrestrial areas to creeks. These features therefore improve habitat connectivity and decrease forest fragmentation. Because of this contribution, preservation these features is important and should be reflected in planning documents.

Wet Forest 1 (WF1)

This forest is one of the largest forests (approximately 7 ha) in the study area, and extends from Steeles Avenue to Highway 401. The forest is well established and provides protection for the creek valley. The species in this forest reflect the wet conditions provided by the creek and the dominant species in the area include willow *(Salix spp.)*, speckled alder (*Alnus icana* ssp. *rugosa*), red maple *(Acer rubrum)*, bur oak *(Q. macrocarpa)*, Manitoba maple *(A. negundo)* and trembling aspen *(Populus tremuloides)*. In the shrub layer, hawthorn was abundant and many riparian herbaceous species including joe-pyeweed *(Eupatorium maculatum)*, fringed loosestrife *(Lysimachia ciliata)* and purple vervain *(Verbena hastata)* were present.

Wet Forest 2 (WF2)

This small deciduous forest (0.7 ha) is directly adjacent to the Highway 401,to the east of the MTO truck inspection station. The ground is quite flat and wet. The dominant tree species are white elm *(U. americana)* and silver maple *(A. saccharinum)* with a few basswood *(T. americana)*, willow *(Salix spp.)* and oak *(Quercus spp.)* also present. Most trees are 15 to 20 cm diameter breast height (dbh).

Wet Forest 3 (WF3)

This wet forest area (approximately 1 ha) is at the south end of Hornby Park. A small creek runs along the western edge of the forest, beside the road. There are many crack *(Salix fragilis)* and white willow *(S. alba)*, silver maple *(A. saccharinum)*, Manitoba maple, *(A. negundo)* speckled alder *(A. incana ssp. rugosa)* and basswood *(T. americana)* trees along the creek. To the northeast, where the forest merges with the park, the ground is drier. In this transitional area, there are large spaces between the trees, and the ground cover is dense with reed canary grass being the dominant species.

Wet Forest 4 (WF4)

This narrow band of wet forest (approximately 0.2 ha) is bordered by the Highway 401 to the south and a wet meadow to the north. The dominant tree species are balsam poplar *(Populus balsamifera)* and hawthorn *(Crataegus spp.)*. The canopy is moderately open which has resulted in dense ground cover.

Deciduous Forest 1 (DF1)

This mature hardwood forest is approximately 1.5 ha. Along the eastern and southern edges the ground is somewhat wet, whereas the majority of the forest is more dry. The dominant species in the dry portion are sugar maple*(A. saccharum)*, walnut *(Juglans nigra)*, beech *(F. grandifolia)* and white ash *(Fraxinus americana)*. There are many mature trees some of which reach 90+ cm dbh and the understorey is dense with saplings of the overstorey. The edge is wetter and contains many trembling aspen *(P. tremuloides)*, apple *(Malus spp.)*, white ash *(F. americana)* and white elm *(U. americana)* trees.

Deciduous Forest 2 (DF2)

This small tract of forest (approximately 1.6 ha), with a large clearing in the middle, contains many different mature tree species. The dominant tree species are bur oak *(Q. macrocarpa)* and white ash *(F. americana)*, but white pine *(P. strobus)*, basswood *(T. americana)*, and sugar maple *(A. saccharum)* are also present. A mature shagbark hickory tree *(Carya ovata)*, a Carolinian species, is also present in this forest. The understorey is dense with hawthorn and buckthorn *(Rhamnus spp.)*.

Deciduous Forest 3 (DF3)

This forest area, covering approximately 4.5 ha, is dominated by deciduous trees including sugar maple *(A. saccharum)*, white oak *(Quercus alba)*, red oak *(Q. rubra)*, beech *(F. grandifolia)*, white pine *(P. strobus)* and hop hornbeam *(Ostrya virginiana)* that surround a creek. The area directly adjacent to the creek is open and contains very few trees. The forest surrounding the open area contains many mature trees including hop hornbeam *(O. virginiana)*, basswood *(T. americana)*, sugar maple *(A. saccharum)* and red oak *(Q. rubra)*. The understorey appears to have been disturbed because there are very few trees under 3 m tall and the ground cover is dominated by grasses. It should be noted that a new electric fence had recently been installed along the fence line suggesting that cattle may be pasturing in the area and causing damage to the understorey.

Mixed Forest (DF4)

This forested area, covering approximately 1 ha, is a small portion of a larger forest. The southern part of the forest which is on a north facing slope contains hemlock *(Tsuga canadensis)*, sugar maple *(A. saccharum)* and trembling aspen *(P. tremuloides)*. At the bottom of the slope there is a small stream. To the north of this stream the forest is mainly composed of deciduous trees, including sugar maple *(A. saccharum)*, hop hornbeam *(O. virginiana)* and white ash *(F. americana)*.

Deciduous Forest (DF5)

This small wooded area (approximately 0.5 ha) contains bur oak (*Q. Macrocarpa*), beech (*Fagus Grandifolia*), hawthorn (*Crataegus sp.*), and silver maple (*A. Saccharinum*). There are many large trees however most of these have suffered wind damage.

Conifer Forest F1

A narrow band of forest (approximately 0.5 ha) dominated by conifers covers a small slope to the north of a wet field (G1). The dominant species in this forest are Norway spruce *(P. abies)*, red pine *(Pinus resinosa)* and pitch pine *(Pinus rigida)*. In addition, there are a few deciduous trees, including sugar maple *(A. saccharum)* and hawthorn *(Crataegus spp.)*, mixed in on the southern edge.

Conifer Forest F2

To the southeast of the above conifer forest (F1) is another small patch of forest (approximately 0.35 ha) that is dominated by conifer trees. This forest is bordered by a creek to the northwest and the 401 to the south. The dominant tree species include red pine *(P. resinosa)* and Norway spruce *(P. abies)*. A few willow *(Salix spp.)* and speckled alder *(A. incana ssp. rugosa)* are also present in this forest.

Conifer Forest F3

This white pine *(P. strobus)* plantation (approximately 0.9 ha) is situated between a mixed forest (DF4) and an agricultural field. The plantation is approximately 30 m wide with trees planted in rows. Along the southern edge, there are a few sugar maple trees *(A. saccharum)*.

In some areas, water has accumulated creating saturated soils that favour the development of riparian species including reed canary grass *(Phalaris arundinacea)*, common reed grass *(Phragmites communis)* , broad leaved cattail *(Typha latifolia)* and narrow leaved cattail *(Typha angustifolia)*. Those areas are relatively small in area but do contribute to the diversity of habitat in the area.

Wet Meadows/Fields

Wet Meadow/Field G1

This wet field is at the bottom of a slope covered by conifer trees (F1). The field covers an area that is mainly flat. In addition to the species that are commonly found in old fields (grasses and golden rods *(Solidago spp.)*) cattails (*Typha* spp.) are also present.

Wet Meadow/Field G2

Next to the southern end of one of the largest forest areas in the study area is another wet meadow/ field similar to G1. This wet field is at the bottom of a slope and contains common old field species as well as cattails (*Typha* spp.).

Wet Meadow/Field G3

This wet area is directly south of Steeles Avenue and just to the east of a house that is surrounded by a small mature forest containing Scots pine *(Pinus sylvestris)*, basswood *(T. americana)*, beech *(F. grandifolia)* and sugar maple *(A. saccharum)* (D1). Broadleaved *(T. latifolia)* and narrow-leaved cattails *(T. angustifolia)* are the most common species in this area, with few other species present.

Ornamental Plantings Around Residential, Commercial and Recreational Development

Most of the trees around the built up areas are in rows, however some have trees scattered throughout the property (D2, D7, D8, D12). In many cases the rows of trees are dominated by conifer trees such as spruce (D2, D3, D4, D6, D10, D11) and cedar (D4, D9). In other cases the trees are predominantly deciduous (D5, D8, D10, D12).

One significant built up area to note is a forested area surrounding the house on D1. On this property there is a hedgerow that is 2-3 trees wide along the western boundary. In addition to this hedgerow there is a small portion of an old deciduous forest in the northeast corner of the property. This small forested area contains many mature trees of significant height, including walnut *(J. nigra)* and sugar maple *(A. saccharum)*.

3.7.2 Wildlife

The wildlife that are in the area are typical of those found in agricultural landscapes with fragmented forests.

Two coyotes were observed in a wet meadow (G2) near a large forest (WF1). In addition, tracks of deer *(Odocoileus virginianus)*, coyote *(Canis latrans)*, raccoon *(Procyon lotor)* and cottontail *(Sylvilagus floridanus)* were found in many of the forest areas. Scat from deer and cottontails was also encountered throughout the study area. Black-capped chickadees *(Parus atricapillus)* were observed in many of the conifer trees and a red tailed hawk *(Buteo jamaicensis)* was observed above one of the hedgerows (G2).

Tables 3.12, 3.13 and 3.14 provide a list of the mammals, herpetofuna and birds that are in the study area based on incidental sightings or other evidence.

Table 3.12 - Mammals Present Within Study Area		
Common Name	**Scientific Name**	**Presence**
Grey squirrel	*Sciurus carolinensis*	sighting
Ground hog	*Marmota monax*	burrow
Eastern chipmunk	*Tamias striatus*	sighting
Vole species	*Microtus* species	nests
Eastern cottontail	*Sylvilagus floridanus*	scat
White tailed deer	*Odocoileus virginianus*	tracks
Striped skunk	*Mephitis mephitis*	corpse, odour
Red fox	*Vulpes fulva*	sighting
Coyote	*Canis latrans*	sighting
Raccoon	*Procyon lotor*	corpse
Red Squirrel	*Tamiasciurus hudsonicus*	sighting

Table 3.13 - Herpetofauna Present Within Study Area	
Common Name	**Scientific Name**
American toad	*Bufo americanus*
Northern Leopard frog	*Rana pipiens*
Wood frog	*Rana sylvatica*
Green frog	*Rana clamitans*
Common gray treefrog	*Hyla chrysoscelis/versicolor*
Common garter snake	*Thamnophis sirtalis*

Table 3.14 - Birds Present Within Study Area

Order	Family	Sub-Family	Scientific Name	Common Name
Anseriformes	Anatidae	Anserinae	*Branta canadensis*	Canada Goose
		Anatinae	*Anas platyrhynchos*	Mallard
Falconiformes	Acciputridae	Buteoninae	*Buteo jamaicensis*	Red-tailed hawk
		Circinae	*Circus cyaneus*	Northern harrier
Charadriiformes	Charadriidae		*Charadrius vociferus*	Killdeer
	Scolopacidae			Spotted sandpiper
	Sittidae		*Sitta carolinensis*	White-breasted nuthatch
Columbiformes	Columbidae		*Columba livia*	Rock dove
			Zenaida macroura	Mourning dove
Piciformes	Picidae		*Picoides pubescens*	Downy woodpecker
			Picoides villosus	Hairy woodpecker
			Colaptes auratus	Common "yellow shafted" flicker
Passeriformes	Bombycillidae		*Bombycilla cedrorum*	Cedar waxwing
	Coruidae		*Cyanocitta cristata*	Blue jay
			Corvus brachyrhynchos	American crow
	Fringillidae		*Cardinalis cardinalis*	Northern cardinal
			Carduelis tristis	American goldfinch
			Passerculus sandwichensis	Savannah sparrow
			Melospize melodia	Song sparrow
	Hirundinidae		*Hirundo pyrrhonota*	Cliff swallow
			Progne subis	Purple martin
	Paridae		*Parus atricapillus*	Black-capped chickadee
	Ploceidae		*Passer domesticus*	House sparrow
	Leteridae		*Sturnella magna*	Eastern meadow lark
			Agelaius phoeniceus	Red-winged blackbird
			Icterus galbula	Northern oriole
	Sturnidae		*Sturnus vulgaris*	European starling
	Turdidae		*Turdus migratorius*	American robin
	Tyrannidae		*Tyrannus tyrannus*	Eastern kingbird

4. SUBWATERSHED CHARACTERIZATION

This section summarizes the significant natural heritage, environmental protection and hazard features in the Subwatershed and discusses opportunities for protection, enhancement and rehabilitation of the environment, as well as identifying constraints to development. It is noted that similar analyses was conducted as part of the Gateway West Subwatershed Study in order to characterize the Mullett Creek subwatershed features on a larger scale. Additional local characterization is provided below as a result of the 401 Corridor study findings, where appropriate. In all cases, these findings concur with those of the Gateway study, e.g., there are no terrestrial or aquatic functions within the local Mullett Creek tributaries. For characterization of elements requiring subwatershed-wide analysis (e.g., regional erosion and hydrologic analyses), the reader is referred to the Gateway study.

4.1 Hydrology

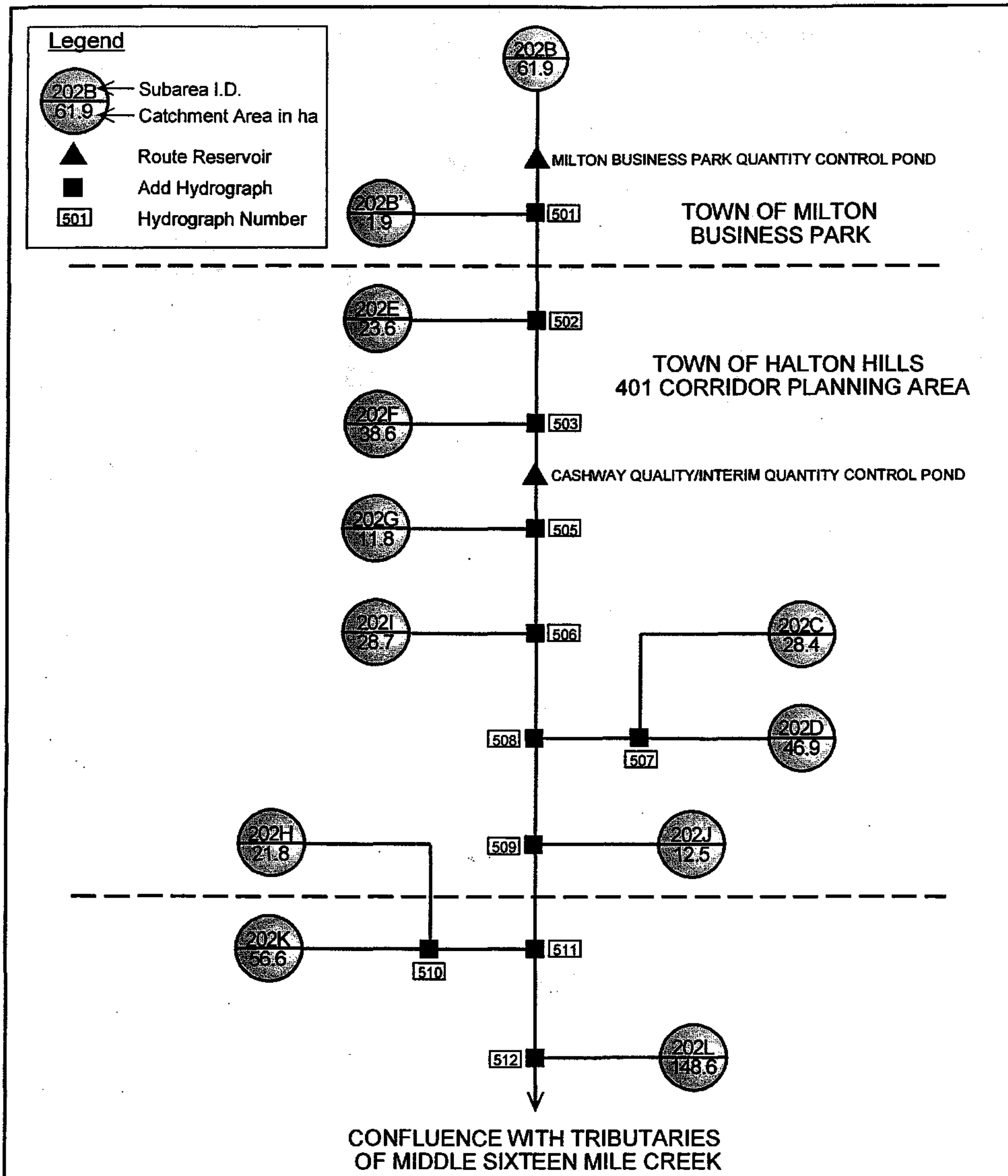
4.1.1 Local Design Flows

In order to effectively analyze local hydrologic conditions in the vicinity of the proposed development corridor, an OTTHYMO89 hydrologic model was developed as part of the 401 Corridor study. The OTTHYMO89 model was chosen above the QUALHYMO model used in the overall watershed analyses due to its ability to handle smaller computational time steps associated with the smaller study area. OTTHYMO89 model schematics for each subwatershed area are shown on **Figures 4.1, 4.2 and 4.3**. The model input and summary output files are included in **Appendix D**.

A summary of design flows simulated using the Town of Halton Hills design standard rainfall events is presented in the following **Table 4.1**. Flow reference location area indicated on **Figure 4.4**. These existing condition flows (or combinations thereof) may be used as target release rates for proposed storm water management facilities in order to meet water quantity control objectives of the Watershed Plan.

Table 4.1 - Local OTTHYMO89 Design Flow Rates (cms)

Reference Location Refer to Fig. 4.4	NHYD	Design Event						
		25 mm	2 year	5 year	10 year	25 year	50 year	100 year
A	501	0.20	0.34	0.48	0.68	1.29	1.89	2.57
B	102	0.20	0.50	0.88	1.19	1.59	1.91	2.22
C	200	0.05	0.11	0.20	0.26	0.34	0.41	0.47
D	208	0.17	0.4	0.7	0.93	1.24	1.48	1.71
E	205	0.08	0.20	0.36	0.48	0.66	0.81	0.93
F	906	0.64	1.67	2.84	3.35	5.25	6.35	7.45
G	400	0.18	0.46	0.80	1.07	1.43	1.71	1.98
H	403	0.35	0.89	1.57	2.11	2.83	3.38	3.93
I	406	0.43	1.07	1.89	2.54	3.40	4.06	4.72
J	409	0.23	0.59	1.03	1.39	1.86	2.23	2.59
K	414	0.12	0.32	0.55	0.74	0.98	1.17	1.36
L	109	0.16	0.4	0.71	0.95	1.26	1.51	1.75
M	513	0.7	3.05	5.73	7.19	9.8	11.89	14.29
N	505	0.15	1.65	3.69	4.84	6.34	7.64	9.24
O	105	0.44	1.05	1.94	2.67	3.61	4.42	5.14
P	600	0.33	0.83	1.43	1.91	2.54	3.02	3.50
Q	302	0.21	0.52	0.91	1.22	1.63	1.94	2.25
R	800	0.44	1.11	1.94	2.6	3.47	4.13	4.8
S	804	0.65	1.54	2.66	3.39	4.51	5.37	6.21
T	806	0.54	1.36	2.40	3.22	4.31	5.15	5.99
U	809	0.37	0.92	1.62	2.18	2.93	3.50	4.07
V	412	0.22	0.56	0.99	1.34	1.8	2.15	2.51



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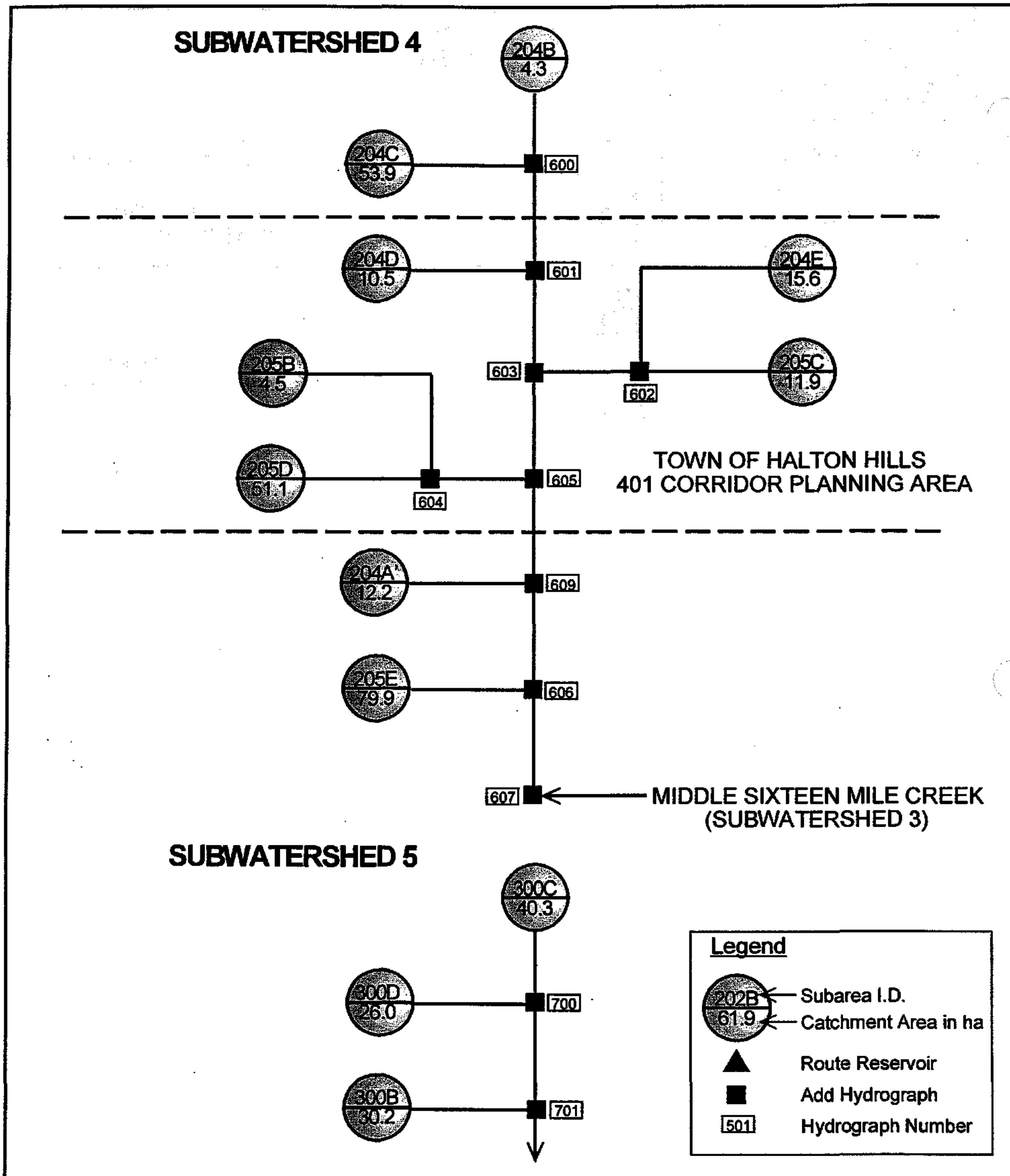
OTTHYMO MODEL SCHEMATIC - SUBWATERSHED 3

FIGURE 4.1



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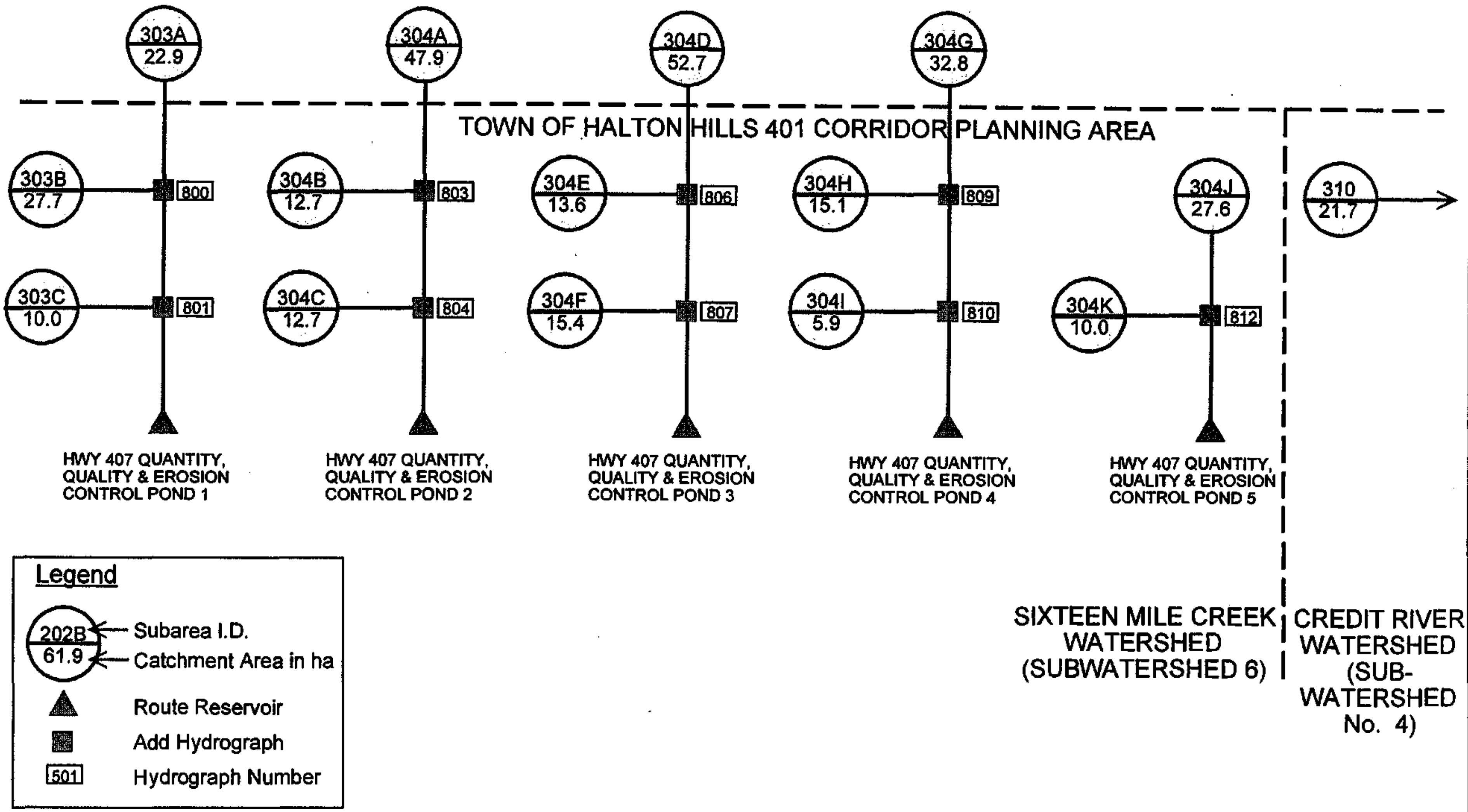
OTTHYMO MODEL SCHEMATIC - SUBWATERSHED 4 AND 5

FIGURE 4.2



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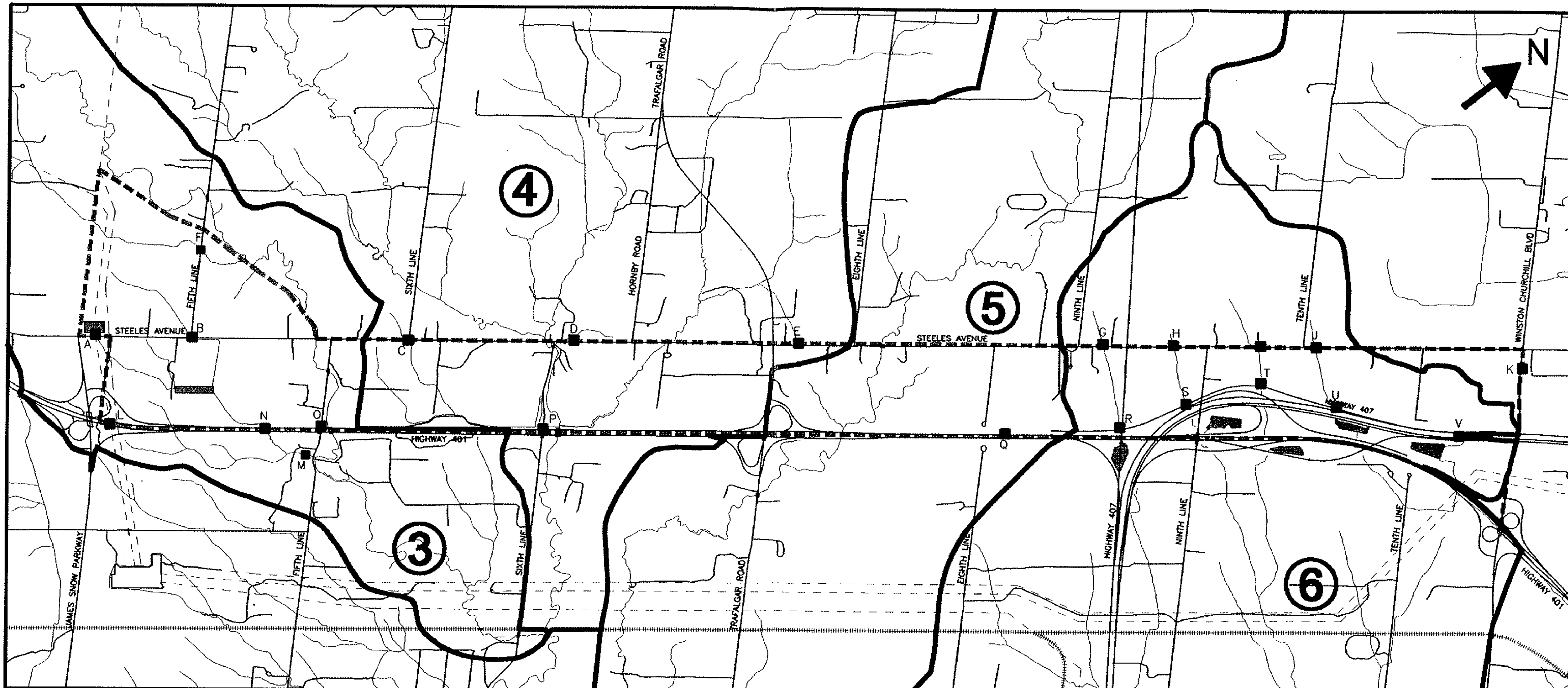
SCOPED SUBWATERSHED STUDIES

OTTHYMO MODEL SCHEMATIC - SUBWATERSHED 6 & MULLETT CREEK SUBWATERSHED

FIGURE 4.3



LEGEND

SCALE 1:25000

WATERCOURSE

③ SUBWATERSHED NUMBER

SUBWATERSHED BOUNDARY

401 CORRIDOR PLANNING AREA

STORMWATER MANAGEMENT POND

CPR RAIL LINE

HYDRO LINE

S FLOW REFERENCE POINT

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SCOPED SUBWATERSHED STUDIES

OTTHYMO FLOW REFERENCE LOCATIONS

FIGURE 4.4

4.1.2 Hydraulic Structure Capacities

Culvert and bridge capacities for main crossings have been determined through hydraulic analyses. The HEC-2 models developed for floodline mapping were used for the bridge structures, while Culvert Master was used at remaining locations. Results are summarized in **Table 4.2** while full details are presented in **Appendix C.**

Results summarized in the table indicate that all Highway 401 crossings have adequate hydraulic capacities (Structure No.'s 33, 34, and 35). Two of the Steeles Avenue crossings, No. 3 (Middle Sixteen Mile Creek) and No. 10 (East Sixteen Mile Creek) have adequate capacity to convey the 100-year design flows with the allowable freeboard. Limited capacity is available at the other two Steeles Avenue crossings (No. 6, Middle Sixteen Mile Creek Tributary and No. 8, Hornby Tributary) where 5 to 10-year capacities are available. Any design for reconstruction of these or other culverts should be such that there is no obstruction to fish migration.

Ultimate improvements to Steeles Avenue, i.e., widening or profile improvements, will require that the Middle Sixteen Mile Creek Tributary and the Hornby Tributary crossings be improved to provide conveyance of the respective 100-year design flow rates. As the Middle Sixteen Mile Creek has been designated as a "Natural Corridor", and the Hornby Tributary has been designated as a "Secondary Linkage" within the Natural Heritage System, redesign of these and any other structures (e.g., Steeles Avenue widening) should have due consideration for the improvement of wildlife passage. Similar consideration should be given at Structure No. 25 at Fifth Line, immediately downstream of Structure No. 6, which also has an inadequate flow capacity (5-year).

4.1.3 Storm Water Facility Capacities

There are currently six stormwater management facilities in operation within the study corridor, including five facilities within the Highway 407 - Highway 401 interchange, and an additional facility located immediately upstream of the corridor, controlling runoff from the Milton Business Park area.

Table 4.2 - Bridge and Culvert Hydraulic Capacity Assessment

Structure No. Refer to Fig. 3.1	Location	Culvert Details	Freeboard	AWH Elevation	Flow Capacity	Design Capacity	Rating
1	Swale 3-1/Milton Pond, 126 m East of James Snow Parkway	Twin 900 mm C.S.P.'s	0.3	207.7	2.004	50 year	AD
2	Swale 3-2, 15 m West of Fifth Line North	970 x 1390 mm C.S.P.A.	0.3	205.13	2.806	100 year	AD
3	Middle Sixteen Mile Creek, 97 m West of Fifth Line South	2.1 x 12.2 m Concrete Bridge	0.3	196.3	50.24	100 year	AD
4	Swale 4-1, 10 m West of Sixth Line North	900 mm C.S.P.	0.3	* 101.38	1.185	100 year	AD
6	Middle Sixteen Mile Creek Tributary, 55 m West of Sixth Line South	1.98 x 9.0 m Concrete Bridge	0.3	193	26.86	5 year	IN
7	Swale 4-3, 100 m East of Sixth Line South	750 mm C.S.P.	0.3	* 101.77	1.037	10 year	AD
7&7A	Swale 4-3, Enclosure through park, outlet into Tributary D/S of Structure #25	750 mm C.S.P.	0.3	* 101.77	1.058	10 year	AD
8	Hornby Tributary, 210 m East of Hornby Road	1.95 x 7.7 Concrete Bridge	0.3	196.2	44.98	10 year	IN
9	Swale 4-4, 170 m East of Trafalgar Road	900 mm C.S.P.	0.3	202.7	1.674	100 year	AD
10	East Sixteen Mile Creek, 170 m East of Eighth Line North	2.3 x 12.3 m Concrete Bridge	0.3	202.9	31.89	100 year	AD
13	Swale 6-1, 150 m East of Ninth Line North	1200 mm C.S.P.	0.3	215	2.216	100 year	AD
14	Swale 6-2, 210 m West of Ninth Line South	970 x 1390 mm C.S.P.A.	0.3	216.5	2.201	10 year	AD
16	Ditch Drainage, 270 m East of Ninth Line South	900 mm C.S.P.	0.3	* 101.01	0.911	25 mm	IN
17	Ditch Drainage, 219 m West of Tenth Line North	1000 mm C.S.P.	0.3	* 101.01	2.138	5 year	IN
19	Swale 6-4, 75 m East of Tenth Line North	Twin 970 x 1390 mm C.S.P.A.	0.3	215.7	4.367	100 year	AD
25	Middle Sixteen Mile Creek Tributary, Sixth Line South at Steeles Ave.	2.6 x 9.1 m Concrete Bridge	0.3	192.7	26.86	5 year	IN
26	Middle Sixteen Mile Creek, Fifth Line 210 m South of Steeles Ave.	2.1 x 18.3 m Concrete Bridge	0.3	193.3	48.74	100 year	AD
27	Tributary, Middle Sixteen Mile Creek, Fifth Line 550 m North of Steeles Ave	2.13 x 2.40 m Concrete Box	0.3	202.33	8.406	100 year	AD
29	Swale 3-1, Fifth Line, South of Hwy. 401	1.95 x 2.95 m Concrete Box	0.3	192.9	10.056	25 year	AD
30	Swale 4-1, Sixth Line , North Side of Hwy. 401	900 mm C.S.P.	1	191.50 (401)	1.24	2 year	AD
31	Hwy. 401 Ditch Drainage, 125 m East of James Snow Parkway	1.22 x 1.22 m	1	100.7	1.656	50 year	AD
32	Swale 3-1/Cashway Pond, Hwy. 401, 550 m West of Fifth Line	1.55 x 3.10 m	1	199.37	10.092	100 year	AD
33	Middle Sixteen Mile Creek, Hwy. 401, 50 m East of Fifth Line	7.9 x 21.3 m Concrete Bridge	1	200.3	264.66	Regional	AD
34	Middle Sixteen Mile Creek Tributary, Hwy. 401, 100 m East of Sixth Line	4.0 x 12.2 m Concrete Bridge	1	192.4	254.96	Regional	AD
35	East Sixteen Mile Creek, Hwy. 401, 500 m East of Trafalgar Road	3.4 x 13.0 m Twin Cell Concrete	1	201.4	122.15	Regional	AD
37	Hwy. 401 Ditch Drainage, 1500 m East of Trafalgar Road	1.22 x 2.44 m Concrete Box	1	99.7	3.675	100 year	AD

Note:
* Denotes assumed elevation of 100.0 m at upstream invert for modelling purposes where survey information was not available.
AWH Elevation is equal to the freeboard based on the edge of pavement.
AD - Adequate IN - Inadequate

Highway 407 - Highway 401 Interchange

The Highway 407 - Highway 401 facilities were recently designed to provide water quality, water quantity and erosion control for runoff from Highway 407. Treatment of runoff from the existing Highway 401 was also provided where feasible. As these wet pond facilities are located online of drainage features D6-1 to D6-5, they also provide water quality control benefits to runoff from lands upstream the highway, including a portion of the study corridor and drainage areas upstream of the corridor.

The primary function of the facilities is water quality and erosion control as water quantity impacts as a result of the highway development were determined to be minor both in the context of the local drainage features and the local subwatershed. Based on design criteria adopted for all Highway 407 facilities within the Sixteen Mile Creek Watershed, water quality and erosion control are achieved through 24 hour extended detention of runoff from tributary areas, based on a 25 mm design event. This is consistent with the water quality control criteria used in the Sixteen Mile Creek Watershed Plan technical analyses, which was based on guidelines to protect cold water fisheries (MOEE/MNR, 1991)

Although environmental classification of the drains generally indicated a low sensitivity (i.e., MNR Type 3, warm water habitat with a Low MNR habitat sensitivity rating), a higher level of quality control as described in the MOEE Stormwater Management Practices (SWMP) Planning and Design Manual (1994) was provided at each facility. **Table 4.3** summarizes the water quality treatment characteristics of the facilities.

Table 4.3 - Highway 407 - Highway 401 Interchange SWM Pond Capacities

Swale ID Refer to Fig. 2.2	Drainage Area (ha)	Permanent Pool Volume (m^3)	Extended Detention Volume (m^3)	Total Volume / Drainage Area (m^3/ha)	Permanent Pool Volume / Area (m^3/ha)	Extended Detention Volume / Area (m^3/ha)
D6-1	60.8	10000	4600	240	164	76
D6-2	75.8	11000	5800	222	145	77
D6-3	91.9	6200	7200	145	67	78
D6-4	63.6	6300	5000	177	99	78
D6-5	41.4	10000	3400	325	242	83

The SWMP Manual recommends an extended detention volume of 40 m^3/ha for wet ponds which is exceeded in all instances. The total volume recommended for wet ponds with Level 3 control is 60 m^3/ha, which is also exceeded. This applies to existing development conditions with well less than 35% impervious land use within the tributary drainage areas.

Under ultimate development conditions within subwatershed 6, additional impervious area will be introduced within the study corridor as well as in headwater areas located upstream of the corridor, i.e., north of Steeles Avenue. Based on a future impervious percentage of 70 % (according to QUALHYMO hydrologic modelling performed as part of the Sixteen Mile Creek Watershed Plan), the existing ponds could provide Level 2 to Level 1 water quality control for all upstream areas, using SWMP design guidelines for total volume of 130 m^3/ha to 225 m^3/ha, respectively.

Erosion control recommendations developed as part of the Sixteen Mile Creek Watershed Plan are based on the preservation of existing condition flow duration curves with an emphasis on maintaining lower frequencies for flow rates above an erosion threshold rate. A threshold rate of 0.103 L/s/ha, based on the most sensitive downstream reach, was identified in the plan (see Section 2.4.1). Using the 25 mm design event, average release rates from the Highway 407 - Highway 401 facilities are within the range of 0.48 to 0.61 L/s/ha. While these rates are generally an order of magnitude less than those of undeveloped conditions, the local rates are higher than the downstream target value. As these rates do not reflect routing through central downstream facilities (e.g., Highway 407 Derry Road facility for D6-1 and the Lisgar Pond for D6-2 to D6-5), more detailed hydrologic analysis using the watershed QUALHYMO model will be required in order to determine the affect of these local flows (and those of existing residential development downstream in the study corridor) on target values downstream.

The Highway 407 - Highway 401 interchange facilities have been designed to provide 100-year water quantity control based on a 24 hour Chicago Storm distribution using intensity-duration-frequency data derived for the Pearson International Airport gauge (used for all recent Highway 407 design). The total design rainfall volume was 122 mm with a peak intensity of 174 mm/hr. This compares well with the 24 hour storm derived using Town of Halton Hills intensity-duration-frequency data, i.e., design volume of 125 mm and peak intensity of 167 mm/hr. Consequently, the interchange ponds will continue to achieve 100-year control under the Town of Halton Hills standards.

Milton/401 Industrial Park Quantity Control Pond

The Milton/401 Industrial Park Quantity Control Pond was designed to provide 100-year flood control for the Milton Business Parks Industrial Subdivision. The OTTHYMO hydrologic model used for analysis in this area was updated to OTTHYMO89 and minor corrections to modelling parameters were made (e.g., pervious area roughness of 0.035 corrected to 0.25). A 24 hour design storm with a 112 mm volume and 125 mm/hr peak intensity was used in the original analysis, which is slightly less than the current standard. Table 4.4 compares the original design flow rates with those of the updated model using the Town's standard design storms.

Table 4.4 - Comparison of Milton Business Park Design Flows

Design Storm Event	Existing Development	Proposed Development			
		Original Model		Revised Model	
		Controlled	Uncontrolled	Controlled	Uncontrolled
5-year	0.603	0.477	7.931	0.3	6.95
10-year	0.98	0.617	11.435	0.45	9.07
25-year	1.256	0.753	13.853	0.97	11.3
100-year	1.626	1.422	16.804	2.1	14.63

Results summarized in the table indicate that the water quantity control facility will achieve peak flow reduction targets above the 25-year level when analyzed with the revised hydrology model - in fact, a degree of overcontrol will be achieved. At the 100-year level, substantial peak flow reduction of uncontrolled inflow is achieved, however, the controlled peak outflow appears to be 25% above the existing target when the revised hydrology model is used.

Detailed OTTHYMO89 model output reveals that the maximum storage in the pond is reached between the 50-year and the 100-year design level and that the facility design discharge would be exceeded overtop during 100-year conditions. This is a result of the higher rainfall and runoff volumes associated with the revised design storms. Overall, this facility is providing the necessary level on quantity control, as intended.

Cashway Distribution Centre - Quality/Quantity & Interim Quantity Control Facility

This facility was recently designed and constructed to provide both interim and ultimate stormwater controls to for local and upstream development. The facility is intended to provide water quantity control for the local development area on an interim basis until such time as a centralized facility is constructed downstream. The facility is intended to provide water quality and erosion control for both local and upstream development areas, including the Milton Business Park area.

Hydrologic modelling performed as part of the design process did not accurately account for upstream development conditions in the Milton Business Park area, i.e., this upstream area was modelled under pre-development conditions assuming only a fraction of the actual drainage area and assuming no impervious land use. The stormwater management report states that these assumptions are valid given that the Milton pond will provide peak flow control, reducing developed condition flow rates to existing levels.

While existing peak flows are generally achieved in the Milton Pond, the higher actual drainage area and imperviousness will significantly increase runoff volumes above those represented by existing conditions. Furthermore, the 3-hour design storm with a total depth of 82.6 mm used in the design is considered to be low for the design of a facility whose performance is dictated by runoff volumes. Revised modelling with the updated OTTHYMO89 model indicates that when actual development conditions are considered and a 24-hour design storm is used, the facility as built does not provide the desired level of quantity control.

Water quality control and erosion control at the facility are to be achieved through extended detention of runoff. An extended detention storage volume of 7800 cubic metres, corresponding to the 2-year runoff volume, has been provided for this purpose.

Revised modelling, again using actual development conditions, indicates extended detention treatment is provided up to the 25 mm rainfall event, which is less than the 2-year design level stated for erosion control. The peak release rate under these conditions is 0.15 cms which equates to 1.19 L/s/ha based on 126 ha upstream drainage area. This unit release rate is greater than the target rate of 0.103 L/s/ha indicated in the Sixteen Mile Creek Watershed Plan.

Design details prepared for the construction of the facility were reviewed. The drawings indicate that the Swale 2 (D3-2) inflow occurs at the outlet of the facility which will compromise the effectiveness of water quality treatment, as flows essentially 'short-circuit' the facility. The cross section details indicate that vertical drops have been incorporated at the normal water level which is contrary to standard design practice. Mild slopes at the permanent pool level are recommended by MOEE guidelines to provide safety as well as improved water quality treatment.

4.1.4 Baseflow Characterization

Based on monitoring information presented in **Section 3**, the following conclusions regarding baseflows within the Middle Sixteen Mile Creek system have been made:

1) the majority of baseflow contributions to the system occur along the Middle Sixteen Mile Creek Tributary (total flow of 52 L/s at Steeles Avenue, G9) while the Hornby Tributary contributes to a lesser degree (14 L/s at Steeles Avenue, F23);

2) baseflow contributions along the Middle Sixteen Mile Creek Tributary are distributed relatively evenly between the West and East Branches upstream of Steeles Avenue (31 L/s and 21 L/s, respectively);

3) the eastern tributary (G12) of the East Branch of the Middle Sixteen Mile Creek Tributary provides the virtually all of the baseflow contribution the East Branch and has been described by long-time residents as having never dried up over the past 60 years. Flows originate south of the Fifth Side Road, upstream of which the tributary is dry;

4) the eastern and western tributaries of the West Branch of the Middle Sixteen Mile Creek Tributary contribute more equally to baseflows. Upstream of Sixth Line, the western tributary (F14) contributes 11 L/s while the eastern tributary (G5) contributes 19 L/s. The majority of the eastern tributary flows originate downtream of Fifth Side Road (upstream of which flows total only 2 L/s (F13, G1,F11 and G2)). In contrast, the majority of the eastern tributary flows originate upstream of Fifth Side Road (15 L/s at F12);

5) within the Hornby Tributary system, all flow originates downstream of Fifth Side Road and Eighth Line;

6) flow rates increase marginally throughout the 401 Corridor Planning Area, representing less that 5% of the total flow recorded downstream (66 L/s total at Steeles Avenue, 69 L/s downstream of Highway 401) indicating marginal contributions from the local basal aquifer.

As the majority of the baseflow originates upstream of Steeles Avenue, local lands within the 401 Corridor area are considered to not contribute significantly to any recharge function which sustains baseflows in the Middle Sixteen Mile Creek Tributary system.

Temperature monitoring presented in **Figure 3.3** in **Section 3** generally confirm the results of the baseflow monitoring throughout this area and offers insight into the dry weather and wet weather hydrology within this portion of the study area. A statistical summary of the observed temperature series is presented in **Table 4.5**.

Table 4.5 - Temperature Monitoring Summary (deg.C)			
Statistic	**Monitoring Location**		
	Hornby Tributary	**Middle Sixteen Mile Creek Tributary (Steeles)**	**Middle Sixteen Mile Creek Tributary (Highway 401)**
Average	16.3	14.4	15.8
Maximum	32.1	24.1	26.7
Minimum	8.1	8.4	10.2
Range	24	15.7	16.5

Temperatures at the confluence of the two tributaries downstream of Highway were found to reflect the mixing of the tributaries observed at Steeles Avenue, i.e, the downstream average temperature lies between the two upstream values. During dry weather periods, the downstream temperature series follows the Middle Sixteen Mile Creek Tributary series which reflects the higher flow contribution of this tributary. The presence of significant baseflow contributions through the study area are not apparent in the observed data as this would result in downstream temperatures that are below upstream values.

The following observations may also be made:

1) the Hornby Tributary exhibits the greatest diurnal variation in temperature which likely reflects a lesser degree of riparian stream cover in upstream reaches;

2) diurnal variations in temperature decrease significantly during wet weather period which reflects a) the moderating effect of the lower temperature of rainfall and runoff water and b) the lesser amount of daytime warming associated with overcast weather conditions;

3) during wet weather the downstream temperature series follows the Hornby Tributary series which reflects either the higher flow contribution of this tributary during wet weather (as a results of urban development) or thermal impacts of runoff from Highway 401.

The streamflow temperature characteristics are discussed further in **Section 4.4** in the context of aquatic habitat.

Baseflow characterization of the upper reaches of the Mullett Creek subwatershed was completed as part of the Gateway West Subwatershed Study. Upper reaches were found to drain surface runoff only with no baseflow component. High temperatures in downstream reaches were found to be influenced by ambient air temperatures, indicating a lack a riparian vegetation.

4.2 Flood Plain Analysis

4.2.1 Flood Line Extensions

Floodline extensions for the Mansewood and Highway 401 Tributaries are presented on **Figures 4.5 and 4.6.** HEC-2 model results are provided in **Appendix E.** Structures 27, 29 and 32 on these tributaries were all found to have adequate capacities as indicated in **Table 4.2.**

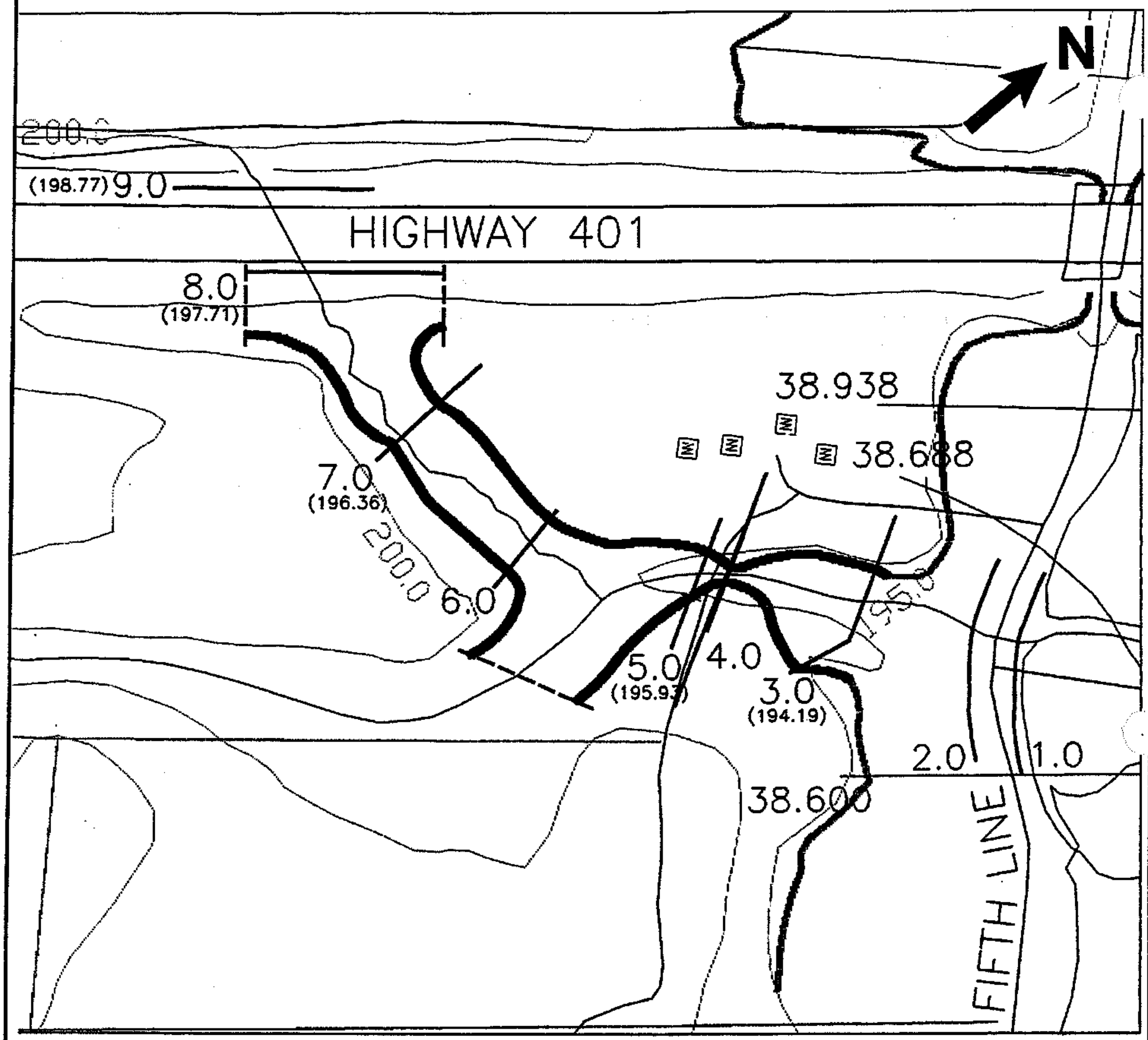
4.2.2 Fill Impact Assessment

Since the original flood line mapping was completed in 1988, a significant quantities of fill have been placed within the flood plain in two locations within the 401 Corridor Planning Area.

The first location is within the Middle Sixteen Mile Creek valley, specifically along the west valley wall, downstream of Steeles Avenue. The areal extent of the fill has been estimated by Halton Region Conservation Authority staff in a notice of violation to the property owner dated July 7, 1998. This area has been reproduced on the existing flood line mapping in **Figure 4.7.**

Hydraulic analysis has been performed in order to assess potential flooding impacts of the fill placement. The HEC-2 hydraulic model for the reach was modified to restrict overbank flow within the limit of fill at cross-sections 39.550 and 39.630, shown on the figure. While the width of fill encroachment at section 39.630 appears to be small at the exact location of this section, the wider extent of fill immediately downstream will restrict flow in this reach and, therefore, has been reflected in the revised model.

Results of the hydraulic modelling indicate that regulatory flood levels will increase by 0.02 metres immediately upstream of the fill area and that levels return to existing values immediately upstream of Steeles Avenue. This occurs despite reductions in effective flow conveyance width of 15 and 48 m at sections 39.550 and 39.630, respectively. This amount of increase is generally considered to be small given the accuracy of modelling techniques.



LEGEND

5.0	CROSS-SECTION NUMBER
	REGIONAL STORM FLOOD LINE
(196.36)	REGIONAL STORM FLOOD LEVEL
	EXISTING REGIONAL FLOOD LINE

SCALE 1:2500

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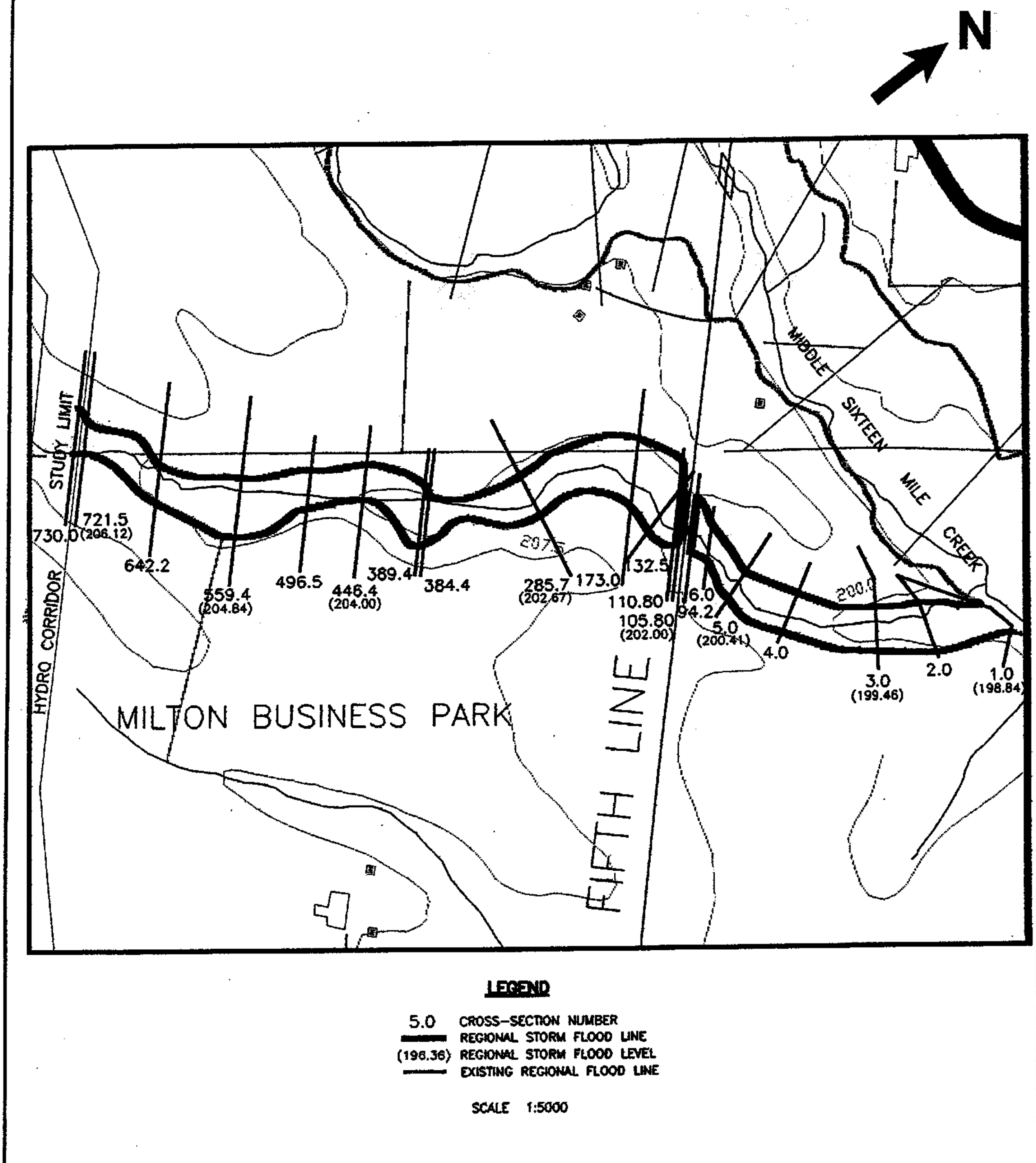
FLOOD LINE EXTENSION - HIGHWAY 401 TRIBUTARY

FIGURE 4.5



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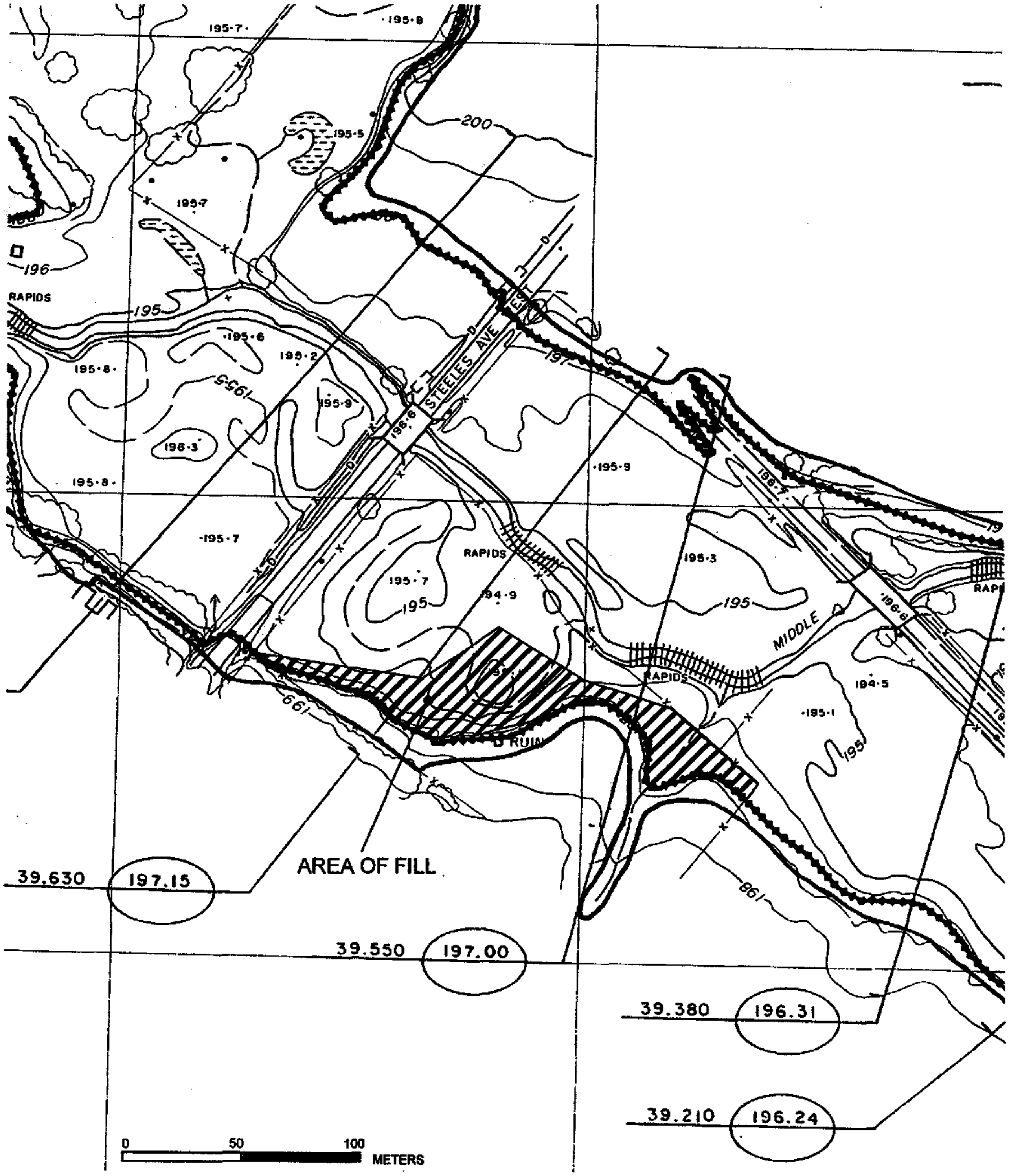
FLOOD LINE EXTENSION - MANSEWOOD TRIBUTARY

FIGURE 4.6



SOURCE: BASE MAP - SIXTEEN MILE CREEK FLOOD RISK MAP, SHEET NO 44 OF 76
LIMIT OF FILL - ESTIMATED BY HRCA, JULY 1998.

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MIDDLE SIXTEEN MILE CREEK FLOOD PLAIN FILL

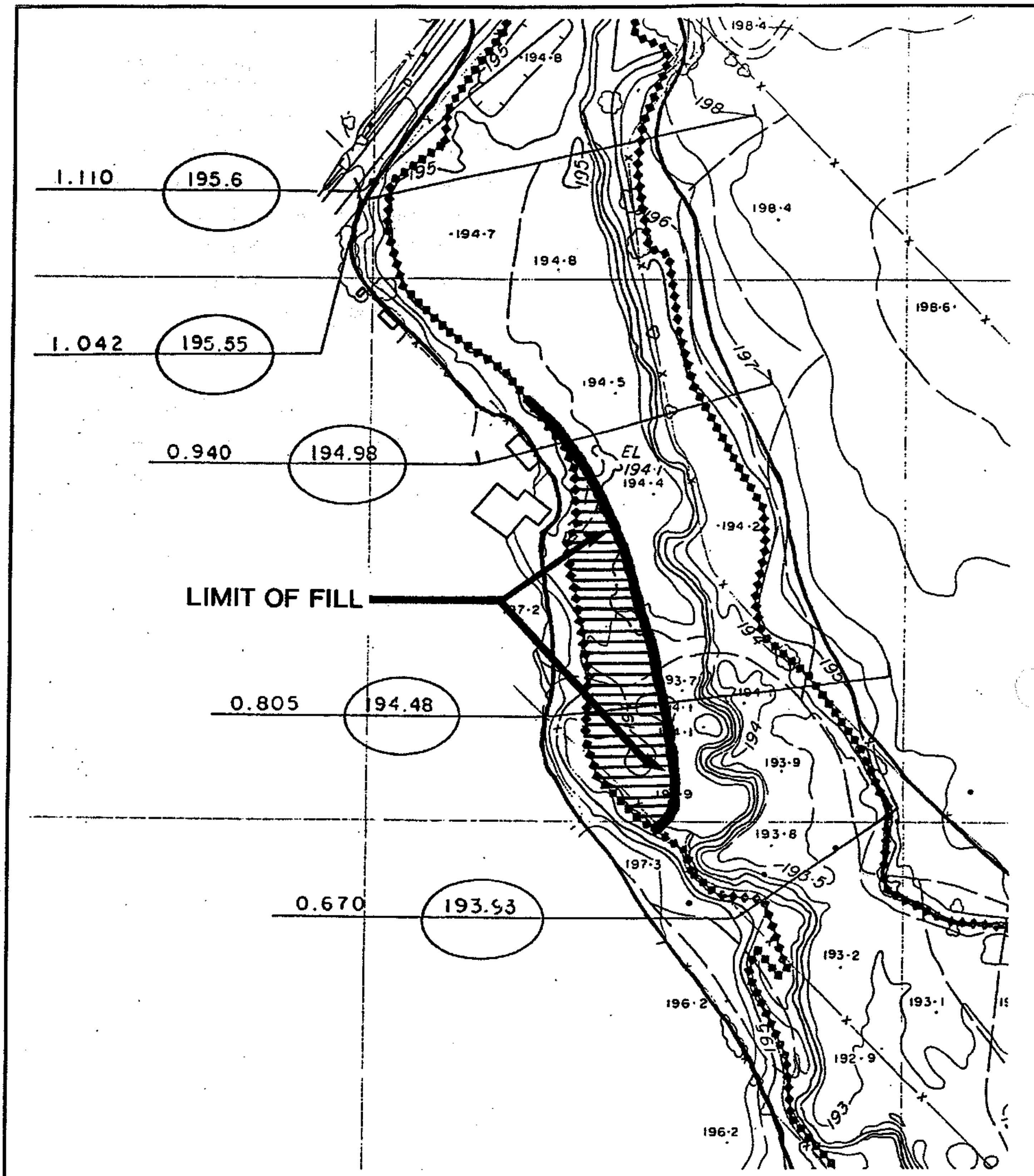
FIGURE 4.7

While the placement of fill does not appear to pose a significant impact on flooding, it was noted during field investigations that a significant amount erosion of fill material has occurred. Furthermore, recent field investigations conducted as part of the scoped subwatershed studies indicate that this reach of the Middle Sixteen Mile Creek may be considered to be Type I, coldwater habitat, based on observed species. As a 30 m setback is recommended for creeks of this sensitivity, the placement of fill within this setback limit will likely adversely affect fish habitat in the creek, which runs near the edge of fill.

The second location is within the Hornby Tributary valley, again along the west valley wall, downstream of Steeles Avenue. The extent of the fill was estimated by Dillon Consulting staff during a field survey in May 1998 and has been reproduced on the existing flood line mapping for the Hornby Tributary on **Figure 4.8.** These conditions represent a reduction in the previous amount of fill in some areas and the possible additional of fill in others, as noted by HRCA staff during a site inspection on April 22, 1998.

Hydraulic analysis has been performed in order to assess potential flooding impacts of the fill placement. The HEC-2 hydraulic model for the reach was modified to restrict overbank flow within the limit of fill at cross-sections 0.805 and 0.940.

The HEC-2 model results indicate that relative to 1988 conditions, regulatory flood levels will increase by 0.27 metres in the immediate vicinity of the fill. Levels remain higher in upstream reaches extending to Steeles Avenue where levels are 0.19 metres above 1988 levels. Immediately upstream of Steeles Avenue, the effect of the fill is less pronounced as levels are only 0.02 metres above existing values. Water level increases downstream of Steeles are believed to constitute increased risks to life and property.



SOURCE: BASE MAP - SIXTEEN MILE CREEK FLOOD RISK MAP, SHEET NO 49 OF 76
LIMIT OF FILL - ESTIMATED BY DILLON CONSULTING LIMITED, JUNE 1999.

TOWN OF HALTON HILLS

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HORNBY TRIBUTARY FLOOD PLAIN FILL

FIGURE 4.8

4.3 Water Balance Analysis

Water balance analysis is used to quantify the distribution of water throughout the hydrologic cycle, a continuous cycle of evapotranspiration, evaporation, precipitation, runoff and infiltration (ground water recharge). Maintaining this cycle helps to ensure the natural function of the surface and ground water systems which in turn protects aquatic and terrestrial habits which rely on this water.

The recent draft of the MOEE's SWMP Planning and Design Manual advocates a detailed approach to the accounting of water balance components. These details include the estimation of actual versus potential evapotranspiration values as a function of the land's soil and vegetation characteristics (as this determines the water holding capacity of the soil reservoir) and the distribution of water surplus (precipitation minus actual evapotranspiration) into recharge and runoff as a function of the soil type, vegetation and slope.

Detailed water balance analyses have been carried out for each Subwatershed according to the general MOEE approach, as described below. Average annual precipitation from the Pearson International Airport gauge was selected as the primary input to the system and potential evapotranspiration, used to calculate the primary output (actual evapotranspiration), was calculated using the Thornthwaite empirical relationship using long-term temperature data from the airport weather station.

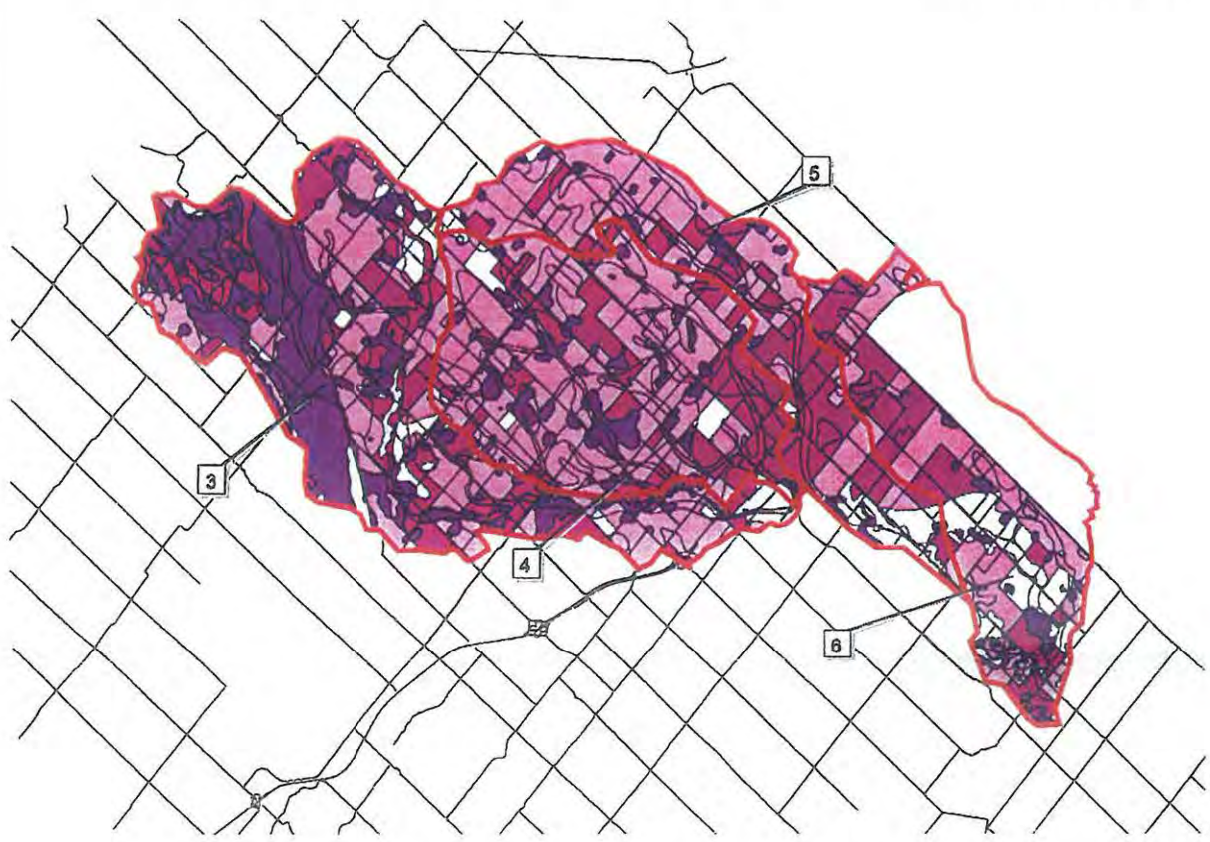
Land use and soil OMAFRA GIS coverages were intersected across the Subwatersheds and were then classified according to unique combinations of rooting depth, soil texture and slope (which is an attribute of the soil series). The classification system represents an expansion of the classes proposed by MOEE in order to reflect the detailed breakdown available in the GIS coverages.

Map No. 4 summarizes analysis input characteristic parameters for each unique combination of soil texture, land use (as it relates to rooting depth), and slope throughout the subwatersheds. The three maps illustrate the fraction of water surplus which contributes to recharge, the soil/land-use water holding capacities and ratio of actual to potential evapotranspiration. This ratio is derived using a function which relates it to the water holding capacity - areas with high water holding capacities (combinations of moderate to deep rooting vegetation and cohesive soils) generally achieve 95% or more of the potential evapotranspiration. In contrast, areas with low capacities (extremely well-drained soils with shallow rooting vegetation) will achieve as low as 75% of the potential evapotranspiration on an average annual basis.

Recharge Characteristics (Recharge/Surplus)

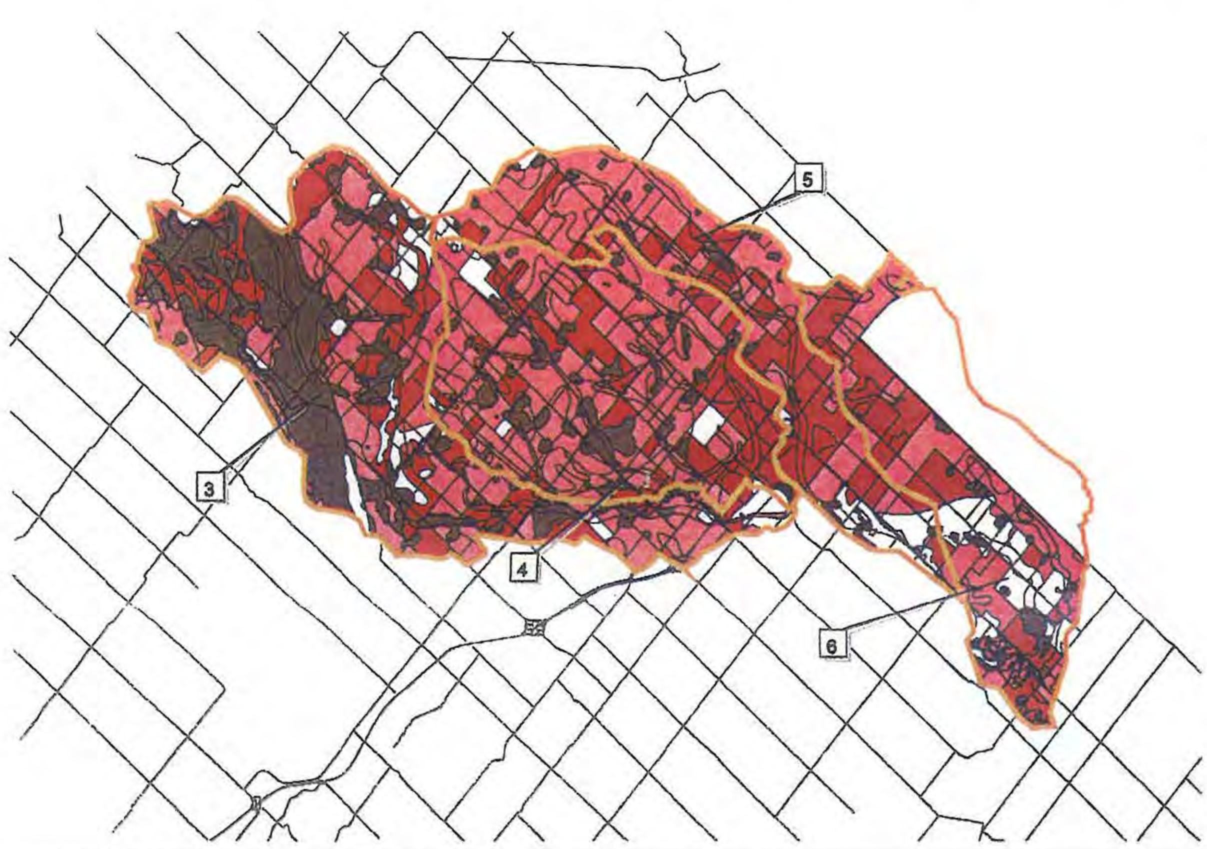
Subwatershed Boundaries
Major Roads
Recharge Fraction
0.285 - 0.39
0.39 - 0.45
0.45 - 0.56
0.56 - 0.75
No Data

Soil/Land Use Water Holding Capacity



Subwatershed Boundaries
Major Roads
Water Holding Capacity (mm)
66 - 150
200
250
284 - 400
No Data

Evapotranspiration Characteristics (Actual/Potential)



Subwatershed Boundaries
Major Roads
Actual/Potential ET
0.82 - 0.92
0.92 - 0.95
0.95 - 0.97
0.97 - 1.00
No Data

TOWN OF HALTON HILLS

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Water Balance Characteristics

Map No.4

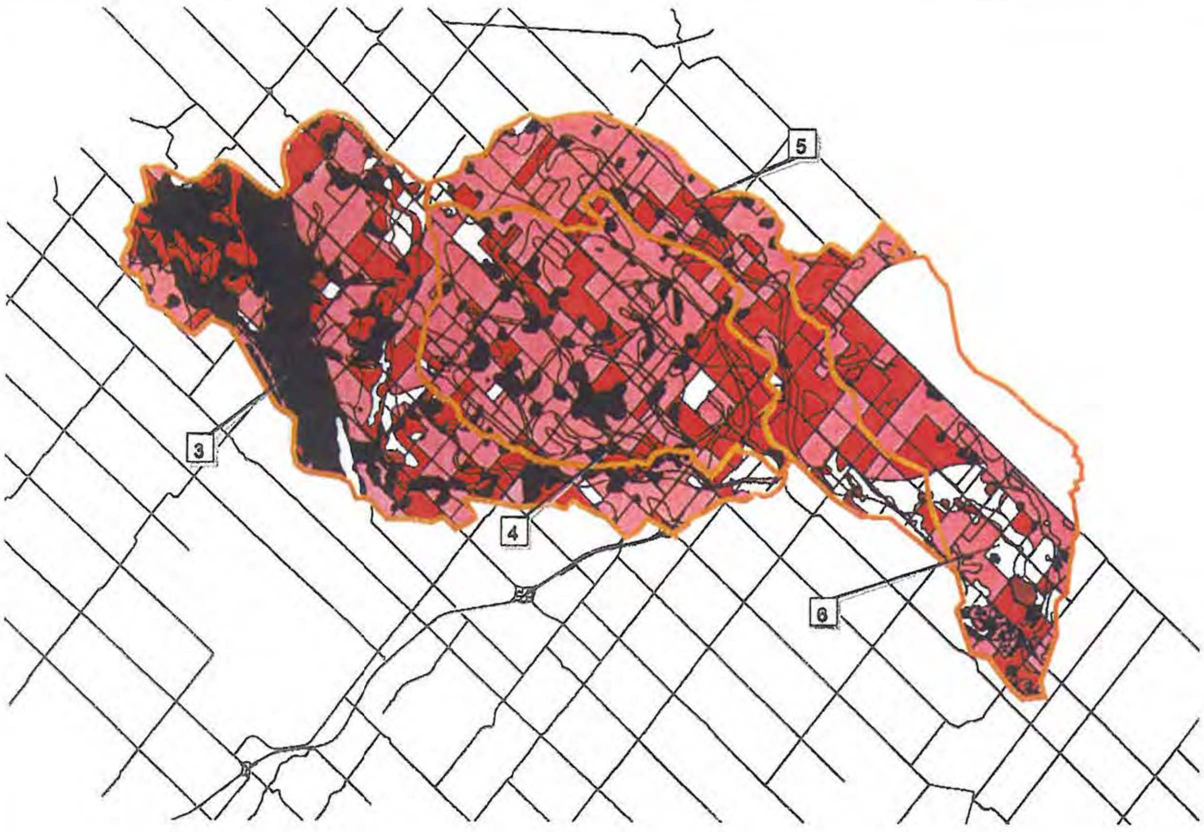
Using the characteristics illustrated on **Map No. 4**, water balance calculations were performed for each area. Average annual precipitation and potential evapotranspiration values of 781 mm and 591 mm, respectively, were used for all areas. Actual evapotranspiration values shown on Map No. 5, calculated as a fraction of the potential value using factors from **Map No. 4**, were subtracted from precipitation to provide a water surplus. The surplus was then divided into recharge and runoff components as shown on **Map No. 5**, again using the factors on **Map No.4**.

Water balance results on **Map No.5** suggest recharge patterns which generally agree with recharge areas suggested in background documents. Recharge areas F and H on **Figure 2.6**, located within the headwater regions of Subwatersheds 3 and 4, respectively, both exhibit high recharge values on the water balance map. Surrounding areas have relatively high recharge potential as well. In addition, the water balance map indicates high recharge potential within other areas having sandy loam soil classes, i.e., downstream region of Subwatersheds 3 and 4, and throughout the lower half of Subwatershed 6.

In relative terms, the recharge area above the escarpment contributes consistently higher recharge compared to areas below the escarpment. It is also noted that by observing the boundaries between areas with different recharge results, it is apparent that values are influenced as much by land use (values vary according to lot and field boundaries) as by soil type. This is due to the variability in actual evapotranspiration which is related to rooting depths. Similarly, runoff also varies according to both land use and soil type: the wooded area above the escarpment combined with areas of well-drained soil, exhibits low runoff.

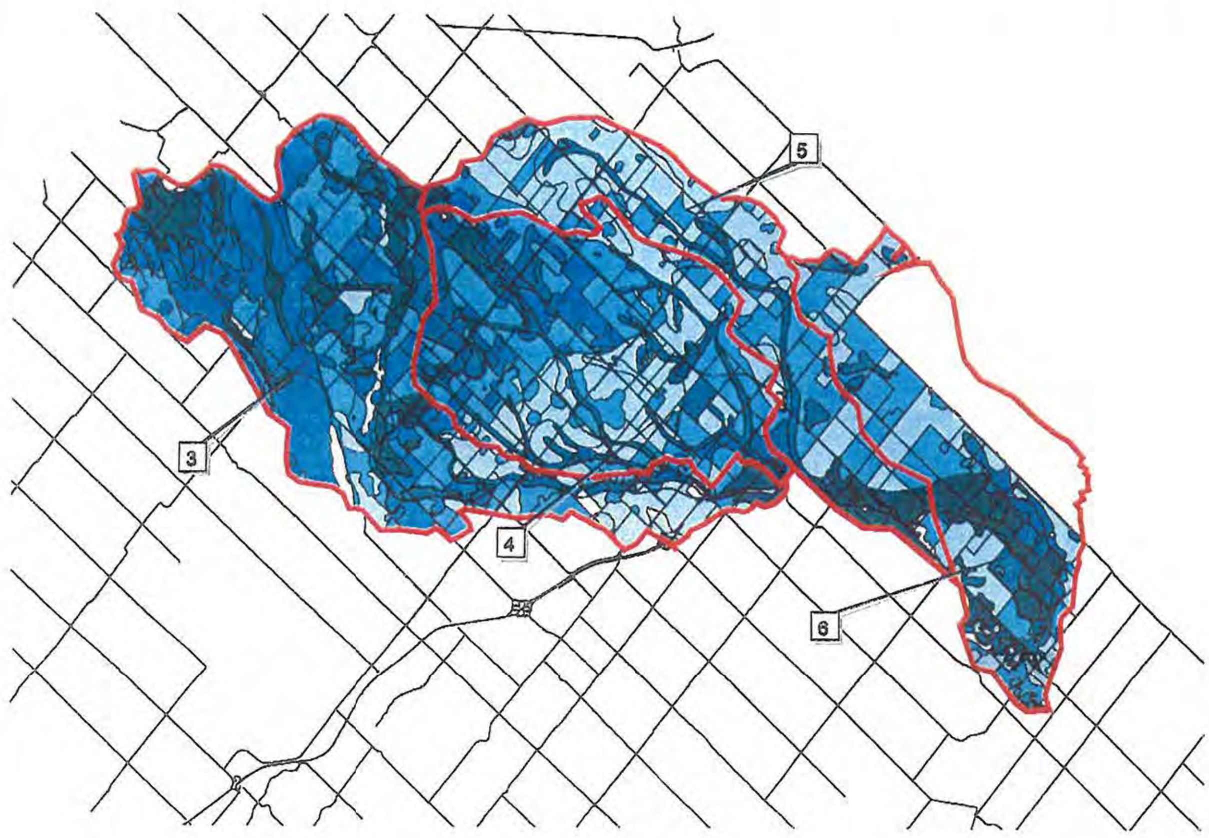
Areas for each individual map unit were calculated and used to provide overall areal weighted water balance values for each Subwatershed. To properly account for extensive existing development within Subwatershed 6 (approximately 1050 ha of the 3370 ha Subwatershed is located in the City of Mississauga.), a separate water balance accounting for existing imperviousness in this area was performed. Results were integrated with those for the Region of Halton shown. Overall results for each subwatershed are presented graphically in **Figure 4.9**.

The figure indicates that all three of the rural subwatersheds (3, 4 and 5) exhibit similar evapotranspiration, runoff and recharge characteristics. In contrast, Subwatershed 6, with a higher overall imperviousness (8%) has markedly less evapotranspiration, higher surplus, and higher runoff. Overall recharge values are relatively low due to the large extent of sandy loam in the undeveloped areas within the Region of Halton.



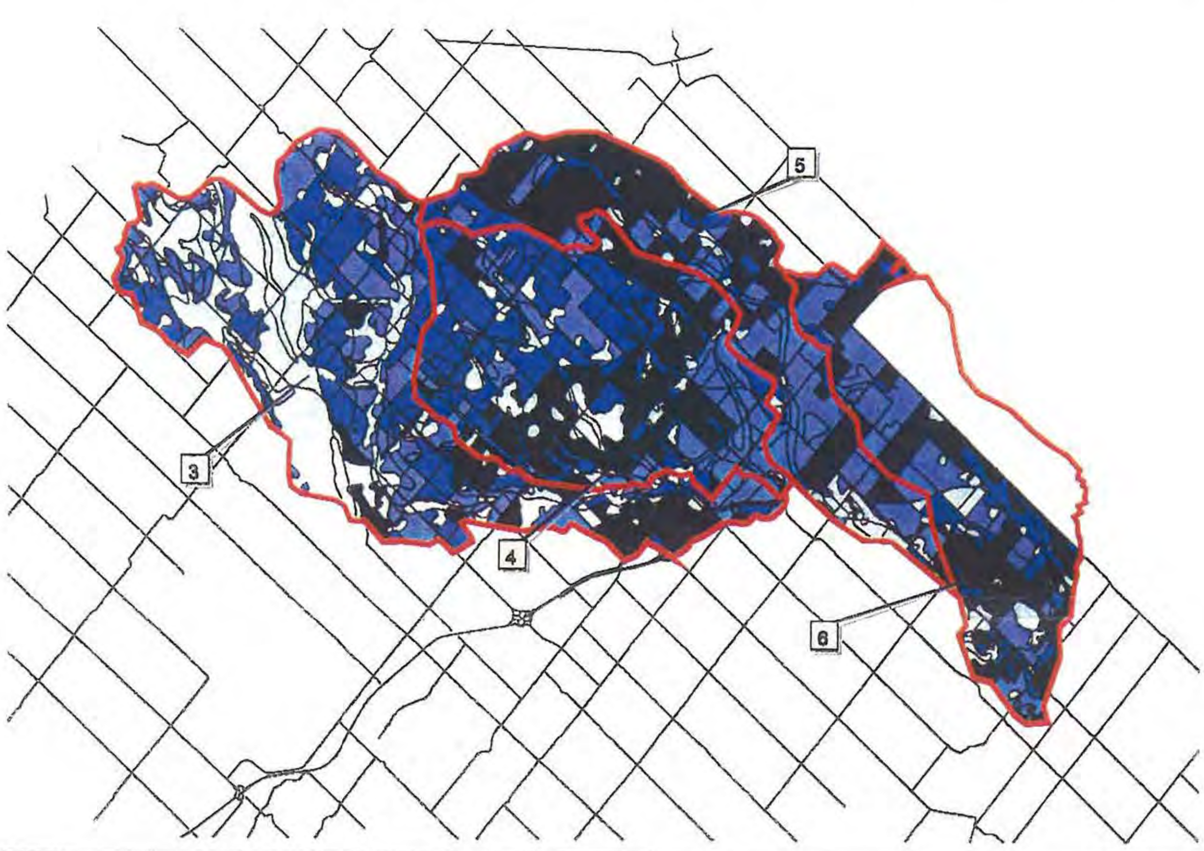
Annual Actual Evapotranspiration

Subwatershed Boundaries
Major Roads
Actual ET (mm)
486.93 - 542.74
542.74 - 562.09
562.09 - 574.35
574.35 - 588.23
588.23 - 595.17
No Data



Annual Recharge

Subwatershed Boundaries
Major Roads
Recharge (mm)
67.85 - 78.74
78.74 - 84.2
84.2 - 88.17
88.17 - 92.9
92.9 - 188.08
No Data



Annual Runoff

Subwatershed Boundaries
Major Roads
Runoff (mm)
50.2 - 106.74
106.74 - 123.87
123.87 - 134.51
134.51 - 135.18
135.18 - 183
No Data

TOWN OF HALTON HILLS

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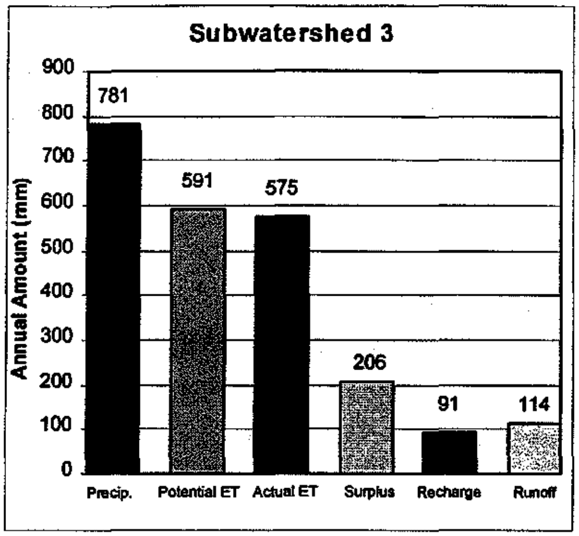
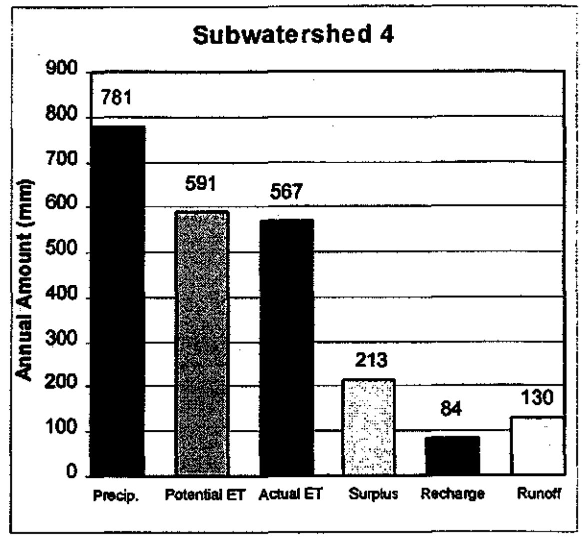
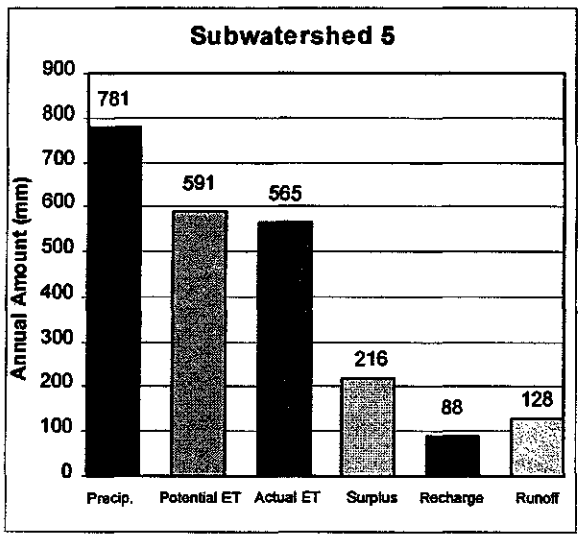
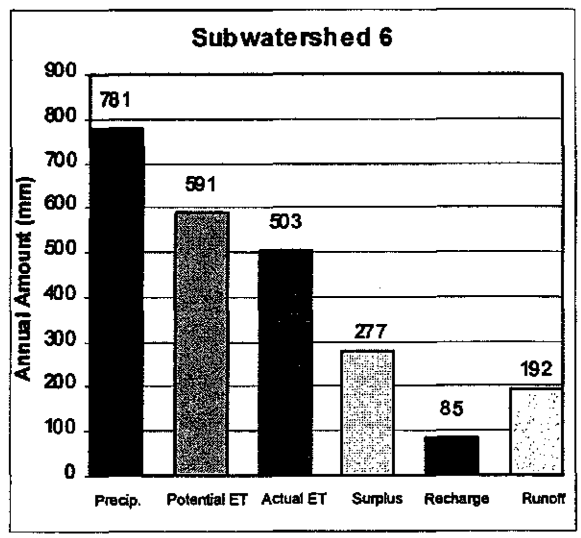
Water Balance Results

Map No.5









Note:

Precip. = Precipitation
ET = Evapotranspiration

TOWN OF HALTON HILLS

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401 CORRIDOR INTEGRATED PLANNING PROJECT
SCOPED WATERSHED STUDIES

SUBWATERSHED WATER BALANCE SUMMARIES

FIGURE 4.9

4.4 Stream Geomorphology

Morphometric Characterization

Morphometric parameters of reaches within the study area were presented in **Section 2.4**. Results of this classification indicate that the headwater areas for the west-end streams tends to be further upstream within the subwatersheds while the east-end streams are situated within or immediately upstream of the proposed industrial corridor. Headward erosion of low-order streams within the corridor can be expected to occur in the middle and west-end of the industrial corridor.

From the historical analyses, additional insight has been gained into the function of the main reaches within the study area. Specifically, reaches B and C appear to be actively adjusting their planforms (i.e. increasing sinuosity). These adjustments are likely a function of the upstream changes to the hydrologic regimes of the reaches. In general, the re-equilibration of channel configuration to imposed changes in hydrologic and sediment regimes requires several decades and is dependent on the nature of the floodplain materials. Thus, it is likely that the modifications of reach B and C planforms will continue into the future. Reaches A and D appear to be most stable and likely will maintain this trend of stability if unaltered.

Rosgen Classification

Morphometric parameters have been used to classify the reaches according to Level I of Rosgen's classification system (see **Table 4.5** below) so that comparisons with other channels (within and outside of the study area) can be made. In addition, meander belt width estimates have been derived.

Given the characteristics of headwater streams (steep gradients, low sinuosity), the classification of many of the reaches into Rosgen type F channels was expected. Typically, F-type channels are described as entrenched and are working to regain a functional floodplain inside the valley in which it flows. C-type channels are also common within the Study area. Such channels have well defined floodplains and well defined pool-riffle sequences. Rosgen level III classifications were applied to reaches A-D where as detailed field work was undertaken.

Table 4.5 - Level I Rosgen's Classification and Meander Belt Widths					
Reach	**Rosgen Classification**	**Meander Belt Width (m)**	**Reach**	**Rosgen Classification**	**Meander Belt Width (m)**
1	C	50	9 & 10	C	N/A
3	C	50	C [3]	C4	60
4	C	40	11	B	30
5	N/A	N/A	D [4]	C4	75
4 & 5	N/A	N/A	12	B	65
6	G	10	13	C	55
7	C	25	14	F	15
7 (past 401)	C	N/A	15	C	40
A [1]	F4	95	16	C	50
8	C	60	17	F	65
9	C	70	18	N/A	15
10	C	20			

[1] - Middle Sixteen Mile Creek
[2] - Middle Sixteen Mile Creek Tributary
[3] - Hornby Tributary
[4] - East Sixteen Mile Creek

The meander belt width is a quantitative measure of the lateral extent that a meandering pattern occupies on the floodplain. The belt width is measured as the distance normal to tangential lines drawn to outside bends of meanders within a reach of interest. Streams migrate both laterally across a valley and in the downstream direction. The meander belt width then, encompasses the area that the stream presently occupies, and can be expected to occupy in the future.

The relation between the reaches and their floodplains was examined on 1:10,000 topographic mapping of the study area. From this map it is evident that several reaches impinge on valley walls. Specifically, the mid-section of reach A and the downstream ends of reaches 8, C, and 13 are adjacent to valley walls **(Figure 2.11)**. At these sites, excessive erosion of the channel banks/valley wall was expected an d was confirmed through field investigations.

Channel Functions Data collected during the detailed field investigation are used not only to quantify channel dimensions and reach characteristics of the watercourses, but also to assess channel functions and channel thresholds. An assessment is made of hydraulic geometry relations to determine how an increasing discharge is accommodated in the channel. Functions that are examined include the erosion potential of the reach and whether the reach tends to be characterized by erosion, deposition, or transport processes. Specific thresholds that were examined include the shear stress required to entrain substrate materials, the grain size that will be moved during bankfull discharge events, and the critical velocity of channel flow at which substrate transport can begin. A summary of critical threshold values is presented in **Table 4.6.**

Table 4.6 - Summary of Channel Functions and Thresholds for Each Reach Surveyed in the Proposed 401 Industrial Corridor				
Variable	**A**	**B**	**C**	**D**
Bankfull Discharge (cms)	4.25	2.31	2.18	4.97
Flow competence (m/s)	0.56	0.82	0.33	0.20
D50 entrained (cm)	2.5	2.1	3.0	2.0
Critical Depth (m)	0.21	0.25	0.05	0.09
Critical Discharge (cms)	2.56	2.08	0.11	0.10
Stream Power (W) per unit width of channel	30	16	35	27
Erosion Potential (N/ms)	18.05	8.72	37.67	21.72
General Trends	Transport	Mainly transport, long-term minor erosion	Erosion	Erosion

The low-order streams that are situated within the study area serve an important function within any watershed. That is, during precipitation events, water from surrounding land is gradually conveyed to the channel through surface overland flow and through-flow. When surface and groundwater gradually begin to fill the low-order channel, the water is stored until the volume in the channel is sufficient to flow towards the main drainage channel. As a result, when natural low-order channels are part of a drainage network, the duration of storm-hydrographs is lengthened. The peak discharge of the hydrograph is delayed and attenuated when water is conveyed to the main channel through natural low-order channels. When these channels are altered such that they become the conveyors of storm drain water, then the hydrograph of the main channel will change. In general, the duration of the discharge event will decrease, the time to peak discharge will shorten and the magnitude of the peak discharge event will increase.

Channel functions and thresholds were evaluated using several standard empirical relations (**Table 4.6**). The stream power per unit width of channel is indicative of the energy of the flows that occupy the channel. This information, coupled with measures of the erosion potential of the flow, yields insight into the dominant processes that occur in the channel and the potential for channel boundary changes. Both the stream power and erosion potential of reach B are low. It follows that the dominant process in this reach is transport. This observation is supported by the fact that the D50 of the substrate grain size distribution is similar to the D50 that is entrained during bankfull flow conditions. Using a similar line of reasoning, the dominant process that occurs in reaches C and D is erosion: stream power and erosion potential are high, the D50 size that is entrained is much larger than the D50 of the substrate.

Hydraulic geometry is a concept introduced by Leopold and Maddock (1953) which describes quantitatively how an increase in flow is accommodated by each of the variables that define flow (i.e. discharge = width * depth * velocity). The exact quantities, in percentage, depend on the cross-sectional shape of the channel, a function of the erodibility of channel boundary materials. The technique may be applied to a single cross-section (at-a-station) or to a watercourse (downstream).

Results of the at-a-station hydraulic geometry analyses indicate that, as water fills a channel, a larger percentage of the increased water volume is conveyed by velocity than by either channel width or depth. An evaluation of the analytical results (**Table 4.7**) shows that although the percentage values for the variables are comparable for each reach, some subtle, but important, differences exist. Similar to preceding discussions of reach properties, the hydraulic geometry characteristics of reaches A/B are different from those of reaches C/D. Specifically, water-depth and flow-velocity accommodate ~ 28 % and 64 % respectively of increasing flow in reaches A and B. In reaches C and D, water-depth and flow-velocity accommodate 19 % and 69 % respectively of an increase in flow. Flow velocity changes more, proportionally, than any other variable when water begins to fill the channel, indicating that the channel boundary materials are resistant to erosion and that the energy within the river is high. The differences in percentages for each of the variables between reaches A/B and C/D is a function of the erodibility of boundary material materials, confirming observations described earlier. Specifically, local alluvium are more erodible in reaches C/D (glacial till surficial geology) than in reaches A/B (glacio-lacustrine).

Table 4.7 - Percentage Accommodation of a Cross-Sectional Increase in Water Volume by Channel Width, Water Depth, and Flow Velocity, Based on At-A-Station Hydraulic Geometry

Variable	A	B	C	D
Channel Width	7	10	9	14
Channel Depth	27	28	20	19
Velocity	66	62	71	67

Various channel thresholds were quantified and analyses were conducted to determine how sensitive the reaches are to erosion. This information is especially important in planning studies to determine what the tolerance of the channel is to imposed changes in hydrologic regime. Several of the important thresholds calculated are presented in **Table 4.6** and in the data summaries provided in **Appendix A.** Critical values should be compared to data presented in **Table 3.3.** Such comparisons support the conclusions drawn from other components of the geomorphic assessment. Specifically, reaches C and D are part of a long-term erosion process whereas reaches A and B are part of long-term transport and deposition processes.

The purpose of the geomorphic assessment was to determine the form and function of the watercourses within the study area. To fulfill the objective of the geomorphic assessment, several analyses were conducted at varying scales of spatial and temporal resolution. The salient features of the analyses are noted below:

- Two different surficial geology deposits are in the study area: glacio-lacustrine (west-end) and glacial till (east-end);
- Most of the channels situated in the study area are 1st order streams;
- Only reach A appears to have been altered by human activity;
- Only minor changes in land use have occurred in, and immediately upstream of, the study area between 1954 and 1996;
- Reach C is actively migrating; natural planform adjustments have occurred in reach B between 1954 and 1996;
- Reaches A/B (west-end) are somewhat less resistant to erosion than reaches C/D (east-end);
- In all reaches, an increase in discharge is accommodated mainly by an increase in flow velocity;
- Erosion is the dominant process in reaches C/D, transport is dominant in A/B.

4.5 Erosion

The threshold flow targets for erosion control determined from the field surveys at the local sites within the study area are generally higher than those determined in the Watershed Plan. The watershed plan targets, therefore, will be used for the erosion control facility design. A summary of these targets (**Table 4.8**) throughout the study subwatersheds is provided in the following table.

While the field-measured critical rate for the East Sixteen Mile Creek is less than that of the watershed plan, the value may be characteristic of only the south slope area which ends south of the proposed development corridor. As a result, this lower value may govern upstream development throughout the south slope but not the local corridor development. Nonetheless, future development controls should strive to maintain the existing flow duration characteristics for both the higher watershed and the lower local critical rates. This approach is in the interest of maintaining the existing flow regime to the maximum extent possible.

The QUALHYMO model developed as part of the Sixteen Mile Creek Watershed Plan was reviewed and updated to allow existing condition hydrologic regime of the 401 Corridor Planning Area to be assessed. Details of the model have been provided in **Appendix H**. The existing condition model was first run for the average-year period using a 1-hour time step (DT) and flow duration exceedance curves were compared with those of the Sixteen Mile Creek Watershed Plan. Values for these curves at the subwatershed outlets and two erosion sites from the Watershed Plan are provided in **Table 4.9** and values for the subwatershed outlets are presented graphically in **Figure 4.10**. The figure indicates very close agreement for Subwatershed 3, 4 and 7, while Subwatershed 5 generally follows the same pattern with same variability, perhaps due to the discretization of the 401 Corridor model (HHCS series). Subwatershed 6 results suggest

Table 4.8

Halton Hills - 401 Corridor Integrated Planning Project

Erosion Control Threshold Flow Rates

(1) Catch-ment No.	QUAL-HYMO Series No.	Description	(2) Area (ha)	Area u/s of Erosion Control Target Site (ha)	Erosion Threshold Flow Rate SMCWP (3) (m3/s)	Erosion Threshold Flow Rate 401 Corr. (4) (m3/s)
Subwatershed 3						
200	200	u/s Scotch Block	1327			
201	201	u/s Scotch Block	2000			
201B	202	Scotch Block	566			
202A	210	u/s of Study Area	1195.1			
202B	215	Study Aea (202B,A,B,C)	209.48			
	332	**Development Areas 202B, A, B, C**		**5298**	**0.53**	**2.56**
202C	220	d/s of Study Area + Hazard	238.45			
	333	**Sub-Watershed 3 Totals**	5536.03	**5536**	**0.55**	-
Subwatershed 4						
203	203	u/s External Area	2136.7			
204A	204	u/s External Area	901.06			
204B	**441**	**Study Area (D,E)**	**85.39**			**2.08**
205A	205	u/s External Area	934.08			
205B	**442**	**Study Area (F)**	**36.51**			**0.11**
	443	**Development Areas D, E, F**		**4094**	**0.41**	
205C	245	d/s of Study Area + Hazard	109.25			
	444	**Sub-Watershed 4 Totals**	4202.99	**4203**	**0.42**	
	110	**Erosion Monitoring Site # 2**		**9739**	**0.96**	
Subwatershed 5						
300	551	u/s External Area	1902.3			
301A	552	Study Area (G,H)	84.82			
	553	**Development Areas G, H**		**1987**	**0.20**	
301B	301	d/s of Study Area + Hazard	882.43			
	555	**Sub-Watershed 5 Totals**	2869.55	**2870**	**0.29**	**0.10**
Subwatershed 6						
303A	661	u/s External Area	22.91			
303B	662	Study Area (I)	22.33			
	663	**Development Area I**		**45**	**0.005**	
303C	303	d/s of Study Area	589.82			
304A	671	u/s External Area	133.33			
304B	672	Study Area (J,K,L,M)	91.29			
	953	**Development Areas J, K, L, M**		**814**	**0.08**	
304C	674	407 Interchange	56.88			
	675	**Development Areas J, K, L, M + 407**		**282**	**0.03**	
304D	304	d/s of Study Area	825.41			
302	302	d/s of Study Area	713.5			
305	305	d/s of Study Area	906.56			
	666	**Sub-Watershed 6 Totals**	3362.03	**3362**	**0.33**	
Subwatershed 7						
206	375	Sub-catchment 206	710			
207A	380	Sub-catchment 207A	781			
207B	385	Sub-catchment 207B	442			
306	390	Sub-catchment 306	643			
	386	**Erosion Monitoring Site #5**		**18547**	**1.84**	
307	395	Sub-catchment 307	508			
308	400	Sub-catchment 308	594			
309	405	Sub-catchment 309	525			
	777	**Sub-Watershed 7 Totals**	4203	**4203**	**2.00**	

Notes :
1. See Figure 2.1 (in report) and Drawing No.1 (back pocket) for subcatchment locations.
2. Updated Areas by Dillon Consulting.
3. Taken from the Sixteen Mile Creek Watershed Plan Tables 4.6 and D.11 or calculated on the basis of 0.1 L/s/ha
4. Taken from investigations by Parish Geomorphic, 1998

Table 4.9
Halton Hills - 401 Corridor Integrated Planning Project
Qualhymo Model Exceedance Curves

Avg. Year Simulation ***** 15 min. DT *****

No. hrs of simulation from 71/11/2 to 72/10/30 = 8736 hrs

Input File : ex1yr.inp

SW 3

Flow (m3/s)	(L/s)	SMCWP (1hr DT) Exceed (hrs)	SMCWP (1hr DT) (%)	This Study (15min DT) Exceed (hrs)	This Study (15min DT) (%)
0.18	180			8147	93.3
0.27	270	5396	61.8	4900	56.1
0.54	540	1512	17.3	1715	19.6
0.68	680	943	10.8	1011	11.6
0.81	810	751	8.6	709	8.1
0.95	950	607	6.9	596	6.8
1.1	1100	501	5.7	511	5.8
3.1	3100	152	1.7	127	1.5
9.2	9200	12	0.1	19	0.2
15	15000	0	0.0	0	0.0

SW 4

Flow (m3/s)	(L/s)	SMCWP (1hr DT) Exceed (hrs)	SMCWP (1hr DT) (%)	This Study (15min DT) Exceed (hrs)	This Study (15min DT) (%)
0.14	140		0.0	1772	20.3
0.21	210	1265	14.5	1239	14.2
0.42	420	790	9.0	720	8.2
0.63	630	628	7.2	575	6.6
1.26	1260	419	4.8	370	4.2
2.1	2100	306	3.5	249	2.9
4.2	4200	184	2.1	155	1.8
6.1	6100	128	1.5	94	1.1
14.5	14500	18	0.2	24	0.3
26.9	26900	0	0.0	8	0.1

E 2

Flow (m3/s)	(L/s)	SMCWP (1hr DT) Exceed (hrs)	SMCWP (1hr DT) (%)	This Study (15min DT) Exceed (hrs)	This Study (15min DT) (%)
1	1000		0.0	971	11.1
1.5	1500		0.0	622	7.1
2	2000		0.0	482	5.5
3	3000		0.0	328	3.8
4	4000		0.0	250	2.9
6	6000		0.0	183	2.1
9	9000		0.0	99	1.1
15.6	15600		0.0	47	0.5
25.7	25700		0.0	19	0.2
50	50000		0.0	0	0.0

SW 5

Flow (m3/s)	(L/s)	SMCWP (1hr DT) Exceed (hrs)	SMCWP (1hr DT) (%)	This Study (15min DT) Exceed (hrs)	This Study (15min DT) (%)
0.1	100		0.0	2278	26.1
0.15	150	1597	18.3	1685	19.3
0.29	290	1062	12.2	973	11.1
0.44	440	746	8.5	722	8.3
0.58	580	478	5.5	599	6.9
0.87	870	275	3.1	431	4.9
1.45	1450	195	2.2	228	2.6
3	3000	176	2.0	93	1.1
5.8	5800	74	0.8	30	0.3
9.1	9100	0	0.0	16	0.2

SW 6

Flow (m3/s)	(L/s)	SMCWP (1hr DT) Exceed (hrs)	SMCWP (1hr DT) (%)	This Study (15min DT) Exceed (hrs)	This Study (15min DT) (%)
0.17	170	2211	25.3	1583	18.1
0.22	220		0.0	1265	14.5
0.33	330	1602	18.3	915	10.5
0.5	500	781	8.9	667	7.6
0.99	990	449	5.1	404	4.6
1.65	1650	281	3.2	291	3.3
2.48	2480	166	1.9	198	2.3
3.7	3700	154	1.8	106	1.2
8.1	8100	59	0.7	33	0.4
14.8	14800	0	0.0	12	0.1

E 5

Flow (m3/s)	(L/s)	SMCWP (1hr DT) Exceed (hrs)	SMCWP (1hr DT) (%)	This Study (15min DT) Exceed (hrs)	This Study (15min DT) (%)
0.61	610		0.0	3117	35.7
1.23	1230		0.0	1601	18.3
1.84	1840		0.0	967	11.1
3	3000		0.0	618	7.1
5	5000		0.0	404	4.6
9	9000		0.0	258	3.0
15	15000		0.0	126	1.4
25	25000		0.0	66	0.8
50	50000		0.0	17	0.2
75	75000		0.0	9	0.1

SW 7

Flow (m3/s)	(L/s)	SMCWP (1hr DT) Exceed (hrs)	SMCWP (1hr DT) (%)	This Study (15min DT) Exceed (hrs)	This Study (15min DT) (%)
0.67	670		0.0	3037	34.8
1	1000	2145	24.6	2207	25.3
2	2000	1019	11.7	985	11.3
3	3000	774	8.9	679	7.8
4	4000	585	6.7	535	6.1
7	7000		0.0	342	3.9
10	10000	182	2.1	262	3.0
15.6	15600	162	1.9	131	1.5
39.7	39700	56	0.6	35	0.4
72.7	72700	0	0.0	12	0.1

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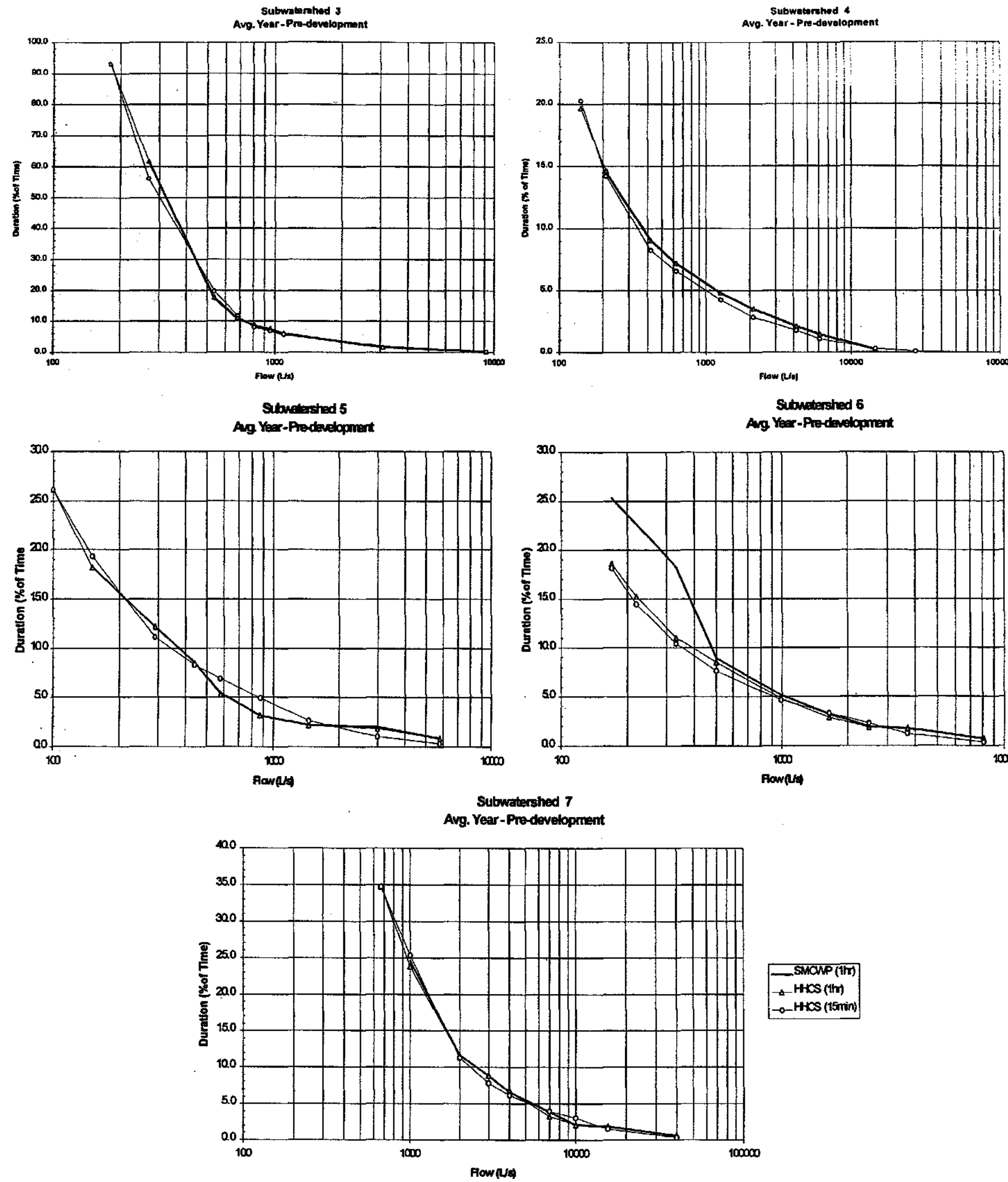

TOWN OF HALTON HILLS

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401 CORRIDOR INTEGRATED PLANNING PROJECT
SCOPED WATERSHED STUDIES

EXISTING SUBWATERSHED FLOW DURATION CURVES
15 MINUTE TIME STEP

FIGURE 4.10

a discrepancy at lower flow rates where the values from the Watershed Plan show an irregular pattern, which has been attributed by the original modeller to typographical or other errors in the original reports.

In order to account for the smaller development and drainage areas within the subwatersheds, a smaller 15 minute simulation time step was adopted to allow for a more accurate characterization of short term runoff events. Flow exceedance values at the subwatershed outlets and two erosion sites from the Watershed Plan are provided in **Table 4.10** and **Figure 4.10** compares results of the 15-minute time step simulations with the 1-hour simulations. The figure indicates a good agreement between the results for the various subwatershed, and therefore these 15-minute values have been adopted to describe the existing condition hydrologic regime.

Results of the Sixteen Mile Creek Watershed Plan erosion analysis using QUALHYMO characterizes existing flow conditions and provides direction for future development controls which can meet existing targets. Further analysis indicates that results for subcatchment 203 provide the most accurate starting point for control volumes and rates. Erosion control storage requirements derived for this area are 155 cubic metres per hectare (52 mm / impervious hectare). The total storage required for 100-year flood and erosion protection was 260 cubic metres per hectare (87 mm / impervious hectare).

4.6 Aquatic Environment

Field investigations performed as part of this study have provided habitat characterization and species classifications for main tributaries of the Sixteen Mile Creek which are discussed separately below. A broad comparison between the various watercourse systems shows a high degree of correlation between factors such as the nature and extent of riparian vegetation, the resulting habitat characteristics (such as temperature) and the type of species actually observed within the systems.

Higher proportions of wooded and idle riparian land uses correlate positively with the quality of species found. For example, Subwatershed 3 has a total of 35% wooded riparian land use, indicating a relatively high degree of riparian cover. This Subwatershed was observed to have the highest quality of fish species (coldwater). Subwatershed 4 which has a total of 15% wooded riparian land use and a moderate degree of riparian cover, has a mixed quality of species in its two main tributaries . Lastly, Subwatershed 5, with only 8% was observed to have the lowest quality of fish species (warmwater).

Table 4.10
Halton Hills - 401 Corridor Integrated Planning Project
Qualhymo Model Exceedance Curves

Avg. Year Simulation ***** 1 hr. DT *****

No. hrs of simulation from 71/11/2 to 72/10/30 = 8736 hrs

Input File : hhex1h.inp

SW 3

Flow		Watershed Plan		401 Corridor Study	
		Exceed		Exceed	
(m3/s)	(L/s)	(hrs)	(%)	(hrs)	(%)
0.18	180			8138	93.2
0.27	270	5396	61.8	5395	61.8
0.54	540	1512	17.3	1555	17.8
0.68	680	943	10.8	962	11.0
0.81	810	751	8.6	780	8.9
0.95	950	607	6.9	661	7.6
1.1	1100	501	5.7	547	6.3
3.1	3100	152	1.7	149	1.7
9.2	9200	12	0.1	19	0.2
15	15000	0	0.0	0	0.0

SW 4

Flow		Watershed Plan		401 Corridor Study	
		Exceed		Exceed	
(m3/s)	(L/s)	(hrs)	(%)	(hrs)	(%)
0.14	140		0.0	1719	19.7
0.21	210	1265	14.5	1278	14.6
0.42	420	790	9.0	789	9.0
0.63	630	628	7.2	630	7.2
1.26	1260	419	4.8	418	4.8
2.1	2100	306	3.5	308	3.5
4.2	4200	184	2.1	185	2.1
6.1	6100	128	1.5	128	1.5
14.5	14500	18	0.2	18	0.2
26.9	26900	0	0.0	0	0.0

E 2

Flow		Watershed Plan		401 Corridor Study	
		Exceed		Exceed	
(m3/s)	(L/s)	(hrs)	(%)	(hrs)	(%)
1	1000		0.0		0.0
1.5	1500		0.0		0.0
2	2000		0.0		0.0
3	3000		0.0		0.0
4	4000		0.0		0.0
6	6000		0.0		0.0
9	9000		0.0		0.0
15.6	15600		0.0		0.0
25.7	25700		0.0		0.0
50	50000		0.0		0.0

SW 5

Flow		Watershed Plan		401 Corridor Study	
		Exceed		Exceed	
(m3/s)	(L/s)	(hrs)	(%)	(hrs)	(%)
0.1	100		0.0	2278	26.1
0.15	150	1597	18.3	1591	18.2
0.29	290	1062	12.2	1063	12.2
0.44	440	746	8.5	741	8.5
0.58	580	478	5.5	465	5.3
0.87	870	275	3.1	274	3.1
1.45	1450	195	2.2	193	2.2
3	3000	176	2.0	162	1.9
5.8	5800	74	0.8	75	0.9
9.1	9100	0	0.0	0	0.0

SW 6

Flow		Watershed Plan		401 Corridor Study	
		Exceed		Exceed	
(m3/s)	(L/s)	(hrs)	(%)	(hrs)	(%)
0.17	170	2211	25.3	1627	18.6
0.22	220		0.0	1331	15.2
0.33	330	1602	18.3	967	11.1
0.5	500	781	8.9	740	8.5
0.99	990	449	5.1	422	4.8
1.65	1650	281	3.2	252	2.9
2.48	2480	166	1.9	164	1.9
3.7	3700	154	1.8	153	1.8
8.1	8100	59	0.7	60	0.7
14.8	14800	0	0.0	0	0.0

E 5

Flow		Watershed Plan		401 Corridor Study	
		Exceed		Exceed	
(m3/s)	(L/s)	(hrs)	(%)	(hrs)	(%)
0.61	610		0.0	3117	35.7
1.23	1230		0.0	1601	18.3
1.84	1840		0.0	967	11.1
3	3000		0.0	618	7.1
5	5000		0.0	404	4.6
9	9000		0.0	258	3.0
15	15000		0.0	126	1.4
25	25000		0.0	66	0.8
50	50000		0.0	17	0.2
75	75000		0.0	9	0.1

SW 7

Flow		Watershed Plan		401 Corridor Study	
		Exceed		Exceed	
(m3/s)	(L/s)	(hrs)	(%)	(hrs)	(%)
0.67	670		0.0	3037	34.8
1	1000	2145	24.6	2080	23.8
2	2000	1019	11.7	1010	11.6
3	3000	774	8.9	771	8.8
4	4000	585	6.7	588	6.7
7	7000		0.0	289	3.3
10	10000	182	2.1	181	2.1
15.6	15600	162	1.9	162	1.9
39.7	39700	56	0.6	65	0.7
72.7	72700	0	0.0	0	0.0

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The correlation between land uses and habitat extends to the tributary level as well, as illustrated in the Subwatershed 4 creek system. The Middle Sixteen Mile Creek Tributary in which coldwater species were observed has 23% wooded riparian land use while the Hornby Tributary in which warmwater species were observed has 8%. It is apparent these land use characteristics have a direct bearing on habitat quality as revealed through temperature monitoring in these tributaries. Monitoring showed that the Hornby Tributary had a higher average temperature, higher maximum temperature and higher range in temperature when compared with the Middle Sixteen Mile Creek Tributary. All of these characteristics can be partially explained by the degree of shading received by the upstream watercourses.

East Sixteen Mile Creek and Tributaries

The fish species captured through the three sampled reaches of East Sixteen Mile Creek are indicative are warmwater baitfish communities. In general, streams which have been designated warmwater are considered Type II habitat, and thus are considered moderately sensitive to developmental impacts. Recommended setbacks for a warmwater stream are 15 metres on each side of the stream.

The five headwater tributaries located at the east end of the study area lack channel structure and have no discernible baseflow. These tributaries have been described as intermittent swales by the Ministry of Natural Resources and by the Department of Fisheries and Oceans (Toll Highway 407 Stormwater Management Strategy Study Final Report, 1997) and do not constitute fish habitat.

Middle Sixteen Mile Creek Tributaries

The fish community through the study area is characteristic of warmwater baitfish. However the capture of two brook trout, one each in the lower and upper reaches of this tributary, necessitates its reclassification to coldwater, Type I habitat. A 30 metre setback on each side of the stream is recommended for streams of this designation. Given the degraded condition of the Hornby Tributary and the Middle Sixteen Mile Creek Tributary, water temperature may rise above the optimum for brook trout at certain times of the year. The presence of these fish within these reaches, however, should provide incentive to restore these watercourses to a level where they are able to support a coldwater fish community year round.

Middle Sixteen Mile Creek

Middle Sixteen Mile Creek has been classified as coldwater (Type I) habitat within the upper half of the study area. The presence of 7 rainbow trout south of Steeles Avenue will change the classification of the downstream reaches of the study area to Type I habitat also. As mentioned above, 30 metre setbacks are recommended for watercourses with this designation.

The Mansewood Tributary has been designated warmwater baitfish (Type II) habitat and 15 metre setbacks are recommended.

Mullet Creek

Headwater tributaries of Mullett Creek have been assessed within the Gateway West Subwatershed Study. The report indicates that Mullett Creek upstream of Steeles Avenue and its tributaries downstream of Steeles Avenue have "low" ranking for habitat and act primarily to convey stormwater. This ranking would apply to the intermittent swales within the north-east corner of the 401 Corridor Planning Area. The Gateway report indicates that these swale features may be replaced by urban drainage components combined with stormwater management.

4.7 Terrestrial Environment

Valleylands of the Middle Sixteen Mile Creek and the Middle Sixteen Mile Tributaries system (including the Middle Sixteen Mile Creek Tributary and the Hornby Tributary) have been identified as "natural corridors" within the Sixteen Mile Creek Watershed Plan's Natural Heritage System. The plan defines "natural corridors" as lands which connect "core" areas (defined in the plan as ESA, ANSI, critical wildlife habitat, provincially significant wetland, old growth (>100 years), a large woodland (>30 ha) and/or containing endangered, threatened or rare flora or fauna). In the case of the above noted 401 Corridor valleylands, these lands provide primary linkages between core natural areas located north and south of the 401 Planning Area. Field investigations determined that the riparian area of the Middle Sixteen Mile Creek requires enhancement as the area is barren and eroded. Woody cover along the creeks is recommended to improve local aquatic and terrestrial habitat to contribute to the overall health of the natural corridor. On the side of the road adjacent to the creek, the species planted would be somewhat salt tolerant, however additional species, with less tolerance, could be planted on the opposite side of the creek. Suggested species for this area include bur oak (*Q. macrocarpa*), green ash (*Fraxinus pensylvanica lanceolata*), hackberry (*C. occidentalis*), red osier dogwood (*C. stolonifera*) and hawthorn (*Crataegus* spp.).

The Mansewood Tributary of Middle Sixteen Mile Creek transects the portion of the 401 Planning Area extending north of Steeles Avenue. It has also been identified as a "natural corridor" in the Natural Heritage System. Currently the watercourse runs through a hedgerow with limited riparian vegetation. Enhancement with tree species able to withstand the prevailing winds in this exposed area is recommended. Less tolerant species could be planted in the lee of the hegderow. Suggested species for planting include red osier dogwood, (*Cornus stolonifera),* white birch (*Betula papyrifera)* bur oak (*Q. macrocarpa)* white elm (*U. americana*), and hackberry (*Celtis occidentalis*).

The East Sixteen Mile Creek has been identified as a "secondary linkage" in the Watershed Plan as it connects core areas and "other" natural areas. The plan defines a secondary linkage as a natural feature such as a stream, floodplain, steep slope, valley, contiguous narrow woodland and wetlands that are not provincially significant, that connects secondary natural areas (non-core areas) with core areas or natural corridors). Due to the extensive existing vegetation, this valley itself has been classified as an "other" (i.e., non-core) natural area throughout the 401 Planning Area from Steeles Avenue to Highway 401, and south of the Planning Area to Trafalgar Road. This natural area is to be maintained.

Several areas of potential flood plain wetlands in the southern reaches of the Middle Sixteen Mile Creek and its tributaries (subwatersheds 3 and 4) were identified in the Sixteen Mile Creek Watershed Plan. Field investigations revealed no indication of species which would classify these areas as being significant. However, due to the time of year when these investigations were conducted, features may have been obscured, and therefore additional monitoring during the summer period should be conducted prior to any necessary works conducted in these areas (e.g., storm outfall).

The Gateway West Subwatershed Study indicates that there are no significant vegetation features, or terrestrial or aquatic linkages within the headwater areas of the Mullett Creek subwatershed.

5. TECHNICAL ASSESSMENT OF HYDROLOGIC PROCESSES AND NATURAL SYSTEMS

5.1 General

This section establishes how the hydrologic processes and natural systems within the Subwatersheds will respond to proposed changes in land use within the 401 Corridor. The purpose of this assessment is to determine how sensitive the overall system is to change; identify specific features, areas and functions that may be affected (*i.e.*, lost or disturbed); and to gain insight into what management measures may be necessary to protect those features and functions affected.

The technical assessment examines the key Subwatershed hydrologic processes and natural systems based on their present state and quantifies where possible, changes to those processes and systems arising from proposed changes in land use. The potential impacts of land use change were evaluated using the future land use scenario and assumes no mitigation or management measures (such as storm water management facilities) are in place. This scenario includes newly designated lands for prestige industrial and gateway commercial.

Specifically, the assessment identifies whether the future land use changes will negatively impact the features or ecological functions of an area. In this manner, the technical assessment is meant to satisfy the guideline requirements of the *Policy Statement* and the Sixteen Mile Creek Watershed Plan. Technical analyses relating to regional hydrology, erosion and natural features in the Mullett Creek subwatershed may be found in the Gateway West Subwatershed Study.

The majority of this assessment focuses on quantifying various components of the hydrologic cycle, such as evapotranspiration, infiltration, runoff and groundwater recharge, and assessing how those functions may be impacted as a result of development. In addition, natural systems including the significant natural heritage features and ecological functions have been assessed.

Analytical methods, including water balances, hydrologic modelling, empirical equations and areal measurements, have been used to quantify/assess changes to the hydrologic processes and natural features within the Subwatersheds. Indicators, such as increases/decreases to peak flows, runoff volumes, flow velocities, groundwater recharge/discharge volumes, and the area of woodland, fish habitat, etc., affected have been used to assess potential effects.

Aspects of the Subwatershed environment assessed are:

- Hydrologic processes/functions including increases or decreases to:
  - evapotranspiration, infiltration, surface runoff and groundwater recharge/discharge (hydrologic functions)
  - frequency, magnitude and duration of streamflows (hydrologic streamflow regime, streambank erosion, flooding)
  - surface runoff peak flows and volumes (flooding)
  - streamflow channel velocities (streambank erosion)

- Natural heritage features and ecological functions, including loss or disturbance to:
  - fish habitat
  - woodlands
  - valleylands (including: lake, river and stream systems; natural corridors)

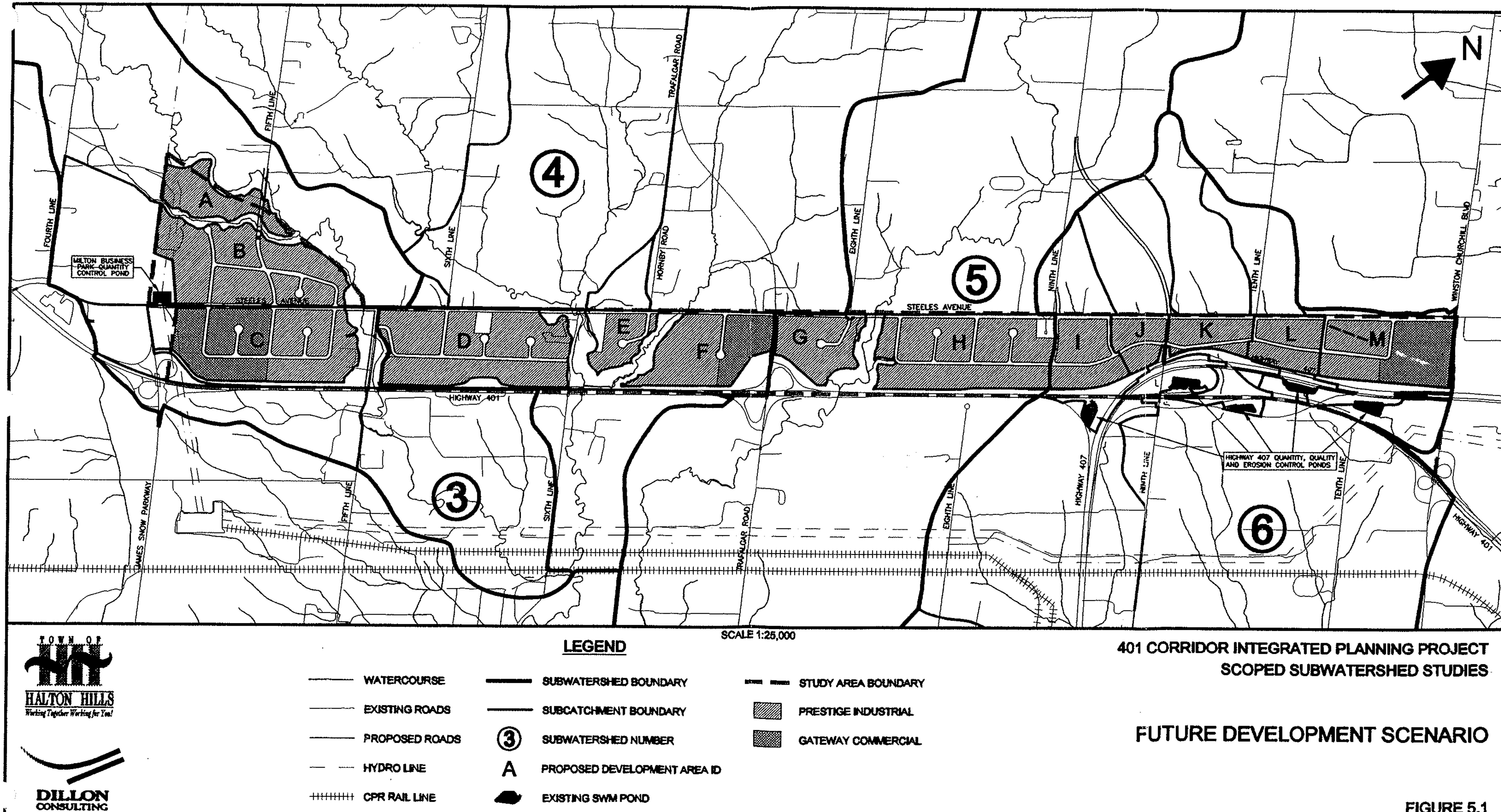
5.2 Future Land Use

5.2.1 Future Land Use Scenario for Impact Assessment

The assessment of potential development impacts is based on the future land use scenario within the 401 Corridor, as presented in **Figure 5.1** and includes newly designated lands for commercial and industrial development. This scenario represents the foreseeable "future" development planned for the Subwatersheds, according to the Halton Urban Structure Plan.

It is estimated that all of lands currently used for rural land uses (including agriculture, idle fields and existing development) may be developed for urban uses over the long-term. This, in turn, would increase the total urban land use from 15%, under existing conditions, to over 80%.

Using the estimates of percent imperviousness for each land use contained in **Table 5.1**, complete development of all lands designated for urban use will add approximately 300 ha of impervious area (*i.e.*, rooftops, roads, driveways, sidewalks, etc.) to the 401 Corridor. The net result will be an increase in percent imperviousness from 7%, for existing land use conditions, to over 60% for future conditions.



401 CORRIDOR INTEGRATED PLANNING PROJECT
SCOPED SUBWATERSHED STUDIES

FUTURE DEVELOPMENT SCENARIO

FIGURE 5.1

Table 5.1 - Percent Imperviousness Associated with Future Land Use Scenario	
Land Use	**Percent Imperviousness (%)**
Prestige Industrial	70
Gateway Commercial	80
Local Right-of-Ways	50

5.3 Hydrologic Processes

5.3.1 General

Changes to hydrologic processes resulting from proposed changes in land use were examined in terms of potential surface water impacts. Potential impacts to hydrologic processes were established by comparing differences in the hydrologic regime based on existing and proposed changes in land use. Both continuous and single event hydrologic modelling (using QUALHYMO and OTTHYMO89, respectively) were used to identify and assess impacts related to various components of the hydrologic cycle. Continuous simulations were also used to assess impacts to streamflow regimes of Sixteen Mile Creek in terms of the frequency, magnitude and duration of streamflow events that occur throughout the entire year. Increases (or decreases) to the frequency, magnitude and duration of streamflow events were used as indicators of potential impacts associated with streambank erosion.

Surface water runoff impacts were further quantified by comparing differences in the hydrologic response of the local planning area to extreme rainfall events. Single event hydrologic computer modelling (OTTHYMO89), using a range of design storm events, was used to identify and assess impacts related to surface water runoff. Increases (or decreases) to peak flows, were used as indicators of potential impacts associated with flooding and streambank erosion.

5.3.2 Hydrologic Modelling

The QUALHYMO model was utilized to assess changes to the hydrologic regimes associated with future land use conditions. The hydrologic model for future land use conditions was based on the same hydrologic model used for existing conditions, but with specific sub-areas further discretized and/or revised to reflect differences in proposed land use, drainage and development boundaries. It is noted that area M represents both Subwatershed 6 (Sixteen Mile Creek Watershed) and Mullett Creek (Credit River Watershed) tributary areas which are to be drained and controlled separately following development (i.e., only minor grading to redefine the boundary is permitted).

The input parameters describing the characteristics of each of the sub-areas may be found in **Appendix H**. A schematic of the QUALHYMO model showing the sub-area addition and routing is also contained in the appendix.

5.3.2.1 Continuous Hydrologic Modelling

Continuous simulations using 6 years of precipitation and temperature data as input to the QUALHYMO model was used to assess impacts to the streamflow regime of the receiving tributaries. The streamflow regime is embodied within the flow-duration summary curves which reflect the continuous flow characteristics throughout the entire simulation period. While changes to the flow-duration characteristics at any flow magnitude may constitute effects on the streamflow regime, changes at or above critical flow threshold values, determined through geomorphologic analyses, are of primary concern since it is this range of flows which influence the channel morphology (e.g., shape, stability). As expected, uncontrolled development resulted in increases in flow duration at each of the Subwatershed outlets as well as the local outlets across the proposed development area.

5.3.2.2 Single Event Hydrologic Modelling

Single event OTTHYMO89 modelling was used to compute flow estimates (hydrographs) for a range of design storm frequencies that were compared to those obtained from the existing condition modelling results. Increases to peak flows were used as indicators of potential flooding impact.

The results of the single event modelling for the developed land use conditions are summarized in **Table 5.2**, together with the existing condition values for comparative purposes. The table lists peak flows for the various design storm events at proposed outlet locations to receiving watercourses across the 401 Corridor.

The table indicates that significant increases in flow rates at each of the outlets would be observed following development without stormwater management controls in place.

Table 5.2 - Future Uncontrolled Design Flows

Pond ID Refer to Dwg 4	Hydrograph ID		Design Flows (cms)											
			2 year		5 year		10 year		25 year		50 year		100 year	
	Existing	Future	Existing	Future	Existing	Future	Existing	Future	Existing	Future	Existing	Future	Existing	Future
1	106	104	0.42	1.82	0.75	2.62	1.02	3.24	1.38	3.97	1.66	4.52	1.94	5.03
2	508	503	3.33	9.63	7.55	15.04	10.1	18.64	13.35	23.03	16.11	27.47	18.86	30.88
3	601	600	1.02	4.83	1.75	7.47	2.33	9.43	3.1	11.69	3.69	13.4	4.28	15.74
4	602	202	0.5	1.26	0.9	1.82	1.22	2.21	1.65	2.81	1.99	3.21	2.33	3.59
5	206	203	1.03	3.22	1.81	4.77	2.42	5.8	3.23	7.62	3.85	8.69	4.47	9.71
6	302	300	0.052	1.99	0.91	3.11	1.22	3.76	1.63	4.73	1.94	5.4	2.25	6.02
7	700	301	1.31	4.53	2.31	6.99	3.11	8.81	4.17	10.9	4.98	13.03	5.8	14.66
8	800	800	1.11	2.39	1.94	3.45	2.6	4.24	3.47	5.74	4.13	6.61	4.8	7.43
9	803	804	1.13	1.56	1.99	2.45	2.67	3.05	3.59	3.85	4.29	4.46	4.99	5.03
10	806	808	1.36	1.76	2.4	2.59	3.22	3.48	4.31	4.41	5.15	5.12	5.99	5.79
11	809	812	0.92	1.99	1.62	2.9	2.18	3.86	2.93	4.83	3.5	5.57	4.07	6.27
12	412	412	0.56	4.28	0.99	6.35	1.34	2.83	1.8	9.76	2.15	10.89	2.51	12.22

5.4 Natural Heritage Features and Areas

Changes to natural heritage features and areas, and their inherent ecological functions resulting from proposed changes in land use were assessed qualitatively, by estimation of areas that may be lost, disturbed or displaced by new development through an assessment of the features' sensitivity with respect to their proximity to planned development. Where possible, both direct and indirect impacts were identified and assessed. Direct impacts were viewed as those that result in a physical destruction or alteration to the feature. Indirect impacts emphasize those that result from environmental changes, which in turn affect the quality and/or quantity of the feature or ecological function.

A decrease in the quantity (*i.e.*, size) and/or quality of a significant natural heritage feature or its ecological functions was used as an indicator of potential negative impacts.

Significant natural heritage features and ecological functions assessed include:

- Fish Habitat;
- Woodlands; and
- Valleylands (including river and stream systems, and natural corridors).

Fish Habitat

It is not expected that development will result in a significant loss of fish habitat, since the limits of proposed development will be located away from this feature. Federal, Provincial and Conservation Authority guidelines regulate the impacts on fish habitat due to valley encroachment, stream crossings and urban development.

Some direct impact on fish habitat could arise from the construction of new road crossings, road widenings or utility easements across Sixteen Mile Creek watercourses. These aspects, if they were to occur, are not expected to impact the fish habitat in a significant way, since these could be mitigated through application of management practices incorporated in the roadway design and construction.

Indirect impacts to fish habitat could arise from uncontrolled releases of urban storm water runoff from new development. Increases in peak flows and changes to the hydrologic regime (discussed previously) would alter the streamflow conditions, which in turn could lead to streambank erosion, increased turbidity, loss of riparian vegetation and the disruption of biological activities. Also, the increased washoff of pollutants carried in the storm water could lead to higher levels of nutrients, organics, toxins, trace metals and hydrocarbons in the receiving watercourses. The resulting degradation of the water quality would negatively impact the aquatic ecosystem, potentially jeopardizing the sustainability of the aquatic resources of the 401 Corridor and the broader Subwatersheds.

Without agricultural and rural land best management practices, significant impacts to aquatic organisms (fish and invertebrates) and resources (feeding, spawning and nursery areas) will continue. Pollutants such as suspended sediments, nutrients and bacteria carried in agricultural runoff and the lack of riparian tree cover will continue to impair the surface water quality in Sixteen Mile Creek; limiting aquatic habitat resources and restricting the number and diversity of fish species. These impacts are viewed as negatively impacting the fish habitat and aquatic resources of the Subwatersheds.

Woodlands

Urban development of all designated lands are not expected to result in a direct loss of significant woodlands area. The limits of proposed development will be located away from all significant woodlands and the study requirements for development of adjacent lands will ensure the protection and integrity of this resource. Furthermore, development will be directed away from other fragmented woodlands through planning restrictions to ensure the protection and enhancement of this scarce resource.

Valleylands

Complete development of lands designated for urban development will not result in a direct loss of significant valleylands. The limits of proposed development will be located away from this feature and the adjacent land study requirements will ensure the protection and integrity of this resource.

Some direct loss of valleyland area and disruption to the ecological functions within the corridors could arise from the construction of new road crossings and utility easements associated with servicing of new development areas (e.g. north of the Mansewood Tributary). It is felt that the creation of any new road or utility crossings could result in the loss of corridor continuity and increased fragmentation of existing linkages. If so, possible negative impacts to the corridor functions could include hindrance of species movement, reduced local diversity of habitats and reduced buffering from adjacent impacts.

These potential impacts are viewed as negatively impacting the valleylands. Consequently, each new crossing or utility corridor should be examined and assessed individually as part of a scoped EIS. The intent and nature of a scoped EIS is discussed in Section 7.3.3.

Indirect impacts to the ecological functions within the valleylands could arise from changes to the hydrologic processes discussed previously. Uncontrolled releases of urban storm water from new development would increase peak flows and runoff volumes, and alter annual streamflow conditions. This in turn, could alter the stream morphology, habitat and ecological conditions. Adverse changes to stream morphology could include stream channel widening and downcutting, streambank erosion, and elimination of pool/rifle structure. Changes to habitat and ecology would result from the incurring loss of riparian vegetation, streambank and channel substrate material brought on by changing streamflow conditions. This in turn, would contribute to the disrupting of biological activities that occur in immediate contact with the shoreline, reducing the diversity and the abundance of fish, aquatic organisms and animals that depend on them.

These potential impacts are viewed as negatively impacting the functions that occur within the valleylands. Accordingly, it is essential that municipal initiatives continue to require that all development proponents incorporate appropriate stormwater management measures into their site plans.

5.5 Water Quality and Quantity Areas

Changes to sensitive water quality and quantity areas, and the ecological functions they provide, and support were assessed quantitatively, by direct measurement of areas that may be lost, disturbed or displaced by new development; and qualitatively through an assessment of the features' sensitivity with respect to their proximity to planned development.

A decrease in the quantity (*i.e.*, size) and/or quality of a sensitive water quality or quantity feature or its ecological functions was used as an indicator of potential negative impacts.

Sensitive water quality and quantity areas assessed include:

- watercourses of Sixteen Mile Creek;
- groundwater recharge and discharge areas.

It is not expected that development will result in a direct loss of stream reach of Sixteen Mile Creek, since the limits of proposed development will be located away from these features. Federal, Provincial and Conservation Authority guidelines regulate the impacts on watercourses due to valley encroachment, stream crossings and urban development. Indirect impacts to quality and quantity of water have been discussed previously.

For the most part, areas of identified groundwater recharge are located in the upstream portions of the Subwatersheds, beyond the proposed 401 Corridor development. As such, planned development is not expected to impact these areas directly. In addition, the continuation of agricultural and rural land use activities in the broad subwaterheds are not anticipated to negatively impact the hydrologic/hydrogeologic functions associated with the recharge areas.

As noted on **Map No. 2**, several localized areas of moderately well-drained soils are distributed across the 401 Corridor. These do not constitute significant recharge areas, however, consideration should be given to minimizing recharge reduction in such areas where feasible, both within and outside of the 401 Corridor. As part of the site investigations for development, exploratory field works should be conducted (e.g. boreholes, test pits, etc.) to confirm the hydrogeologic conditions and to assess the potential for lot level recharge practices. If the findings support the use of infiltration techniques, then such practices should be incorporated into the site drainage plan.

Regional groundwater discharge areas are primarily located within the significant valleylands, downstream of the 401 Corridor. As such, development of the lands designated for urban use is not expected to result in a direct loss of regional groundwater discharge areas, nor is it expected to negatively impact on the hydrologic and/or ecologic functions associated with the quantity of groundwater discharge.

The source of local baseflows within the Middle Sixteen Mile Creek Tributary system has been shown to be located upstream of the 401 Corridor developments; i.e., there is limited contribution from the local basal aquifer. Consequently, development is not expected to result in a loss of local discharge areas.

5.6 Summary of Technical Assessment and Required Management Measures

The previous sections have identified a number of potential Subwatershed impacts under future land use conditions. The following summarizes the key findings of the technical assessment and presents a number of interrelated issues to be addressed in the Subwatershed Plan.

- Continuous modelling of the hydrologic streamflow regime the Sixteen Mile Creek (and a minor portion of the Credit River) system shows changes to the annual streamflow conditions. The uncontrolled release of urban storm water runoff from proposed development could result in increases to the frequency, magnitude and duration of streamflow events. These changes are assessed as negatively impacting (*i.e.*, increasing) the potential for streambank erosion in the system. In addition, changes to the hydrologic streamflow regime could result in a range of indirect impacts that could negatively affect the existing natural features and ecological functions.

- Single event modelling of design storm rainfall events show changes to the storm event peak flows system. These changes were not assessed as negatively impacting (*i.e.*, increasing) the flood hazard, but may contribute to increased streambank erosion.

- Surface water quality conditions within Sixteen Mile Creek tributaries are currently degraded having been impacted from past and present land use activities. Without effective management measures for existing agricultural, rural and urban lands, and new development areas, pollutants such as suspended sediments, nutrients and bacterial inputs will continue to reach these watercourses. The input of pollutant loadings to the streams is assessed as potentially negatively impacting the water quality, the aquatic ecosystems and limiting the recreational use of the water.

- Forest vegetation within Subwatersheds 3, 4, 5, and 6 has been reduced to 36%, 12%, 5% and 4% respectively as a result of past land clearing for agriculture and urban settlement (primarily within Subwatershed 6). The impact assessment indicated that proposed development within the 401 Corridor could result in a further loss of remaining fragmented woodlands, if protection is not provided through recognition in the planning documents.

- The valleylands associated with Sixteen Mile Creek watercourses may be subjected to disruption or loss of valleyland or corridor area from the creation of new road crossings and utility easements associated with development servicing. However, through proper mitigation and restoration measures, the potential for adverse impacts can be prevented.

- Fish within several tributaries of Sixteen Mile Creek are small in number and diversity, exhibiting signs of stress. Results of the impact assessment suggest that uncontrolled releases of agricultural/rural runoff will negatively impact the existing fish communities and habitat in the Sixteen Mile Creek system. While no fisheries assessment could be carried out in the intermittent tributary of Mullett Creek, agricultural/rural runoff will negatively impact downstream fish communities in the Credit River system as well.

The impact assessment indicates that there are many interrelated aspects of the Subwatershed that are sensitive to change, and that there are specific features and functions that will be negatively impacted if new development and existing agricultural/rural land activities are allowed to proceed without adequate protection, mitigation and enhancement measures. The assessment has confirmed that certain significant natural heritage features should not be developed and should be protected. With this in mind, the following management measures should be adopted.

- Land use controls and management measures to protect human life and property from natural hazards associated with flooding and erosion;
- Land use controls to protect significant natural heritage features and ecological functions integral to the functioning of the Subwatersheds;
- Land use controls and management initiatives to protect (and enhance where possible) sensitive water quality and quantity areas and groundwater recharge/discharge areas, including their functioning to ensure that existing sources of surface and groundwater are maintained;
- Rehabilitation, restoration and enhancement measures (including maintenance considerations) to address streambanks and channels, natural corridors, woodlands, aquatic and terrestrial habitats, and fish and wildlife resources;
- Storm water management controls (management practices) for the control/treatment of urban storm water runoff; and
- Continuation of an effective program of agricultural and rural land stewardship initiatives, emphasizing water and land management (*i.e.*, soil conservation) through the use of best management practices.

6. ENVIRONMENTAL TARGETS FOR SUBWATERSHED MANAGEMENT

6.1 General

This section discusses the establishment of environmental targets to protect/maintain, restore/enhance and monitor the various ecological facets of the Subwatersheds. The environmental targets were founded on the Subwatershed goals and objectives outlined in Section 1 and the results of the technical analyses. Accordingly, the targets reflect an overall desire to ensure the safety of the Subwatersheds' residents and to protect the quality and integrity of existing ecosystems. In addition, the targets are aimed at restoring healthy, self-sustaining, resource-rich conditions, those aspects of the ecosystem that have been diminished.

6.2 Natural Heritage Features and Areas

The key Subwatershed natural heritage features and areas described in Section 4 are:

- Fish Habitat;
- Significant Woodlands; and
- Significant Valleylands.

Significant wildlife habitat is assumed to be included and covered by the above areas. No significant wetlands, habitats of endangered and threatened species, and/or areas of natural and scientific interest have been identified within the 401 Corridor Planning Area. Consequently, no specific environmental targets are proposed for such features.

6.2.1 Fish Habitat

Targets for the protection and restoration of fish and fish habitat are based on objectives to maintain/rehabilitate fish species composition and diversity to promote healthy, self-sustaining populations. In addition to field investigations and analyses performed as part of this study, sources of information used in the development of several of the aquatic targets included Habitat Suitability Index (HSI) models from the U.S. Fish and Wildlife Service (Hays 1988) and specific habitat information for individual fish species (*i.e.*, Scott and Crossman 1973).

Sensitive warmwater fish habitats have been identified for protection. To protect, maintain and enhance the fish and aquatic habitats, a 15 m riparian shore buffer is recommended for moderate to low quality Type 2 habitats; and a 30 m riparian shore buffer is recommended for Type 1 and high quality Type 2 habitats. These buffers are suggested as a guide in the development of suitable protection and restoration initiatives. The actual buffer dimensions should be based on criteria established through a site-specific assessment of the local shoreline buffer characteristics, as well as input from relevant agencies (*e.g.* OMNR). It should integrate such aspects as groundwater seepage, geomorphology, streamside vegetation and opportunities for storm water management that best fit the specific site characteristics for habitat protection/restoration.

Targets for the restoration of fish habitat are as follows:

- regeneration of 75% (35% minimum) of natural streamside woody vegetation for shorelines adjacent to Types 1 and 2 habitats;

- regeneration of 80% of the riparian canopy along shorelines adjacent to Types 1 and 2 habitats;

- rehabilitation of natural stream morphological characteristics (structure, diversity and integrity) along previously altered stream reaches to:

    - establish a composition of 15% riffle area and 20% pool area during low flow periods, and a minimum pool depth of 0.4 m during the summer for Type 1 and Type 2 habitats;
    - restore altered Type 2 habitats as development proceeds;
    - replace hard engineered erosion and floodwater protection with soft or bioengineered features;
    - stabilize meander frequency with 50% stable banks using rock or well rooted vegetation for Type 1 and Type 2 habitats;
    - remove in-water barriers to fish movement.

- promote landowner awareness and adoption of a 5 m riparian shore buffer for highly altered Type 3 habitats including any municipal drains (outside of the 401 Corridor).

6.2.2 Significant Woodlands

Targets for the protection and restoration of significant woodlands are based on objectives to maintain/ rehabilitate species composition and diversity to promote healthy, self-sustaining ecosystems.

Within the 401 Corridor, a total of 14 ha of woodlands has been identified as significant and suitable for the highest degree of protection within the urban setting (DF4-F3 = 2.6 ha, DF3 = 4.5 ha, DF5=0.5, C11=3 ha, D4<0.5 ha, D5<0.5 ha, WF3=1 ha, WF4=0.2 ha, F1=0.5 ha, F2=0.35 ha, and WF1 = 7 ha). Significant woodlands have been defined as those which i) are situated within or adjacent to significant valleylands, or which ii) are greater that 2 hectares in size (i.e., upland fragmented woodlots). The later criterion has been suggested by the Region of Halton's background research.into significant woodlands. Overall, these significant features represent just over 3% of the study area.

Targets for the restoration of woodlands are based on a general guideline for habitat restoration from Environment Canada which suggests 30% forest coverage for the total Subwatershed areas. This represents a desire to maintain (or increase) the existing 1990 ha (36%) forest coverage in the Subwatershed 3, increase the existing 490 ha (12%) forest coverage in the Subwatershed 4 by ±770 ha (18%), increase the existing 148 ha (5%) forest coverage in the Subwatershed 5 by ±710 ha (25%), and increase the existing 153 ha (4%) forest coverage in the Subwatershed 6 by ±880 ha (26%).

To meet the above guideline, forest area can be increased by expanding and rehabilitating significant woodlands, other woodlands, hedgerows and corridors by artificial and natural regeneration measures. To this end, other woodlands have been selected for protection through the development approval process. Rehabilitation should be directed towards healthy, self-sustaining, interconnected woodland ecosystems that integrate water infiltration/stream flow management. Consequently, application of the Regional target on the relatively small scale of the 401 Corridor may not be appropriate. For example, within the portion of the corridor which crosses Subwatershed 6, there are no identified significant woodlands, wildlife linkages, aquatic habitat or downstream erosion sites, resulting in limited associated benefits of woodland creation in this area.

Targets here are also offered for improving forest composition and structure. Providing long-lived species that offer particular benefits in terms of ecological stability, wildlife, economic values and aesthetics include oaks, hickories, hard maples, beech, walnut, sycamore, white pine and hemlock. These species should represent more than half of the long-term forest cover in the Subwatershed. Initial regeneration planting may utilize species such as white birch, poplar, ash, soft maple, cherry, basswood, larch or cedar for site amelioration prior to natural or artificial introduction of the previously listed species.

Woodlands should be managed to retain at least 12 trees/ha that are over 50 cm in diameter at breast height on at least 50% of the total woodland area in order to provide the area needed by some species to reach their growth potential.

Provision and restoration of woodland corridors of at least 100 m wide will improve corridor functions for species depending on interior forest conditions.

Establishment of woodlands along watercourses will improve the effectiveness of the protective functioning of such woodlands.

Provision of tall treed hedgerows no more than 200 m apart in agricultural areas (outside of the 401 Corridor) will improve habitat connectivity and reduce the negative impacts of high winds. Removal of incompatible non-native species that have potential to outcompete native species will improve the representativeness of the natural habitats.

6.2.3 Significant Valleylands

Targets for the protection and restoration of significant valleylands are based on objectives to maintain the essential features and ecological functions associated with riverine and stream systems.

Five significant valleylands have been identified for permanent protection including the Middle Sixteen Mile Creek, Mansewood Tributary, Middle Sixteen Mile Creek Tributary, Hornby Tributary and East Sixteen Mile Creek. These lands have been identified as "natural corridors" or "secondary linkages" in the Sixteen Mile Creek Watershed Plan.

Targets for restoration and possible enhancement are directed in part towards the stated forest coverage target of 30% for the Subwatershed, additional targets include:

- rehabilitate steep slopes and top-of-bank areas impacted by erosion, agriculture and/or new development through stabilization of severely eroded slopes and revegetation of barren areas;
- encourage usage of signed trails and discourage the formation of random trails and public access to naturalized areas or along steep slopes;
- restore valleyland tree coverage by expanding and rehabilitating woodlands, slopes and floodplain areas situated in valleylands.

6.3 Water Quality and Quantity

Targets for the water quality and quantity reflect Subwatershed objectives for protecting, maintaining and enhancing the quality and quantity of surface and groundwater; including, sensitive water quality and quantity areas.

6.3.1 Water Quality

Water quality targets are based on protecting and enhancing (where that quality has been diminished) the water quality of the surface and groundwater resources in the Subwatershed. Where possible, the targets have been based on reasonable uses of water within the Subwatershed. Many of the targets are, or have been, based on the *"Provincial Water Quality Objectives"* (PWQOs) set by the Ministry of the Environment and Energy (MOEE, 1994a). Additional targets have been drawn from the *"Ontario Drinking Water Guidelines"* (ODWGs) (MOEE, 1994b), the *"Canadian Water Quality Guidelines"* (CWQGs) (CCREM, 1993), the *"Canadian Water Guidelines"* (Environment Canada, 1995), and literature sources pertaining to the protection of aquatic and terrestrial habitats.

The results of the surface water quality sampling indicated several exceedances of the PWQOs, suggestive of degraded water quality conditions in several Subwatersheds. Recognizing the predominately rural character of the Subwatersheds which includes intensive agricultural practices and rural development, this result is not unexpected.

As a general guideline for the Subwatershed, water quality should meet or exceed the Provincial Water Quality Objectives. However, meeting the PWQOs is recognized as a long-term objective. As an interim objective, in instances where water quality does not meet the PWQOs, the water quality should not be degraded further and all practical measures should be taken to improve the water quality. This is felt to represent a more realistic goal.

To ensure that surface and groundwater quality is protected, preserved or restored for both human and non-human uses (including aquatic and terrestrial ecosystems), the following[4] targets are identified:

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[4] The stated water quality targets are selected values drawn from the *Provincial Water Quality Objectives*, the *Ontario Drinking Water Guidelines* and the *Canadian Water Quality Guidelines*, among others. They are not intended to represent the sole parameters which must satisfied for acceptable water quality. In this regard, all of the relevant

- Groundwater quality targets to maintain sources of human drinking water should meet or exceed all relevant Ontario Drinking Water Objectives; key parameters include (but are not limited to) the following:

  - Nitrates < 10 mg/L
  - Chloride < 250 mg/L
  - Bacteria (*E coli*) < 1 cts/100 Ml

- Groundwater (or surface water) quality targets for livestock watering should meet or exceed all relevant Canadian Water Quality Guidelines for agricultural uses; key parameters include (but are not limited to) the following:

  - Copper < 1 mg/L (cattle); < 5 mg/L (swine, poultry); <0.5 mg/L (sheep);
  - Cobalt < 1 mg/L

- Instream surface water quality targets for human bodily contact recreation should meet or exceed all relevant Provincial Water Quality Objectives; key parameters include (but are not limited to) the following:

  - Bacteria (*E coli*) < 100 cts/100mL

- Instream surface water quality targets to avoid excessive growth of algae and aquatic plants are:

  - Dissolved Oxygen 4-12 mg/L or 100% saturation during daytime
  - Total Phosphorus < 30 ug/L

- Instream surface water quality target to maintain acceptable aesthetic conditions is:

  - Devoid of debris, oil, scum and/or any substance which would produce an objectional deposit, colour, odour, taste or turbidity.

PWQOs, ODWGs and CWQGs, etc. must be applied. For a complete list of all constituents that may be applicable to the Subwatersheds, the reader is referred to these publications.

- Instream surface water quality targets to support fish and aquatic communities should meet or exceed all relevant Provincial Water Quality Objectives; key parameters include (but are not limited to) the following:

  - Suspended Sediment < 30 mg/L
  - Water temperature (average daily) between 22 to 24°C
  - Total Phosphorus < 30 ug/L
  - Copper < 5 ug/L
  - Lead < 5 ug/L
  - Zinc < 20 ug/L
  - Ph > from 6.5 to 8.5
  - Dissolved Oxygen > 4 mg/L
  - Turbidity at or near 1.0 NTU during low flow conditions; < 5 NTUs change over natural levels

6.3.2 Water Quantity

Targets for the water quantity reflect objectives for maintaining existing streamflow conditions in the receiving waters of Sixteen Mile Creek. Water quantity targets are also provided for the protection of existing surface and groundwater supplies.

6.3.2.1 Streamflows

Streamflow targets are based on maintaining the entire range (or regime) of streamflows (*i.e.*, their frequency, magnitude and duration); essential for preserving many of the natural and ecological functions that occur within Sixteen Mile Creek watercourses. They are:

- To minimize <u>flood risk</u> associated with Natural Hazards due to flooding; maintain the existing frequency, magnitude and duration of return period peak flows (2 to 100-year). The 100 year control volume throughout the 401 Corridor is 87 mm/impervious hectare.

- To minimize against <u>streambank erosion</u>; maintain the existing frequency, magnitude and duration of moderate streamflow events that control erosive conditions and channel morphology, estimated according to geomorphologic analysis. The updated 15-minute simulation flow duration curves are provided in **Figure 4.9**.

Targets to be applied within the Mullett Creek subwatershed (north-east portion of the 401 Corridor) are defined in the Gateway West Subwatershed Study. These targets are:

- To minimize <u>flood risk</u> associated with Natural Hazards due to flooding; maintain the existing frequency, magnitude and duration of return period peak flows (2 to Regional).

- To minimize against <u>streambank erosion</u>; maintain the existing frequency, magnitude and duration of moderate streamflow events that control erosive conditions and channel morphology, estimated according to geomorphologic analysis.

6.3.2.2 Surface and Groundwater Supply

To ensure that sufficient supplies of surface and groundwater continue to be available for both human and non-human uses (including aquatic and terrestrial ecosystems), the following targets are identified:

- To manage/preserve existing supplies of surface and groundwater within the Subwatersheds; restrict/regulate surface water withdrawals from Sixteen Mile Creek watercourses.

- To maintain existing levels of groundwater recharge within identified recharge areas (regionally significant areas identified in Section 4, upstream and downstream of the 401 Corridor).

- To maintain existing surface and groundwater drainage patterns and discharge characteristics; <u>interbasin transfers of surface water through stream diversions should be restricted/regulated</u>. Where possible, existing drainage boundaries, flow patterns, outlets, and recharge and discharge areas should be maintained.

6.4 Urban Storm Water Management

The primary concerns regarding the discharge of urban storm water from the developed areas of the Subwatershed relate to changes or alterations that will detrimentally affect the hydrologic regime; specifically, alterations to streamflow conditions (*i.e.*, flooding and streambank erosion), surface water quality and groundwater recharge conditions.

6.4.1 Flooding

Based on the impact assessment conducted in the previous section, the uncontrolled release of storm water from proposed development would result in significant increases to the local 2 to 100-year peak flows. While peak flow rates in the main branches of the Sixteen Mile Creek system may not be adversely affected, given the relatively small size of the 410 Corridor drainage areas, flood control is required to address the cumulative downstream effects of future and ultimate development within the watershed. Target flood control volumes as presented in Section 6.3.2.1 are 87 mm per impervious hectare.

Within the Mullett Creek subwatershed, the proposed development area within the 401 Corridor represents a more significant proportion of the total drainage area to the local tributary, and therefore flood control measures are required to address local as well as downstream effects. This local analysis may form part of an Environmental Implementation Report completed at the draft plan stage. Specific control guidelines for this subwatershed (i.e., including downstream areas) were determined during the Gateway West Subwatershed Study. Central on-line facilities are proposed for flood control up to the Regional Storm frequency. Until such time as these downstream facilities are build, interim measure may be developed as part of the Environmental Implementation Report analyses.

On-site management of storm water quantity to ensure an adequate level of service and safety will be required in all areas. This includes minimizing flow depths on roadways and ponding depths in parking lots, as well as maintaining a continuous overland (major system) flow path to a safe outlet. This aspect is discussed further in **Section 7**.

6.4.2 Streambank Erosion

As discussed previously in this report, uncontrolled discharges of urban storm water will increase the frequency, magnitude and duration of streamflows in the receiving watercourses, which in-turn will increase the potential for streambank erosion. This finding is consistent with that of the Gateway West Subwatershed Study. Therefore, quantity control of the developed condition peak flows will be necessary for purposes of preventing streambank erosion. Streambank erosion should be prevented for the following reasons:

- the streambanks, when gradually undercut, will slump into the channel exposing soil normally bound by tree roots and vegetation to even further erosion;

- the resulting increased sedimentation and turbidity will contribute to water quality impairment and degradation of aquatic ecosystems.

For this purpose, a target level of control is to maintain the existing condition flow-duration-frequency characteristics. Recognizing that the increase in runoff volume following development will necessarily increase the duration of certain flows, these flow rates should be less than the threshold flow rate (i.e., do not increase the duration of flow rates above the threshold value).

Storm water management (quantity) controls are recommended to minimize the potential for streambank erosion. For the Sixteen Mile Creek watershed, the target level of quantity control mentioned above is recommended for new development areas and may be achieved by detaining (*i.e.*, temporarily storing) the runoff volume equivalent to 52 mm depth per impervious development hectare and by releasing the detained runoff over a period of 48 hours. This guideline is developed based on governing downstream locations within the Sixteen Mile Creek system. Within the Mullett Creek Subwatershed portion of the 401 Corridor, these targets are 25 mm storage depth per impervious development hectare (equivalent to 250 cu.m per impervious hectare stated in the Gateway West Subwatershed Study) and a release rate of 1.6 L/s per impervious hectare. The detention time associated with this release rate is approximately 43 hours, which is similar to the Sixteen Mile Creek target.

6.4.3 Storm Water Quality

Storm water quality considerations and implementation of appropriate management practices for enhancing urban runoff is a requirement for the proposed development areas in the Subwatersheds.

The MOEE (MOEE, 1994c) has developed target water quality criteria based the Ministry of Natural Resources' fish habitat classifications (OMNR, 1994a), which are used as indicators of the receiving waters' sensitivity to urban development impacts. The MOEE criteria identifies different types of storm water management practices along with recommended storage volume targets based on different levels of imperviousness. The targets were developed using continuous hydrologic modelling to assess the water quality performance of different storm water management facilities (including infiltration techniques). Facility effectiveness and the resulting storage volume criteria was based on the minimum size of facility required to remove a certain percentage of total suspended solids from urban storm water runoff. This information has been reproduced in **Table 6.1**.

In the case of wet pond, the MOEE table indicates control volumes for total (active and inactive) storage volumes where 40 m^3/ha represents the active component and the remainder represents the inactive (non-fluctuating) permanent pool component. The 40 m^3/ha component is equivalent to an areal runoff depth of

Table 6.1 - [1]Water Quality Storage Requirements Based on Receiving Water Sensitivity

Protection Level	Description	[2]SWMP Type	[3]Storage Volume (m³/ha) for Impervious Level			
			35%	55%	70%	85%
Level 1	Applied in areas of Type 1 fish habitat requiring high level of protection. Includes: • spawning areas, essential rearing areas, and highly productive feeding areas (wetlands) • groundwater recharge areas in coldwater streams • habitats supporting endangered, threatened, or vulnerable species	Infiltration	25	30	35	40
		Wetlands	80	105	120	140
		Wet Ponds	140	190	225	250
		Dry Pond	140	190	210	235
Level 2	Applied in areas of Type 2 fish habitat. Includes: • aquatic habitat identified as ecologically valuable, but is sufficiently abundant or not considered to be a limiting factor for habitat productive capacity • general feeding areas and pool-riffle-run complexes	Infiltration	20	20	25	30
		Wetlands	60	70	80	90
		Wet Ponds	90	110	130	150
		Dry Pond	60	80	95	110
Level 3	Applied in areas of Type 3 habitat. Includes: • habitat with low productive capacity, requiring minimum level of protection • habitat with low potential for restoration potential such as municipal drains and highly altered watercourses	Infiltration	20	20	25	30
		Wetlands	60	60	60	60
		Wet Ponds	60	75	85	95
		Dry Pond	40	50	55	60
Level 4	Applied in existing urban areas where planned development is assess as retrofitting or re-development. This is minimum level of protection and should only be applied when the appropriate level of protection (above) is too stringent.	Infiltration	20	20	25	30
		Wetlands	60	60	60	60
		Wet Ponds	60	75	85	95
		Dry Pond	40	50	55	60

Note:

[1] Source, *Stormwater Management Practices Planning and Design Manual*, (MOEE, 1994c).
[2] For wetlands and wet ponds, the required storage volume is comprised of 40 m³/ha extended detention, while the remainder is the permanent pool volume.
[3] Storage volumes are based on 24 hour detention.
Storage volumes are based on a 80, 70, 60 and 50% TSS removal for Protection Levels 1, 2, 3 and 4, respectively.

4 mm over the tributary catchment area, which is considerable less than the approximately 36 mm depth which is required for erosion control purposes (assuming 70% impervious development). Consequently, the erosion control target volume governs the water quality control volume for active storage. The permanent pool component, representing the majority of the water quality control volume, still applies. Likewise, erosion control requirements govern active quality control requirements in for the Mullett Creek subwatershed, as identified in the Gateway study.

Where possible, stormwater control facilities should be combined to facilitate maintenance. Within the Sixteen Mile Creek watershed portion of the 401 Corridor, limited opportunities are available to combine downstream facilities due to the drainage barrier imposed by the Highway 401 corridor. Furthermore, facilities will service sufficiently large areas to lessen the need to combine them. Within the Mullett Creek watershed, the 401 Corridor drainage area is small (approximately 20 hectare). While this area could support a wet pond, opportunities to combine a facility for this area with downstream areas within the City of Brampton could be pursued given that the existing drainage features will likely be replace with urban drainage components (i.e., storm sewers). This approach would also ensure that runoff from within the Corridor is not treated twice, i.e., locally as well as downstream prior to discharge into the receiving watercourse (Mullett Creek).

6.4.4 Groundwater Recharge: Infiltration

The potential impact to infiltration and groundwater recharge conditions in the 401 Corridor resulting from complete development of the lands designated for urban use, do not represent an appreciable disruption or change to the existing hydrologic processes and were therefore assessed as not significant. The potential reduction in groundwater recharge will not affect groundwater discharge (baseflow) conditions in the Middle Sixteen Mile Creek Tributary system, the local basal aquifer systems, nor the Mullett Creek subwatershed system.

However, it is recognized that in development areas where suitable subsoils exist, infiltration and groundwater recharge of urban storm water runoff could provide the following benefits:

- Water quality treatment/enhancement of urban storm water, including mitigation of potential thermal impacts to receiving watercourses;
- Reduction of the volume of urban runoff, thereby reducing increases in peak flows and streamflow velocities (*i.e.*, flooding and erosion impacts);

- Contribution to the maintenance of local recharge conditions; and,

- Consequently, infiltration of urban runoff is recommended for development areas with suitable subsoil conditions that include:

  - Native soils with a minimum percolation rate > 15 mm/hr;
  - Seasonally high water table depth > 1 m below the bottom of the facility (if applicable);
  - Depth to bedrock > 1 m below the bottom of the facility (if applicable).

These measures must be considered a part of detailed servicing studies when local information on soil conditions becomes available.

7. SCOPED SUBWATERSHED PLAN: RECOMMENDED MANAGEMENT STRATEGIES

7.1 General

This section discusses the development of a Scoped Subwatershed Plan for the 401 Corridor Planning Area and associated Subwatersheds. The recommended Scoped Subwatershed Plan consists of several different, but interrelated management strategies, each comprised of a series of management measures/actions designed to: protect and enhance the natural features and ecological functions of the 401 Corridor; restore those features/functions that have been degraded; and guide future development in a manner that will ensure the long-term health of the environment.

The primary focus of the scoped subwatershed plan is the lands scheduled for urban development within Subwatersheds 3, 4, 5 and 6, and the preparation of suitable management and control policies and works to support the conversion from existing conditions to an urban form. However, throughout the process, the importance of the subwatershed as the logical unit for both long term land use planning and environmental protection was recognized as a key issue. The specific actions recommended for the 401 Corridor were developed with due consideration for the linkages and pathways that extend beyond the defined planning boundaries and into the remaining areas of the subwatersheds. The technical analyses also demonstrated that current land use activities beyond the 401 Corridor are contributing to the stresses that are now being experienced by the natural environment, particularly in regard to water quality along the watercourses, and the dependant habitat. Accordingly, the Scoped Subwatershed Plan incorporates steps and action measures (e.g., agricultural Best Management Practices) that can be implemented in the external areas to improve conditions and enhance the health of the ecosystem.

The evolution of the overall Scoped Subwatershed Plan was based on the following objectives:

- Management measures should ensure that human life and property is protected from natural and man-made hazards arising from flooding, erosion and water quality impairment;
- Management measures should recognize and preserve important environmental features and ecological functions;
- Management measures should recognize and preserve sensitive water quality and quantity features and hydrologic functions;

- Management measures should recognize opportunities for the enhancement and restoration of natural systems and processes in an effort to help improve the ecosystem integrity and the resiliency of the overall Subwatersheds;

- Management actions should reduce the impacts of existing land uses (both agricultural and urban) on the environment in an effort to reduce stresses currently placed on the environment.

- Specific control measures to protect the environment from adverse impacts resulting from changes in land use (*i.e.*, urban land development) should be identified. This section includes a discussion of storm water management practices (SWMPs) that have been considered for the control/treatment of urban storm water runoff.

The recommended management strategies are:

- Hazard Land Management (Flooding and Erosion, Uncontrolled Fill, Illicit Waste Disposal);
- Natural Heritage and Environmental Protection;
- Water Quality and Quantity Management;
- Rehabilitation, Restoration and Improvement Measures;
- Agricultural and Rural Land Management;
- Urban Storm Water Management.

An overview of the recommended Subwatershed Plan is presented in **Table 7.1.** The following sections discuss each of the individual management strategies, subcomponents and management measures.

7.2 Hazard Land Management

The formulation of a strategy to manage areas susceptible to hazards is premised on the recognition that areas within the Subwatersheds are inherently susceptible to increased risk arising from hazards, and that this risk may present an unacceptable threat to human life or property. This requires that both, natural hazards, such as those associated with flooding and erosion, and human-made hazards, such as areas of uncontrolled fill, and illicit waste disposal sites, be identified and that new development or non-compatible land uses be required to locate in areas outside of hazardous lands. In instances where works (e.g., improved stream crossings) are located in areas of the hazardous lands, the design of these works must ensure that the underlying hazards can be safety addressed, no new hazards are created, and that no adverse environmental impacts will result.

Table 7.1 - Summary of Recommended Subwatershed Plan

Strategy Component	Subcomponent	Management Measures
Hazard Land Management	Natural Hazards: Flooding, Erosion and Unstable Slopes	Secondary Plan policies and land use designations to prohibit/restrict development in Hazard Lands and direct development outside of hazardous areas.
	Human-made Hazards: Uncontrolled Fill, Illicit Waste Disposal	Secondary Plan policies and land use designations to require that human-made hazards such as uncontrolled fill sites be restored prior to any activity on the site and that illicit waste disposal be eliminated.
Natural Heritage and Environmental Protection	Protection of Significant Natural Heritage Features and Ecological Functions	Secondary Plan policies and land use designations to prohibit incompatible development in Category 1 areas and limit development subject to conditions in Category 2 areas.
Water Quality and Quantity Management	Surface Water Quality and Quantity	Agricultural/rural BMPs and urban SWMPs to manage runoff. Maintain existing hydrologic regime, surface water drainage patterns.
	Groundwater Quality and Quantity	Agricultural/rural BMPs for the safe storage and application of pesticides, fertilizers and manure near potable sources of water, wells and recharge areas. Protect groundwater discharge zones and flow patterns.
Rehabilitation, Restoration and Improvement Measures	Reforestation, Natural Corridor and Woodland Improvement	Vegetative plantings and reforestation along Category 2 natural corridor areas, block regeneration on retired or marginal land, area regeneration within Adjacent Lands of Category 1 and 2 areas, naturalization of existing parks and green spaces, habitat improvement, wetland creation, education and tax incentives.
	Stream and Aquatic Habitat Restoration	Streambank stabilization, channel morphology improvements, streambank plantings, restricted livestock access, removal of fish barriers, creation of pool and riffle areas, habitat enhancement.
Agricultural and Rural Land Use Management	Agricultural and Rural Land Stewardship	Land stewardship through preparation of Environmental Farm Plans and landowner initiatives to incorporate agricultural/rural BMPs for soil conservation, chemical management, waste management, water management, forestry and habitat management.
Urban Storm Water Management	Storm Water Management Practices	Lot Level Controls (reduced lot grading, ponding areas, soak away pits). Storm Water Conveyance Controls (grassed swales, catchbasin modification). End-of-Pipe-Controls (artificial wetlands, wet ponds, dry ponds, infiltration trenches, buffer strips, oil/grit separators).
	Erosion and Sediment Control	Erosion/Sediment Control Plans incorporating site control measures to minimize surficial erosion during construction.
	Design Guidelines for Development	Recommend design guidelines for site drainage and servicing, the sizing, design and maintenance of storm water management ponds and submission of Storm Water Management Plans.

For the most part, many of the components necessary for the management of hazard lands within the Planning Area are already in place or have been completed as part of this study. This includes: the HRCA's flood line mapping of Middle Sixteen Mile Creek, Middle Sixteen Mile Creek Tributary, Hornby Tributary and East Sixteen to denote hazards associated with flooding; HRCA prepared fill line mapping denoting hazards associated with erosion and unstable slopes; and, the identification of human-made hazards, such as uncontrolled fill with two of the valley corridors (HRCA file reports). In addition, Official Plan policies dealing with flooding and erosion hazards have been prepared by the Region of Halton.

The <u>Hazard Land Management Strategy</u> for the 401 Corridor is shown on Drawing No. 2 (back pocket). The fundamental elements of the strategy includes the following policy basis:

(i) Appropriate land use planning controls, designations and mechanisms should be established in the Secondary Plan to prohibit/restrict development in Hazard Lands and permit development subject to conditions in areas defined as less hazardous. The actual limits of the hazardous lands along river and stream systems impacted by flooding and/or erosion hazards should be based on the land, including that covered by water, to the furthest landward limit of the flooding or erosion hazards limits.

- Hazardous lands adjacent to river and stream systems impacted by <u>flooding hazards</u> should be based on the flood hazard limits defined by the regulatory flood standard, established as the greater of the flood resulting from the Regional (Hurricane Hazel) Storm or the one hundred year flood.

- Hazardous lands adjacent to river and stream systems impacted by <u>erosion hazards</u> should be based on the erosion hazard limits defined by the application of the geomorphic meander belt width of the watercourse and an allowance for slope stability. The Fill Line generally encompasses the erosion hazard limits along the main tributaries, however, erosion hazards outside these limits are indicated as part of the management strategy.

(ii) Appropriate land use planning controls, designations and mechanisms should be established in the Secondary Plan that require human-made hazards such as uncontrolled fill be restored (*i.e.*, mitigated) as necessary prior to any activity on the site associated with the proposed use such that there will be no adverse effect. In addition, the Secondary Plan should establish appropriate controls to eliminate the illicit disposal of waste material within the Planning Area.

(iii) The Town may request that detailed hydrotechnical analysis be prepared (i.e., for stream crossing, culvert/roadway improvement) and geotechnical analyses be prepared (i.e., slope stability) by proponents of development proposals in order to identify and fully assess the site-specific hazards associated with i) and ii) as part of functional servicing studies.

The following describes the specific aspects of the strategy.

7.2.1 Natural Hazards: Flooding and Erosion

7.2.1.1 Flooding Hazards

Mapping of the flooding hazards within much of the 401 Corridor Planning Area has been prepared as part of previous studies under the Flood Damage Reduction Program. Flood plain limits based on the regional (Hurricane Hazel) storm have been delineated on the 1:2,000 scale and 1:5,000 topographic based mapping.

Watercourse reaches that have been mapped include:

- Middle Sixteen Mile Creek, extending from Highway 401 to the western Town Boundary;
- Middle Sixteen Mile Creek Tributary, extending from Highway 401 to Steeles Avenue;
- Hornby Tributary, extending from Highway 401 to Steeles Avenue; and
- East Sixteen Mile Creek, extending from Highway 401 to Steeles Avenue.

Additional mapping has been prepared as part of this study including:

- Highway 401 Tributary, extending from Middle Sixteen Mile Creek to Highway 401;
- Mansewood Tributary, extending from Middle Sixteen Mile Creek to the western Town Boundary.

The following points are recommended to assist in managing natural hazard areas associated with flooding:

- *Regulation of Uncontrolled Fill*: Uncontrolled filling with the flood plains of the Middle Sixteen Mile Creek and the Hornby Tributary has been pursued by private land owners. As cumulative impacts of these activities may increase flooding hazards on upstream and local lands by constricting flow and on downstream lands by displacing flood plain storage, uncontrolled fill should be removed or recontoured and stabilized to minimize potential flooding impacts.

- *Revise/Update Flood Plain Mapping*: Replacement/upgrading of stream crossings to accommodate servicing improvements associated with greater projected transportation demands should include hydraulic analyses and any associated revisions to existing flood plain mapping.

- *Reduce Flooding Impacts Associated with New Development*: New development should include storm water management facilities to provide water quantity control (*i.e.*, flooding) of urban runoff to minimize the potential for increasing flooding impacts in the Sixteen Mile Creek Watershed. A thorough discussion of the recommended urban storm water strategy is provided in Section 7.7.

- *Hydraulic Structure Improvements*: Hydraulic modelling identified several structures with inadequate capacity to pass the current design flood standards. Consequently, hydraulic structure improvements including enlargement and/or replacement of existing bridges and roadway culverts should be considered as part of any structural upgrading works.

  The following structures are identified as presenting an opportunity to reduce the hazards associated with flooding:

  Middle Sixteen Mile Creek Tributary: Sixth Line, Steeles Avenue
  Hornby Tributary: Steeles Avenue

- *Assess Flooding Hazards to New Development, Site Alteration or Land Use Change*: The following points are recommended to assist the Town and the HRCA in reviewing development applications in or adjacent to natural hazard areas associated with flooding:

  i) For areas where flood lines have been mapped as part of the FDRP, the Flood Line should be used by the HRCA to assess the natural hazards associated with flooding. If the HRCA feels that site-specific information is required to assess the potential flooding impacts associated with a development proposal, the proponent of the development proposal shall be required to prepare hydrotechnical analysis as part of the functional servicing plan.

ii) For areas where flood lines have been mapped as part of this study (Mansewood Tributary and Highway 401 Tributary), the proponent of the development proposal shall be required to delineate the hazardous lands associated with flooding on detailed mapping. The extent of the flood hazard may be defined as the lands situated at or below the Regional Storm flood elevations defined in **Appendix** E as delineated on detailed topographic mapping to be prepared by the proponent.

If the development proposal is such that additional information is required to assess the potential flooding impacts, e.g., address the construction of watercourse crossings, the proponent of the development proposal shall be required to prepare hydrotechnical analyses.

iii) All technical and planning related issues pertaining to delineation of the flooding hazards and the technical assessment of impacts thereof should adhere to the procedures, methods and technical standards requirements defined in the Province's *"Flood Plain Planning Policy Statement - Implementation Guidelines"* and accompanying *"Technical Guidelines"* (MNR, 1988) and the HRCA's, *"Fill, Construction and Alteration to Waterways"* regulations.

iv) Any hydrotechnical studies conducted under points i) or ii) shall recognize and be consistent with the methodologies and findings established in the hydrologic and hydraulic investigations conducted as part of this Study.

7.2.1.2 Erosion Hazards

Erosion related hazards within the 401 Corridor Planning Area are generally included within the delineation of the Fill Line. The fill lines, which were previously mapped by the HRCA are delineated on the Authority's 1:2,000 and 1:5,000 scale topographic based mapping. Notwithstanding this, *Provincial Policy* does require that the erosion hazard limit be determined using the 100-year erosion rate (the annual rate of recession extended over a hundred year time span), an allowance for slope stability, and an erosion allowance.

Areas where these latter criteria may influence the limits of the erosion hazard have been identified on Drawing No. 2 according to meander belt widths developed as part of this study and assumed 3:1 stable slopes. These areas include:

- Sixteen Mile Creek Tributary, southern bank at the upstream limit of the Planning Area ;

- Sixteen Mile Creek Tributary, eastern bank extending upstream of the Highway 401;
- Hornby Tributary, eastern bank downstream of Steeles Avenue.

The following points are provided to assist in reviewing development applications in or adjacent to natural hazard areas associated with erosion:

i) For areas where one or both of the meander belt limit and the slope stability line extends beyond the Fill Line as indicated on Drawing Number 2, site-specific information is required to assess the potential hazard associated with erosion and unstable slopes. In these cases, the proponent of a development proposal shall be required to prepare a geotechnical study to define the one hundred year erosion limits.

ii) For areas where the HRCA feels that site-specific information is required to assess the potential hazard associated with erosion and unstable slopes, the proponent of a development proposal shallbe required to prepare a geotechnical study to define the one hundred year erosion limits.

7.2.2 Human-Made Hazards

7.2.2.1 Uncontrolled Fill

Two areas of uncontrolled fill have been identified as human-made hazards as referenced above. In addition to posing flood hazards, these sites may pose safety risks due the presence of excessive/unstable slopes as a result of non-engineered placement of fill material and may contribute to water degradation arising from on-site erosion and sediment transport to the receiving watercourse. As stated earlier in the context of flooding, the Secondary Plan should establish appropriate land use planning controls, designations and mechanisms that require human-made hazards such as uncontrolled fill be restored (*i.e.*, mitigated) as necessary prior to any activity on the site associated with the proposed use such that there will be no adverse effect. HRCA files indicate that specific directions to this effect have already been developed by Authority staff and have been found to be consistent with the objectives of the Scoped Subwatershed Plan Strategies.

7.2.2.2 Illicit Waste Disposal

A single site characterized by past dumping activities was identified along the west bank of the Sixteen Mile Creek Tributary upstream of Highway 401. Some observed disposed materials (e.g., rock salt, refrigerator, television) may contribute to in-stream violations of provincial water quality guidelines and are considered to adversely affect local aquatic and terrestrial habitat.

The Secondary Plan should establish appropriate land use planning controls, designations and mechanisms that require human-made hazards such as illicit waste disposal sites be restored as necessary prior to any activity on the site. Suggested measures to prevent further environmental degradation may include the posting of signs to advise of current dumping by-laws, and/or the installation of fencing to prevent access to the existing disposal area from the Sixth Line right-of-way.

7.3 Natural Heritage And Environmental Protection

One of the most important components of the Scoped Subwatershed Plan is the recognition and protection of important environmental features and ecological functions integral to the ecosystem health of the Subwatersheds. The key Subwatershed natural heritage features identified are:

- Fish Habitat;
- Significant Woodlands; and
- Significant Valleylands.

Protection and management of these areas constitute the core of the Scoped Subwatershed Plan and form the basis for contributing to a healthier ecosystem within the Sixteen Mile Creek Watershed.

The Natural Heritage and Environmental Protection Strategy for the 401 Corridor Planning Area is shown on Drawing No. 2. The fundamental elements of the strategy are discussed as follows.

7.3.1 Environmental Land Use Categories

To facilitate the incorporation of the natural heritage features and areas into the planning documents for the purpose of environmental protection and management, the features have been integrated into two categories of lands, namely:

Category 1 - where no development is permitted; and,

Category 2 - where development may be permitted, subject to the completion of an EIS, which demonstrates that the proposed undertaking will not negatively impact the natural features or the ecological functions.

The integration of natural heritage features and areas together in a system is advantageous because it considers overlaps and inter-relationships between the various components.

Also recognized are *adjacent lands* contiguous to the Category 1 and 2 areas (*i.e.*, Fish Habitat, Significant Valleylands, Significant Woodlands, Hazards). Development and site alteration may be permitted on adjacent lands if it has been demonstrated that there will be no negative impacts on the natural features or the ecological functions for which the area is identified. This may require that the proponent of a development proposal prepare an environmental impact study (EIS).

Areas outside of Category 1 and 2 areas, are identified as *remaining areas*, which are considered to be of lower environmental priority for protection, but which should also incorporate appropriate environmental management and protection measures.

Category 1

Category 1 areas include lands which contain significant natural heritage features that support a diversity of plant, animal and aquatic habitats, as well as perform important ecological functions integral to the ecosystem health of the watershed.

Category 1 areas also include areas that may present a hazard to human life and property due to flooding and/or erosion hazards. The management of these areas is discussed in Section 7.2 as part of the Hazard Land Management Strategy.

The types of areas included in the Category 1 designation include:

- Significant Woodlands (identified in Section 6.2.2) ;
- Fish Habitat;
- Sensitive Water Quality and Quantity Areas (groundwater discharge); and
- Hazards Lands (natural and human-made hazards).

Category 2

Category 2 areas encompass lands which also contain significant natural heritage features and ecological functions, but may not have specific provincial policy to preclude development. Category 2 areas may include features that would require management and rehabilitation to improve their ecological functioning. Examples include woodlands adjacent to stream corridors. These areas would benefit from stream rehabilitation efforts, reforestation and vegetative plantings, which in turn would improve aquatic habitat conditions, increase plant and animal diversity and help reduce further ecosystem stresses from adjacent land uses.

Category 2 areas may also include areas of natural hazard associated with flooding. The management of these areas are discussed in Section 7.2 as part of the Hazard Land Management Strategy.

The types of areas included in the Category 2 designation include:

- "Small upland, fragmented woodlots which are important given their relative contribution to stated coverage targets and and other benefits (ecological stability, wildlife, economic value and aesthetics)(see Figure 3.7A and Figure 3.6B);
- Sensitive Water Quality and Quantity Areas (groundwater discharge).

Remaining Areas

Remaining areas *i.e.* those lands located outside of Categories 1 and 2, represent lands where development may occur. Recognizing that existing and proposed changes in land use will affect both the character and health of the Subwatersheds, these areas still have a great potential to impact the features and functions associated with Category 1 and 2 areas. Accordingly, these areas should incorporate appropriate environmental land use management and design to minimize and prevent adverse environmental impacts. These initiatives are discussed in Section 7.4 as part of the Water Quality and Quantity Management; Section 7.5 as part of the Rehabilitation, Restoration and Improvement Measures; Section 7.6, as part of the Agricultural and Rural Land Management; and, in Section 7.7, as part of the Urban Storm Water Management strategies.

7.3.2 Recommendations for Secondary Plan Amendments and Land Use Designations

The Secondary Plan should formulate specific protection policies, land use designations and comprehensive zoning by-laws that:

- Restrict land uses in Category 1 areas by application of a restrictive no development land use designation.

- Prevent or mitigate the impact of any necessary works (i.e., stormwater treatment facility outlets) on features within Category 1 areas by requiring a scoped EIS to identify and protect any rare and/or significant flora.

- Control land uses in Category 2 areas by application of planning policies which requires an environmental impact study (EIS) for all development proposals within Category 2 areas. The EIS should satisfy the minimum requirements identified in Section 7.3.3 of this Study. It is recommended that discussions be held with the Town and the HRCA to determine the scope of the EIS prior to initiation of any study.

- Recognize adjacent areas contiguous to Category 1 and 2 lands as areas which <u>may</u> require an environmental review to determine if an EIS is required to address environmental concerns related to development proposals within these areas. In the case of the Mullett Creek tributary area, in the north-west corner of the Corridor, an environmental implementation report may be required by Credit Valley Conservation.

- Encourage restoration and remediation of Category 1, 2 and remaining areas where those natural ecosystems have been degraded by identifying specific planning requirements/options as part of the Master Planning, such as: valleyland corridor and parkland dedication; planting and naturalization of existing parks and/or designated areas; and terrestrial and aquatic habitat restorations, including the preservation/integration of hedgerow and other upland wood lots (or where not feasible, compensation through riparian plantings within the study area).

7.3.3 <u>Guidelines for the Preparation of Environmental Impact Studies</u>

The following guidelines are recommended to assist development proponents, municipalities and the HRCA in preparing and reviewing environmental impact studies.

An <u>Environmental Impact Study (EIS)</u> is a study that identifies and assesses the impacts of development on a specified natural heritage feature or system. In order for development and site alteration to be permitted, the study must demonstrate that there will be no negative impacts on the natural features or the ecological functions for which the area is identified. Generally, EISs are prepared by proponents of private development proposals, but may also be prepared by municipalities in instances of infrastructure development which is subject to the *Planning Act*, but which is not authorized under an *environmental assessment process* (*i.e.*, *Class Environmental Assessment for Municipal Water and Wastewater Projects*).

The purpose of an EIS, *"...is to prevent negative impacts to significant natural heritage features and areas by providing a careful analysis of the environmental effects of development proposals before development is approved"* (OMMA, 1995).

The scope and content of EISs is likely to vary depending upon the size and type of development, the development's proximity to the natural heritage feature and the type of heritage feature for which the area has been identified. For instance, a large scale industrial development encroaching into a significant valleyland may require a detailed EIS, with indepth investigations, examining many potential impacts, over a large study area. Whereas, a small development adjacent to a significant woodland may require a scoped EIS, that is very focussed and examines a limited range of potential impacts within the boundaries of the site. In other situations, an EIS may not be required at all.

By virtue of the environmental monitoring, species inventories and mapping of natural heritage features completed as part of this Study, important information is available that should guide the particular focus of an EIS.

The contents of an environmental impacts study should include the following:

1. A Description of the Development Proposal

A description of the proposed development including:

- The size, type and purpose of the development;
- The type of activities, processes and land uses associated with the development;
- A site map showing the location of the development, site alteration and any activities associated with it in relation to known or the identified natural heritage features and areas, ecological functions and hazards; and
- The expected timing for undertaking the proposal and phasing of construction.

2. A Description of the Existing Natural Environment

A complete description of the existing natural environment that will be affected or that might reasonably be expected to be affected, either directly or indirectly. The description should include:

- An environmental inventory of the specific biological (*i.e.*, aquatic and terrestrial) features, communities, and their characteristics on and through the site, including a description of the methodology and techniques used to conduct the inventory;
- Identification of any ecological (*i.e.*, wildlife breeding or nesting) and physical functions (*e.g.* erosion) and processes occurring on and through the site;
- Identification of any existing man made features; and

- A discussion of the environmental significance of the natural features, linkages and ecological processes within the development area, and the significance of their relationship to the ecosystem of the larger planning area or Subwatershed.

3. An Assessment of the Environment Effects

A description of the extent and degree of environment effects that might *reasonable be expected to occur* resulting from the proposal including:

- The predicted effects on the natural heritage feature, area and/or its function (*i.e.*, groundwater recharge/discharge);
- Predicted effects on linkages between natural heritage features and areas within the larger planning area or Subwatershed;
- Direct and indirect effects (*i.e.*, those that result as a consequence of development usually through a series of other effects, and may appear at some other location or sometime in the future); and
- On-site and off-site effects (*i.e.*, those that extend beyond the boundary of the development site);

Also to be included, is a discussion of the methodology and techniques used to assess environmental effects, particularly negative impacts.

4. A Description of the Proposed Mitigation

A description of the alternative methods and measures that are proposed to mitigate any predicted impacts identified in step 3, such that the development does not negatively impact the features or ecological function for which the area is identified. The description should include:

- Modifications to the development proposal to avoid or maintain key features or functions (*i.e.*, reduced development density, setbacks, buffers, etc.);
- Identification of alternative methods and measures to minimize impacts, where mitigation through avoidance is not possible;
- Identification of any restoration/remediation and/or improvement/enhancement measures proposed as a means to complement the recommended mitigation measures;
- Plans, details and/or specifications discussing how the recommended mitigation, restoration or improvement measures will be incorporated into site plans, subdivision drawings, servicing plans, etc.

If mitigation measures cannot be designed to ensure that the development does not negatively impact the features or ecological functions for which the area is identified, the no-development option should be considered.

7.4 Water Quality And Quantity Management

The successful management of the quality and quantity of water resources within the 401 Corridor and the associated Subwatersheds forms an essential and integral component of the overall Scoped Subwatershed Plan. Such a strategy is founded on the protection and enhancement (where those resources have been diminished) of the quality and quantity of the surface and groundwater resources.

The strategy for water quality and quantity is discussed separately in terms of surface and groundwater.

7.4.1 Surface Water Quality and Quantity

As a general guideline for the four Subwatersheds (3, 4, 5, 6) overall, water quality should meet or exceed the Provincial Water Quality Objectives. In instances where water quality does not meet the PWQOs, the water quality should not be degraded further and all practical measures should be taken to upgrade the water quality to the Objectives (MOEE, 1994a).

The following measures are recommended:

- *Protect and Enhance Sensitive Water Quality and Quantity Areas*: Watercourses within the Subwatersheds should be recognized as sensitive water quality and quantity areas. As such, the quality and quantity of surface water associated with these areas, including their hydrologic (and hydrogeologic) functioning should be protected and enhanced. This may necessitate that proponents of developments or site alterations on, or in the vicinity of these areas, be required to prepare hydrologic, hydrogeologic and/or environmental analyses as part of functional design studies to ensure that these resources are protected or enhanced.

- *Streambank Stabilization and Rehabilitation*: Locations of excessive streambank erosion (including gullies) as identified in Figure 3.4 should be stabilized using natural channel design techniques. This would reduce sediment loads to the streams, lower turbidity levels and improve water quality conditions.

- *Storm Water Quality Treatment for Existing Urban Areas*: Employ lot-level storm water management measures to treat urban runoff in existing built-up areas of the Town of Milton (Milton Business Park), located upstream of the 401 Corridor Planning Area. This aspect is discussed further in Section 7.7.

- *Reduce Impacts of Runoff from Agricultural and Rural Areas*: Agricultural operations should be encouraged to use numerous best management practices directed at reducing the runoff impacts from agricultural and rural lands are available through improved land stewardship, conservation activities and management initiatives where possible. Many of these measures are discussed in Section 7.6 and typically include improved cropping and drainage practices to reduce sediment erosion and the transport of pollutants to receiving watercourses; establishing riparian vegetation along streamsides to stabilize eroding banks and mitigate temperature impacts; restricting livestock access to streams; improved handling, application and storage techniques for manure, pesticides and fertilizers; and, repairing/replacing faulty septic systems in areas of rural development.

- *Reduce Impacts of Runoff from New Development*: New development should include storm water management facilities to provide both water quality enhancement and water quantity control (*i.e.*, flooding) of urban runoff prior to its discharge into receiving streams and waterbodies. A thorough discussion of the recommended urban storm water strategy for the 401 Corridor Planning Area is provided in Section 8.6.

- *Maintain Hydrologic Regime*: The hydrologic regime (or range) of streamflow conditions (*i.e.*, their frequency, magnitude and duration) in the receiving waters associated with the Subwatersheds should be maintained in order to preserve many of the natural and ecological functions that occur and to minimize potentially adverse impacts relating to flooding and erosion.

- *Maintain Existing Surface Water Drainage Patterns*: Existing surface water drainage patterns and discharge characteristics should be maintained when considering development or land uses changes. Interbasin transfers of surface water through stream diversions should be restricted/regulated. Where possible, existing drainage boundaries, flow patterns, and outlets should be maintained.

7.4.2 Groundwater Quality and Quantity

- *Protect and Enhance Sensitive Water Quality and Quantity Areas*: Potential groundwater discharge areas identified within the Middle Sixteen Mile Creek and Hornby Tributary systems (Figure 2-9) and groundwater recharge areas identified in the upstream portions of Subwatersheds 3 and 4 (Map No. 5) should be recognized as sensitive water quality and quantity areas. As such, the quality and quantity of ground water associated with these areas, including their hydrogeologic (and hydrologic) functioning should be protected and enhanced. This may necessitate that proponents of developments or site alterations on, or in the vicinity of these areas, be require to prepare hydrogeologic, hydrologic and/or environmental studies to ensure that these resources are protected or enhanced.

- *Reduce Groundwater Impacts Associated with Agricultural and Rural Areas*: Agricultural operations should be encouraged to use management practices directed at reducing the potential for groundwater contamination arising from agricultural and rural land use activities (as per Section 7.6). These measures typically include improved handling, application and storage techniques for manure, pesticides and fertilizers, and repairing/ replacing faulty septic systems that may leach wastewater into the groundwater aquifers.

- *Maintain Existing Levels of Groundwater Recharge*: Existing groundwater recharge conditions should be maintained when considering development or land use changes within identified recharge areas.

- *Maintain Existing Baseflow Conditions*: Existing baseflow conditions should be maintained by protecting identified groundwater discharge zones, and recharge areas. This is necessary to protect aquatic and terrestrial ecosystems (and surface water quality conditions) during periods of low flow.

7.5 Rehabilitation, Restoration And Improvement Measures

Rehabilitation and restoration of ecosystem features focuses on identifying opportunities to help restore or improve environmental features and ecological functions that have been lost or degraded. The objective of these measures is to increase the size, extent and quality of the core valleylands and stream corridors, natural corridors and woodlands; thereby improving the ecosystem diversity, ecological functions and the resiliency of the Subwatershed.

Opportunities exist for restoration and enhancement within Category 1 areas of the 401 Corridor Planning Area and the broader Subwatersheds. The strategy for environmental rehabilitation and restoration for the Planning Area consists of two subcomponents, namely:

- Reforestation and Natural Corridor Restoration; and
- Stream and Aquatic Habitat Restoration.

The details of each of these subcomponents are discussed in the following sections.

7.5.1 Reforestation, Natural Corridor Restoration and Woodland Improvement

Reforestation to create new woodland areas and/or to expand existing areas responds to the long-term objective to increase the percentage of total forest cover within the Subwatersheds, thereby contributing to the creation/maintenance of a healthy ecosystem. The Terrestrial Habitat Restoration and Improvement Strategy for the Planning Area is shown on Drawing No. 3.

A reforestation program would include artificial and/or natural regeneration at suitable locations including:

- Area regeneration within adjacent lands to Category 1 and 2 areas;
- Area regeneration within designated natural corridors of Category 2 areas; and
- Naturalization of existing parks and green spaces.

Enhancement of natural corridors involves vegetative planting and reforestation of the natural corridors defined within the Category 2 areas. These efforts would extend the core valleylands and stream corridor systems, connect woodlands and vegetative remnants, and re-establish linkages to other Subwatershed corridors. This in turn, would create new habitat and terrestrial resource areas, reduce fragmentation, increase the percentage of forest cover within the Subwatershed and facilitate the movement of native plant and animal species.

Enhancement and restoration is intended to:

- improving forest composition and structure;
- increasing the proportion of native species; and
- establishing treed hedgerows.

Specific recommendations are as follows:

Plantings in the corridors should be pursued to extend the linkages connecting woodlands and vegetative remnants, thereby reducing the effects of forest fragmentation, as well as creating new habitat and terrestrial resource areas. Bur oak (*Q. macrocarpa*), hawthorn (*Crataegus* sp.), and sugar maple (*A. saccharum)* should be planted in the hedgerows with low tree densities to improve connectivity of the wooded areas; hedgerow C11 is one feature lacking a continuous tree cover. Given its locations along the Mansewood Tributary, it is particularly important to enhance this riparian area which will also benefit the aquatic habitat by providing shading. Species such as bur oak (*Q. macrocarpa*), hawthorn (*Crataegus* sp.), silver maple (*A. saccharinum*), willow (*Salix* sp.) and red osier dogwood (*Cornus stolonifera*) should be planted.

The existing forests in the study area should be maintained and would benefit from restoration to improve forest composition and structure. Deciduous forest DF3, approximately 4.5 ha in size surrounds the Mansewood Tributary and warrants protection. In time, the understory and ground cover in this forest may return naturally, however, this process could be assisted by planting shrubs and seedlings in the forest. The edges of the forest should also be stabilized with species such as eastern white cedar (*Thuja occidentalis*) and alternate leaved dogwood (*Cornus alternifolia*). This edge restoration will reduce wind damage and limit the invasion of exotic species. Similarly, edge stabilization along forests DF3 and D1 would help to enhance the form and function of these features.

The larger forest areas WF1 and the cluster of WF3-F1-WF4-F2 also warrant protection; enhancement in these areas would improve the forest composition and structure. Reforestation between WF1 and G2 would increase the size of WF1, thereby establishing a buffer around the watercourse. Plantings between WF3, F1, WF4, and F2 would create a continuous larger forest complex.

Some of the smaller forests could also be protected and enhanced to improve the overall environmental character of the Planning Area. Deciduous forest DF5 ha is a 0.5 ha forest on the south side of the Mansewood Tributary which shows evidence of wind damage and which would benefit from the restoration of the existing edges.

The loss of small upland woodlots within the study area will result in a reduction of forest cover in the subwatersheds. Compensation for loss of forest cover and function could assist in meeting fish habitat, woodland and valleyland restoration targets, as described in Section 6.0.

7.5.2 Stream and Aquatic Habitat Restoration

The focus of stream and aquatic habitat restoration is to improve the overall physical structure of the stream channels and bordering shorelines while restoring the stream's natural morphological characteristics. Stream rehabilitation techniques would be employed to achieve a stable equilibrium of erosion and deposition along degraded reaches. This initiative would be closely associated with specific rehabilitation measures and techniques to restore and enhance aquatic habitats that have been degraded. Physical improvements to the aquatic habitat are necessary to help achieve stream stability (from the effects of erosion) and enhance its ecological function.

A significant component of these initiatives is the replanting of vegetation in the riparian zone and removal of in-stream barriers and anthropogenic debris. The initiatives would serve to further enhance the existing fish habitat within the subwatersheds (as shown by the direct correlation of riparian vegetation and observed species), extend the range of fish movement throughout the subwatersheds, and help improve water quality in the downstream reaches.

Drawing No. 3 displays the Stream and Aquatic Habitat Restoration Strategy for the 401 Corridor Planning Area. The various components of the strategy are discussed in the following.

East Sixteen Mile Creek

- Restoration and enhancement of stream bed structure, through selective placement of gravel, boulders (vortex rock weirs), deflector logs and lunker structures to reinstate a regular riffle-pool complex and improve habitat quality.
- Consideration of opportunities to integrate/create/enhance fish habitat as part of new development (e.g. naturalized outlet channels from stormwater management facilities, temperature-mitigating outlet design features (bottom draw)).

Hornby Tributary

- Stabilization of currently eroding streambanks, using natural channel design techniques and natural materials, such as root wads, live log crib walls, willow brush bundles or live willow stakes.
- Replanting of vegetative buffer zones using native woody plant species to stabilize streambanks, provide shade and increase plant biodiversity along the shoreline.
- Rechannelization in certain areas using natural channel design techniques to restore riffle-pool complexes.
- Restoration and enhancement of stream bed structure, through selective placement of gravel, boulders (vortex rock weirs), deflector logs and lunker structures, as well as removal of anthropogenic debris.
- Recommendations to upstream residents to avoid mowing to stream's edge, and to plant shrubs which will reduce erosion on their property and decrease sediment load downstream.

- Consideration of opportunities to integrate/create/enhance fish habitat as part of new development (e.g. naturalized outlet channels from stormwater management facilities, temperature-mitigating outlet design features (bottom draw)).

Middle Sixteen Mile Creek Tributary

- Restoration and enhancement of stream bed structure in certain areas through selective placement of gravel, boulders, deflector logs and lunker structures.
- Replanting of vegetative buffer zones, particularly through park area, using native woody plant species to provide shade, temperature moderation and increase vegetative diversity. This measure may improve habitat to the extent that conditions are suitable for brook trout year round.
- Rechannelization, where appropriate, using natural channel design techniques and bioengineering materials (coconut fibre fabric, live willow stakes) and reinstating a regular riffle-pool complex. Implementation of this measure will result in the presence of habitat quality which will support a permanent brook trout population.
- Consideration of opportunities to integrate/create/enhance fish habitat as part of new development (e.g. naturalized outlet channels from stormwater management facilities, temperature-mitigating outlet design features (bottom draw)).

Middle Sixteen Mile Creek (main branch)

- Replanting of vegetative buffer zones using native woody plant species to stabilize streambanks, provide shade and increase vegetative diversity along the stream edge. The temperature moderation resulting from this measure may result in condition suitable for rainbow trout year round.
- Restoration and enhancement of stream bed structure, through selective placement of gravel, boulders, deflector logs and lunker structures to reinstate regular pool-riffle complexes and improve habitat quality for resident rainbow trout population.
- Consideration of opportunities to integrate/create/enhance fish habitat as part of new development (e.g. naturalized outlet channels from stormwater management facilities, temperature-mitigating outlet design features (bottom draw)).

Mansewood Tributary

- Stabilization of eroding streambanks, using natural channel design techniques and natural materials such as root wads, live log crib walls, willow brush bundles or live willow stakes.
- Replanting of vegetative buffer zones using native woody plant species to stabilize streambanks, provide shade and increase vegetative diversity along the stream edge.

- Rechannelization where appropriate, using natural channel design techniques and bioengineering materials and reinstating a regular riffle-pool complex.
- Consideration of opportunities to integrate/create/enhance fish habitat as part of new development (e.g. naturalized outlet channels from stormwater management facilities, temperature-mitigating outlet design features (bottom draw)).

Potential areas of rehabilitation or improvement identified within the Subwatersheds include many of the following general measures:

- Natural channel rehabilitation in areas that have been channelized and/or artificially hardened.

- Removal of instream barriers as identified in the Sixteen mile Creek Watershed Plan.

- Stabilization of excessively eroding streambanks, preferably using natural channel design techniques and natural materials, such as root wads, live log crib walls, willow brush bundles or live willow stakes.

- Restoration and enhancement of stream bed structure, through selective placement of gravel, boulders (vortex rock weirs), deflector logs and lunker structures. Natural channel design techniques will be selected based on a detailed assessment by a fluvial geomorphologist to determine the fluvial characteristics of specific stream reaches.

- Improvement of low flow characteristics, through the restoration of natural sinuosity characteristics and the use of deflector structures, as well as the removal of anthropogenic debris.

- Rechannelization, where appropriate, using natural channel design techniques and bioengineering materials (coconut fibre fabric, live willow stakes) and reinstating a regular riffle pool complex.

- Eliminate, remediate or bypass instream barriers such as blocked culverts, or other anthropogenic migration barriers to allow easier movement of all aquatic fauna.

- Replanting of vegetative buffer zones using native woody plant species to stabilize streambanks, improve groundwater regime, provide shade and increase vegetative diversity along shorelines, as well as enhance terrestrial habitats. Watercourses which provide significant baseflow and which should be targeted as priority rehabilitation areas have been identified in Section 4.1.4.

- Restriction of livestock access to watercourses by constructing fences or other means.

7.6 Agricultural and Rural Land Management

With the majority of Subwatersheds remaining in some form of agricultural and rural land use for the foreseeable future, formulation of an effective agricultural and rural land management strategy has been recognized as an important aspect of the overall Scoped Subwatershed Plan. Proper management of farming and rural land use activities and the lands upon which they are conducted is central to the environmental health of the Subwatersheds, just as environmental quality is essential to sustainable agriculture.

Farmers, along with the rural community are stewards of the land. They act as land managers responsible for the rural environment (similar to Municipalities and urban residents who assume responsibility for the urban environment). As such, the process of agricultural and rural land management is of a farm or landowner-specific nature and left to the actions of the individual. Many environmental concerns cannot be addressed by individual landowners initiatives alone; some require government co-ordination, education programs, community cooperation and financial assistance.

The development of an agricultural and rural land management strategy (through the environmental farm plan) includes the identification of standard mitigative and restoration measures (such as Best Management Practices) to minimize the potential impacts associated with agricultural practices and rural development, as well as protecting and restoring waterways, streamside vegetation, woodlots and wetlands. The strategy includes the identification of existing government programs, participating agencies and potential funding mechanisms available to assist farmers and the rural community in implementation.

If properly planned, co-ordinated and implemented in an integrated manner with the other Subwatershed management programs (*i.e.*, rehabilitation and restoration), agricultural and rural land management initiatives can contribute significantly to the maintenance and restoration of natural ecosystems and associated resources including wildlife and fisheries. It is imperative to recognize however, that the present day agricultural and rural land activities, and the communities that support them are intrinsic to the existing environment. Similarly, it must be stressed that the environmental needs of the Subwatersheds (*i.e.*, protection of groundwater recharge areas, environmental buffers for fish habitat protection, reforestation, and natural corridor restoration) must recognize, and be balanced with the needs of the farming/rural community.

7.6.1 Best Management Practices

Best Management Practices (BMPs) embody a wide range of alternative measures directed at minimizing the potentially adverse impacts associated with current agricultural practices. These measures emphasize: soil conservation to reduce soil loss due to wind, gully, sheet or rill erosion; chemical management to reduce/manage the application of fertilizers and pesticides; waste management for improved storage and handling of manure, milkhouse wastes and feedlot runoff control; water management to protect and conserve surface and groundwaters, and maintenance of septic systems; and, forestry and habitat management to restore and enhance the ecological integrity in wetlands, woodlands and waterways.

Best Management Practices include both structural and non-structural measures, and practical guidelines and techniques for managing soil and water related problems associated with agricultural and rural land use activities. **Table 7.2** summarizes several agricultural and rural land management alternatives and accompanying Best Management Practices applicable for the Subwatershed. Many of the BMPs presented **in Table 7.2** are drawn from research and on-farm experience gathered by government agencies and farm groups, and published in a series of information booklets for Ontario Farmers. The publications discuss strategies and recommendations for incorporating BMPs dealing with soil and nutrient management, water management, livestock and poultry waste management, field crop production, horticulture crops, and farm forestry and habitat management.

7.7 Urban Storm Water Management

This section discusses the development of an urban storm water management strategy which will provide an integrated approach to storm water management within the 401 Corridor Planning Area. Included in this strategy are recommended measures for the control/treatment of urban storm water quality and quantity, design guidelines for new development areas, and erosion and sediment controls.

The urban storm water management strategy consists of three subcomponents, namely:

i) Storm Water Management Practices *(SWMPs)*

These consist of a number of recommended structural and non-structural measures to mitigate the adverse effects associated with urban storm water runoff. The measures can be

Table 7.2 - Agricultural and Rural Land Management Alternatives and Best Management Practices

Management Alternative	Description	Best Management Practices
Soil Conservation		
• Conservation Tillage	• Tillage practices aimed at reducing soil loss resulting from tillage.	• Conventional tillage • No till/ridge till • Mulch till/residue management • Crop rotation and cover crops
• Conservation Practices	• Cropping and management practices to reduce soil loss from wind and water erosion by stabilizing exposed areas and reducing sediment delivery to streams.	• Contouring • Grassed headlands • Strip cropping
• Conservation Structures	• Structural measures to reduce soil loss from wind and water erosion by reducing the volume of surface water runoff and/or the erosive forces of overland flow.	• Tile drainage • Tile drain outlet stabilization • Terraces • Water & sediment control basins • Grassed waterways • Filter/buffer strips • Rock chutes • Windbreaks and shelterbelts
• General Practices	• Structural and non-structural measures to reduce streambank erosion.	• Streambank stabilization • Livestock fencing • Stream crossings
Chemical Management		
• Chemical Handling and Storage	• Handling and storage methods to minimize the potential for surface and groundwater contamination.	• Biodegradable herbicides and pesticides • Storage/containment facilities
• Chemical Application	• Application methods and formulations directed at using the appropriate chemicals at their recommended rates, times and by appropriate means.	• Application protocols • Monitoring
Waste Management		
• Manure and Milkhouse Waste Handling and Storage	• Handling and storage methods to minimize the potential for surface and groundwater contamination.	• Storage/containment facilities • Manure treatment • Manure composting • Sediment tank and treatment trenches
• Manure Application	• Application methods directed at proper application of liquid and solid manure.	• Application protocols • Liquid manure injection techniques
Water Management		
• General Practices	• Structural and non-structural measures to protect and conserve domestic supplies of surface and groundwater.	• Water well testing • Water conservation techniques • Hazardous waste disposal • Fuel storage tanks • Pond creation and maintenance
• Private Sewage Disposal Systems	• Care and maintenance of septic systems (tanks and leaching beds)	• Monitoring • Repair and replacement • Good housekeeping measures
Forestry and Habitat Management		
• General Practices	Structural and non-structural measures to restore and enhance wetlands, woodlands, wildlife and waterways.	• Retirement of fragile/marginal lands • Buffer strips • Natural fencerows • Intercropping and sivipasture • Woodlot management • Stream restoration • Revegetation and reforestation

incorporated on individual lots, as part of the storm water conveyance system and/or at the end-of-pipe, to enhance water quality, control peak flows and control spills.

ii) Erosion and Sediment Controls

These consist of a series of recommended site measures to control erosion and sediment during the construction phase of new developments.iii)Design Guidelines for Development

To complement the above, a set of design recommendations are provided for future development proposals, to ensure development conforms to the intent of the urban storm water management strategy. This section includes a discussion of recommended sizing, design and maintenance guidelines for storm water management ponds and outlines guidelines for the submission of Storm Water Management Plans.

The details of each of these subcomponents are discussed in the following sections. Drawing No. 4 displays the principal components of the Urban Storm Water Management Strategy for the planning area based on the future land use scenario. Recommended storm water management practices (SWMPs) for the planning area as well as the remainder of the study Subwatersheds are discussed in detail in the following sections.

It is important to note that elements of the urban storm water management strategy represent a planning level strategy for managing future urbanization within the 401 Corridor in an environmentally compatible manner. Accordingly, the details of the SWMPs presented in this Report, including the configuration, geometry and location of end-of-pipe storm water management facilities, are preliminary in nature. They are intended to serve as a guide for the developer proponent, the Town and the review agencies (e.g. HRCA, MNR and MOE) in the preparation, review and approval of storm water management plan and reports. It is important to note, the detailed design and siting of the SWMPs is dependent on site-specific constraints and opportunities which only become evident, and can be best addressed, during design of the individual subdivision. General criteria for facility design, such as volumetric control requirements, developed on a per area basis, may still be applied. As shown on Drawing No. 4, 12 end-of-pipe storm water management facilities, complemented with a series of lot level and conveyance SWMPs, are recommended within the Sixteen Mile Creek system. The function of these facilities is to provide both water quantity control (*i.e.*, peak flow control for flooding and streambank erosion) and water quality enhancement of urban storm water runoff. The use of a limited number of strategically located facilities is favoured for both environmental and practical considerations (e.g. in the western portion of the study area). Experience indicates that a reduced number of multi-purpose regional facilities achieve a higher standard of performance in terms of water quality abatement, while also minimizing maintenance and operational requirements once constructed.

Generally, the economics of **multi-purpose** regional facilities are more favourable, resulting in a cost-effective use of available lands. An additional facility to control Mullett Creek tributary runoff will be required either locally or downstream of the 401 Corridor should a central facility be adopted.

The relevant details for each of the 12 Sixteen Mile Creek system storm water management facilities, including the maximum area serviced, quantity and quality storage volumes, and the control achieved on peak flows, are summarized on the Drawing and **Tables 7.3** and **7.4.** The detailed storage-discharge characteristics, established for each facility, are contained in **Appendix I**, in addition to details used in the design of the various pond components. The controlled release rates are the prescribed outflows from the ponds recognizing the recommended targets for water quality, streambank erosion and flooding to ensure acceptable flow conditions are maintained along the receiving watercourses of Sixteen Mile Creek. Each of these design parameters may be scaled according to actual development area, e.g., to account for final grading between the Mullett Creek and Sixteen Mile Creek systems.

Table 7.3 - Stormwater Facility Design Details

Pond ID	Type	Drainage Area (ha)	Design Volumes (m^3) Permanent Pool	Extended Detention (Erosion)	Flood Control (100 yr)
1	Wetpond	18.39	3400	6700	11100
2	Wetpond	191.09	22400	44300	74100
3	Wetpond	65.9	11500	22600	37800
4	Wetpond	15.16	2300	4400	7400
5	Wetpond	36.51	6800	13700	22900
6	Wetpond	22.93	2000	8000	13500
7	Wetpond	61.89	5200	21300	35700
8	Wetpond	22.33	1000	7700	13000
9	Wetpond	13	600	4500	7500
10	Wetpond	14.71	600	5000	8400
11	Wetpond	18.11	800	6300	10500
12	Wetpond	45.47	1900	15700	26300

Critical threshold unit release rate for erosion control (SMCWP): 0.103 L/s.ha
Erosion control depth for impervious hectares: 52.00 mm/impervious hectare (for Pond 2, calculations are based on new development areas excluding existing Milton Business Park - new development area is 127 ha).
100 year control depth for impervious hectares: 87.00 mm/impervious hectare (includes erosion component) (for Pond 2, calculations are based on new development areas excluding existing Milton Business Park - new development area is 127 ha).

Table 7.4 - Future Controlled Design Flows														
Pond ID	**Hydrograph ID**		**Design Flows (cms)**											
			2 year		**5 year**		**10 year**		**25 year**		**50 year**		**100 year**	
	Existing	**Future**	**Existing**	**Future**	**Existing**	**Future**	**Existin g**	**Future**	**Existing**	**Future**	**Existing**	**Future**	**Existing**	**Future**
1	106	505	0.42	0.05	0.75	0.14	1.02	0.31	1.38	0.60	1.66	0.85	1.94	1.12
2	508	504	3.33	0.48	7.55	1.63	10.10	3.52	13.35	6.50	16.11	9.12	18.86	11.86
3	601	601	1.02	0.17	1.75	0.63	2.33	1.34	3.10	2.45	3.69	3.38	4.28	4.36
4	602	602	0.50	0.03	0.90	0.22	1.22	0.49	1.65	0.89	1.99	1.23	2.33	1.56
5	206	603	1.03	0.10	1.81	0.32	2.42	0.76	3.23	1.52	3.85	2.18	4.47	2.88
6	302	698	.052	0.06	0.91	0.24	1.22	0.57	1.63	1.12	1.94	1.58	2.25	2.07
7	700	699	1.31	0.16	2.31	0.56	3.11	1.28	4.17	2.45	4.98	3.45	5.80	4.51
8	800	801	1.11	0.31	1.94	1.01	2.60	1.60	3.47	2.37	4.13	3.01	4.80	3.67
9	803	805	1.13	0.92	1.99	1.80	2.67	2.45	3.59	3.27	4.29	3.90	4.99	4.52
10	806	809	1.36	1.09	2.40	2.20	3.22	3.00	4.31	4.01	5.15	4.78	5.99	5.54
11	809	813	0.92	0.48	1.62	1.22	2.18	1.77	2.93	2.49	3.50	3.02	4.07	3.57
12	412	816	0.56	.011	0.99	0.30	1.34	0.68	1.80	1.34	2.15	1.91	2.51	2.52

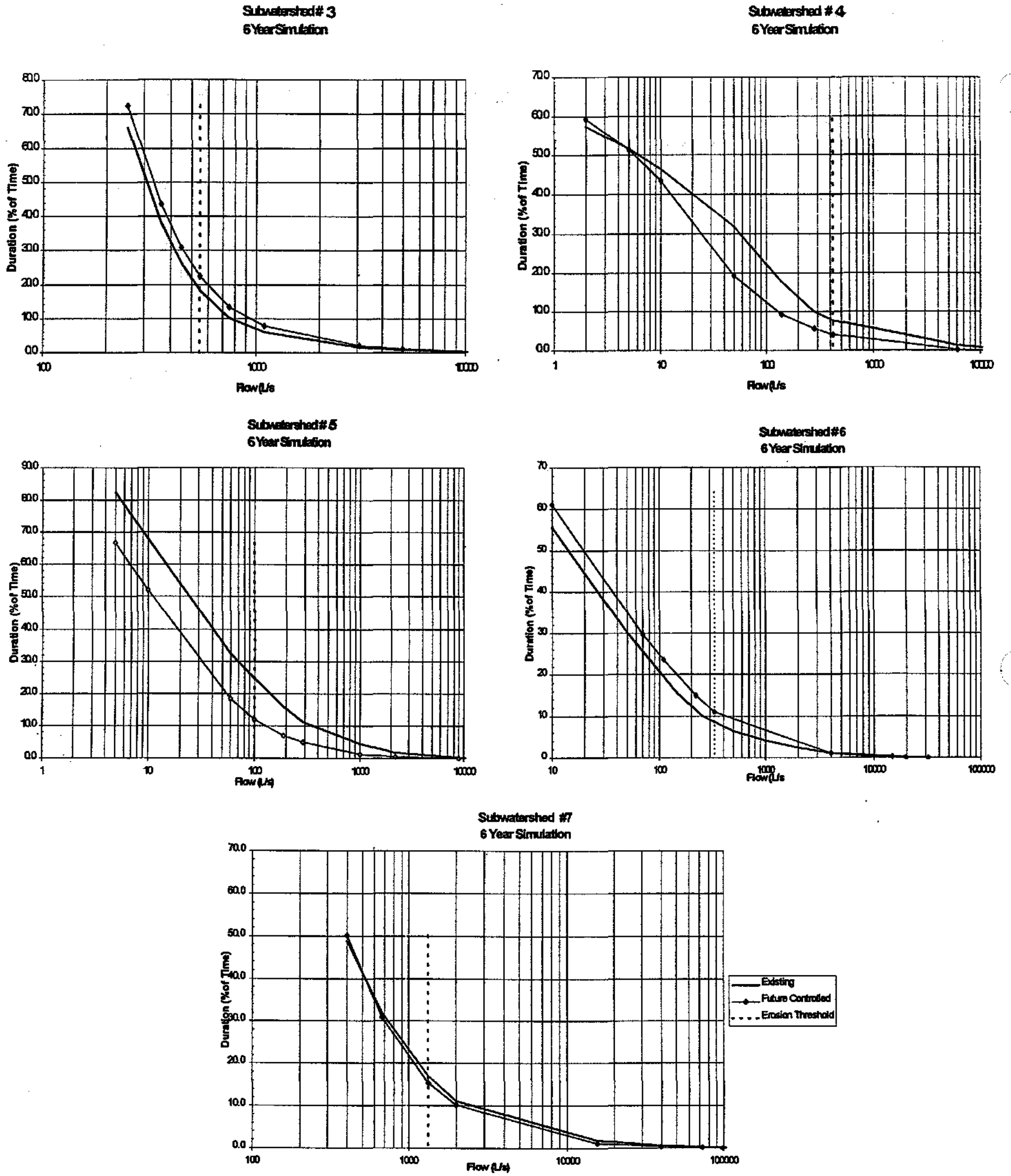
Notes for table 7.3 (continued):
Permanent pool based on SWMP Manual Table 4.1 and proposed impervious values.
Extended detention governed by erosion control criterion. Refer to Appendix I.
Control guidelines for Mullett Creek Subwatershed (part of Area 12) may be determined from the Gateway West Subwatershed Plan.

Proposed stormwater control ponds which have been evaluated on a local basis in terms of peak flow control using OTTHYMO89 have been integrated within the Sixteen Mile Creek QUALHYMO model for Subwatersheds 3, 4, 5, 6 and 7. While the proposed 401 Corridor development does not impact hydrologic conditions within Subwatershed 7, it must be considered when evaluating the cumulative impact of runoff from the study Subwatersheds; i.e., 3, 4, 5, and 6, since a significant portion of Subwatershed 7 runoff combines with runoff from 3, 4, and 5 prior to the confluence with 6. It is noted that proposed development within Subwatershed 7 is not included in this model and that the effects of this development is the subject of subwatershed studies being performed by others. Flow duration exceedance curves for future development with stormwater controls in place have been created based on model results and are presented in **Figure 7.1**. For evaluation purposes, the existing condition flow curves have been included as well as the governing erosion threshold flow rates determined as part of the Watershed Plan and as part of local geomorphologic analysis (see **Table 4.8**).

The curves for Subwatershed 3 indicate an increase of 5% or less in the duration of flows at or above the governing watershed threshold value of 550 L/s (shown) and an increase of 1% or less above the local threshold of 2560 L/s. This indicates a minor increase in downstream erosion potential based on watershed-wide control and a negligible increase in local erosion potential. The effect of the minor increase based on the watershed threshold must be evaluated using curves generated for the downstream erosion site (E5), on which the watershed threshold was based.

Curves for Subwatershed 4 indicate a reduction in the duration of flows at or above the watershed threshold value of 420 L/s (shown) and a reduction in durations of up to 10 % at lower flow rates. The watershed threshold is noted to be significantly less than the local thresholds based on Watershed Plan investigations (i.e., 960 L/s threshold at erosion station E2) and local investigations performed as part of this study (i.e., 2190 L/s in total in Subwatershed 4 main branches). Overall, this indicates a minor decrease in downstream and local erosion potential.

Subwatershed 5 curves follow the same pattern as those of Subwatershed 4 with lower durations at and above the governing local threshold of 100 L/s (shown) and the watershed threshold of 290 L/s. This indicates a decrease in both the downstream and local erosion potential.



TOWN OF HALTON HILLS

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401 CORRIDOR INTEGRATED PLANNING PROJECT
SCOPED WATERSHED STUDIES

FUTURE SUBWATERSHED FLOW DURATION CURVES
15 MINUTE TIME STEP

FIGURE 7.1

The curves for Subwatershed 6 indicate an increase of 3% or less in the duration of flows at or above the watershed threshold value of 330 L/s (shown) which is the only value available for this Subwatershed. Previous studies have indicated that there are no known local erosion sites within the Subwatershed and as a result, the effect of this minor increase must be evaluated using curves generated for the downstream erosion site (E5), on which the watershed threshold was based.

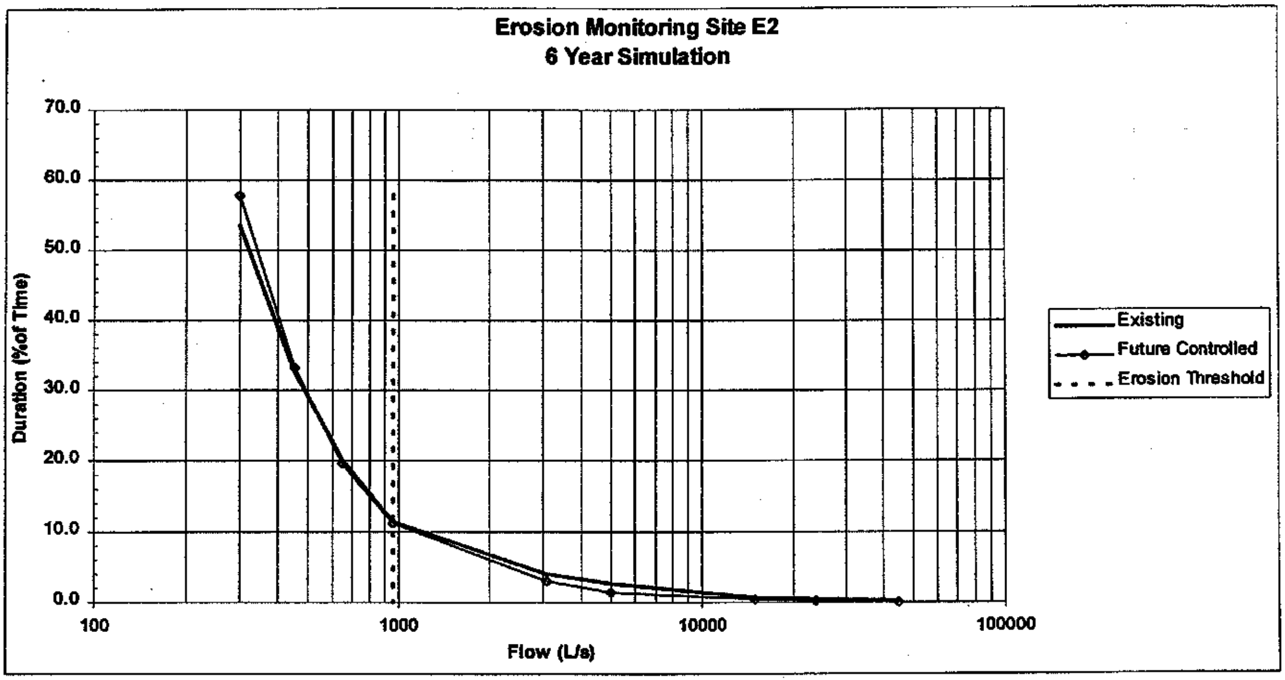
The curves for erosion station E5 (**Figure 7.2**) and Subwatershed 7 (including all of the upstream Subwatersheds) indicate a reduction in the duration of flows at or above the watershed threshold values of 1840 L/s and 2000 L/s, respectively, and generally no increase in lesser flow rates. This indicates that there is no cumulative net downstream effect of local increases in critical local threshold durations in Subwatersheds 3 and 6. The curves for erosion station E2 (**Figure 7.2**) indicate no change in the duration of flows at the watershed threshold value of 960 L/s. In summary, the proposed stormwater management control works maintain the overall existing condition flow regime within the watershed. While local watershed-based thresholds may be exceeded in some locations (where over-control had been suggested in the Watershed Plan), no locally-based thresholds have been exceeded, indicating that the absence of local over-control would not result in increased erosion potential.

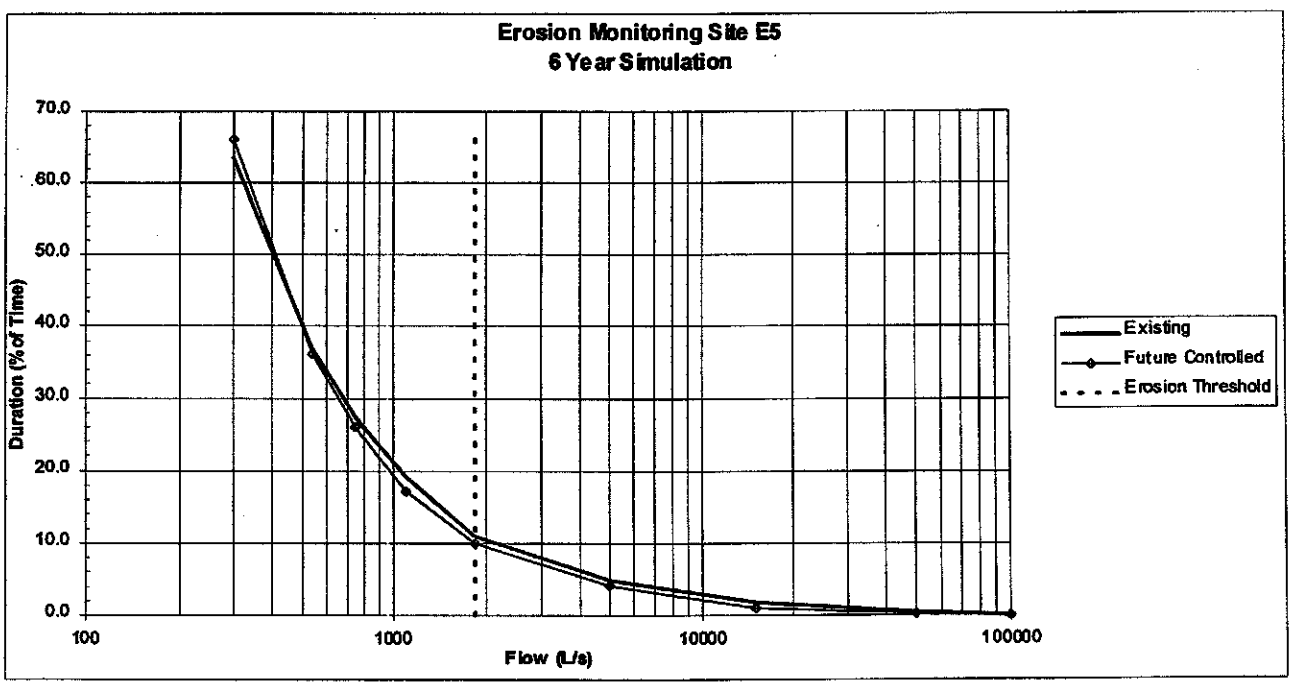
The location and sizing of the end-of-pipe storm water management facilities is based on a preliminary estimate of the land area that can be serviced by the individual ponds, taking into account the existing natural and man-made features, proximity to existing drainage outlets, minimum slope requirements for the drainage system and topographic characteristics. If during the detailed design phase, site constraints indicate that achieving the service area presented in this Report for a particular storm water management pond may involve extensive regrading works or prohibitive costs, an additional pond(s) could be implemented to alleviate the servicing constraint without compromising the intent of the urban storm water management strategy, provided that volumetric control and release rates targets are met.

7.7.1 Storm Water Management Practices

The following section includes a discussion of storm water management practices (SWMPs) that have been considered for incorporation into an overall storm water management strategy. The various management practices are discussed in terms of applicability, site integration, land use compatibility, and effectiveness. Ineffective and/or inappropriate SWMPs are screened out based on site constraints and target requirements identified for the 401 Corridor Planning Area and the Subwatersheds.

Storm water management practices are discussed in terms of:





HALTON HILLS

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SCOPED WATERSHED STUDIES

FUTURE EROSION SITE FLOW DURATION CURVES
15 MINUTE TIME STEP

FIGURE 7.2

Storm Water Lot Level (Source) Controls	-	measures implemented at the lot level (reduced lot grading, soakaway pits)
Storm Water Conveyance Controls	-	measures implemented via the conveyance systems used to transport storm water from the lots to the receiving waters (pervious pipes, grassed swales)
End-of-Pipe Storm Water Management Facilities	-	measures that are used to service secondary planning areas, subdivisions or multiple lots (wet ponds, wetlands, infiltration basins)

7.7.1.1 Lot Level (Source) Controls

Reduced Lot Grading

Reduced lot grading involves flattening the surface gradients around the building envelop as a means to create additional depression storage and promote natural infiltration. Reducing the minimum allowable lot grade from 2% to 0.5% is one approach for consideration. Such a change would require revising the municipality's typical development standard. Since runoff from building roofs and lot areas is relatively clean, the benefits of this measure are directed at promoting recharge, and reducing flooding and erosion potential.

Owing to the relatively flat surface gradients present in many areas of the Subwatershed, reduced lot grading would be advantageous and relatively easy to implement pending municipal review and acceptance, and is recommended for further consideration.

Roofleaders to Ponding Areas

Discharging roofleaders to grassed ponding areas instead of connecting them to the storm sewer via the private drain connection is another means to reduce the potential for flooding and erosion. Typically, ponding areas would consist of a shallow grassed depression (< 100 mm) created in the in the rear yard or rear lot line of each lot. Ponded water would then be detained until it infiltrated and/or evaporated. Water quality benefits of this measure would be limited to the treatment of atmospheric pollutants, since no road runoff is treated. Lot level ponding can be implemented for soil types with a minimum percolation rate ≥ 15 mm/hr (MOEE, 1994c).

Roofleaders to ponding areas may have applications in the development areas where suitable subsoils exist. These areas include those areas identified as groundwater recharge areas or lands with well-drained soils as identified earlier. Within the 401 Corridor Planning Area these measures are not recommended for widespread application given the isolated nature of well-drained soil conditions; site-specific investigations are recommended to confirm local conditions and to determine the suitability of these measures.

Roofleaders to Soakaway Pits

An alternative means of providing flooding and erosion benefits involves directing roofleaders to soakaway pits for infiltration in areas where suitable subsoils exist. Soakaway pits can be implemented for soil types with a minimum percolation rate ≥ 15 mm/hr (MOEE, 1994c). Generally, they are constructed on a lot-by-lot basis by excavating a pit, which is backfilled with stone and connected to the roofleader downspout via, a pipe.

Roofleaders to soakaway pits may have applications for planned residential development areas in groundwater recharge areas or on lands with well-drained soils, generally as part of ultimate development conditions. Within the 401 Corridor Planning Area, these measures are not recommended for application given the isolated nature of well-drained soil conditions and the unsuitability of the large scale pits required for large commercial/industrial building developments.

Sump Pumping of Foundation Drains

Pumping foundation drainage by means of sumps to soakaway pits (if suitable subsoils exits) or to rear yards for ponding/infiltration would separate relatively clean foundation drainage from polluted storm and sanitary drainage. This in turn, may enhance groundwater recharge, and reduce the volume of wastewater conveyed to sewage treatment plants.

As with the above measures, sump pumping of foundation drains may have application in those areas identified as groundwater recharge areas or lands with well-drained soils. Similarly, within the 401 Corridor Planning Area these measures are not recommended for widespread application given the isolated nature of well-drained soil conditions and the unsuitability of the large scale pits required for large commercial/industrial building developments.

7.7.1.2 Storm Water Conveyance Controls

Pervious Pipe Systems

Pervious pipe systems are used in place of, or in conjunction with traditional storm sewer systems to convey road drainage. The use of perforated sewers allows exfiltration of water through the pipe wall and into the surrounding soil for subsequent infiltration. Pervious pipe systems would provide both water quality and quantity benefits. Suspended solids, soluble pollutants (chlorides) and oil/grease carried in road runoff would be removed along with the infiltrated storm water. Groundwater recharge of infiltrated storm water would reduce peak flows and runoff volumes, lowering the potential for flooding and erosion downstream.

Pervious pipes are not recommended for soils with minimum percolation rates less than 15 mm/hr (MOEE, 1994c). Pervious pipe systems are experimental, and there is limited Ontario experience with their application. Experience ~~in the~~ United States has proven them to be unreliable and prone to sediment clogging which stresses the need for proper pre-treatment of runoff.

Pervious pipe systems may have application for development areas where suitable subsoils exist and pretreatment can be achieved. These areas include those areas identified as groundwater recharge areas where the systems should be retained for consideration upon review of any future development plans.

Similarly to the above lot-level control measures related to infiltration pervious pipe systems may have application in those areas identified as groundwater recharge areas or lands with well-drained soils. Within the 401 Corridor Planning Area, these measures are not recommended for widespread application given the isolated nature of well-drained soil conditions.

Pervious Catchbasins

Previous catchbasins are used to infiltrate road drainage containing high levels of suspended sediment to provide water quality enhancement benefits. The catchbasin sump is used to pre-treat runoff by particulate settling. Low flows are discharged through the catchbasin wall to a soakaway pit via a small pipe. The soakaway pit is located in the grassed boulevard (within the ROW) and infiltrates the road runoff into the surrounding soil. High flows are discharged to the storm sewer via the catchbasin lead. Implementation of pervious catchbasins are not recommended for soils with minimum percolation rates less than 15 mm/hr (MOEE, 1994c). As with pervious piped systems, pervious catchbasins are experimental and recognized as susceptible to clogging.

Pervious catchbasins may have application in development area where suitable subsoils exist. They are not recommended at this time, but instead should be retained for consideration upon review of any future development plans. Within the 401 Corridor Planning Area, these measures are not recommended for widespread application given the isolated nature of well-drained soil conditions.

Grassed Swales

Grassed swales and enhanced grassed swales (grassed swales functioning with a permanent check dam) can provide effective removal of particulate pollutants and some (minor) removal of soluble pollutants if constructed under optimal conditions (*i.e.*, extremely gentle slopes, permeable and uncompacted soils, and provision of dense vegetation cover). Water quality benefits are provided by means of sedimentation, filtration, infiltration and absorption by vegetation. Tall dense stands of turf-forming grass (≥ 75 mm) are deemed to be most effective for pollutant removal and erosion control.

Research conducted by the US Federal Highway Administration (USFHWA, 1986), has shown that grassed swales with a length of at least 30 m provide adequate suspended solids removal (> 80%) and dissolved lead removal (> 60%). For other pollutants, such as heavy metals, approximately 50% removal is expected.

When incorporated in a rural road section, grassed swales can be used to replace storm sewers, thereby providing longer travel times, reduced peak flows and infiltration of roadway runoff. As an alternative, grassed swales can be combined with storm sewers in the form of a modified rural road section to provide pretreatment of pollutants (carried by roadway washoff) prior to its capture into the storm sewers. Grassed swales may also be used within individual lots to convey site runoff to roadways with urban sections and storm sewer servicing.

The use of grassed swales and enhanced grassed swales are well suited to widespread application in instances where a rural or modified rural/urban road section may be desirable or where conveyance within individual lots can be employed . Such examples would include an industrial or commercial subdivision, or an estate residential subdivision development. A review of servicing alternatives within the 401 Corridor Planning Area indicated that given the large drainage areas and mild slopes, a rural cross section is not recommended for this area. Swales may be integrated, however, within the lot conveyance systems and combined in series with other lot-level management measures (e.g., ponding areas).

7.7.1.3 End-of-Pipe Storm Water Facilities

Wet Ponds

Wet ponds are a form of surface water storage that can provide both water quality and quantity benefits for the control/treatment of urban storm water runoff. The utilization of a permanent (wet) pool results in increased pollutant removal. The extended detention storage provides additional water quality treatment through particulate settling, as well as, water quantity benefits of flood and erosion mitigation through regulation of peak flows. In order to sustain a permanent pool, wet ponds require a minimum drainage area of ≥ 5 ha (MOEE, 1994c).

Wet ponds are recommended for application in instances where site-specific concerns determine that an artificial wetland cannot be implemented (*i.e.*, temperature concerns, land constraints, insufficient drainage area to support a permanent pool). These measures are recommended for use throughout the 401 Corridor Planning Area.

Constructed/Artificial Wetlands

Constructed or artificial wetlands have been identified as very effective management practices for water quality enhancement. Artificial wetlands provide very efficient particulate pollutant removal, and also offer additional enhancement capabilities for both nutrient uptake and soluble pollutant removal. The artificial wetland's enhanced pollutant removal capabilities are linked to the biological interactions and aquatic vegetation in the wetland. Incorporation of extended detention storage provides water quantity benefits of flood and erosion mitigation through regulation of peak flows.

Similar to wet ponds, artificial wetlands require a minimum drainage area of ≥ 5 ha (MOEE, 1994c). To improve pollutant removal of coarse particle and minimize the potential for scour and re-suspension, wetlands should be constructed with a sediment forebay.

The utilization of an artificially created wetland offers the advantage of being a multi-purpose storm water management practice providing pollutant removal, aesthetic enhancement and landscaping/habitat (aquatic and wildlife) improvement or creation.

Considering the distinct advantages they have, utilization of an artificially created wetland should be implemented where possible within the Subwatersheds. Within the 401 Corridor Planning Area, large erosion control volume requirements (and the associated high fluctuations in active storage depth) and long detention times (48 hours) will preclude the application of artificial wetlands which require lesser fluctuations in depths and shorter detention durations.

Dry Ponds

Dry ponds have no permanent pool of water, but rely on extended detention storage to remove storm water contaminants and provide water quantity benefits of flood and erosion mitigation through regulation of peak flows. As with wet ponds, dry ponds are capable of providing moderately high levels of pollutant removal through the settling of suspended solids. Toxicants (*i.e.*, phenols and creosols), hydrocarbons such as oil and grease and trace metals have a strong affinity for sediment and tend to settle out with the sediment. However, unlike wet ponds, dry ponds without a permanent pool can provide only a low level of soluble phosphorus and nitrogen removal (Schueler, 1987).

In order to avoid outlet clogging (associated with small diameter orifices) dry ponds should be implemented for drainage areas of ≥ 5 ha (MOEE, 1994c). To improve pollutant removal of coarse particle and minimize the potential for scour and re-suspension, dry ponds should be constructed with a sediment forebay.

Dry ponds are recommended for application in instances where site-specific concerns determine that a wet pond or wetland cannot be implemented (*i.e.*, temperature concerns, land constraints, insufficient drainage area to support a permanent pool). Dry ponds are not recommended for use within the 401 Corridor Planning Area since treatment efficiencies are generally not sufficient to achieve Level I control.

Infiltration Trenches

Infiltration trenches are below-ground systems designed to treat storm water from several lots as opposed to soakaway pits which are generally used on a lot-by-lot basis. In this regard, they maybe applied in small residential drainage areas < 2 ha, in instances where a group of homes can drain to a common trench. Infiltration trenches provide some treatment of urban storm water through removal of both soluble and particulate pollutants associates with fine grain sediments. They provide only marginal water quantity and erosion benefits, and are generally viewed more for the recharge of water (MOEE, 1994c).

Infiltration trenches consist of shallow (1-2.5 m deep) excavated trenches that have been backfilled with stone or granular material. Urban runoff directed to the trench is either exfiltrated into the underlying soils or collected by underdrain pipes and conveyed to an outlet. The trenches are not intended to trap coarse sediments, but instead are usually combined with grassed buffers, swales or water quality inlets that pretreat the runoff prior to its interception by the trench. Because of their construction, infiltration trenches are susceptible to clogging and require regular inspection/maintenance in to achieve acceptable performance.

Infiltration trenches are not recommended for soils with minimum percolation rates less than 15 mm/hr (MOEE, 1994c).

Infiltration trenches may have applications for planned residential development areas in groundwater recharge areas or on lands with well-drained soils, generally as part of ultimate development conditions within the Subwatersheds. Within the 401 Corridor Planning Area, these measures are not recommended for application given the isolated nature of well-drained soil conditions.

Infiltration Basins

Infiltration basins are large, centralized above-ground systems designed to treat storm water from multiple lots or entire subdivisions. Infiltration trenches provide treatment of urban storm water through removal of both soluble and particulate pollutants. Although they provide a level of water quantity benefit (*i.e.*, flooding and erosion), their primary function is groundwater recharge (MOEE, 1994c).

Infiltration basins are designed to temporarily store a specified runoff volume in an impoundment created by excavation or by constructing an embankment. Stored runoff exfiltrates through the basin floor and into the surrounding native soils.

Infiltration basins are applicable for residential drainage areas < 5 ha. They are not recommended for soils with minimum percolation rates less than 60 mm/hr (MOEE, 1994c). They are generally not recommended for industrial or commercial land uses since there is a high potential for groundwater contamination from chemical spills and maintenance (salting, sanding, etc.). Past experience in the United States indicates that infiltration basins are subject to high failure rates due to clogging and sealing of pores by sedimentation and biological activity (Schueler, 1987).

Infiltration basins may have applications for planned residential development areas in groundwater recharge areas or on lands with well-drained soils, generally as part of ultimate development conditions within the Subwatersheds. Within the 401 Corridor Planning Area, these measures are not recommended for application given the isolated nature of well-drained soil conditions.

Filter Strips

Filter strips are designed to accept and distribute runoff as diffused overland flow. Filter strips consist of a level spreader, such as a raised weir or small berm, and a vegetated strip that is grassed and/or forested. The level spreader is constructed to ensure uniform flow over the vegetation and to maximize the surface contact with the flowing water. The vegetation serves to remove pollutants by filtering runoff (through vegetative cover and/or soil), allowing settling/deposition (of small suspended particles by reductions in overland flow velocities), and by nutrient uptake (of infiltrated pollutants into the roots of vegetation). The filter strip also serves to promote infiltration of storm water.

Filter strips are feasible for drainage areas < 2 ha in size (MOEE, 1994c). Filter strips are ineffective under saturated or frozen ground conditions and are highly dependent upon lengths, slope and soil permeability. Overall, they offer only low effectiveness for water quality control and are best implemented adjacent to buffer strips, watercourses or drainage swales as a complementary management practice.

Filter strips may have application to the planned development areas within in the Subwatersheds and should be considered in the subdivision design process. Within the 401 Corridor Planning Area, these measures are not recommended for application given that the size of proposed drainage areas makes these measures infeasible.

Buffer Strips

In the context of urban storm water management practices, buffer strips are defined as naturally vegetated (or potentially revegetated) areas between development and the receiving waters that help minimize the impact of storm water runoff on the watercourse. Buffer strips are similar to filter strips, but are usually natural areas and do not involve constructed elements such as level spreaders. They provide only limited storm water quality (pollutant filtering) and quantity benefits (groundwater recharge, peak flow reduction), but are recognized as an essential element for the protection of significant natural heritage features (valleylands; woodlands, fish habitat, etc) and ecological functions (wildlife migration, food sources, etc.).

In this regard, buffer strips are strongly recommended for application in the Subwatersheds and within the 401 Corridor Planning Area. These measures may be implemented in concert with other restoration activities proposed within the valley lands.

Oil/Grit Separators

Oil/grit separators are below-ground systems designed to provide storm water quality treatment benefits for small drainage areas. Separators remove suspended sediment (grit) and attached pollutants by particulate settling. Oil is removed by phase separation. Larger separators, such as vortex separators or swirl concentrators, use flow hydraulics to separate and remove particles. Due to their relatively small size and capacity, oil/grit separators provide limited pollutant removal of fine-grained particles and solubles.

Typically, oil/grit separators are used to service small commercial and industrial areas < 2 ha. In addition, they are suitable for areas subject to heavy vehicular traffic, or where petroleum products are handled (gas stations, loading areas) as part of a spills management plan. They also can be used as pretreatment facilities to wet ponds, artificial wetlands or infiltration systems.

Oil/grit separators should not be used as the principle water quality control for new residential developments (MOEE, 1994c).

Oil/grit separators are recommended for industrial and commercial areas and for areas with large imperviousness and heavy vehicular traffic, such as school parking lots or small commercial plazas. These measures are therefore recommended for use as site control measures within the 401 Corridor Planning Area.

7.7.2 Erosion and Sediment Controls

During the construction of the individual subdivision plans within the Subwatersheds and the 401 Corridor Planning Area, an important aspect of development will be the control of erosion and sediment production. Construction activities such as clearing, stripping and shaping of land for development purposes exposes disturbed soil to precipitation and to surface water runoff. If uncontrolled, these activities could create major increases in the sediment loadings to the ravines and tributaries draining these area. This, in turn, could contribute to the impairment of water quality and environmental degradation.

It is imperative that the provisions for erosion and sediment control measures be identified and incorporated into site plans so that they are implemented first in the site development process prior to initiating construction. Once implemented, sediment control measures must be cleaned, checked and maintained in place, for all phases of the construction. The overall objectives of the control measures are to prevent erosion or retain virtually all sediment on-site.

Erosion and sediment controls which should be considered for implementation into individual site plans include:

i) site management practices;
ii) construction scheduling;
iii) temporary sediment traps;
iv) temporary sediment basins;
v) seeding and mulching;
vi) silt fences;
vii) brush barriers;
viii) check dams;
ix) drainage diversions;
x) conveyance channels;
xi) storm drain inlet protection; and
xii) vibration pads.

Where possible, the principles governing the design of erosion and sediment control measures should follow Provincial guidelines outlined in the following documents:

i) *Guidelines on Erosion and Sediment Control for Urban Construction Sites* (MNR, *et al.*, 1987b).
ii) *Technical Guidelines, Erosion and Sediment Control* (MNR, 1989).
iii) *Erosion and Sediment Control.* M.T.C. Drainage Manual, Volume 2, Chapter F (MTO, 1985).

Site Management Practices

These practices involve the careful management of site activities such as:

i) locating stockpiles away from the watercourses and stabilizing them against erosion;
ii) constructing and stabilizing site drainage features before initiating major construction works;
iii) phasing of construction and confining work areas with perimeter fencing;
iv) restricting site access to designated entrance/exit points; and,
v) washing of construction vehicle tires to remove mud and prevent sediment from being carried off-site.

Construction Scheduling

Proper construction scheduling will help ensure planned and orderly development of the site while minimizing and restricting the potential for erosion and sedimentation. Scheduling for the phased development of the site will minimize the duration of exposed areas and limit wind blown dust during summer months. All temporary and permanent control facilities should be constructed prior to the installation of any services on the site or the commencement of earth moving (or filling) operations. This would include the construction of the storm water management facilities (e.g. artificial wetlands, wet ponds, etc.), which should be scheduled before other works, so that they can be used as sediment control facilities.

Temporary Sediment Basins

Sediment basins are large temporary basins that utilize a controlled storm water release structure to achieve greater efficiencies in trapping sediment. Sediment basins offer the greatest potential for the treatment of storm water during construction within the planning area. Strategic placement of the basin, in conjunction with improvements to the natural drainage system (ie. ditches, diversion dykes, etc.), will allow for the interception of the largest possible amount of runoff from the disturbed areas. In addition, sediment basins offer the advantage of being adaptable as permanent water quality ponds when the site is developed. Sediment basins should be sized based on a storage volume of 125 m^3 per hectare of drainage area.

Temporary Sediment Traps

Sediment, or silt traps create small temporary ponding areas to treat sediment-laden storm water. Sediment traps would be used in development site areas not serviced by the larger sediment basins. Silt traps are generally applied for areas <2 ha and are formed by constructing an earthen embankment with a gravel outlet across a drainage swale.

Sediment traps are temporary measures and focus on removing only the coarse soil particles. The sediment traps should be sized with an initial storage volume of 125 m^3 per hectare of drainage area.

Seeding and Mulching

A standard technique for reducing the erosion of soils during the construction period is to seed or place a mulch which promotes vegetative growth. These measures are utilized in areas where construction has been completed, either finally or for a prolonged period. The use of seeding and/or mulches is only effective during the growing season. Therefore, an important aspect of erosion control is scheduling of work so that exposed areas can be seeded and are not left exposed during the winter and spring periods.

Seeding is most appropriate for flat areas and, as such, should be considered fully for development areas within the Subwatershed where gentle to moderately undulating overland slopes prevail.

Silt Fences

A silt fence is a temporary sediment barrier consisting of a filter-fabric stretched across a wire fence and staked into the ground for support. Depending upon fabric type, silt fences can have very high filtering efficiencies for sediments. Silt fences would be used below disturbed areas where erosion would occur in the form of sheet and rill erosion. Consequently, silt fences would be best suited for application in the large, flat tablelands currently used for agricultural practices.

Brush Barriers

Brush barriers are constructed of residual woody material (tree limbs, roots) and minor amounts of soil and rock generated from site clearing and grubbing operations. The material is pushed or dumped into windrows along the toe of the slope to intercept and retain sediment from disturbed areas. Once constructed, brush barriers need to be inspected and repaired after each rainfall. Accumulated sediment should be removed when it reaches one-half the height of the barrier.

Check Dams

Check dams are small temporary dams constructed of stone or rock, wood and/or logs, or metal. Check dams are used to reduce the velocity of concentrated storm water flows and accordingly, are placed in surface drainage routes and ditches. Check dams are used to control erosion. Although some trapping of sediments is possible, they are not recommended to be used as such.

Since the majority of the developable area within the Subwatershed is agricultural tableland, surface runoff tends to occur as broad, overland sheet flow. Therefore the use of check dams would be limited in application. Silt fences would be more beneficial; however, check dams could be utilized in ditches constructed to create an artificial drainage system for the conveyance of storm water to other sediment facilities such as sediment traps and basins.

Drainage Diversions

Drainage diversions are small dikes or earth cuts designed to divert site drainage away from exposed areas or to direct runoff to a sediment trap or pond. These types of diversions are very temporary measures, in place for only a few days, and should be applied to areas less than 2 ha.

Conveyance Channels

Conveyance channels lined with grass, stone or rip rap are used to safely convey excess runoff away from site areas. They are usually temporary measures, but could be permanent if constructed as part of the storm water drainage system (e.g. roadside ditch). Conveyance channels can be v-shaped ditches lined with grass for small volumes of water with low velocities, or parabolic or trapezoidal shaped to convey moderate to large volumes of water, in which case the channel should be lined with rip-rap or stone to prevent scouring and erosion. Grass-lined channels require re-seeding/sodding if scoured. Rip-rap or stoned-lined channels require periodic maintenance to check for scour and to replace any dislodged stones.

Storm Drain Inlet Protection

Storm drain inlet protection, also referred to as catchbasin controls, consist of an excavated ponding area or sediment filter around the storm sewer inlets. The purpose is to filter out sediment from the storm water prior to its discharge to the storm sewer. Numerous different configurations of inlet protection are possible. The most common generally consist of filter cloth and rip rap (or crush stone) placed around or on top of the catchbasin inlet.

Proper scheduling of inlet protection construction is essential, both during the progression of storm sewer installation and disturbance to the site area. Inlet protection requires routine inspection, repair and clean out after each rainfall event.

Vibration Pads

Vibration pads are temporary devices constructed of reinforced concrete, coarse stone or rip rap. The pads are a minimum of 150 mm thick and 15 m in length. The pads promote the removal of mud from construction vehicle tires and trap the sediment preventing it from being transported off site. Vibration pads should be constructed at each access point (entrance/exit) to the development sites.

7.7.3 Design Guidelines for Development

7.7.3.1 Site Drainage and Servicing Guidelines

To ensure the proper design of the on-site storm drainage system associated with new development adherence to the pertinent Municipal *Design & Construction Standards for Sewers, Watermains & Roads* should be maintained to ensure an adequate level of service, facilitate storm drainage and minimize on-site flooding impacts (such as flooding of buildings, roads and parking lots). Accordingly, the following points should be considered in the design of subdivision services.

i) Proper grading of the site properties and roadways should be ensured to provide a continuous flow path for the major system flows.

ii) Flow depths on the roadways should be checked (upon finalization of the grading plan) to ensure that vehicular access can be maintained and buildings are not flooded during severe storm events.

iii) Ponding depths in parking lot areas should be checked to ensure that nuisance flooding is avoided during frequent storm events.

Where possible, the principles governing the design of the major and minor systems should follow Provincial guidelines outlined in the *Urban Drainage Design Guidelines* (MNR, *et al.*, 1987c). Special consideration should be given to the major system drainage design into Pond 2 due to the larger drainage area, as compared to other facilities.

7.7.3.2 Storm Water Management Pond Guidelines

To ensure the successful implementation and general acceptance of the concept of the storm water management facilities, consideration must also be given to safety, aesthetics, maintenance and details of design.

To assist the development proponents and the Town of Halton Hills in the design, implementation and operation of these facilities, we provide the following points.

Sizing and Design

Where possible, pond sizing should be the same as those summarized in **Table 7.3**. The hydraulic operation should reflect the storage-discharge relationships established in **Appendix I**. Facility designs should follow the general design guidelines recommended in the MOEE's *"Storm Water Management Practices Planning and Design Manual"* (MOEE, 1994c). Accordingly, the following points should be considered.

i) A geotechnical investigation should be carried out at all locations to assess the suitability of the sites to accommodate a storm water management pond, particularly in regards to groundwater levels and slope stability concerns at adjacent valleylands.

ii) The end-of-pipe pond facilities should be treated as complementary landscape features, enhancing the adjacent natural features, parklands or the general landscape.

iii) Wet pond facilities located with Subwatersheds 3 and 4 should integrate features within the design to mitigate thermal impacts of discharges on the receiving waters (e.g., shading through perimeter plantings, bottom draw outlet, vegetated outlet swale upstream of receiving waterbody).

iv) A landscape plan should be prepared for each end-of-pipe facility. In addition to aesthetic reasons, shading provided by plantings around the facility will assist in minimizing warming of collected runoff temporarily detained in the facility.

v) A planting plan should be prepared for each end-of-pipe facility to complement and enhance its quality control functions. Plant species should be selected to meet the wide gradient in soil moisture conditions anticipated in and around the ponds.

vi) An access road to each end-of-pipe facility should be provided. In addition, a maintenance strip should be included around the perimeter of the pond to allow for maintenance and operational activities such as grass mowing and the removal of trapped debris.

vii) All end-of-pipe facilities should be constructed with a sediment forebay to trap larger particle near the inlet of the pond. In general, the sediment forebay should be no more than one third of the pond surface area and should have a minimum length to width ratio of 2:1.

viii) An access road extending into the sediment forebay should be incorporated into the pond side slopes to facilitate removal of accumulated sediment by mechanized equipment.

ix) Maximum side slopes for dry ponds should be 4:1 (horizontal to vertical).

x) Consideration for terraced grading (*i.e.*,, alternating sections of 7:1, 3:1, then 3:1) around the perimeter of the pond extending up from the water's edge of the permanent pool should be given based on accessibility, maintenance and safety considerations.

xi) All ponds should have a minimum length to width ratio of 3:1.

xii) All facilities should incorporate an adjustable outlet capacity (e.g., by incorporating a valve) to allow for operation adjustment and potential spill containment.

xiii) Public information initiatives should be undertaken to promote public awareness of the operational aspects, environmental objectives and safety awareness of the ponds.

xiv) During storm events, rapid fluctuations in water levels may occur which could pose some risk to public safety. Therefore, the ponds should not be viewed as recreational facilities, and activities other than passive uses should be discouraged. Often these type of facilities are enclosed by chain link fencing to prevent public access. Measures such as terraced grading, strategic plantings to restrict public access, warning signs and public awareness, are generally sufficient to provide a level of safety such that fencing is not required. In this regard, the Town of Halton Hills should consider the level of precaution required and assess the need for fencing.

<u>Construction Phasing</u>

The construction phasing and implementation of the end-of-pipe storm water management facilities is anticipated to proceed as follows. In instances where the storm water facility's service area essentially corresponds to the developer's boundary then the facility's design and construction would proceed concurrently and as part of the individual Draft Plan of Subdivision.

In instances where one or more developer wants to proceed and the storm water facility is located on another developer's land, the following options exist.

i) The proponent developer(s) could purchase the land or lease agreement to construct the facility.

ii) The Town of Halton Hills could purchase the land or establish a purchase-lease, construct the facility and then seek appropriate compensation from the developers via lot levies.

iii) The individual developer(s) wishing to proceed could construct a temporary facility on their own lands to subsequently treat the storm water on-site until development proceeded, necessitating the need for the regional facility to be built.

<u>Ownership</u>

All end-of-pipe facilities within the planning area, once constructed, will be assumed, maintained and operated by the Town of Halton Hills.

<u>Operation and Maintenance</u>

To ensure that the end-of-pipe storm water management facilities continue to operate as designed, the following points are provided to assist the Town in planning for the routine maintenance of the facilities. The points are general in nature recognizing that there will be slightly different maintenance requirements for each end-of-pipe facility depending upon whether it is an artificial wetland or wet pond. It is noted that wetponds are recommended for use throughout the 401 Corridor Planning Area.

i) Embankment side slopes should be mowed a minimum of 8-12 times per year.

ii) The pond should be inspected annually (during wet weather operation) to assess its performance and operation. Embankment stability, erosion, sediment and debris accumulation, and inlet clogging should be noted.

iii) Debris and litter, particularly floatable debris around the riser pipe should be removed.

iv) Incidence of embankment slumping and/or erosion should be remediated by regrading, revegetating and/or rip-rap placement.

v) Accumulated sediment previously deposited should be cleaned-out approximately once every 10 years (the exact frequency of clean-out is highly dependent upon the stability of the upstream drainage areas contributing suspended sediment to the pond and is best assessed through the annual inspections).

7.7.3.3 Guidelines for Storm Water Management Plans

Each development proponent should prepare a detailed Storm Water Management Report that discusses how storm water generated from the proposed Plan of Subdivision will be managed in accordance to the intent of the Subwatershed Plan. Likewise, any alterations to the urban storm water management strategy resulting from servicing difficulties/constraints identified during the detailed design stage should be discussed and rationalized in the Storm Water Management Report.

i) All new development proposals must prepare site specific storm water management reports that shall include:

- the proposed drainage scheme for the development;
- the proposed Storm Water Management Practices that will be incorporated into the system;
- the proposed methods for minimizing erosion and sedimentation during construction; and
- the compatibility of the proposed works with the Urban Storm Water Management Strategy.

ii) Information from secondary sources indicates that the majority of soils within the 401 Corridor Planning Area are not conducive to SWMPs that rely on infiltration. Widespread use of infiltration measures may be possible in areas within Subwatershed 3 and Subwatershed 4 (ultimate development areas below the escarpment, generally north of 5th Side Road and West of 4th Line), the headwaters of Subwatershed 5 (4th Line to Trafalgar Road extending to south 5th Side Road) and the southern portion of Subwatershed 6. In either case, as part of the initial site investigations for development proposals, exploratory field works should be conducted to determine site specific soil characteristics. Boreholes and/or test pits should be used to confirm the permeability of the native soils, subsoil conditions (*i.e.*, depth to bedrock, etc.) and identify site areas where infiltration techniques are possible. If the results support the use of infiltration techniques, then one or a combination of the measures recommended in Section 7.7 should be incorporated into the site drainage plan.

iii) Within the area of the basil aquifer, boreholes and/or test pits should be used to confirm the subsoil conditions to identify the extent of the aquifer and determine where protection measures are to be incorporated into the servicing design. Within the 401 Corridor Planning Area, the aquifer extends generally from the east limit of the Hornby Tributary valley to a midpoint between Fifth and Sixth Lines. In areas where proposed servicing (e.g., trenches, ponds) intersect with the aquifer or may influence discharge, mitigative measures should be adopted in the servicing design, e.g. the installation of clay plugs and/or linings to prevent interference with the existing aquifer functions.

iv) All storm sewers and internal drainage systems should be sized in accordance with the Town of Halton Hills design standards, without accounting for any flow attenuation achieved by on-site measures such as ponds, rooftop and/or parking lot storage.

v) A fundamental component of an urban drainage system is the provision of an adequate major system flow route. Therefore, attention must be given to proper grading of the roadways and the incorporation of flow easements where necessary to ensure a continuous flow route to a safe outlet. In this regard, consideration must be given to:

- maintaining the existing drainage pattern;
- providing a continuous overland flow route to a safe outlets;
- minimizing flow depths along roadways; and
- minimizing ponding depths in parking areas.

vi) To minimize the potential for flooding, erosion and environmental problems, every attempt should be made to preserve the existing drainage pattern.

vii) Due to the erosion sensitive nature of the valleylands, every effort should be made to minimize the number of storm sewer outlets. And, all outlets should be designed to minimize outlet velocities to non-erodible levels (*i.e.*, typically <1.0 m/s) and/or provide adequate protection measures for energy dissipation such as storm sewer headwalls with chute block aprons, gabion mats, rip-rap, etc.

viii) Concurrent with the preparation of individual storm water management plans is the preparation of an erosion and sedimentation control strategy for the construction phase of each development. Any site specific erosion problems should be identified in the storm water management report, together with appropriate remedial works. Section 7.7.2 of this Report presents and describes several suitable measures which can be drawn from to formulate a control plan.

ix) Storm water management is subject to the review and approval of several public agencies. Therefore, all storm water management plans/reports accompanying all individual development proposals should be circulated to the following agencies:

- Town of Halton Hills
- Ministry of Natural Resources
- Ministry of Environment and Energy
- Halton Region Conservation Authority
- Ministry of Transportation

x) Permits may be required for the construction of storm sewer outfalls under the HRCA's Fill Construction and Alteration to Waterways Regulation, the *Lakes and Rivers Improvement Act* (MNR), and *Ontario Water Resources Act* (MOEE).

8. IMPLEMENTATION STRATEGY

8.1 General

Section 7 comprises an overall Scoped Subwatershed Plan for the 401 Corridor Planning Area. The Plan which consists of several individual strategies identifies numerous environmental concerns, general principles and recommendations for restoring and protecting the area's natural resources.

This section presents the development of an Implementation Strategy designed to implement the recommended management strategies associated with the Scoped Subwatershed Plan. The objective is to develop a plan which will implement the study recommendations for Subwatershed Planning.

The recommended Implementation Strategy is presented in **Table 8.1**. The following sections discuss each of the following strategy components:

- Subwatershed plan strategy component and subcomponent;
- Agency responsible for implementation/operation and maintenance/monitoring;
- Implementation mechanism(s);
- Funding sources including cost-sharing;
- Schedule; and
- Monitoring.

These strategy components focus on requirements within the Sixteen Mile Creek subwatershed portion of the 401 Corridor. A separate Implementation Plan has been developed for the Mullett Creek subwatershed as part of the Gateway West Subwatershed Study. The reader is referred to this document for specific requirements relating to the Mullett Creek subwatershed, particularly, Environmental Implementation Report requirements intended to demonstrate conformance with the subwatershed recommendations.

8.1.1 Plan Component/Subcomponent

To maintain consistency and facilitate ease of implementation, the same recommended Subwatershed Plan components and subcomponents presented in Section 7 have been used to form the basis of the Implementation Strategy.

8.1.2 Implementation Agency

Agencies, associations and individuals responsible for implementation of the Plan recommendations are:

- Municipalities
  - Town of Halton Hills
  - Town of Milton
  - Regional Municipality of Halton
- Conservation Authorities
  - Halton Region Conservation Authority (Sixteen Mile Creek Watershed)
  - Credit Valley Conservation (Mullett Creek Subwatershed)
- Provincial Ministries
  - Ontario Ministry of Agriculture, Food and Rural Affairs
  - Ontario Ministry of Environment and Energy
  - Ontario Ministry of Municipal Affairs
  - Ontario Ministry of Natural Resources
- Federal Institutions
  - Department of Fisheries and Oceans
  - Department of the Environment
- Associations
  - Soil & Crop Improvement Association
  - Ontario Association of Farmers
- Public

Public Involvement

In order to develop a workable Implementation Plan, there must be continuous dialogue with the public to insure that the plan is not only accepted, but willingly adhered to. Although much of the Subwatershed Plan deals with issues such as land use planning and development servicing, which must be addressed at the Municipal level, the continued input of individuals and groups is vital to the effective incorporation of the agricultural and rural land use measures and certain aspects of the monitoring program. Many elements of these strategies are voluntary, and require the active participation of the public to achieve the desired results.

8.1.3 Implementation Mechanism(s)

Implementation mechanisms include the methods and measures by which the various plan components will be implemented.

They include: planning controls such as land use designations and bylaws identified in Secondary Plans; design/servicing options implemented through the preparation and review of subdivision and site plans; Municipal design guidelines, policies and initiatives; Provincial and Federal statutes, policies and initiatives; and Best Management Practices.

8.1.4 Funding Sources

Funding sources includes identification of proponents responsible for funding aspects of the Plan, including possible cost-sharing arrangements and assistance programs that could be used to share the financial responsibilities.

8.1.5 Scheduling

The Implementation Strategy recognizes that many aspects of the Scoped Subwatershed Plan will be phased in gradually over time. In many cases, components such as the Natural Hazard Land Strategy, and Natural Heritage and Environmental Protection which require amendments to Secondary Plans, are expected to occur rapidly. Components such as Urban Storm Water Management will occur only when land development proceeds.

8.1.6 Monitoring

Successful implementation of the Scoped Subwatershed Plan will require monitoring of many of the implementation components to ensure that the goals and objectives of the Plan are being achieved. In the case of the Mullett Creek Subwatershed drainage area, recommendations of the Gateway West Subwatershed Study should be followed. Recommendations for monitoring within the Sixteen Mile Creek Watershed areas are provided below.

The monitoring program involves the collection, interpretation and assessment of observations, field measurements, biotic sampling and analytical analyses of different facets of the environment, which can be used as indicators of the health or status of the Subwatershed resources. Monitoring includes both seasonal, annual or long-term assessments as well as periodic re-evaluations of the overall Scoped Subwatershed Plan.

Monitoring of the Scoped Subwatersheds is required to:

- Supplement and extend the existing Subwatershed database beyond the 401 Corridor Planning Area in order to fill in data gaps, deficiencies, confirm/establish trends relating to the overall health of the ecosystem, and complete/progress the understanding of the hydrologic (surface and groundwater interactions) and ecological functions.

- Allow for the continued examination of the health/resiliency of the ecosystem using the present Subwatershed data as a baseline for comparative assessment. This will facilitate assessments of land use change (*e.g.* development), rehabilitative/restoration measures (*e.g.* reforestation, stream rehabilitation), and the operational performance of SWMPs (*e.g.*, wet ponds, etc.) in order to adopt new technologies as they arise.

- Provide the quantitative and qualitative means to measure/assess how well the Scoped Subwatershed goals and objectives are being achieved by identifying which environmental targets are being met.

Data collection and education are equally important to the success of the monitoring program. Where possible, public input should be solicited and incorporated into the monitoring database.

Information should be compiled by one lead agency. The Halton Region Conservation Authority is recommended for this role (Sixteen Mile Creek Watershed lands), given their extensive local knowledge. Monitoring reports should be compiled and updated periodically and the results disseminated to the municipalities and pertinent agencies including MNR, MOEE and OMAFRA. As the HRCA has limited staff to assist in this regard, an agreement between the Town and the HRCA should be arranged with respect to financing.

The recommended monitoring program, its various elements and parameters to be monitored is discussed below. The program consists of a wide variety of parameters, many of which can be monitored at different levels of detail, and at different frequencies. In many instances, only certain parameters may need to be monitored to give insight into the environmental health of the Subwatershed.

For example, sampling of the aquatic community (*e.g.* benthos and fish) may provide a more economical means to appraise the overall ecosystem health than an extended program of water chemistry sampling. Then, if the aquatic community indicates a problem, additional, more detailed sampling (*i.e.*, water chemistry, stream morphology) could be initiated to pinpoint the problem.

This Study recognizes that, in many instances, financial and personnel constraints may limit the actual scope of the monitoring program that is implemented. The following outlines the proposed monitoring programs:

Water Quality

- Perform water chemistry sampling 2-3 times every 3 years at instream sampling locations, between April and November, for both wet and dry weather events.

- Water chemistry sampling should include a range of typical PWQOs including temperature, pH, turbidity, bacteria, dissolved oxygen, nutrients and metals, as well as less common parameters such as chlorophyll a and soluble reactive phosphorous (SRP).

Aquatic Resources

- Assessments of the fish community would be completed every 3 years at four stations on the main tributaries of Sixteen Mile Creek.

- Establish surveyed cross-section sites prior to and following restoration works to chart long-term stability of dynamic equilibrium processes. Sections surveyed as part of this study may be used as pre-restoration data. The stream monitoring would include the evaluation of stream behaviour and characteristics such as bankfull depth, bankfull width, reach slope, bed materials, etc.

- Benthic-invertebrate communities would be assessed in the spring every 3 years at four locations on the main tributaries of Sixteen Mile Creek. The benthos-sampling sites would correspond to the fish inventory sites as well as water quality monitoring locations where feasible. All collections would be completed using methods similar to this study to allow for direct comparison between studies.

- Conduct stream morphology stability assessments at surveyed cross-section sites including the identification of active erosion sites along Sixteen Mile Creek and its tributaries; follow-up monitoring of erosion sites and any remediation works should occur every 3-5 years thereafter.

Terrestrial Resources

- Compare general changes to woodland area and natural corridors every 5 years using updated aerial photographs and/or advanced satellite imagery.
- Maintain a record of features or species of concern.
- Encourage and co-ordinate (by the HRCA) public involvement of individuals and local naturalists clubs. This would include public observations of human impacts on terrestrial ecosystem such as dredging/filling of ravine gulleys or floodplains, stream shoreline alterations or tree removals, as well as natural impacts such as bank slumping or streambank erosion.

Streamflows

- Periodically estimate streamflows (baseflows) at locations throughout the Subwatersheds using current meters (electronic or mechanical) to measure streamflow velocities and cross-sectional data (surveyed or estimated) to measure flow area. This data is required for identification of sensitive baseflow watercourses.

Surface and Groundwater Supply

- Initiate a Scoped Subwatershed-specific database of surface water-taking permits through the Region in cooperation with the MOEE (and their administrative role in Section 20 of the *Ontario Water Act*) as a means to monitor the types and quantities of water usage within the Scoped Subwatershed.
- Initiate a Subwatershed-specific database of private (septic) sewage systems through the Region in cooperation with the local health unit (as part of their partnership with MOEE and their administrative role in reviewing Certificate of Approval - Private Septic Systems) as a means to monitor the types and numbers of domestic systems in the Scoped Subwatershed.

Storm Water Management Facilities: Pilot Project

- Consider monitoring of a planned storm water (end-of-pipe) facility (*e.g.* artificial wetland or wet pond) as a pilot project to assess its operational performance with regard to urban storm water control/treatment.

  Ideally, monitoring would take place over a period of 2 to 3 years and consist of:

  - continuous measurements of rainfall depth, surface runoff flows entering and discharging from the facility, and water levels in the facility for a minimum of 5 storm events/yr;

  - flow weighted water quality chemistry sampling of urban storm water runoff entering the facility, in the facility (if applicable) and discharging from the facility for a minimum of 5 storm events/yr;

  - water chemistry sampling should include a range of typical PWQOs for urban storm water including temperature, dissolved solids, turbidity, bacteria, dissolved oxygen, nutrients, metals, alkalinity and hardness, and conductivity (Urbonas, 1995);

  - sediment quality sampling for contaminants and particle size distribution of accumulated sediments deposited in the facility, once per year;

  - flora and fauna community mapping (where wetland component is included) should be done annually.

Storm Water Management Facilities: Routine Maintenance

- Maintain monitoring of all storm water management facilities to ensure proper operation. Once assumed, each Municipality would be responsible for the following:

  - removal of trash, floatable debris and blockages (as required);
  - cleanout of deposited sediments (once every 10-15 years);
  - adjustment/maintenance of inlet and outlet control structures (once every 2-3 years);
  - vegetative (re)planting (as required) and grass cutting (as required) for dry ponds;
  - repair of inlet/outlet scouring and/or embankment erosion (as required)

Table 8.1 - Recommended Implementation Strategy

Strategy Component	Subcomponent	Management Measures	Lead Agency (Support Agency)	Implementation Mechanism(s)	Funding Responsibility (Possible Cost Sharing)	Schedule
Hazard Land Management	Natural Hazards: Flooding and Streambank Erosion	Secondary Plan policies and land use designations to prohibit/restrict development in Hazardous Lands adjacent to river and stream systems which are impacted by flooding and/or erosion hazards, and permit development subject to conditions in areas defined as less hazardous.	HRCA (MNR, Municipalities) Municipalities (HRCA)	Identify hazardous lands as Hazard Prone Areas within land use schedules. Development charges for areas within subwatershed	HRCA & Municipalities (MNR) where necessary, developer/proponent, where required. Municipalities (HRCA).	Existing flood line mapping and flood line mapping completed during this study. Secondary Plan policies and land use designations to be completed in 1999-2000. Following collection of development charges.
	Man-made Hazards: Illicit Waste Disposal, Uncontrolled Fill	Secondary Plan policies and land use designations to require that contaminated sites be restored (*i.e.*, mitigated) prior to any activity on the site.	Municipalities (HRCA)	Delineate man-made hazards as Special Policy Areas within OP land use schedules.	Municipalities where necessary, developer/proponent, where required.	Secondary Plan policies and land use designations to be completed in 1999. Scheduling of site restoration will be on an *as required* basis pending Municipal initiatives or developer/proponent needs.
Natural Heritage and Environmental Protection	Protection of Significant Natural Heritage Features and Ecological Functions	Secondary Plan policies and land use designations to prohibit incompatible development in Category 1 areas and limit development subject to conditions in Category 2 areas.	Municipalities (MNR)	Designate Natural Heritage Lands in OP land use schedules. Specify in policy that: • No development land use designations for Category 1 areas. • Development subject to conditions land use designations (*i.e.*, EISs) for Category 2 areas and possibly, adjacent areas.	Municipalities where necessary, developer/proponent, where required.	Secondary Plan policies and land use designations to be completed in 1999-2000. Scheduling of EISs will be on an *as required* basis pending developer/proponent need to respond to Municipal/HRCA/CVC requirements.
Water Quality and Quantity Management	Surface Water Quality and Quantity	Agricultural/rural/urban BMPs (*e.g.*, street sweeping, house keeping measures, etc.) and urban SWMPs to manage runoff. Maintain existing hydrologic regime, surface water drainage patterns, and regulate surface water withdrawals.	Municipalities & HRCA/CVC (MOEE, OMAFRA)	Subwatershed watch programs co-ordinated by Municipality and HRCA/CVC that emphasize landowner, community groups and associations involvement, participation and incorporation of urban/rural BMPs.	Municipalities, community groups or associations.	Ongoing (long-term)
	Groundwater Quality and Quantity	Agricultural/rural BMPs for the safe storage and application of pesticides, fertilizers and manure near potable sources of water, wells and recharge areas. Protect groundwater discharge zones, flow patterns, and regulate groundwater withdrawals.	HRCA/CVC & Municipalities (MOEE & OMAFRA)	Preparation and submission of Storm Water Management Plans, or Env. Implementation Reports for new development. OMAFRA/HRCA/CVC/MNR staff to provide educational, technical assistance to farmers and rural community emphasizing principles of land stewardship.	Developer/proponent for construction of SWM facilities, Individual farmers and landowners (HRCA/CVC, OMAFRA, MNR and MOEE supported assistance programs).	Ongoing (long-term), scheduling based on timing requirements of individual development proposals. Ongoing (long-term)
Rehabilitation and Restoration Measures	Reforestation, Natural Corridor and Terrestrial Habitat Restoration	Vegetative plantings and reforestation along Category 2 natural corridor areas, block regeneration on retired or marginal land, area regeneration within Adjacent Lands of Category 1 and 2 areas, naturalization of existing parks and green spaces, habitat improvement (upland woodlot and hedgerow preservation/integration/establishment, removal of non-natives), wetland creation. Improved forest management methods.	MNR & HRCA (Municipalities)	Regeneration and management plans prepared to target priority areas. Planting to be co-ordinated by HRCA/MNR programs emphasizing landowner, community group and associations, involvement and participation. Education campaigns and tax incentives for improved forest management. Hedgerow/tree preservation strategy to be completed as part of subdivision/site plan approval submissions.	Municipalities, HRCA, MNR, OMAFRA, developer/proponent landowner, community group or associations.	Ongoing (long-term), individual development proposals (i.e., site plan, subdivision plan submissions).
	Stream and Aquatic Habitat Restoration	Streambank stabilization, channel morphology improvements, streambank plantings, restricted livestock access, removal of fish barriers, creation of pool and riffle areas, habitat enhancement.	MNR & HRCA (DFO, DOE, Municipalities)	Rehabilitation plans prepared to target priority areas. Channel stabilization and planting to be co-ordinated by HRCA/MNR programs emphasizing landowner, community group and associations, involvement and participation. DFO authorization as required.	Municipalities, HRCA, MNR, OMAFRA, DFO, developer/proponent landowner, community group or associations.	Ongoing (long-term), scheduling based on timing requirements of
Agricultural and Rural Land Use Management	Agricultural and Rural Land Stewardship	Land stewardship through preparation of Environmental Farm Plans and landowner initiatives to incorporate agricultural/rural BMPs for soil conservation, chemical management, waste management, forestry and habitat management.	HRCA/CVC (OMAFRA, MNR, MOEE)	OMAFRA/HRCA/CVC/MNR staff to provide educational, technical assistance to farmers and rural community emphasizing principles of land stewardship.	Individual farmers and landowners (HRCA/CVC, OMAFRA, MNR and MOEE supported assistance programs).	Ongoing (long-term)
Urban Storm Water Management	Stormwater Management Practices	**Lot Level Controls** (*e.g.*, reduced lot grading, ponding areas, soak away pits). **Storm Water Conveyance Controls** (*e.g.*, grassed swales, catchbasin modification). **End-of-Pipe-Controls** (*e.g.*, artificial wetlands, wet ponds, dry ponds, infiltration trenches, buffer strips, oil/grit separators).	Municipalities (HRCA/CVC, MNR, MOEE) through plan review process	Preparation and submission of Storm Water Management Plans in conformance with Subwatershed Plan. SWM Plans to adhere to MOEE/MNR manual of practice, Town and HRCA/CVC standards and guideline requirements.	Developer/proponent	Ongoing (mid to long-term), scheduling based on timing requirements of individual development proposals.
	Erosion and Sediment Control	Erosion and Sediment Control Plans incorporating site control measures (*e.g.*, silt fences, sediment traps, check dams, etc.) to minimize surficial erosion during construction.	Municipalities (HRCA/CVC, MNR, MOEE) through plan review process	Preparation and submission of Erosion and Sediment Control Plans that accompany Storm Water Management Plans.	Developer/proponent	Ongoing (long-term), scheduling based on timing requirements of individual development proposals.

Note:

- Municipalities refers to the Town of Halton Hills, Town of Milton and the Region of Halton.
- DFO refers to Department of Fisheries and Oceans.
- DOE refers to Department of the Environment.
- HRCA refers to the Halton Region Conservation Authority (Sixteen Mile Creek Watershed jurisdiction)
- CVC refers to Credit Valley Conservation (Credit River Watershed jurisdiction) (note: no flood hazard/erosion hazard/significant natural heritage/fisheries features identified) (Refer to Gateway West Subwatershed Study for additional requirements by CVC and City of Brampton - Environmental Implementation Report)
- MOEE refers to Ministry of Environment and Energy.
- MNR refers to Ministry of Natural Resources.
- OMAFRA refers to Ministry of Agriculture, Food and Rural Affairs.

APPENDIX A

GEOMORPHOLOGIC FIELD INVESTIGATION SUMMARY

401 CORRIDOR INTEGRATED PLANNING PROJECT
SCOPED WATERSHED STUDIES
TOWN OF HALTON HILLS

Halton Hills: Reach A - Middle Sixteen Mile Creek
Fluvial Geomorphology Summary

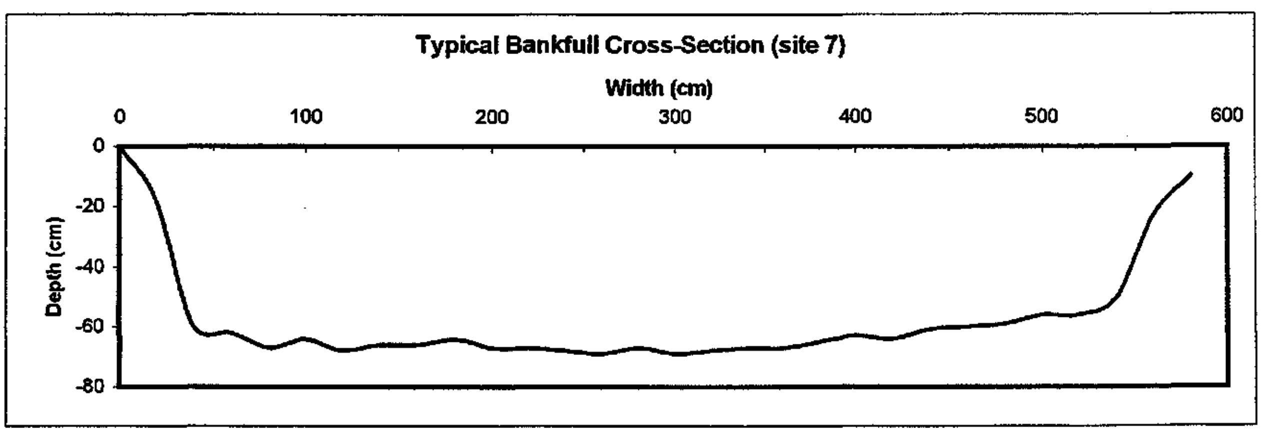
Location: Downstream of Steeles Ave. ~ midway between 5th and 6th line
Number of cross-sections: 10
Date of Survey: November 17, 1998
Channel Length Surveyed: 242.5 m

Controlling Factors
Upstream Drainage Area: 52.3 km^2
Geology / Soils: The surficial geology through which this tributary flows is characterized as glacio-lacustrine. Typically, this material consists of silt, clay and other quiet-water deposits

Modifying Factors
Surrounding Land Use: scrubland and pasture
General Riparian Vegetation: grasses and herbs
Existing Channel Disturbances: bridge, pipe runs down bank+D21
Woody Debris: none

Cross-Sectional Characteristics

	Range	Average
Bankfull Width (m)	5.73 - 8.62	6.44
Bankfull Depth (m)	0.40 - 0.64	0.55
Width / Depth	9.22 - 14.86	11.77
Wetted Width (m)	3.91 - 6.49	5.06
Water Depth (m)	0.11 - 0.39	0.21
Width / Depth	10.49 - 54.08	28.92
Entrenchment (m)	12.54 - 86.91	29.39
Entrenchment Ratio	1.70 - 12.58	4.56
Manning's n		0.038



Hydrology

Measured	**Discharge (cms)**	
Calculated	**Bankfull Flow (cms)**	4.25
	Bankfull Vel (m/s)	1.20
Modelled	**2 year flow (cms)**	

Bank Characteristics

	Range	Average
Bank Height (m)	0.6 - 4.0	1.46
Bank Angle (degrees)	27 - 75	50.05
Root Depth (cm)	4 - 60	17
Amount of undercut (cm)	5.0 - 27.0	11.43
Banks with undercuts (%)		70%

Materials

Torvane values (kg/cm2)	
cl	5.7
*cl/si	3.3
*cl/fs/si	2.8
ms/fs	1.65

Grain Size Analysis (cm):
(Left bank at cross-section 3)

D10	0.00025
D50	0.00575
D90	0.0237

* = dominant material

Planform Characteristics

Long Profile (avg)

Bankfull Gradient	0.46	%
Inter-Pool Gradient	0.40	%
Inter-Riffle Gradient	0.45	%
Riffle Gradient	2.33	%
Riffle Length	5.8	m
Riffle-Pool Spacing	12.5	m
Max Pool Depth	1.01	m

Meander Geometry (avg)

Belt Width	95 m
Radius of Curvature	44 m
Amplitude	30 m
Wavelength	250 m
Sinuosity	1.09

Substrate Characteristics

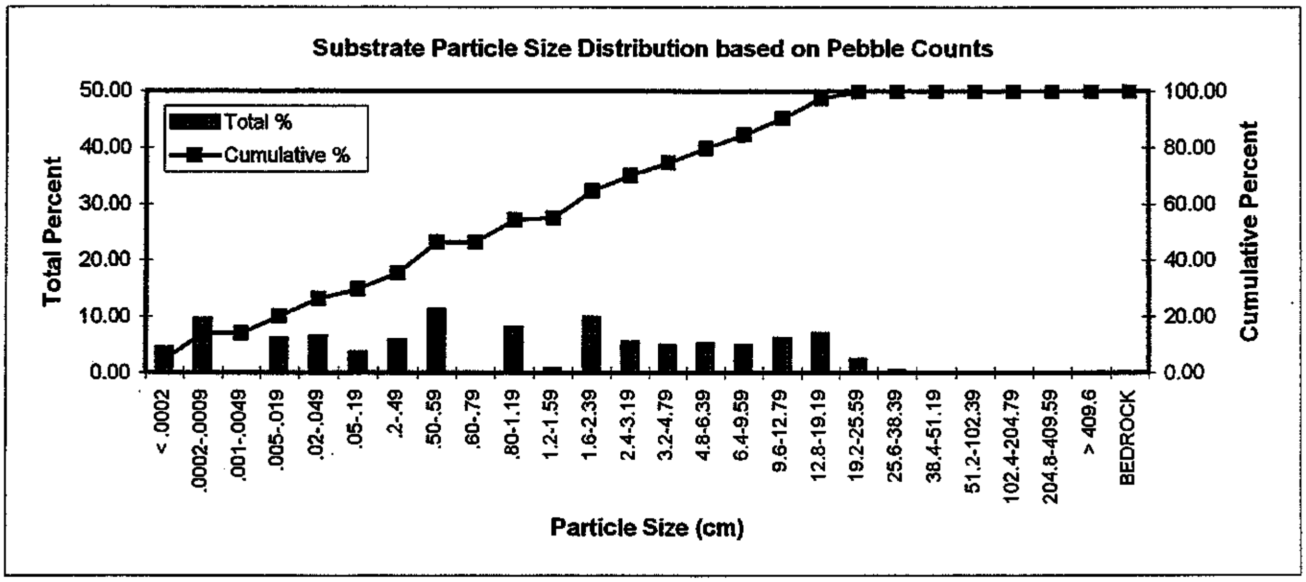
		Range	Average
Particle Shape (cm)			
	X	3.0 - 40.0	15.85
	Y	2.0 - 30.0	11.57
	Z	0.25 - 21.0	5.62
Hydraulic Roughness (cm)			
	Maximum	1.0 - 21.0	13.4
	Median	0 - 8.0	3.15
	Minimum	0 - 1.0	0.3
Embeddedness (%)		40 -100	75

Sub-pavement

Part. Size	**% of subpavement on site**	**Part. Size**	**% of subpavement on site**
cl	11	**P**	12
si	6	**1 cm**	13
vfs	0	**2 cm**	5
fs	7	**3 cm**	6
ms	12	**4 cm**	0
cs	11	**5 cm**	4
vcs	13	**6 cm**	0

Substrate Particle Sizes (cm)

	Pebble Counts	Grain Size Analysis (cross-section 3)
D10	0.0006	0.08
D50	0.98	1.80
D90	12.5	9.37



Historical Air Photo Analysis — Based on an examination of 1954 and 1979 air photos

migration rate: likely some migration - calculated rate = 0.58 m/yr but this is subject to measurement error

channel changes: * no changes have been observed, though measurements of channel length suggest that there has been a slight increase in length
* it is unclear if the channel has been straightened in the lower part of the reach - photocopy may be obscurring the river flow near the road.

Interpretation: * surrounding landuse is agriculture

Channel Thresholds

Flow Competency	0.56 m/s for D50 = 0.98 cm
Tractive Force	24.54 Nm^{-2}
Critical Shear	9.50 Nm^{-2}
Critical Depth	0.21 m
Critical Velocity	0.04 ms^{-1}
Erosion Potential	18.05 N/ms
Stream Power	190 W/m

Interpretation

* during bankfull discharge events, sediment smaller than 2.5 cm will be entrained
* the erosion potential in the reach is small
* long profile of the channel shows that there are 2 different trends. The lower reach is less s steep than the upper reach suggesting that there may be some type of base level control?
* in general, sense that deposition occurs in the lower reach while the upper is in relative equilibrium.
* bank slumping observed along the reach
* will have sediment transport occurring since the Dbf is ~ 1/2 of Dc
* erosion potential and stream power are small but I do think that transport will occur
* the surficial geology of the area seems to reflect the substrate material fairly well as well as the banks

401 CORRIDOR INTEGRATED PLANNING PROJECT
SCOPED WATERSHED STUDIES
TOWN OF HALTON HILLS

Halton Hills: Reach B - Middle Sixteen Mile Creek
Fluvial Geomorphology Summary

Location:	Downstream of Steeles Ave, ~ midway between 6th line and Hornby Rd.
Number of cross-sections:	10
Date of Survey:	November 18, 1998
Cnannel Length Surveyed:	255 m

Controlling Factors

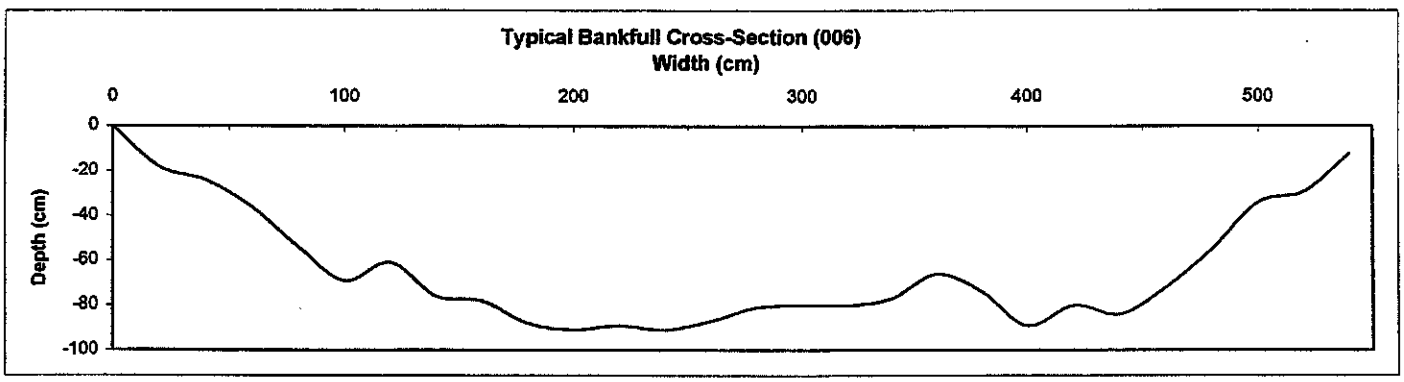
Upstream Drainage Area:	40.61 km^2
Geology / Soils:	The surficial geology through which this tributary flows is characterized as glacio-lacustrine. Typically, this material consists of silt, clay and other quiet-water deposits

Modifying Factors

Surrounding Land Use:	scrubland, park, road
General Riparian Vegetation:	grasses, herbs and trees
Existing Channel Disturbances:	road
Woody Debris:	minimal

Cross-Sectional Characteristics

	Range	Average
Bankfull Width (m)	4.75 - 6.87	5.48
Bankfull Depth (m)	0.45 - 0.66	0.54
Width / Depth	8.45 - 13.71	10.31
Wetted Width (m)	3.41 - 4.65	3.96
Water Depth (m)	0.07 - 0.32	0.21
Width / Depth	13.11 - 63.86	23.04
Entrenchment (m)	9.12 - 21.58	11.83
Entrenchment Ratio	1.51 - 3.87	2.12
Manning's n		0.053



Hydrology

Measured	**Discharge (cms)**	0.081
Calculated	**Bankfull Flow (cms)**	2.31
	Bankfull Vel (m/s)	0.78
Modelled	**2 year flow (cms)**	

Bank Characteristics

	Range	Average
Bank Height (m)	1.1 - 4.0	1.71
Bank Angle (degrees)	22 - 72	40
Root Depth (cm)	4.0 - 18	10.67
Amount of undercut (cm)	4.0 - 17	10.29
Banks with undercuts (%)		35%

Materials	**Torvane values (kg/cm2)**
si/ms	1.3
*ms/si/fs	1.55
si/fs	2.9

Grain Size Analysis (cm):
(Left bank, cross-section 4)

D10	0.0009
D50	0.0062
D90	0.0248

* = dominant material

Planform Characteristics

Long Profile (avg)

Bankfull Gradient	0.39	%
Inter-Pool Gradient	0.52	%
Inter-Riffle Gradient	0.52	%
Riffle Gradient	7.75	%
Riffle Length	3.5	m
Riffle-Pool Spacing	20.64	m
Max Pool Depth	1.2	m

Meander Geometry (avg)

Belt Width	80 m
Radius of Curvature	35 m
Amplitude	14.3 m
Wavelength	120 m
Sinuosity	1.13

Substrate Characteristics

Particle Shape (cm)		Range	Average
	X	15 - 56	32.43
	Y	11.0 - 34.0	21.68
	Z	6.0 - 27.0	13.83
Hydraulic Roughness (cm)			
	Maximum	22.0 - 45.0	29.5
	Median	6.0 - 20.0	9.9
	Minimum	0 - 1.0	0.45
Embeddedness (%)		30 - 90	59.5

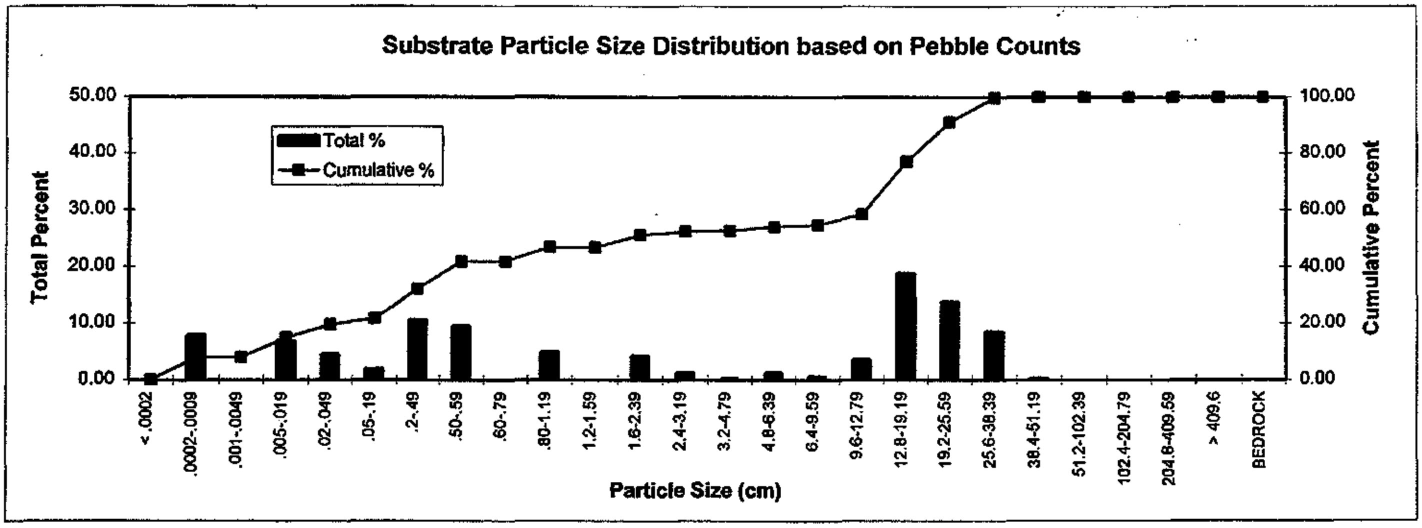
Sub-pavement

Part. Size	**% of subpavement on site**
cl	0
si	12.4
vfs	1
fs	13
ms	16.3
cs	9.3

Part. Size	**% of subpavement on site**
vcs	22
P	14
1 cm	8.3
2 cm	2
3 cm	1.7

Substrate Particle Sizes (cm)

	Pebble Counts	**Grain Size Analysis** (cross-section 8)
D10	0.0091	0.05
D50	2.21	0.27
D90	25.10	2.49



Historical Air Photo Analysis Based on an examination of 1954 and 1979 air photos

migration rate: * some migration has been quantified (0.45 m/yr) but this value is subject to measurement error

channel changes:

* some deposition in meander bend was observed

Interpretation: * the area surrounding the channel was densely forested in 1954, but became sparse by 1979. The creation of parkland accounts for the deforestation observed

Channel Thresholds

Flow Competency	0.56 m/s for D50 = 2.21cm
Tractive Force	20.65 Nm^{-2}
Critical Shear	9.50 Nm^{-2}
Critical Depth	0.25 m
Critical Velocity	0.03 ms^{-1}
Erosion Potential	8.72 N/ms
Stream Power	89 W/m

Interpretation

* during bankfull discharge events, sediment smaller than 2.1 cm will be entrained
* both the erosion potential and stream power are small, suggesting that erosion is not a dominant process in the channel.
* bankfull gradient is smaller than the interpool gradient suggesting that erosion of the bed morphology does occur and is part of a longer term process
* the grain size that can be entrained during bankfull discharge is similar to the D50 that was found in the grain-size distribution
* the longitudinal profile of the channel seems to have a slight concave up profile with an extended downstream limb suggesting that there may be a control at the end of the reach/river - have a rather deep pool at the downstream end of the reach
* there are cobbles in the bank materials - till this will affect the grain size distribution of the substrate and may lead to armouring of the bed
* both the substrate and bank material do not necessarily reflect the surficial geology that characterizes this area (glaciolacustrine). The reach is situated close to the boundary between Halton Till and the glaciolacustrine deposits, potentially accounting for the large-size fraction of clasts that are in the substrate materials.
* depending on the position of the deposit to the inflowing stream (glacial) it is possible that the coarse material may be a deposit near the mouth of the river - somewhat of a deltaic deposit then

401 CORRIDOR INTEGRATED PLANNING PROJECT
SCOPED WATERSHED STUDIES
TOWN OF HALTON HILLS

Halton Hills: Reach C - Middle Sixteen Mile Creek
Fluvial Geomorphology Summary

Location:	Downstream of Steeles Ave., S. of Hornby Rd.
Number of cross-sections:	10
Date of Survey:	November 13, 1998
Cnannel Length Surveyed:	193.5 m

Controlling Factors

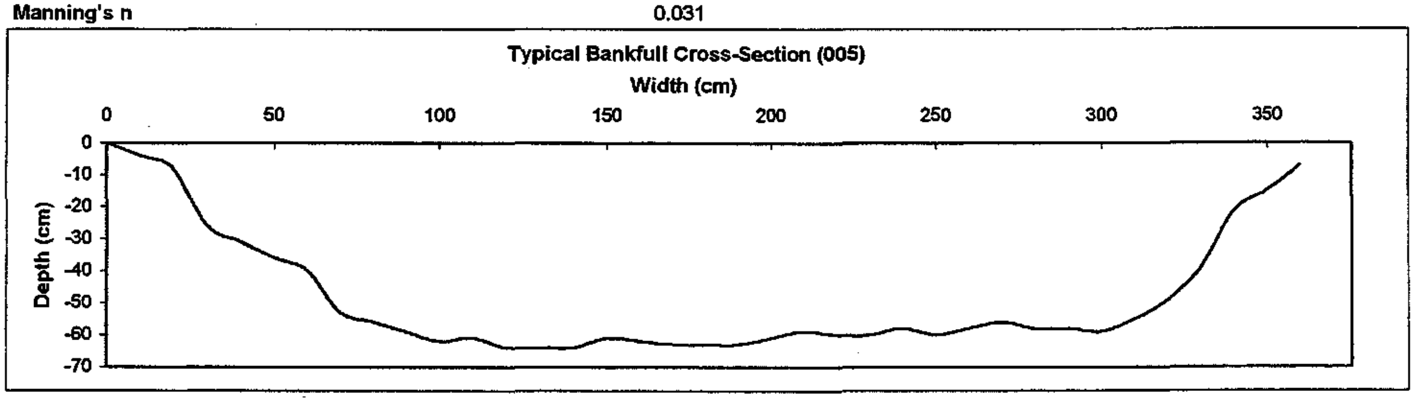
Upstream Drainage Area:	10.02 km^2
Geology / Soils:	The surficial geology through which this tributary flows is characterized as consisting of Halton Till. Typically, this material consists of silt, clay and other quiet-water deposits

Modifying Factors

Surrounding Land Use:	scrubland
General Riparian Vegetation:	grasses and herbs, sparse trees
Existing Channel Disturbances:	none
Woody Debris:	some overhanging trees

Cross-Sectional Characteristics

	Range	Average
Bankfull Width (m)	2.54 - 4.78	3.43
Bankfull Depth (m)	0.29 - 0.56	0.45
Width / Depth	5.18 - 12.93	7.85
Wetted Width (m)	1.30 - 2.92	2.16
Water Depth (m)	0.05 - 0.32	0.17
Width / Depth	8.67 - 55.0	16.98
Entrenchment (m)	8.18 - 62.77	32.13
Entrenchment Ratio	2.57 - 24.62	10.27
Manning's n		0.031



Hydrology

Measured	**Discharge**	0.016
Calculated	**Bankfull Flow (cms)**	2.18
	Bankfull Vel (m/s)	1.41
Modelled	**2 year flow (cms)**	

Bank Characteristics

	Range	Average
Bank Height (m)	0.60 - 1.20	0.86
Bank Angle (degrees)	21.0 - 72.0	47.93
Root Depth (cm)	10.0 - 45.0	20
Amount of undercut (cm)	5.0 - 31.0	12.42
Banks with undercuts (%)		60%

Materials	Torvane values (kg/cm2)
cl/si	3.07
*ms/si/cl/fs	2.50
vcs/si/fs	1.75
si/fs	1.60

Grain Size Analysis (cm):
(Right bank, cross-section 1)

D10	0.00045
D50	0.0042
D90	0.0283

* = dominant material

Planform Characteristics

Long Profile (avg)		
Bankfull Gradient	0.56	%
Inter-Pool Gradient	0.67	%
Inter-Riffle Gradient	0.48	%
Riffle Gradient	4.30	%
Riffle Length	4	m
Riffle-Pool Spacing	7.04	m
Max Pool Depth	0.94	m

Meander Geometry (avg)	
Belt Width	60 m
Radius of Curvature	19 m
Amplitude	10.5 m
Wavelength	40 m
Sinuosity	1.15

Substrate Characteristics

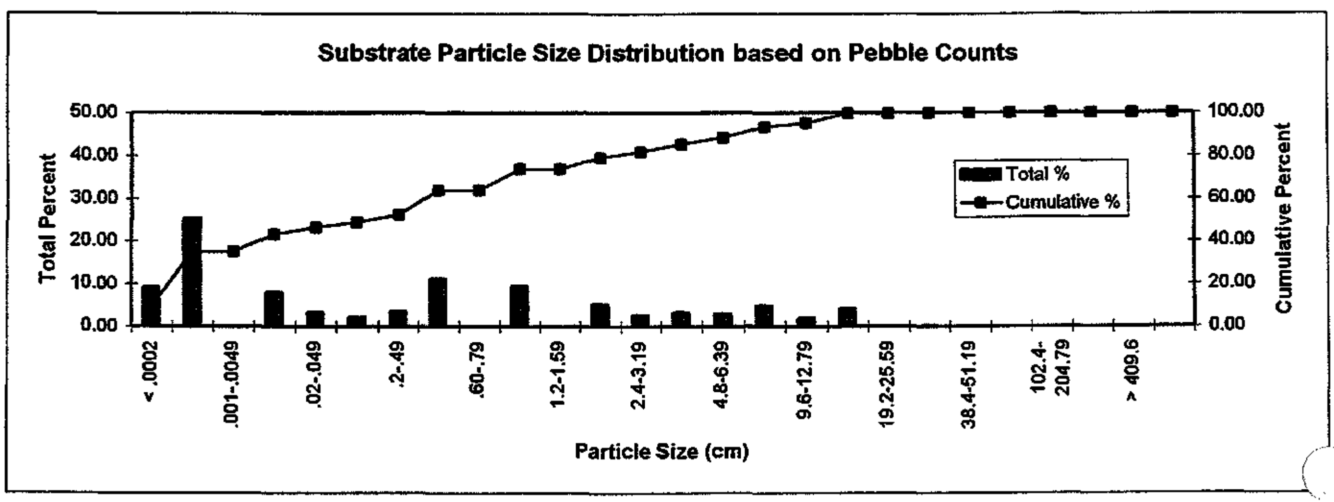
		Range	Average
Particle Shape (cm)			
	X	1.0 - 21.0	8.84
	Y	1.0 - 16.0	6.59
	Z	0.25 - 12.0	3.38
Hydraulic Roughness (cm)			
	Maximum	0.5 - 17.0	8.35
	Median	0 - 6.0	1.88
	Minimum	0 - 0.5	0.05
Embeddedness (%)		40 - 100	80

Sub-pavement

Part. Size	% of subpavement on site	Part. Size	% of subpavement on site
cl	19.3	vcs	5.3
si	18.3	P	8
vfs	0	1 cm	10.3
fs	11	2 cm	4.7
ms	5.5	3 cm	6.3
cs	11.3		

Substrate Particle Sizes (cm)

	Pebble Counts	Grain Size Analysis (cross-section 8)
D10	0.0002	0.13
D50	0.297	0.93
D90	7.45	4.02



Historical Air Photo Analysis	Based on an examination of 1954 and 1979 photos
migration rate:	* the migration rate is very small (measured to be 0.12 m/yr, but this figure is subject to measurement errors
channel changes:	* several meanders have developed within the reach * the length of the channel has increased between 1954 and 1979, a consequence of the increase in sinuosity from the development of meanders
Interpretation:	* dominant landuse is agriculture, this has not changes between 1954 and 1979

Channel Thresholds

Flow Competency	0.33 m/s for D50 = 0.30 cm	
Tractive Force	29.57 Nm^{-2}	
Critical Shear	2.88 Nm^{-2}	for D50
Critical Depth	0.05 m	
Critical Velocity	0.34 ms^{-1}	
Erosion Potential	37.67 N/ms	
Stream Power	119 W/m	

Interpretation

*during bankfull discharge events, sediment smaller than 3 cm will be entrained
* within this reach, calculations of the stream power and erosion potential indicate that there is excess energy available for erosion during bankfull discharge events
* the critical depth for entrainment is small, likely due to the large silt component in the substrate materials.
Comment on erosion potential, long profile insight, comparison between Dc and Dbf Vc and Vbf
* bankfull gradient is less than the inter-pool gradient, suggesting that the general trend in the reach is that of erosion
* undercutting and bank failure is observed throughout the reach
* the bed morphology appears to have steps rather than just riffles.

401 CORRIDOR INTEGRATED PLANNING PROJECT
SCOPED WATERSHED STUDIES
TOWN OF HALTON HILLS

Halton Hills: Reach D - Middle Sixteen Mile Creek
Fluvial Geomorphology Summary

Location:	Downstream of Steeles Ave., just east of Eighth Line
Number of cross-sections:	10
Date of Survey:	November 19, 1998
Channel Length Surveyed:	219 m

Controlling Factors

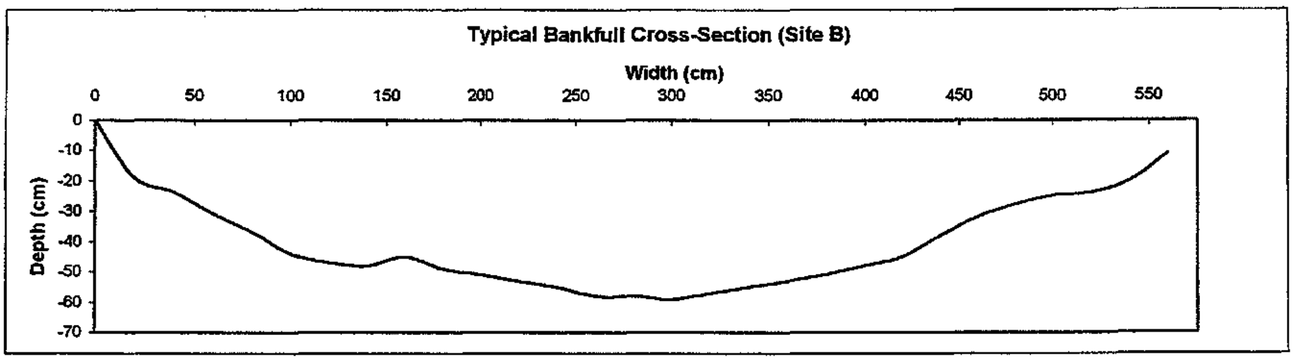
Upstream Drainage Area:	19.72 km^2
Geology / Soils:	The surficial geology through which this tributary flows is characterized as consisting of Halton Till. Typically, this material consists of silt, clay and other quiet-water deposits

Modifying Factors

Surrounding Land Use:	Decidious Forest
General Riparian Vegetation:	grasses and herbs, trees
Existing Channel Disturbances:	culvert upstrean of transect 8 and roadway
Woody Debris:	overhanging and in channel throughout the reach

Cross-Sectional Characteristics

	Range	Average
Bankfull Width (m)	5.42 - 12.35	7.69
Bankfull Depth (m)	0.35 - 0.55	0.44
Width / Depth	12.62 - 32.50	17.45
Wetted Width (m)	1.25 - 7.12	3.62
Water Depth (m)	0.05 - 0.30	0.16
Width / Depth	10.47 - 52.0	25.94
Entrenchment (m)	25.78 - 75.11	43.14
Entrenchment Ratio	2.46 - 8.91	5.68
Manning's n		0.026



Hydrology

Measured	**Discharge (cms)**	
Calculated	**Bankfull Flow (cms)**	4.97
	Bankfull Vel (m/s)	1.47
Modelled	**2 year flow (cms)**	

Bank Characteristics

	Range	Average
Bank Height (m)	0.45 - 1.1	0.85
Bank Angle (degrees)	15 - 78	36.2
Root Depth (cm)	9.0 - 60	29.5
Amount of undercut (cm)	3.0 - 30.0	14.67
Banks with undercuts (%)		30%

Materials	Torvane values (kg/cm2)
ms/cl/si	1.4
*cl/si/fs	2.2
ms/si	1.5
si/fs	0.6
vcs/cl/si/fs	1

* = dominant material

Grain Size Analysis (cm):
(Left bank, cross-section 5)

D10	0.00053
D50	0.0059
D90	0.0212

Planform Characteristics

Long Profile (avg)

Bankfull Gradient	0.44	%
Inter-Pool Gradient	0.74	%
Inter-Riffle Gradient	0.73	%
Riffle Gradient	3.21	%
Riffle Length	5.25	m
Riffle-Pool Spacing	11.72	m
Max Pool Depth	1.4	m

Meander Geometry (avg)

Belt Width	75 m
Radius of Curvature	22 m
Amplitude	24 m
Wavelength	m
Sinuosity	1.11

Substrate Characteristics

Particle Shape (cm)

	Range	Average
X	1.0 - 14.0	5.44
Y	1.0 - 10.0	4.06
Z	0.50 - 7.0	1.76

Hydraulic Roughness (cm)

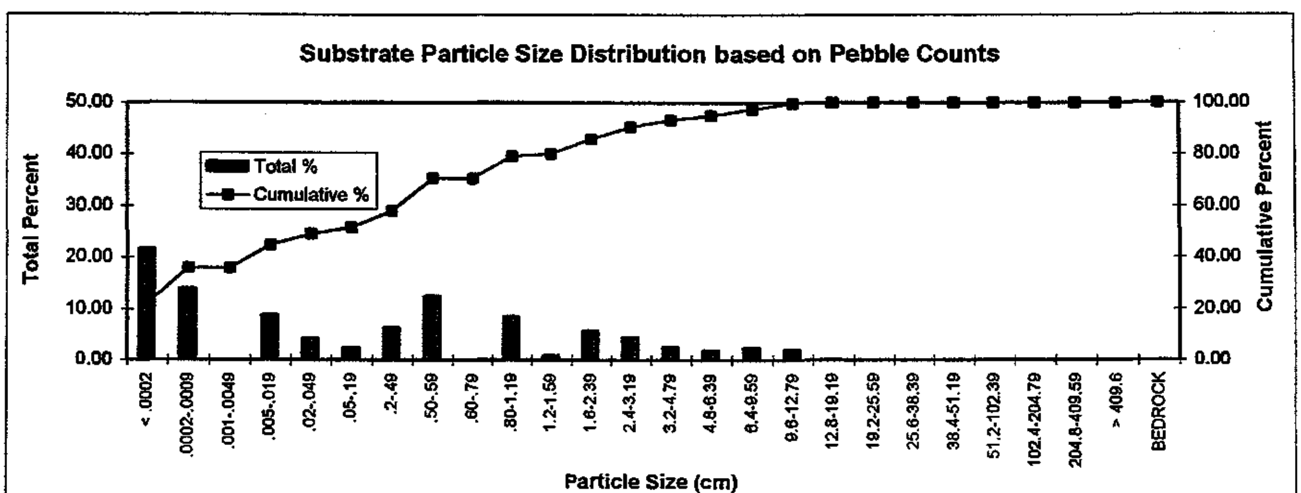
	Range	Average
Maximum	0.5 - 14.0	3.85
Median	0.25 - 2.0	0.75
Minimum	0	0
Embeddedness (%)	40 - 100	72

Sub-pavement

Part. Size	% of subpavement on site	Part. Size	% of subpavement on site
cl	47.6	vcs	5
si	8.8	P	9.2
vfs	0	1 cm	6.7
fs	10	2 cm	1.3
ms	7.7	3 cm	0.7
cs	3		

Substrate Particle Sizes (cm)

	Pebble Counts	Grain Size Analysis (cross-section 3)
D10	0.0002	0.0277
D50	0.103	0.41
D90	3.19	1.94



Historical Air Photo Analysis Based on an examination of 1954 and 1979 air photos

migration rate:	N/A m/yr	
channel changes:	* no changes in channel planform have been observed * potential changes in channel length or width could not be quantified	
Interpretation:	* no changes in landuse have been observed * Trafalgar road has been extended	

Channel Thresholds

Flow Competency	0.20 m/s for D50 = 0.10 cm	
Tractive Force	18.77 Nm^{-2}	
Critical Shear	1.00 Nm^{-2}	using 970 D50
Critical Depth	0.02 m	
Critical Velocity	0.21 ms^{-1}	
Erosion Potential	26.08 N/ms	
Stream Power	212 W/m	

Interpretation

* during bankfull discharge events, sediment smaller than 2 cm will be entrained
* the flow, during bankfull discharge events has a moderate stream power and erosion potential

Comment on erosion potential, long profile insight, comparison between Dc and Dbf
Vc and Vbf

* the critical depth for entrainment is small, a function of the low critical shear required to entrain
* there is a large fine grained portion in the substrate possibly a function of the bank erosion that is observed in the reach
* a deep pool exists within the reach, near a tree that is in the channel - pool may be scoured b/c of tree?

APPENDIX B

WATER QUALITY SAMPLING LABORATORY RESULTS

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Water Samples

Sample Id	Fecal Col. MOE /100mL	Total Col. MOE /100mL	E. Coli MOE /100mL
5836-SW3A	35	2600	18
5836-Sw3B	48	230	17
5836-SW3C	<1	150	<1
5836-SW4A	24	200	11
5836-SW4B	50	70	17
5836-SW4C	27	50	21
5836-SW4D	86	220	48
5836-SW5	29	80	14

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Water Samples

Sample Id	Ag ICP/MS mg/L	Al ICP/MS mg/L	As ICP/MS mg/L	Ba ICP/MS mg/L	Be ICP/MS mg/L	Bi ICP/MS mg/L	Ca ICP/MS mg/L	Cd ICP/MS mg/L
5836-SW3A	<0.0001	0.372	<0.002	0.047	<0.001	<0.001	71.7	<0.0001
5836-SW3B	<0.0001	0.031	<0.002	0.066	<0.001	<0.001	105.	<0.0001
5836-SW3C	<0.0001	0.075	<0.002	0.023	<0.001	<0.001	55.2	<0.0001
5836-SW4A	<0.0001	0.367	<0.002	0.104	<0.001	<0.001	90.0	<0.0001
5836-SW4B	<0.0001	0.117	<0.002	0.066	<0.001	<0.001	85.1	<0.0001
5836-SW4C	<0.0001	0.050	<0.002	0.166	<0.001	<0.001	93.2	<0.0001
5836-SW4D	<0.0001	0.021	<0.002	0.121	<0.001	<0.001	93.8	<0.0001
5836-SW5	<0.0001	0.059	<0.002	0.070	<0.001	<0.001	91.3	<0.0001
Sample+Spike (found)	---	---	0.534	---	0.534	---	---	0.523
Sample+Spike (expected)	---	---	0.500	---	0.500	---	---	0.500
Blank	<0.0001	0.009	<0.002	<0.005	<0.001	<0.001	<0.5	<0.0001
QC Standard (found)	0.0026	1.04	0.098	0.101	0.005	0.111	5.3	0.0509
QC Standard (expected)	0.0030	1.00	0.100	0.100	0.005	0.100	5.0	0.0500
Repeat 5836-SW3A	<0.0001	0.367	<0.002	0.048	<0.001	<0.001	73.4	<0.0001

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Water Samples

Sample Id	Co ICP/MS mg/L	Cr ICP/MS mg/L	Cu ICP/MS mg/L	Fe ICP/MS mg/L	K ICP/MS mg/L	Mg ICP/MS mg/L	Mn ICP/MS mg/L	Mo ICP/MS mg/L
5836-SW3A	0.0003	<0.005	0.0030	0.55	1.5	20.6	0.085	<0.001
5836-SW3B	<0.0001	<0.005	0.0034	<0.03	4.0	29.6	0.023	0.002
5836-SW3C	<0.0001	<0.005	0.0025	<0.03	3.6	13.7	0.010	<0.001
5836-SW4A	0.0003	<0.005	0.0025	0.65	2.4	22.2	0.083	<0.001
5836-SW4B	<0.0001	<0.005	0.0016	0.23	2.4	17.2	0.062	<0.001
5836-SW4C	<0.0001	<0.005	0.0009	<0.03	1.9	27.0	0.029	<0.001
5836-SW4D	<0.0001	<0.005	0.0015	<0.03	2.5	23.9	0.022	<0.001
5836-SW5	<0.0001	<0.005	0.0030	0.11	3.4	21.0	0.057	<0.001
Sample+Spike (found)	0.576	0.517	0.505	1.43	---	---	0.658	0.524
Sample+Spike (expected)	0.500	0.500	0.500	1.05	---	---	0.584	0.500
Blank	<0.0001	<0.005	<0.0005	<0.03	<0.1	<0.05	<0.005	<0.001
QC Standard (found)	0.0511	0.050	0.0484	1.01	1.0	1.13	0.054	0.052
QC Standard (expected)	0.0500	0.050	0.0500	1.00	1.0	1.00	0.050	0.050
Repeat 5836-SW3A	0.0003	<0.005	0.0020	0.57	1.6	21.1	0.087	<0.001

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Water Samples

Sample Id	Na ICP/MS mg/L	Ni ICP/MS mg/L	P ICP/MS mg/L	Pb ICP/MS mg/L	Sb ICP/MS mg/L	Se ICP/MS mg/L	Sr ICP/MS mg/L	Ti ICP/MS mg/L
5836-SW3A	21.1	<0.001	0.07	<0.0005	<0.0005	<0.002	0.191	0.007
5836-SW3B	521.	0.001	0.07	<0.0005	<0.0005	<0.002	0.535	<0.005
5836-SW3C	53.7	<0.001	0.10	<0.0005	<0.0005	<0.002	0.146	<0.005
5836-SW4A	26.0	<0.001	0.09	0.0007	<0.0005	<0.002	0.346	0.007
5836-SW4B	17.9	<0.001	0.06	<0.0005	<0.0005	<0.002	0.311	<0.005
5836-SW4C	13.1	<0.001	<0.05	<0.0005	<0.0005	<0.002	0.326	<0.005
5836-SW4D	30.3	<0.001	<0.05	<0.0005	<0.0005	<0.002	0.363	<0.005
5836-SW5	62.3	<0.001	0.05	<0.0005	<0.0005	<0.002	0.484	<0.005
Sample+Spike (found)	---	0.515	---	0.537	0.506	0.498	---	0.529
Sample+Spike (expected)	---	0.500	---	0.500	0.500	0.500	---	0.506
Blank	<0.1	<0.001	<0.05	<0.0005	<0.0005	<0.002	<0.001	<0.005
QC Standard (found)	5.6	0.048	1.02	0.0543	0.0933	0.099	0.051	0.048
QC Standard (expected)	5.0	0.050	1.00	0.0500	0.100	0.100	0.050	0.050
Repeat 5836-SW3A	20.8	<0.001	0.07	<0.0005	<0.0005	<0.002	0.194	0.007

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Water Samples

Sample Id	V ICP/MS mg/L	Zn ICP/MS mg/L	F- SM 4500F mg/L	Cl- SM 4110B mg/L	NO2-N SM 4110B mg/L	PO4-3 SM 4110B mg/L	Br- SM 4110B mg/L	NO3-N SM 4110B mg/L
5836-SW3A	<0.0005	0.005	0.1	45.5	<0.2	<1	<0.5	1.0
5836-SW3B	<0.0005	0.007	0.2	905.	<0.2	<1	<0.5	<0.2
5836-SW3C	<0.0005	0.003	0.2	93.5	<0.2	<1	<0.5	<0.2
5836-SW4A	<0.0005	0.011	0.1	61.9	<0.2	<1	<0.5	2.2
5836-SW4B	<0.0005	0.023	0.1	40.5	<0.2	<1	<0.5	1.1
5836-SW4C	<0.0005	<0.002	<0.1	37.8	<0.2	<1	<0.5	3.8
5836-SW4D	<0.0005	0.003	0.1	79.7	<0.2	<1	<0.5	3.6
5836-SW5	<0.0005	0.010	0.1	133.	<0.2	<1	<0.5	0.6
Sample+Spike (found)	0.556	0.506	0.5	49.3	2.0	13	2.1	2.9
Sample+Spike (expected)	0.500	0.505	0.5	49.0	2.0	20	2.0	3.0
Blank	<0.0005	<0.002	<0.1	<0.5	<0.2	<1	<0.5	<0.2
QC Standard (found)	0.0517	0.051	0.2	252.	10.5	20	21.4	4.4
QC Standard (expected)	0.0500	0.050	0.2	250.	10.0	20	20.0	4.4
Repeat 5836-SW3A	<0.0005	0.005	0.1	44.5	<0.2	<1	<0.5	0.9

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Water Samples

Sample Id	SO4= SM 4110B mg/L	pH SM 4500B pH Units	Alk 8.3 SM 2320B mg CaCO3/L	Alk 4.2 SM 2320B mg CaCO3/L	NH3-N SM 4500H mg/L	DOC SM 5310C mg/L	Th. TDS Calc. mg/L
5836-SW3A	50.9	8.35	<1	181	0.03	3.3	320
5836-SW3B	88.8	8.58	9	137	0.02	6.0	1736
5836-SW3C	39.0	8.06	<1	132	0.04	6.9	338
5836-SW4A	55.0	8.40	<1	214	0.05	3.7	386
5836-SW4B	53.4	8.33	4	196	0.04	4.1	334
5836-SW4C	49.3	8.30	<1	232	0.05	1.6	361
5836-SW4D	60.7	8.45	<1	216	0.03	3.4	421
5836-SW5	65.7	8.47	<1	186	0.04	4.7	489
Sample+Spike (found)	83.5	---	---	---	0.35	7.9	nan
Sample+Spike (expected)	80.5	---	---	---	0.35	8.0	nan
Blank	<0.5	---	---	1	<0.02	<0.2	2
QC Standard (found)	61.6	7.03	---	249	0.30	5.1	476
QC Standard (expected)	60.0	7.00	---	250	0.30	5.0	472
Repeat 5836-SW3A	50.0	8.37	<1	180	0.03	3.5	319

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Water Samples

Sample Id	pHs Calc. pH Units	CAB Calc. %	Hard(Calc) SM 2340B mg CaCO3/L	CO3= Calc. mg/L	HCO3- Calc. mg/L	L.I. Calc. None	A.I. Calc. None	R.S.I. Calc. None
5836-SW3A	7.35	-2.27	263.8	1	217.9	1.0	13.03	6.4
5836-SW3B	7.40	-0.58	384.1	5	145.6	1.2	13.30	6.2
5836-SW3C	7.60	-1.84	194.5	1	158.7	0.5	12.47	7.1
5836-SW4A	7.18	-2.40	316.3	1	258.5	1.2	13.23	6.0
5836-SW4B	7.24	-2.62	283.4	3	228.5	1.1	13.07	6.2
5836-SW4C	7.13	-5.44	344.0	1	279.9	1.2	13.20	6.0
5836-SW4D	7.16	-1.28	333.0	1	261.3	1.3	13.31	5.9
5836-SW5	7.25	-1.35	314.6	1	225.0	1.2	13.24	6.0
Sample+Spike (found)	nan	nan	nan	nan	nan	nan	nan	nan
Sample+Spike (expected)	nan	nan	nan	nan	nan	nan	nan	nan
Blank	11.53	12.9	1.5	nan	nan	nan	nan	nan
QC Standard (found)	8.35	90.7	18.0	nan	nan	-1.3	10.68	9.7
QC Standard (expected)	8.38	91.4	16.6	nan	nan	-1.4	10.62	9.8
Repeat 5836-SW3A	7.34	-3.74	270.2	1	216.9	1.0	13.06	6.3

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Water Samples

Sample Id	Colour SM 2120B TCU	Turb. SM 2130B NTU	Sp. Cond. SM 2510B umhos/cm	TOC SM 5310C mg/L	TKN SM 4500B mg/L	TSS SM 2540B mg/L	Total P SM 4500C mg/L
5836-SW3A	42	21.0	565	4.1	0.48	29	0.046
5836-SW3B	21	1.3	2736	6.0	0.41	5	0.010
5836-SW3C	31	1.3	615	8.0	0.67	2	0.052
5836-SW4A	44	27.0	677	4.3	0.84	41	0.171
5836-SW4B	29	3.3	585	4.9	0.55	9	0.023
5836-SW4C	14	0.9	639	2.7	0.28	2	0.011
5836-SW4D	21	1.0	748	3.5	0.47	2	0.009
5836-SW5	31	1.8	857	5.6	0.5	2	0.012
Sample+Spike (found)	---	---	---	---	0.93	---	0.050
Sample+Spike (expected)	---	---	---	---	0.96	---	0.057
Blank	<1	0.2	3	<0.2	<0.02	<1	<0.002
QC Standard (found)	23	18.0	716	5.1	0.87	50	0.085
QC Standard (expected)	25	18.0	718	5.0	0.84	50	0.084
Repeat 5836-SW3A	42	21.0	568	4.0	0.46	33	0.043

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5735 McAdam Road, Mississauga, Ontario, Canada L4Z 1N9 Tel:(905) 890-8566 Fax:(905) 890-8575

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Job approved by:

Signed: ....
Mike Muneswar
Manager, Environmental Inorganic Services

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Organochlorine Pesticides/Water

Parameter	M.D.L. ug/L	Reagent Blank	5836-SW3A	5836-SW3A Repeat	5836-SW3B	5836-SW:
Aldrin	0.002	ND	ND	ND	ND	NI
Alpha-BHC	0.002	ND	ND	ND	ND	NI
Beta-BHC	0.002	ND	ND	ND	ND	NI
Delta-BHC	0.002	ND	ND	ND	ND	NI
Gamma-BHC	0.002	ND	ND	ND	ND	NI
Alpha-Chlordane	0.002	ND	ND	ND	ND	NI
Gamma-Chlordane	0.002	ND	ND	ND	ND	NI
4,4'-DDD	0.004	ND	ND	ND	ND	NI
4,4'-DDE	0.002	ND	ND	ND	ND	NI
4,4'-DDT	0.004	ND	ND	ND	ND	NI
2,4'-DDT	0.004	ND	ND	ND	ND	NI
Dieldrin	0.002	ND	ND	ND	ND	NI
Endosulfan I	0.004	ND	ND	ND	ND	NI
Endosulfan II	0.004	ND	ND	ND	ND	ND
Endosulfan sulfate	0.004	ND	ND	ND	ND	ND
Endrin	0.004	ND	ND	ND	ND	ND
Endrin aldehyde	0.01	ND	ND	ND	ND	ND
Heptachlor	0.002	ND	ND	ND	ND	ND
Heptachlor Epoxide	0.002	ND	ND	ND	ND	ND
Methoxychlor	0.004	ND	ND	ND	ND	ND
Mirex	0.004	ND	ND	ND	ND	ND
Total PCB's	0.05	ND	ND	ND	ND	ND
Endrin ketone	0.004	ND	ND	ND	ND	ND
Toxaphene	0.300	ND	ND	ND	ND	ND
TCMX	---	83.0 %	75.0 %	76.0 %	74.0 %	75.0 %

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Organochlorine Pesticides/Water

Parameter	5836-SW4A	5836-SW4B	5836-SW4C	5836-SW4D	5836-SW5
Aldrin	ND	ND	ND	ND	ND
Alpha-BHC	ND	ND	ND	ND	ND
Beta-BHC	ND	ND	ND	ND	ND
Delta-BHC	ND	ND	ND	ND	ND
Gamma-BHC	ND	ND	ND	ND	ND
Alpha-Chlordane	ND	ND	ND	ND	ND
Gamma-Chlordane	ND	ND	ND	ND	ND
4,4'-DDD	ND	ND	ND	ND	ND
4,4'-DDE	ND	ND	ND	ND	ND
4,4'-DDT	ND	ND	ND	ND	ND
2,4'-DDT	ND	ND	ND	ND	ND
Dieldrin	ND	ND	ND	ND	ND
Endosulfan I	ND	ND	ND	ND	ND
Endosulfan II	ND	ND	ND	ND	ND
Endosulfan sulfate	ND	ND	ND	ND	ND
Endrin	ND	ND	ND	ND	ND
Endrin aldehyde	ND	ND	ND	ND	ND
Heptachlor	ND	ND	ND	ND	ND
Heptachlor Epoxide	ND	ND	ND	ND	ND
Methoxychlor	ND	ND	ND	ND	ND
Mirex	ND	ND	ND	ND	ND
Total PCB's	ND	ND	ND	ND	ND
Endrin ketone	ND	ND	ND	ND	ND
Toxaphene	ND	ND	ND	ND	ND
TCMX	77.0 %	72.0 %	72.0 %	71.0 %	73.0 %

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Organochlorine Pesticides - Spiked Recoveries

Parameter	Spiked Amount ug/L	Spiked Reagent Blank	5836-SW3A Spiked
Aldrin	0.03	78%	60%
Alpha-BHC	0.03	75%	61%
Beta-BHC	0.03	94%	77%
Delta-BHC	0.03	71%	60%
Gamma-BHC	0.03	71%	58%
Alpha-Chlordane	0.03	83%	68%
Gamma-Chlordane	0.03	80%	65%
4,4'-DDD	0.060	74.0 %	61.0 %
4,4'-DDE	0.06	82%	64%
4,4'-DDT	0.06	74%	61%
2,4'-DDT	0.060	92.0 %	64.0 %
Dieldrin	0.06	75%	66%
Endosulfan I	0.03	73%	66%
Endrin	0.06	68%	60%
Heptachlor	0.030	78.0 %	33.0 %
Heptachlor Epoxide	0.03	75%	62%
Methoxychlor	0.300	81.0 %	72.0 %
Mirex	0.06	91%	69%
Total PCB's	0.25	104%	---
Endrin ketone	0.06	75%	69%
TCMX	0.060	79.0 %	80.0 %

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Chlorinated Herbicides

Parameter	M.D.L. ug/L	Reagent Blank	5836-SW3A	5836-SW3A Repeat	5836-SW3B	5836-SW3C
2,4-D	0.20	ND	ND	ND	ND	ND
Silvex	0.05	ND	ND	ND	ND	ND
2,4,5-T	0.05	ND	ND	ND	ND	ND
Dicamba	0.20	ND	ND	ND	ND	ND
MCPP	50.0	ND	ND	ND	ND	ND
MCPA	50.0	ND	ND	ND	ND	ND
Dichlorprop	0.05	ND	ND	ND	ND	ND
Dinoseb	0.05	ND	ND	ND	ND	ND
2,4-DB	0.05	ND	ND	ND	ND	ND
DCPAA	2.50	91.0%	67.0%	68.0%	84.0%	68.0%

Parameter	5836-SW4A	5836-SW4B	5836-SW4C	5836-SW4D	5836-SW5
2,4-D	ND	ND	ND	ND	ND
Silvex	ND	ND	ND	ND	ND
2,4,5-T	ND	ND	ND	ND	ND
Dicamba	ND	ND	ND	ND	ND
MCPP	ND	ND	ND	ND	ND
MCPA	ND	ND	ND	ND	ND
Dichlorprop	ND	ND	ND	ND	ND
Dinoseb	ND	ND	ND	ND	ND
2,4-DB	ND	ND	ND	ND	ND
DCPAA	77.0%	64.0%	72.0%	72.0%	67.0%

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Chlorinated Herbicides - Spiked Recoveries

Parameter	Spiked Amount ug/L	Spiked Reagent Blank
2,4-D	1.25	70.0%
Silvex	0.13	78.0%
2,4,5-T	0.13	58.0%
Dicamba	0.13	75.0%
MCPP	125.	77.0%
MCPA	125.	64.0%
Dichlorprop	1.25	84.0%
Dinoseb	0.63	88.0%
2,4-DB	1.25	104. %
DCPAA	2.50	76.0%

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Chlorinated Herbicides - Spiked Recoveries

Abbreviations:

Parameters:

TCMX	:	Tetrachloro-meta-xylene(Surrogate standard)
2,4-D	:	2,4-dichlorophenoxyacetic acid
Silvex	:	2,4,5-trichlorophenoxypropionic acid
2,4,5-T	:	2,4,5-trichlorophenoxyacetic acid
Dicamba	:	2-methoxy-3,6-dichlorobenzoic acid
MCPP	:	2-(4-chloro-2-methylphenoxy)propanoic acid
MCPA	:	4-chloro-2-methylphenoxyacetic acid
Dichlorprop	:	2-(2,4-dichlorophenoxy)propionic acid
Dinoseb	:	2,4-dinitro-6-sec-butylphenol
2,4-DB	:	4-(2,4-dichlorophenoxy)butyric acid
DCPAA	:	2,4-dichlorophenylacetic acid (surrogate standard)

Quality codes:

%	:	Percent
ND	:	Not detected

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Job approved by:

Signed: M. Riskallah

Medhat Riskallah, Ph.D., C.Chem.
Manager, Gas Chromatography Section

401 Corridor Integrated Planning Project
Scoped Subwatershed Studies
Town of Halton Hills

Water Quality Sampling Results - Dry Weather Continuous DO and Temperature Monitoring
Sampling Date : April 13, 1999

	Middle Sixteen Mile Creek - Site 3				Middle Sixteen Mile Creek Tributary - Site 4				East Sixteen Mile Creek - Site 4			
Reading No.	Time	Air Temp. (deg. C)	Water Temp. (deg. C)	DO (mg/L)	Time	Air Temp. (deg. C)	Water Temp. (deg. C)	DO (mg/L)	Time	Air Temp. (deg. C)	Water Temp. (deg. C)	DO (mg/L)
1	6:30	2	4	13	6:30	2	4	13.2	6:45	2	5.5	12.1
2	8:15	2	4	12.3	8:40	2	4	14.2	9:00	3	5.5	11.3
3	10:15	7	5.5	12.8	10:35	6	5	13.7	10:50	7	6.5	10.8
4	12:15	10	8	12.3	12:20	10	7.5	13.7	12:45	12	8.5	11.2
5	1:50	12	11	12.9	2:25	12	10.75	14.6	2:45	13	10.5	11.8
6	3:55	12	13	12.6	4:10	12	12.5	14.6	4:35	12	11	11.5
7	5:50	12	12.5	12.8	6:15	11	12	13.3	6:30	11	11	11.3
8	8:00	7	10.5	12	8:15	6	11	12	8:30	6	10	10.8
Maximum				13.0				14.6				12.1
Minimum				12.0				12.0				10.8
Average				12.6				13.7				11.4
Range				1.0				2.6				1.3

APPENDIX C

HYDRAULIC STRUCTURE INVENTORY AND HYDRAULIC ASSESSMENT

Culvert Assessment Summary

Survey Date: Mar. 30/99

Culvert Identification

Culvert ID: 1
Location: Steeles Avenue West, 126 m East of James Snow Parkway
Watercourse: Drain 3-1/Milton Pond

Culvert Data

Shape:	Circular	Manning's n:	0.024
Material:	Corrugated Steel	Ke:	0.9
Size (h*w/dia):	Twin 900 mm	Flood Criteria:	10 year
Length:	34.0 m	EP Elevation:	208.0 m
Skew No.:	30	AHW:	207.7 m

	Inlet	**Outlet**
Type:	Projecting	Projecting
Obvert:	207.35 m	207.15 m
Design Invert:	206.45 m	206.25 m
Actual Invert:	N/A	N/A
Sediment Depth:	N/A	N/A

Comments: Culvert barrels are in good condition with heavy vegetation on the upstream side.

Photo # 1: Upstream view of twin C.S.P.'s just downstream of Milton Business Park pond outlet.

Culvert Assessment Summary

Survey Date: Dec. 22/98, Mar.30/99

Culvert Identification

Culvert ID: 2
Location: Steeles Avenue West, 15 m West of Fifth Line North
Watercourse: Drain 3-2

Culvert Data

Shape:	Arch	Manning's n:	0.024
Material:	Corrugated Steel	Ke:	0.9
Size (h*w/dia):	970 x 1390 mm	Flood Criteria:	10 year
Length:	42.5 m	EP Elevation:	205.43 m
Skew No.:	30	AHW:	205.13 m

	Inlet	**Outlet**
Type:	Projecting	Projecting
Obvert:	203.95 m	203.56 m
Design Invert:	N/A	N/A
Actual Invert:	202.97 m	202.56 m
Sediment Depth:	N/A	N/A

Comments: Inlet of the culvert is in good condition with a slight dent. Outlet has recently been reconstructed with the addition of the Cashway driveway entrance, adding a bend under the driveway (4.5 m), with a 300 mm C.S.P. cross culvert joining at the bend providing ditch drainage from the west.

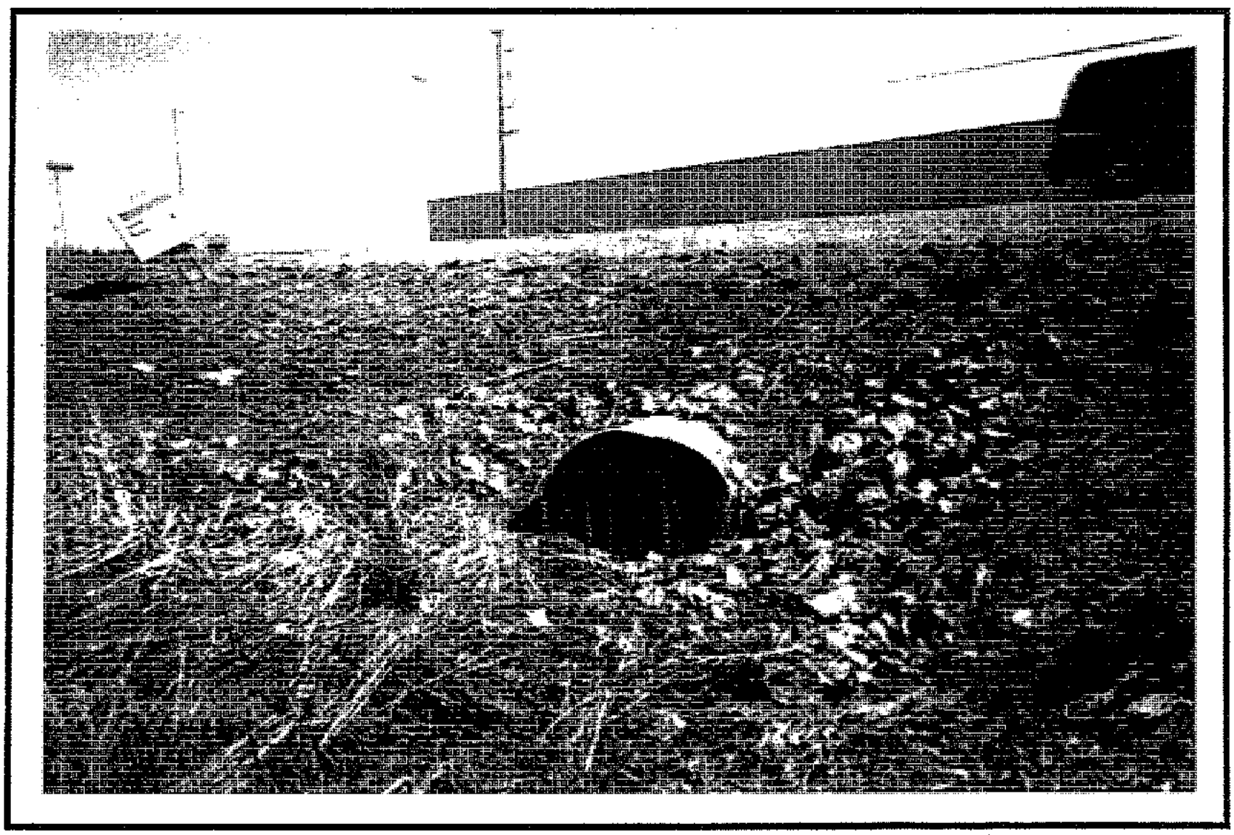


Photo # 2: Upstream view on North side of Steeles Avenue.

Culvert Assessment Summary

Survey Date: Mar. 30/99

Culvert Identification

Culvert ID: 2A

Location: Fifth Line North at Steeles Avenue

Watercourse: Ditch Drainage

Culvert Data

Shape:	Circular	Manning's n:	0.024
Material:	Corrugated Steel	Ke:	0.9
Size (h*w/dia):	600 mm	Flood Criteria:	N/A
Length:	19.1 m	EP Elevation:	205.17 m
Skew No.:	90	AHW:	204.87

	Inlet	**Outlet**
Type:	Projecting	Projecting
Obvert:	203.69 m	203.78
Design Invert:	N/A	N/A
Actual Invert:	203.09 m	203.18
Sediment Depth:	N/A	N/A

Comments: Outlet of culvert is in good condition, however is blocked with thick vegetation. Inlet on East side of road is in poor condition, crushed and torn.

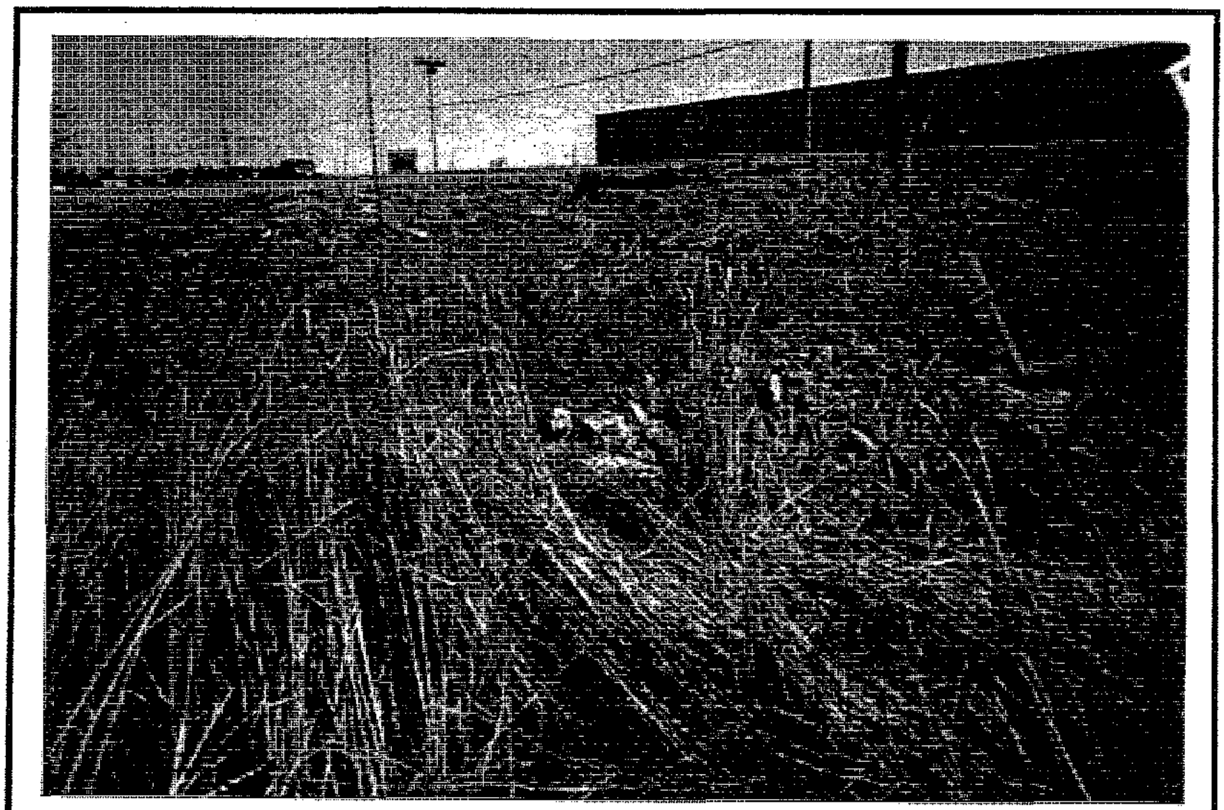


Photo #3: Outlet on the West side of the Fifth Line cross culvert.

Culvert Assessment Summary

Survey Date: Mar. 30/99

Culvert Identification

Culvert ID: 2B

Location: Steeles Avenue West, 375 m East of Fifth Line North

Watercourse: Ditch Drainage

Culvert Data

Shape:	Circular	Manning's n:	0.024
Material:	Corrugated Steel	Ke:	0.9
Size (h*w/dia):	600 mm	Flood Criteria:	10 year
Length:	25.0 m	EP Elevation:	204.27 m
Skew No.:	90	AHW:	203.97 m

	Inlet	**Outlet**
Type:	Projecting	Projecting
Obvert:	203.40 m	203.18 m
Design Invert:	N/A	N/A
Actual Invert:	202.80 m	202.69 m
Sediment Depth:	N/A	N/A

Comments: Culvert is in good condition, except for slight dents in the inlet (north side) and debris in the ditch.

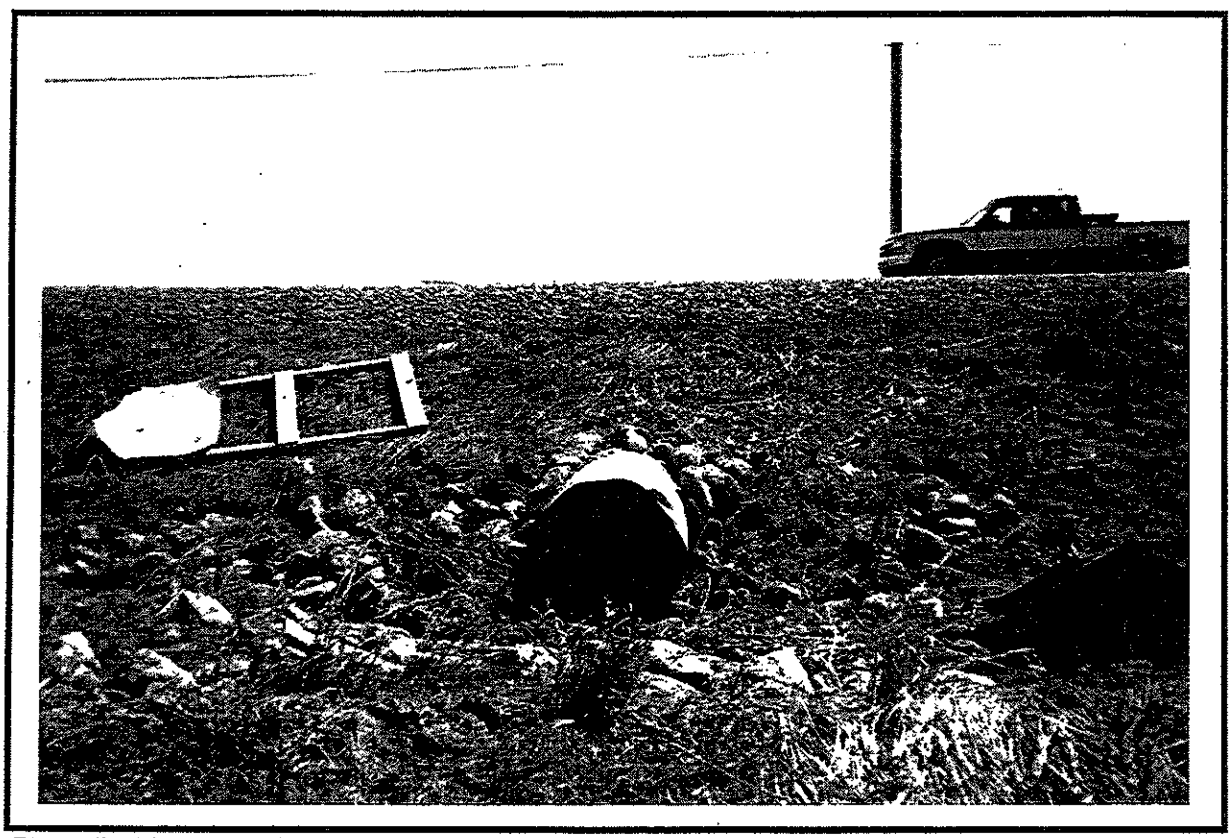


Photo #4: View of the inlet on the North Side of Steeles Avenue.

Culvert Assessment Summary

Survey Date: Dec. 22/98

Culvert Identification

Culvert ID: 3
Location: Steeles Avenue West, 97 m West of Fifth Line South
Watercourse: Middle Sixteen Mile Creek

Culvert Data

Shape:	Bridge	Manning's n:	0.013
Material:	Concrete	Ke:	0.5
Size (h*w/dia):	2.1 x 12.2 m	Flood Criteria:	100 year
Length:	12.0 m	EP Elevation:	196.6 m
Skew No.:	90	AHW:	196.3 m

	Inlet	Outlet
Type:	Headwall	Headwall
Obvert:	195.90 m	195.90 m
Design Invert:	N/A	N/A
Actual Invert:	194.50 m	193.80 m
Sediment Depth:	N/A	N/A

Comments: Bridge is in good condition, although sediment deposition has decreased the structure's cross sectional area.

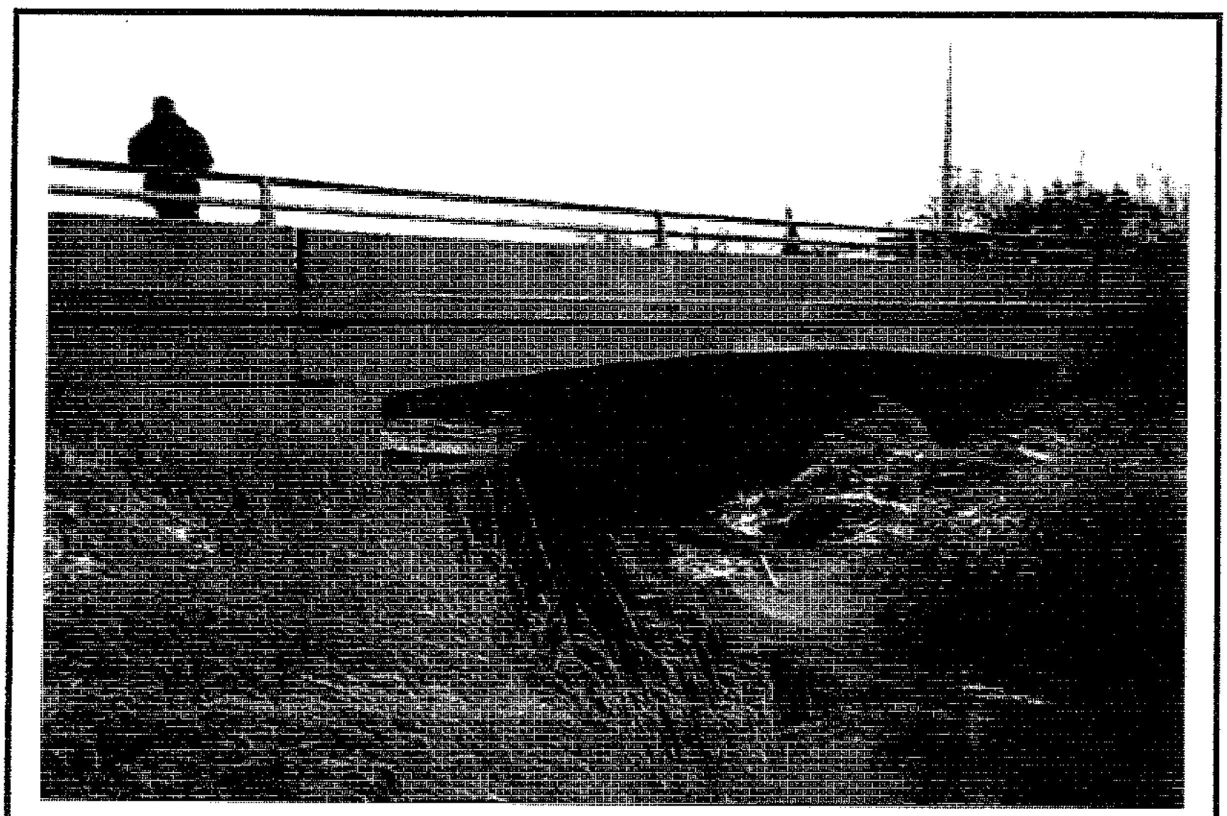


Photo #5: Upstream view of the Middle Sixteen Mile Creek bridge.

Culvert Assessment Summary

Survey Date: Dec.22/98, Mar.30/99

Culvert Identification

Culvert ID:	4
Location:	Steeles Avenue West, 10 m West of Sixth Line North
Watercourse:	Drain 4-1

Culvert Data

Shape:	Circular	Manning's n:	0.024
Material:	Corrugated Steel	Ke:	0.9
Size (h*w/dia):	900 mm	Flood Criteria:	10 year
Length:	27.0 m	EP Elevation:	101.68 m
Skew No.:	30	AHW:	101.38 m

	Inlet	Outlet
Type:	Projecting	Projecting
Obvert:	100.65 m	100.40 m
Design Invert:	99.75 m	99.50 m
Actual Invert:	100.0 m	99.94 m
Sediment Depth:	0.25 m	0.44 m

Comments: Culvert is in poor condition with the inlet crushed and the outlet silted up.

Note: An elevation of 100.0 m was assumed for the upstream invert.

Photo #6: Upstream view (North Side) of Drain 4-1 cross culvert.

Culvert Assessment Summary

Survey Date: Mar. 30/99

Culvert Identification

Culvert ID: 4A
Location: Sixth Line North at Steeles Avenue
Watercourse: Dtich Drainage

Culvert Data

Shape:	Circular	Manning's n:	0.024
Material:	Corrugated Steel	Ke:	0.9
Size (h*w/dia):	300 mm	Flood Criteria:	N/A
Length:	23.0 m	EP Elevation:	101.68 m
Skew No.:	90	AHW:	101.38 m

	Inlet	**Outlet**
Type:	Ditch Inlet	Projecting
Obvert:	100.91 m	100.34
Design Invert:	N/A	N/A
Actual Invert:	100.13	100.02
Sediment Depth:	N/A	N/A

Comments: Catch Basin ditch inlet on the east side of Sixth Line, with oulet in good condition.

Note: An elevation of 100.0 m was assumed for the upstream invert of culvert #4.

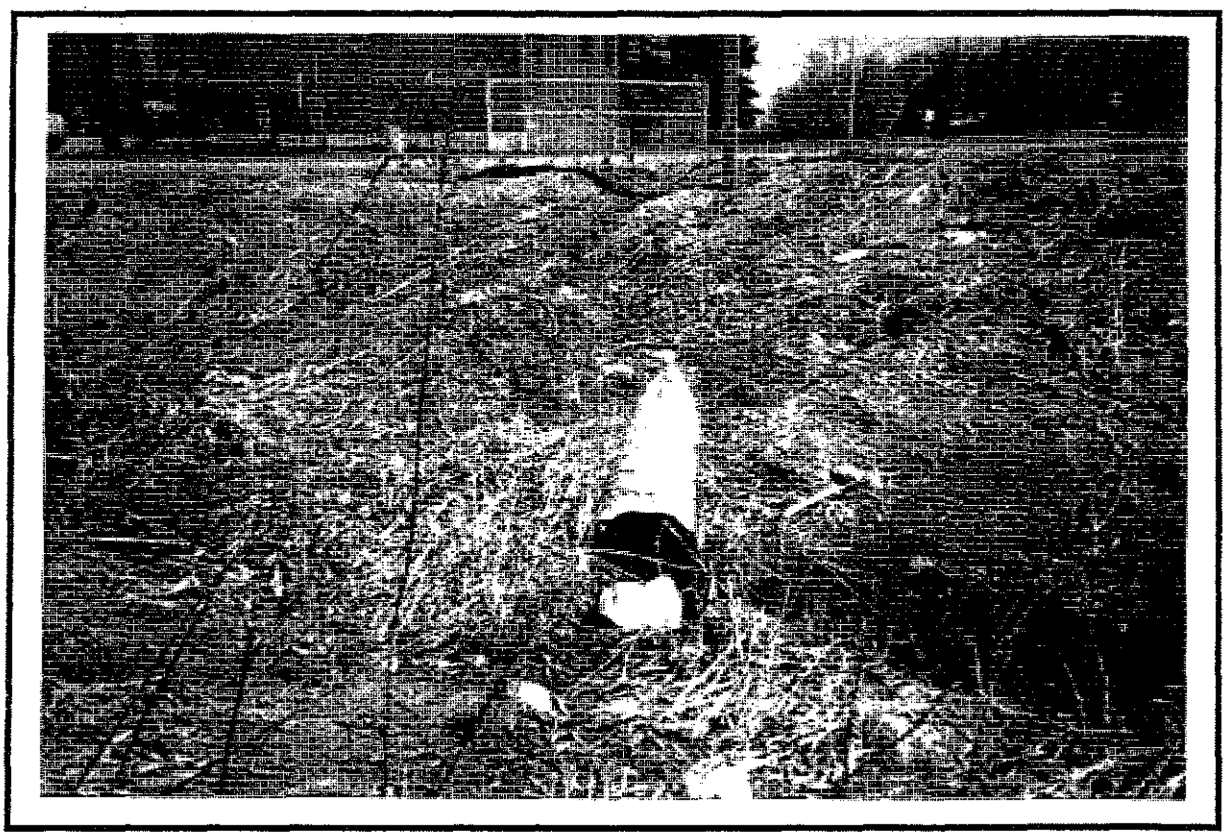


Photo #7: View of the outlet from the Northwest corner of Steeles Avenue and Sixth Line North.

Culvert Assessment Summary

Survey Date: Dec.22/98, Mar.30/99

Culvert Identification

Culvert ID: 5

Location: Steeles Avenue West, 44 m East of Sixth Line North

Watercourse: Dtich Drainage

Culvert Data

Shape:	Circular	Manning's n:	0.024
Material:	Corrugated Steel	Ke:	0.9
Size (h*w/dia):	600 mm	Flood Criteria:	10 year
Length:	41.0 m	EP Elevation:	103.10 m
Skew No.:	30	AHW:	102.80 m

	Inlet	**Outlet**
Type:	Projecting	Projecting
Obvert:	100.62 m	100.44 m
Design Invert:	N/A	N/A
Actual Invert:	100.07 m	100.00 m
Sediment Depth:	N/A	N/A

Comments: Condition of the culvert has not ben determined since both the inlet and outlet are covered and blocked with thick vegetation.

Note: An elevation of 100.0 m was assumed for the downstream invert on the North Side of Steeles Avenue.

Photo #8: View of the outlet on the North side of Steeles Avenue.

Culvert Assessment Summary

Survey Date: Dec. 22/98

Culvert Identification

Culvert ID: 6

Location: Steeles Avenue West, 55 m West of Sixth Line South

Watercourse: Middle Sixteen Mile Creek Tributary

Culvert Data

Shape:	Bridge	Manning's n:	0.013
Material:	Concrete	Ke:	0.5
Size (h*w/dia):	1.98 x 9.0 m	Flood Criteria:	100 year
Length:	15.0 m	EP Elevation:	193.3 m
Skew No.:	90	AHW:	193.0 m

	Inlet	**Outlet**
Type:	Headwall	Headwall
Obvert:	192.82 m	192.82 m
Design Invert:	N/A	N/A
Actual Invert:	190.77 m	190.80 m
Sediment Depth:	N/A	N/A

Comments: Bridge is in good condition.

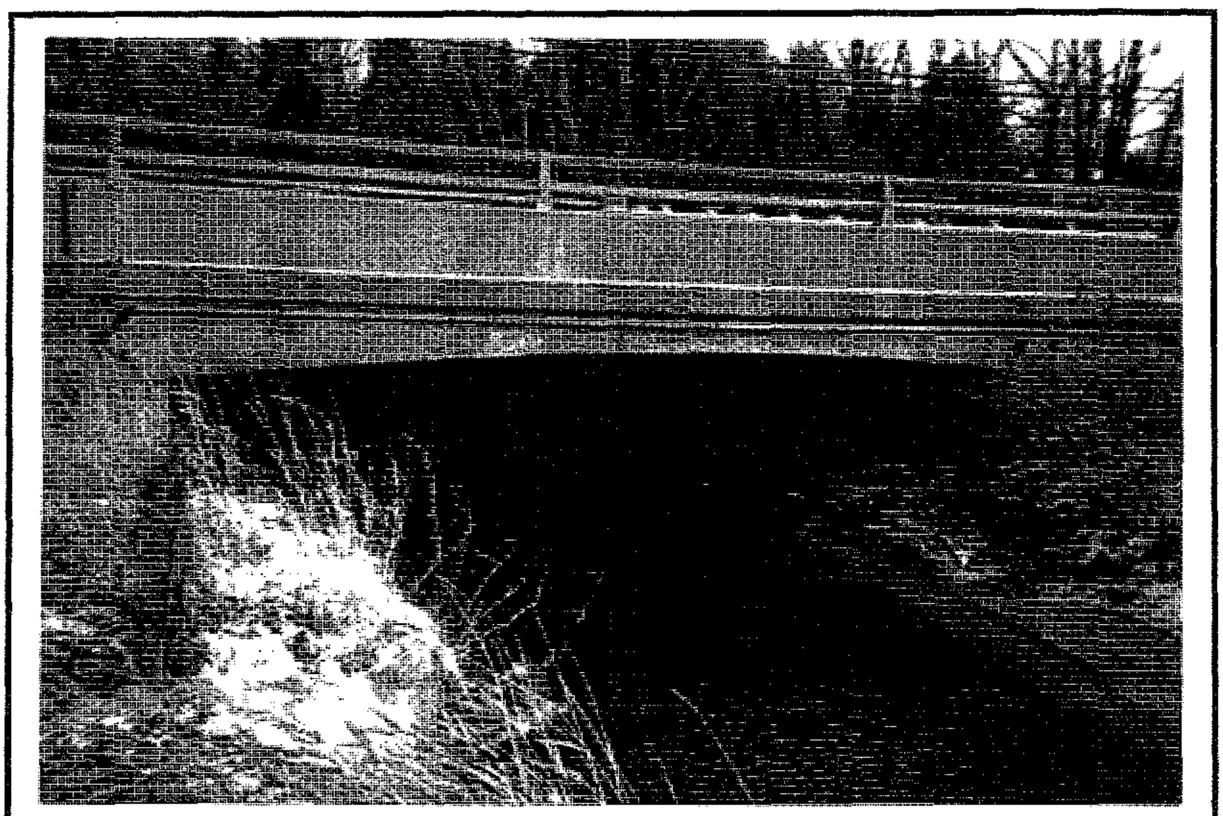


Photo #9: Upstream view of the tributary of Middle Sixteen Mile Creek structure at Steeles Avenue.

Culvert Assessment Summary

Survey Date: Dec.22/98, Mar.30/99

Culvert Identification

Culvert ID: 7

Location: Steeles Avenue West, 100 m East of Sixth Line South

Watercourse: Drain 4-3

Culvert Data

Shape:	Circular	Manning's n:	0.024
Material:	Corrugated Steel	Ke:	0.9
Size (h*w/dia):	750 mm	Flood Criteria:	10 year
Length:	23.0 m	EP Elevation:	102.07 m
Skew No.:	30	AHW:	101.77 m

	Inlet	Outlet
Type:	Projecting	Projecting
Obvert:	100.75 m	100.64 m
Design Invert:	N/A	N/A
Actual Invert:	100.00 m	99.91 m
Sediment Depth:	N/A	N/A

Comments: Both the inlet and outlet are in good condition.

Note: An elevation of 100.0 m was assumed for the upstream invert (North side).

Photo #10: View of the inlet from the North side of Steeles Avenue.

Culvert Assessment Summary

Survey Date: Mar. 30/99

Culvert Identification

Culvert ID: 7A

Location: Steeles Avenue West, 44 m East of Sixth Line North

Watercourse: Drain 4-3

Culvert Data

Shape:	Circular	Manning's n:	0.024
Material:	Corrugated Steel	Ke:	0.9
Size (h*w/dia):	750 mm	Flood Criteria:	N/A
Length:	+/-65.0 m	EP Elevation:	N/A
Skew No.:	N/A	AHW:	N/A

	Inlet	**Outlet**
Type:	Projecting	Projecting
Obvert:	100.53 m	98.76 m
Design Invert:	N/A	N/A
Actual Invert:	99.76 m	97.98 ,m
Sediment Depth:	N/A	N/A

Comments: Enclosure of Drain 4-3 through park at Sixth Line South and Steeles Avenue, draining into the tributary of Middle Sixteen Mile Creek .

Note: An elevation of 100.0 m was assumed from culvert #7.

Photo #11: Looking from the South side of Steeles at the oulet of #7 and the inlet of #7A.

Culvert Assessment Summary

Survey Date: Dec. 22/98

Culvert Identification

Culvert ID: 8
Location: Steeles Avenue West, 210 m West of Hornby Road
Watercourse: Middle Sixteen Mile Creek, Hornby Tributary

Culvert Data

Shape:	Bridge	Manning's n:	0.013
Material:	Concrete	Ke:	0.5
Size (h*w/dia):	1.95 x 7.7 m	Flood Criteria:	100 year
Length:	8.5 m	EP Elevation:	196.50 m
Skew No.:	30	AHW:	196.20 m

	Inlet	**Outlet**
Type:	Headwall	Headwall
Obvert:	196.40 m	196.40 m
Design Invert:	N/A	N/A
Actual Invert:	194.40 m	194.30 m
Sediment Depth:	N/A	N/A

Comments: Bridge is in good condition.

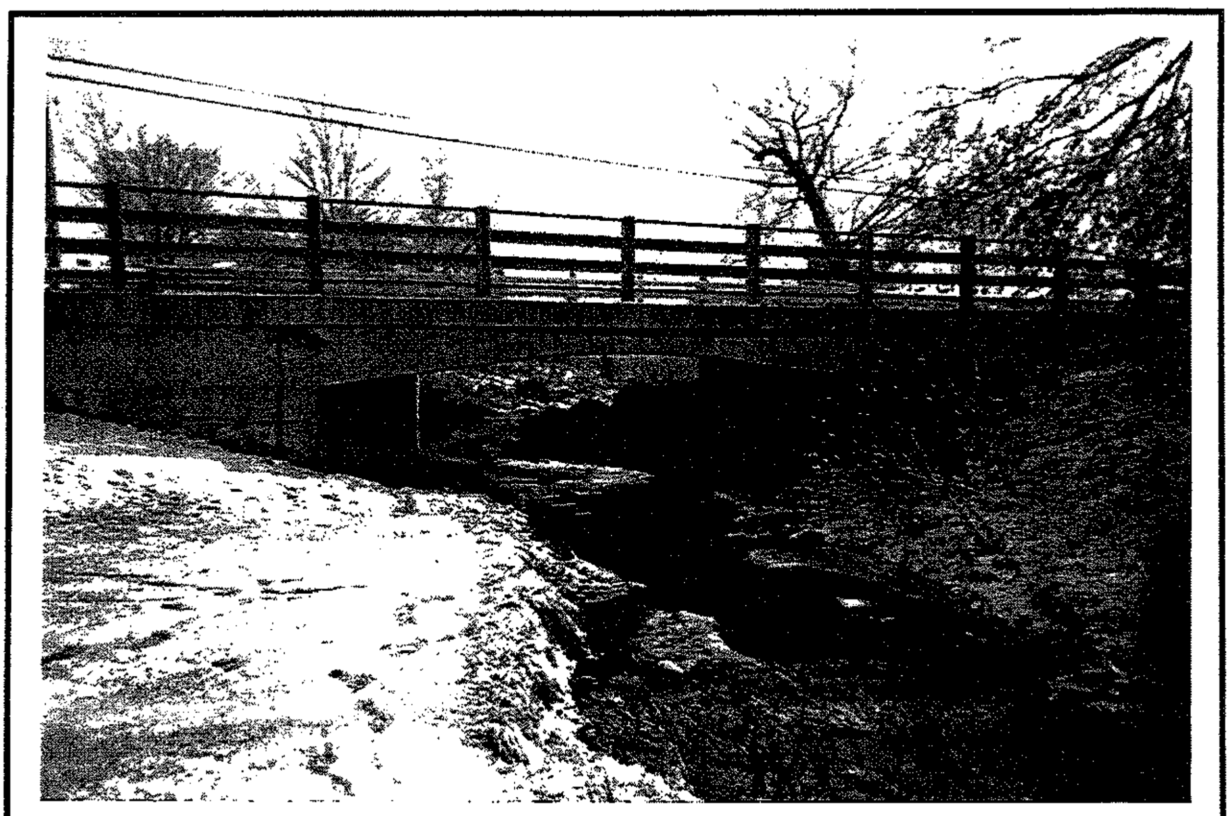


Photo #12: Upstream view of the Hornby Tributary structure at Steeles Avenue.

Culvert Assessment Summary

Survey Date: Dec. 22/98

Culvert Identification

Culvert ID: 9
Location: Steeles Avenue West, 170 m East of Trafalgar Road
Watercourse: Drain 4-4

Culvert Data

Shape:	Circular	Manning's n:	0.024
Material:	Corrugated Steel	Ke:	0.9
Size (h*w/dia):	900 mm	Flood Criteria:	10 year
Length:	25.0 m	EP Elevation:	207.5 m
Skew No.:	90	AHW:	207.2 m

	Inlet	Outlet
Type:	Projecting	Projecting
Obvert:	206.20 m	205.90 m
Design Invert:	205.30 m	205.00 m
Actual Invert:	N/A	N/A
Sediment Depth:	N/A	N/A

Comments: Culvert is in good condition.

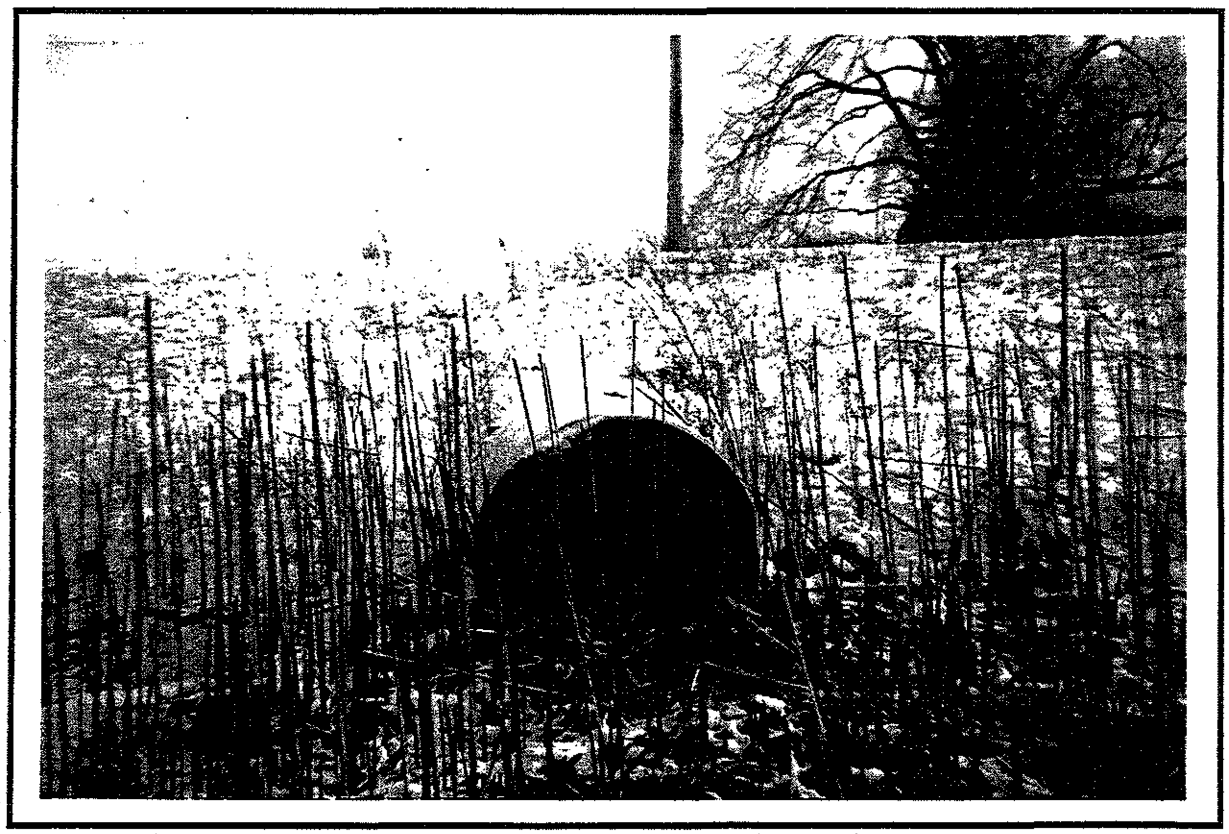


Photo #13: Looking at the outlet of the cross culvert on the North side of Steeles Avenue.

Culvert Assessment Summary

Survey Date: Dec. 22/98

Culvert Identification

Culvert ID: 10

Location: Steeles Avenue West, 170 m East of Eighth Line North

Watercourse: East Sixteen Mile Creek

Culvert Data

Shape:	Bridge	Manning's n:	0.013
Material:	Concrete	Ke:	0.5
Size (h*w/dia):	2.3 x 12.3 m	Flood Criteria:	100 year
Length:	8.0 m	EP Elevation:	203.20 m
Skew No.:	90	AHW:	202.90 m

	Inlet	**Outlet**
Type:	Headwall	Headwall
Obvert:	202.40 m	202.40 m
Design Invert:	N/A	N/A
Actual Invert:	199.25 m	200.05 m
Sediment Depth:	N/A	N/A

Comments: Bridge is in good condition.

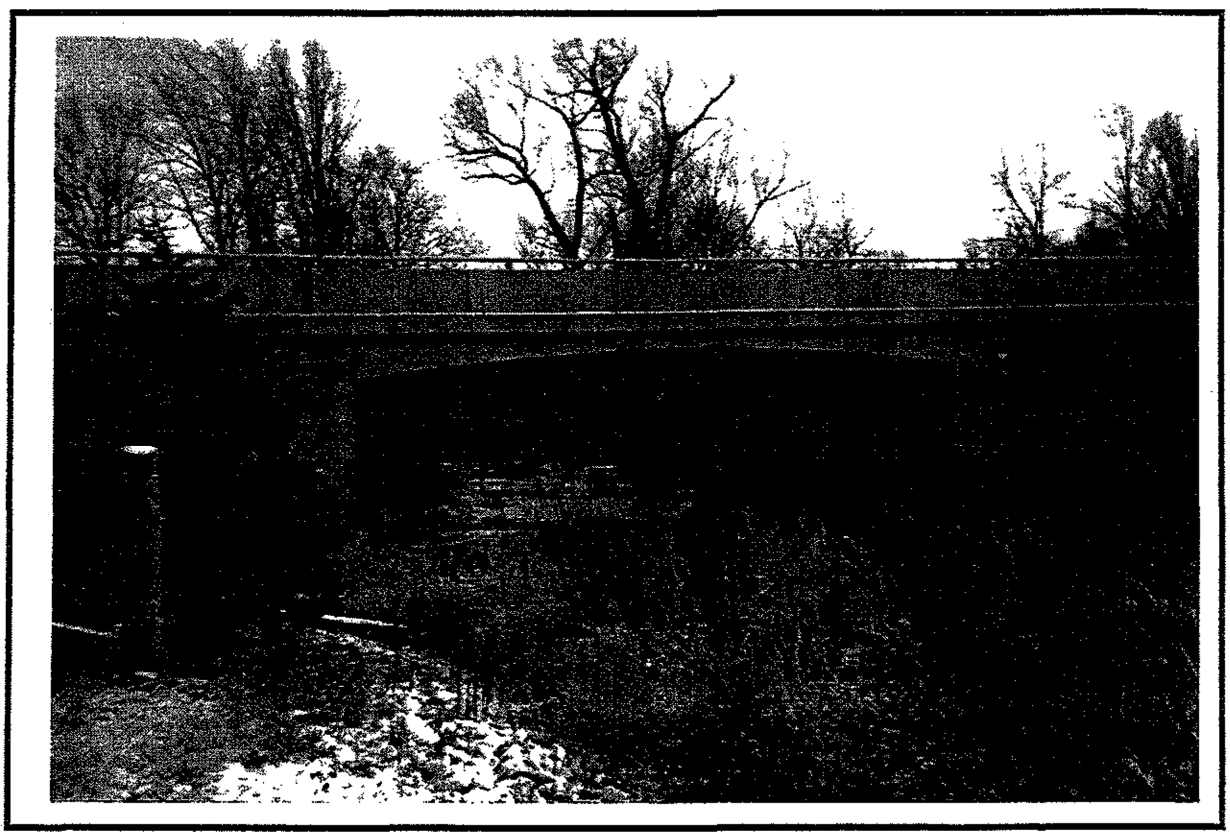


Photo #14: Upstream view of the East Sixteen Mile Creek bridge at Steeles Avenue.

Culvert Assessment Summary

Survey Date: Mar. 30/99

Culvert Identification

Culvert ID: 11

Location: Steeles Avenue West, 335 m East of Eighth Line

Watercourse: Ditch Drainage

Culvert Data

Shape:	Circular	Manning's n:	0.024
Material:	Corrugated Steel	Ke:	0.9
Size (h*w/dia):	750 mm	Flood Criteria:	10 year
Length:	24.0 m	EP Elevation:	207.10 m
Skew No.:	30	AHW:	206.80 m

	Inlet	**Outlet**
Type:	Projecting	Projecting
Obvert:	206.45 m	206.25 m
Design Invert:	205.70 m	205.50 m
Actual Invert:	206.05 m	205.67 m
Sediment Depth:	0.35 m	0.17 m

Comments: Culvert is in poor condition with the inlet silted up and blocked by vegetation.

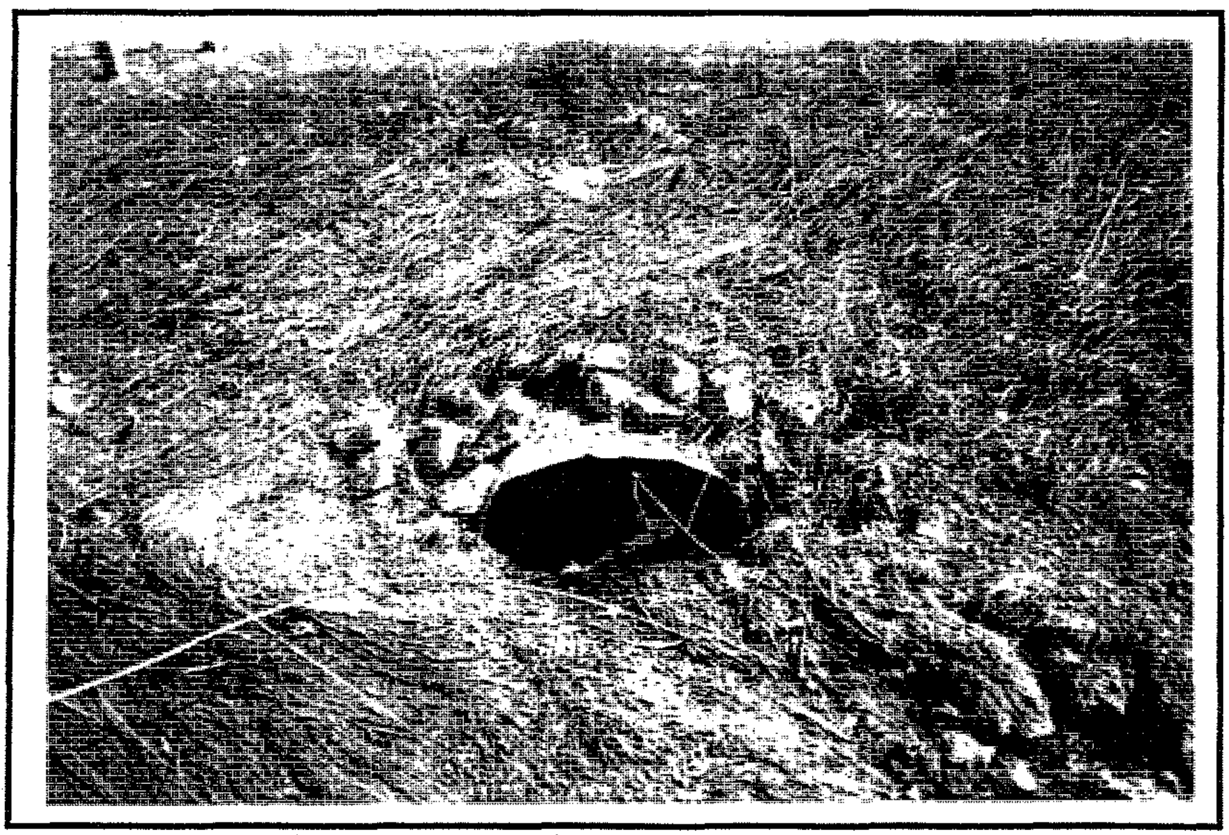


Photo #15: Upstream view of the inlet on the North side of Steeles Avenue.

Culvert Assessment Summary

Survey Date: Jan. 21/99

Culvert Identification

Culvert ID: 12
Location: Steeles Avenue West, 15 m East of Ninth Line North
Watercourse: Ditch Drainage

Culvert Data

Shape:	Circular	Manning's n:	0.024
Material:	Corrugated Steel	Ke:	0.9
Size (h*w/dia):	900 mm	Flood Criteria:	10 year
Length:	27.5 m	EP Elevation:	215.30 m
Skew No.:	15	AHW:	215.00 m

	Inlet	**Outlet**
Type:	Projecting	Projecting
Obvert:	214.85 m	214.75 m
Design Invert:	213.95 m	213.85 m
Actual Invert:	N/A	N/A
Sediment Depth:	N/A	N/A

Comments: Culvert appeared to be in good condition at the time of the survey.

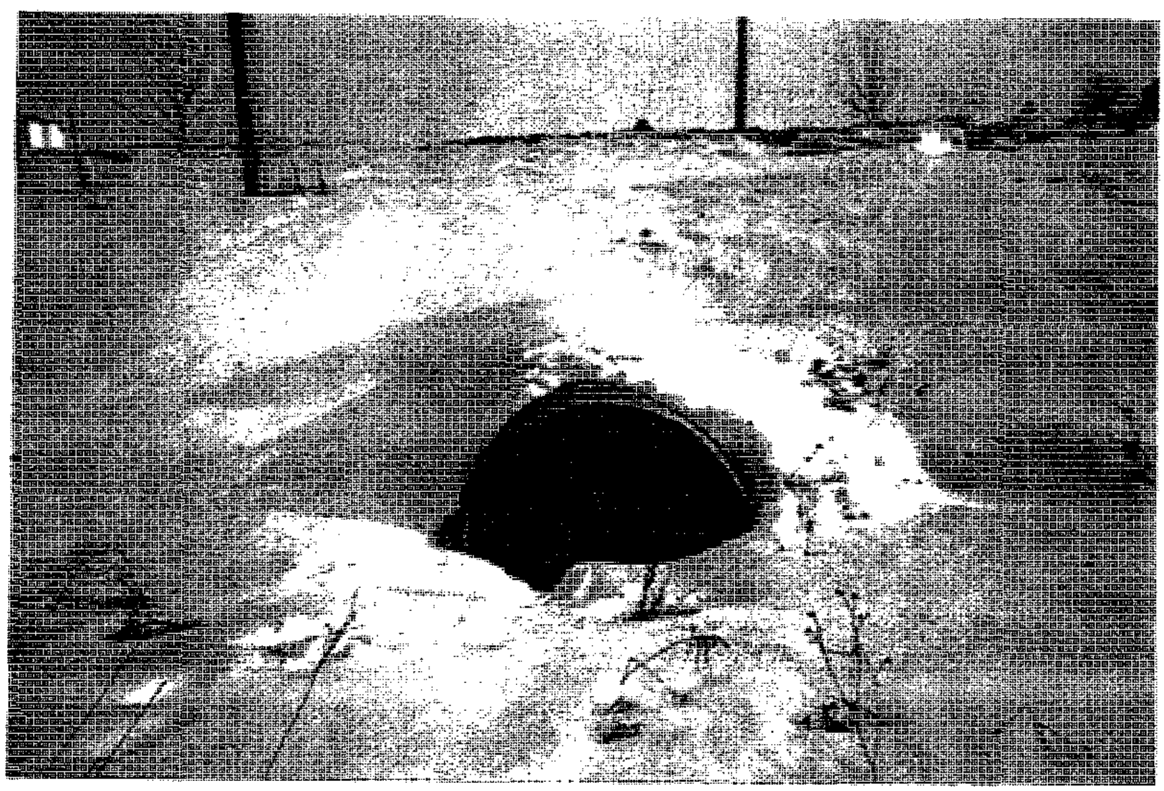


Photo #16: View of the inlet on from the ditch on the North side of Steeles Avenue.

Culvert Assessment Summary

Survey Date: Dec.22/98

Culvert Identification

Culvert ID: 13
Location: Steeles Avenue West, 150 m East of Ninth Line North
Watercourse: Drain 6-1

Culvert Data

Shape:	Circular	Manning's n:	0.024
Material:	Corrugated Steel	Ke:	0.9
Size (h*w/dia):	1200 mm	Flood Criteria:	10 year
Length:	26.0 m	EP Elevation:	215.30 m
Skew No.:	15	AHW:	215.00 m

	Inlet	Outlet
Type:	Projecting	Projecting
Obvert:	214.62 m	214.40 m
Design Invert:	213.42 m	213.20 m
Actual Invert:	N/A	N/A
Sediment Depth:	N/A	N/A

Comments: Culvert is in good condition.

Photo #17: Upstream view of the cross culvert for Drain 6-1 at Steeles Avenue.

Culvert Assessment Summary

Survey Date: Dec.22/98, Mar.30/99

Culvert Identification

Culvert ID:	14
Location:	Steeles Avenue West, 210 m West of Ninth Line South
Watercourse:	Drain 6-2

Culvert Data

Shape:	Arch	Manning's n:	0.024
Material:	Corrugated Steel	Ke:	0.9
Size (h*w/dia):	970 x 1390 mm	Flood Criteria:	10 year
Length:	21.0 m	EP Elevation:	216.80 m
Skew No.:	30	AHW:	216.50 m

	Inlet	Outlet
Type:	Gabion Headwall	Projecting
Obvert:	216.03 m	215.88 m
Design Invert:	215.06 m	214.91 m
Actual Invert:	N/A	N/A
Sediment Depth:	N/A	N/A

Comments: Both the inlet and outlet of the culvert are in good condition, along with the gabion basket headwall. The twin 5 m, 600 mm C.S.P.'s from the pond are rusted and dented.

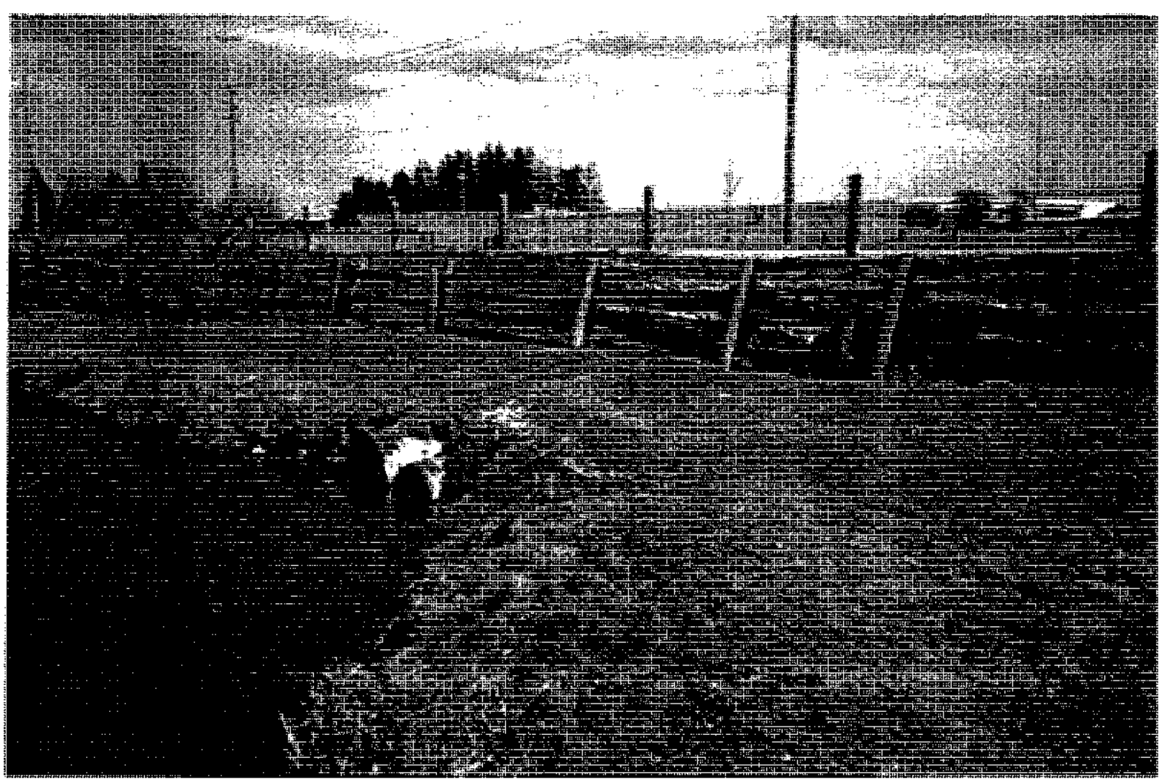


Photo #18: Looking at the upstream side of the culvert and the pond outlet.

Culvert Assessment Summary

Survey Date: Dec.22/98

Culvert Identification

Culvert ID:	15
Location:	Steeles Avenue West, 95 m West of Ninth Line South
Watercourse:	Ditch Drainage

Culvert Data

Shape:	Circular	Manning's n:	0.024
Material:	Corrugated Steel	Ke:	0.9
Size (h*w/dia):	600 mm	Flood Criteria:	10 year
Length:	24.0 m	EP Elevation:	217.80 m
Skew No.:	22	AHW:	217.50 m

	Inlet	**Outlet**
Type:	Projecting	Projecting
Obvert:	216.86 m	216.69 m
Design Invert:	216.26 m	216.09 m
Actual Invert:	N/A	N/A
Sediment Depth:	N/A	N/A

Comments: Culvert is in good condition.

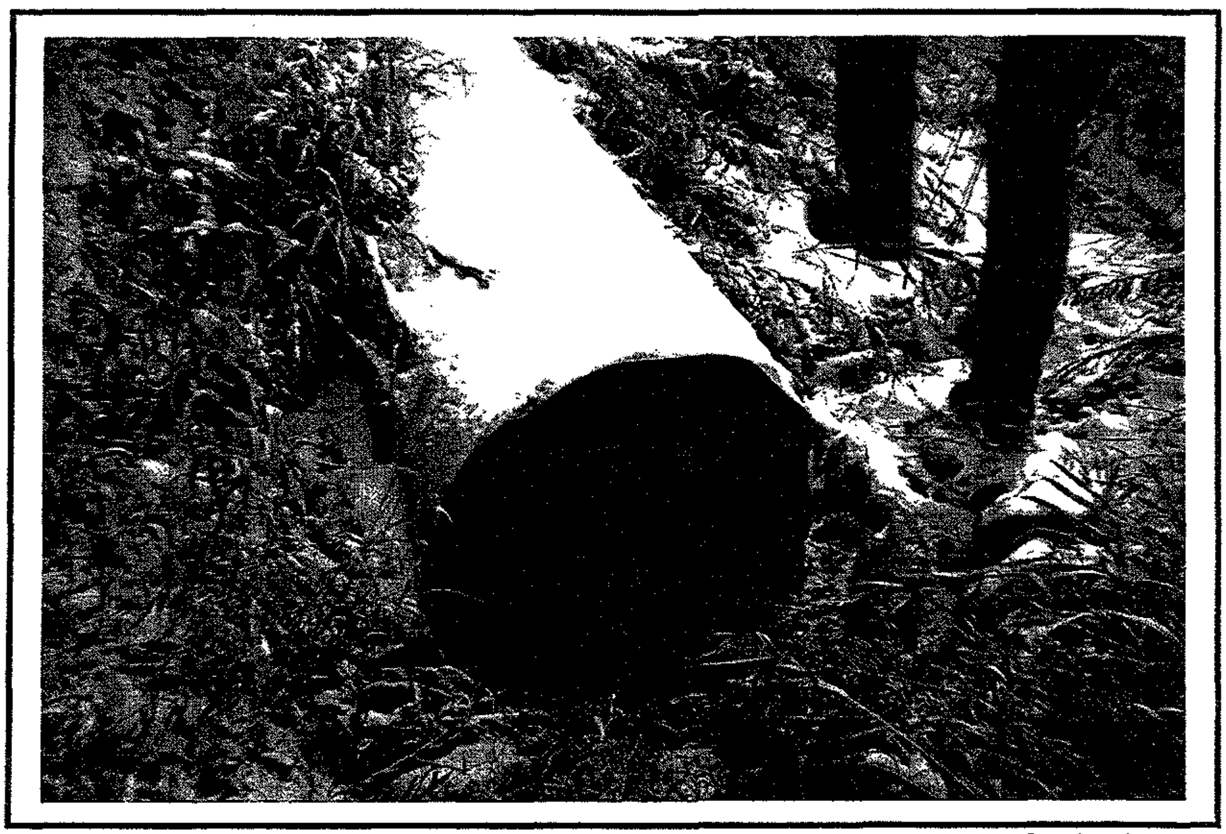


Photo #19: Looking at the inlet of the cross culvert from the ditch on the North Side of Steeles Avenue.

Culvert Assessment Summary

Survey Date: Dec. 22/98, Mar. 30/99

Culvert Identification

Culvert ID: 16
Location: Steeles Avenue West, 270 m East of Ninth Line South
Watercourse: Drain 6-3

Culvert Data

Shape:	Circular	Manning's n:	0.024
Material:	Corrugated Steel	Ke:	0.9
Size (h*w/dia):	900 mm	Flood Criteria:	10 year
Length:	19.5 m	EP Elevation:	101.31 m
Skew No.:	90	AHW:	101.01 m

	Inlet	Outlet
Type:	Projecting	Projecting
Obvert:	100.74 m	100.67 m
Design Invert:	99.84 m	99.77 m
Actual Invert:	100.00 m	99.99 m
Sediment Depth:	0.16 m	0.22 m

Comments: Inlet of culvert is torn and has separated apart, silted up and blocked by heavy vegetation. Outlet appears to be in good condition.

Note: An elevation of 100.0 m was assumed at the upstream invert of the culvert.

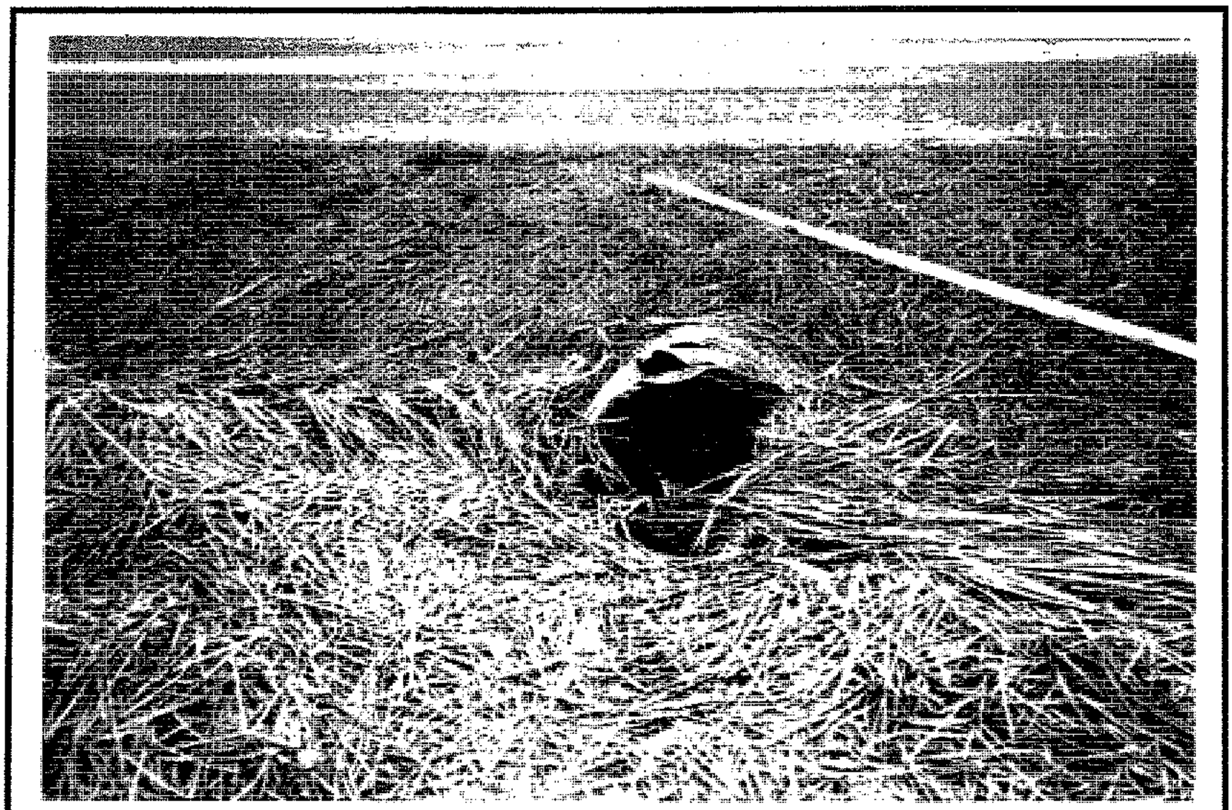


Photo #20: Upstream view of the cross culvert for Drain 6-3 at Steeles Avenue.

Culvert Assessment Summary

Survey Date: Dec. 22/98, Mar. 30/99

Culvert Identification

Culvert ID: 17

Location: Steeles Avenue West, 219 m West of Tenth Line North

Watercourse: Ditch Drainage

Culvert Data

Shape:	Circular	Manning's n:	0.024
Material:	Corrugated Steel	Ke:	0.9
Size (h*w/dia):	1050 mm	Flood Criteria:	10 year
Length:	23.5 m	EP Elevation:	101.22 m
Skew No.:	30	AHW:	100.92 m

	Inlet	**Outlet**
Type:	Projecting	Projecting
Obvert:	100.87 m	10.81 m
Design Invert:	99.82 m	99.76 m
Actual Invert:	100.21 m	100.11 m
Sediment Depth:	0.39 m	0.35 m

Comments: Inlet of culvert is torn and silted up. Outlet is also silted up and is blocked by thick vegetation.

Note: An elevation of 100.0 m was assumed at the upstream invert of #16.

Photo #21: View of the inlet from the North side of Steeles Avenue.

Culvert Assessment Summary

Survey Date: Feb. 14/99, Mar.30/99

Culvert Identification

Culvert ID: 18

Location: Steeles Avenue West, 10 m West of Tenth Line North

Watercourse: Ditch Drainage

Culvert Data

Shape:	Arch	Manning's n:	0.024
Material:	Corrugated Steel	Ke:	0.9
Size (h*w/dia):	Twin 740x1030 mm	Flood Criteria:	10 year
Length:	23.5 m	EP Elevation:	215.90 m
Skew No.:	30	AHW:	215.60 m

	Inlet	**Outlet**
Type:	Projecting	Projecting
Obvert:	215.45 m	214.86 m
Design Invert:	214.71 m	214.14 m
Actual Invert:	N/A	N/A
Sediment Depth:	N/A	N/A

Comments: Inlet and oulet are both silted up, but are in good condition

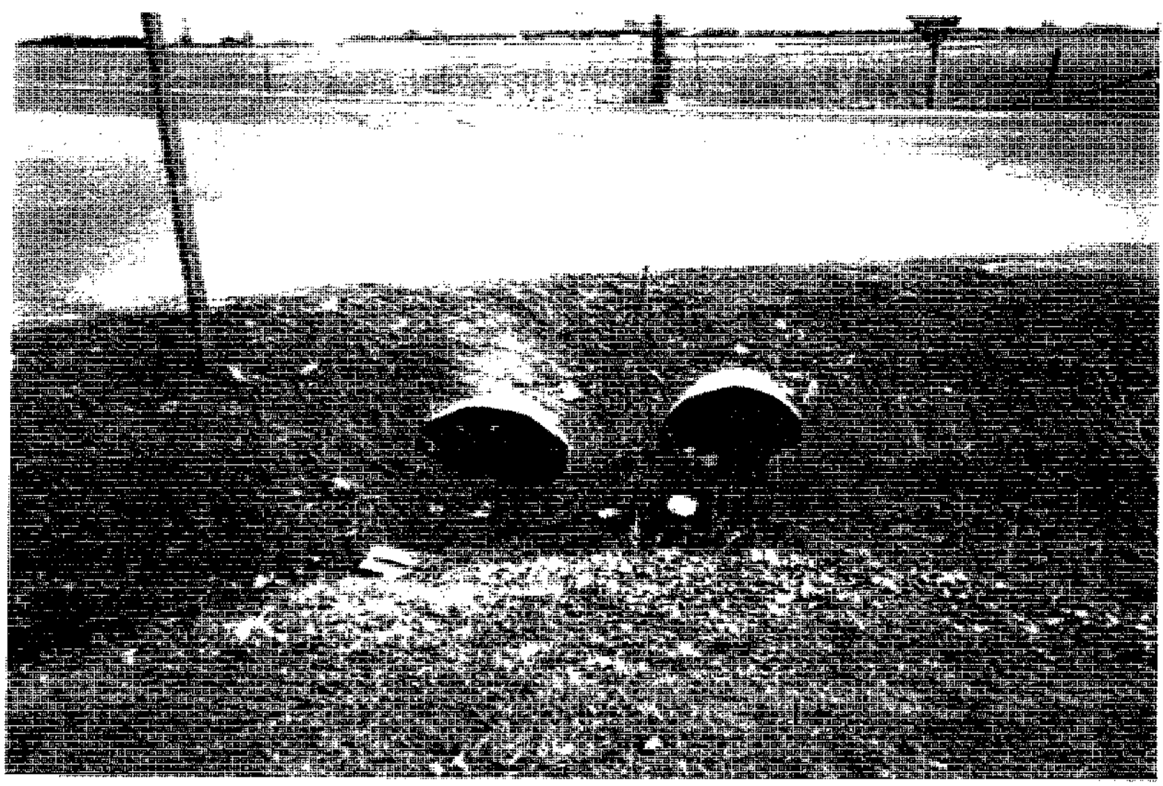


Photo #22: Looking at the culvert inlets from the Northwest corner of Steeles Avenue and Tenth Line.

Culvert Assessment Summary

Survey Date: Dec. 22/98

Culvert Identification

Culvert ID: 19
Location: Steeles Avenue West, 75 m East of Tenth Line North
Watercourse: Drain 6-4

Culvert Data

Shape:	Arch	Manning's n:	0.024
Material:	Corrugated Steel	Ke:	0.9
Size (h*w/dia):	Twin 970x1390 mm	Flood Criteria:	10 year
Length:	20.0 m	EP Elevation:	216.00 m
Skew No.:	90	AHW:	215.70 m

	Inlet	**Outlet**
Type:	Projecting	Projecting
Obvert:	215.19 m	215.02 m
Design Invert:	214.22 m	214.05 m
Actual Invert:	N/A	N/A
Sediment Depth:	N/A	N/A

Comments: Culvert's are in good condition.

Photo #23: Upstream view of Steeles culverts of Drain 6-4.

Culvert Assessment Summary

Survey Date: Mar. 30/99

Culvert Identification

Culvert ID:	19A
Location:	Steeles Avenue West, 35 m West of Winston Churchill Boulevard
Watercourse:	Ditch Drainage

Culvert Data

Shape:	Circular	Manning's n:	0.024
Material:	Corrugated Steel	Ke:	0.9
Size (h*w/dia):	600 mm	Flood Criteria:	10 year
Length:	25.0 m	EP Elevation:	101.33 m
Skew No.:	90	AHW:	101.03 m

	Inlet	Outlet
Type:	Projecting	Projecting
Obvert:	100.64 m	100.50 m
Design Invert:	100.04 m	99.90 m
Actual Invert:	100.00 m	100.07 m
Sediment Depth:	N/A	0.17 m

Comments: Culvert is in good condition.

Note: An elevation of 100.0 m was assumed at the upstream invert on the North sid

Photo #24: View of the inlet on the North Side of Steeles Avenue.

Culvert Assessment Summary

Survey Date: Feb. 14/99, Mar. 30/99

Culvert Identification

Culvert ID: 20

Location: Winston Churchill Boulevard, 76 m South of Steeles Avenue

Watercourse: Ditch Drainage

Culvert Data

Shape:	Circular	Manning's n:	0.024
Material:	Corrugated Steel	Ke:	0.9
Size (h*w/dia):	Twin 600 mm	Flood Criteria:	N/A
Length:	16.1 m	EP Elevation:	207.75 m
Skew No.:	15	AHW:	207.45 m

	Inlet	**Outlet**
Type:	Projecting	Projecting
Obvert:	207.40 m	207.30 m
Design Invert:	207.80 m	206.70 m
Actual Invert:	N/A	N/A
Sediment Depth:	N/A	0.17 m

Comments: Culverts are in good condition.

Photo #25: View of the inlets from the West side of Winston Churchill Boulevard.

Culvert Assessment Summary

Survey Date: Feb. 14/99, Mar. 30/99

Culvert Identification

Culvert ID: 21

Location: Tenth Line South at Steeles Avenue West

Watercourse: Ditch Drainage

Culvert Data

Shape:	Circular	Manning's n:	0.024
Material:	Corrugated Steel	Ke:	0.9
Size (h*w/dia):	600 mm	Flood Criteria:	N/A
Length:	23	EP Elevation:	211.13 m
Skew No.:	90	AHW:	210.83 m

	Inlet	Outlet
Type:	Projecting	Projecting
Obvert:	210.67 m	210.26 m
Design Invert:	210.07 m	209.66 m
Actual Invert:	210.09 m	209.83 m
Sediment Depth:	0.02 m	0.17 m

Comments: Culvert is in good condition.

Photo #26: View of the inlet on the West side of Tenth Line South.

Culvert Assessment Summary

Survey Date: Mar. 30/99

Culvert Identification

Culvert ID:	22
Location:	Ninth Line South at Steeles Avenue West
Watercourse:	Ditch Drainage

Culvert Data

Shape:	Circular	Manning's n:	0.024
Material:	Corrugated Steel	Ke:	0.9
Size (h*w/dia):	600 mm	Flood Criteria:	N/A
Length:	23.7 m	EP Elevation:	100.76 m
Skew No.:	90	AHW:	100.46 m

	Inlet	**Outlet**
Type:	Projecting	Projecting
Obvert:	100.45 m	100.09 m
Design Invert:	N/A	N/A
Actual Invert:	100.00 m	99.98 m
Sediment Depth:	0.15 m	0.11 m

Comments: Culvert is in good condition.

Note: An elevation of 100.0 m was assumed at the upstream invert on the East side

Photo #27: Looking West at the inlet of the Ninth Line South cross culvert.

Culvert Assessment Summary

Survey Date: Jan. 21/99

Culvert Identification

Culvert ID: 23

Location: Ninth Line North at Steeles Avenue West

Watercourse: Ditch Drainage

Culvert Data

Shape:	Circular	Manning's n:	0.024
Material:	Corrugated Steel	Ke:	0.9
Size (h*w/dia):	800 mm	Flood Criteria:	N/A
Length:	34.0 m	EP Elevation:	215.40 m
Skew No.:	90	AHW:	215.10 m

	Inlet	**Outlet**
Type:	Projecting	Projecting
Obvert:	214.92 m	214.85 m
Design Invert:	214.12 m	214.05 m
Actual Invert:	N/A	N/A
Sediment Depth:	N/A	N/A

Comments: Culvert oulet appeared to be in good condition at time of survey.

Photo #28: Outlet of the Ninth Line North cross culvert.

Culvert Assessment Summary

Survey Date: Mar. 30/99

Culvert Identification

Culvert ID: 24

Location: Eighth Line South at Steeles Avenue West

Watercourse: Ditch Drainage

Culvert Data

Shape:	Circular	Manning's n:	0.024
Material:	Corrugated Steel	Ke:	0.9
Size (h*w/dia):	60 mm	Flood Criteria:	N/A
Length:	25.0 m	EP Elevation:	213.10 m
Skew No.:	90	AHW:	212.80 m

	Inlet	Outlet
Type:	Projecting	Projecting
Obvert:	212.00 m	211.70 m
Design Invert:	211.40 m	211.10 m
Actual Invert:	N/A	N/A
Sediment Depth:	N/A	N/A

Comments: Culvert is in good condition.

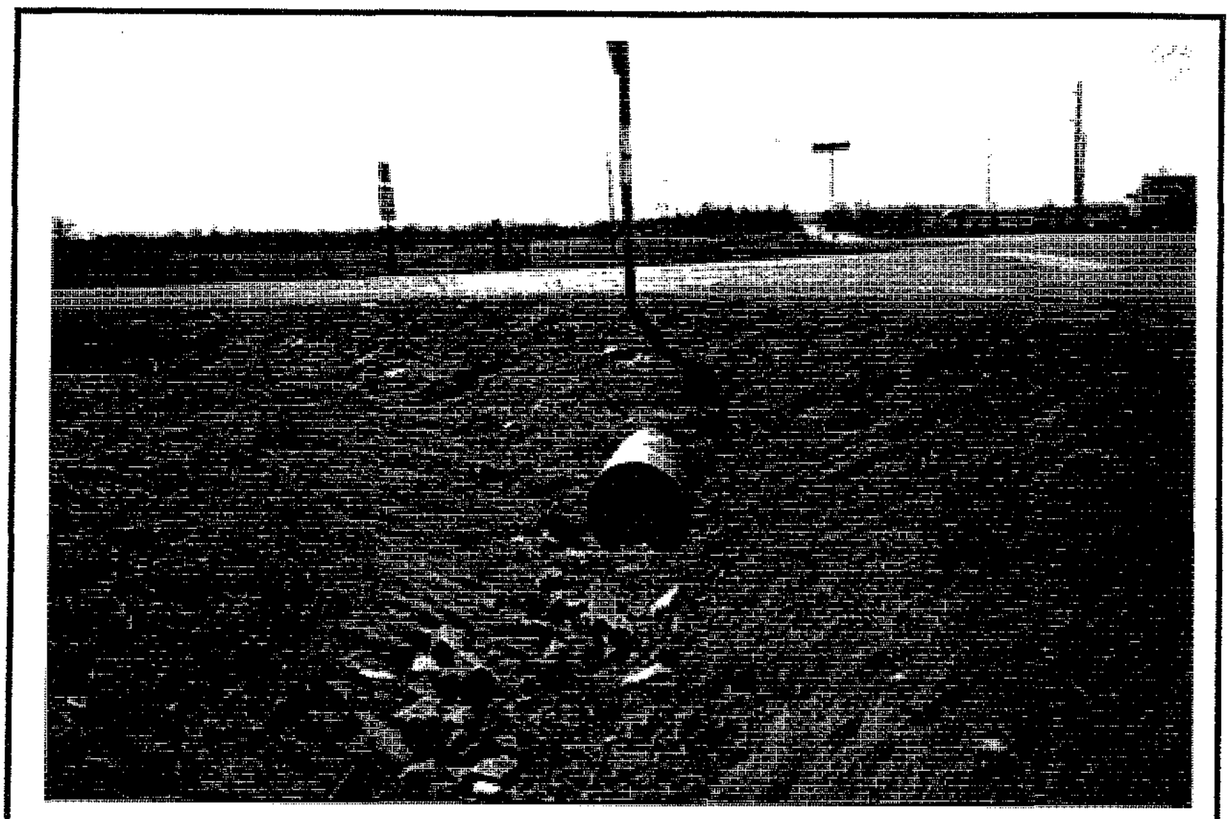


Photo #29: Looking West at the inlet of the cross culvert.

Culvert Assessment Summary

Survey Date: Jan. 21/99

Culvert Identification

Culvert ID: 25

Location: Sixth Line South at Steeles Avenue West

Watercourse: Middle Sixteen Mile Creek Tributary

Culvert Data

Shape:	Bridge	Manning's n:	0.013
Material:	Concrete	Ke:	0.5
Size (h*w/dia):	2.6 x 9.1 m	Flood Criteria:	100 year
Length:	8.7 m	EP Elevation:	193.00 m
Skew No.:	90	AHW:	192.70 m

	Inlet	**Outlet**
Type:	Headwall	Headwall
Obvert:	192.90 m	192.90 m
Design Invert:	N/A	N/A
Actual Invert:	190.13 m	190.76 m
Sediment Depth:	N/A	N/A

Comments: Bridge is in good condition.

Photo #30: Downstream view of bridge south of Steeles Avenue.

Culvert Assessment Summary

Survey Date: Mar. 30/99

Culvert Identification

Culvert ID: 26

Location: Fifth Line South, 210 m South of Steeles Avenue West

Watercourse: Middle Sixteen Mile Creek

Culvert Data

Shape:	Bridge	Manning's n:	0.013
Material:	Concrete	Ke:	0.5
Size (h*w/dia):	2.1 x 18.3 m	Flood Criteria:	50 year
Length:	8.6 m	EP Elevation:	196.60 m
Skew No.:	90	AHW:	196.30 m

	Inlet	**Outlet**
Type:	Headwall	Headwall
Obvert:	195.80 m	195.80 m
Design Invert:	N/A	N/A
Actual Invert:	193.70 m	193.60 m
Sediment Depth:	N/A	N/A

Comments: Bridge is in good condition.

Photo #31: Looking at the upstream face of the Fifth Line South structure.

Culvert Assessment Summary

Survey Date: Feb. 14/99, Mar. 30/99

Culvert Identification

Culvert ID: 27

Location: Fifth Line North, 550 m North of Steeles Avenue West

Watercourse: Mansewood Tributary

Culvert Data

Shape:	Box	Manning's n:	0.013
Material:	Concrete	Ke:	0.5
Size (h*w/dia):	2.13 x 2.4 m	Flood Criteria:	25 year
Length:	11.6 m	EP Elevation:	202.63 m
Skew No.:	20	AHW:	202.33 m

	Inlet	**Outlet**
Type:	Headwall	Headwall
Obvert:	202.11 m	202.10 m
Design Invert:	N/A	N/A
Actual Invert:	199.98 m	200.03 m
Sediment Depth:	N/A	N/A

Comments: Culvert is in good condition.

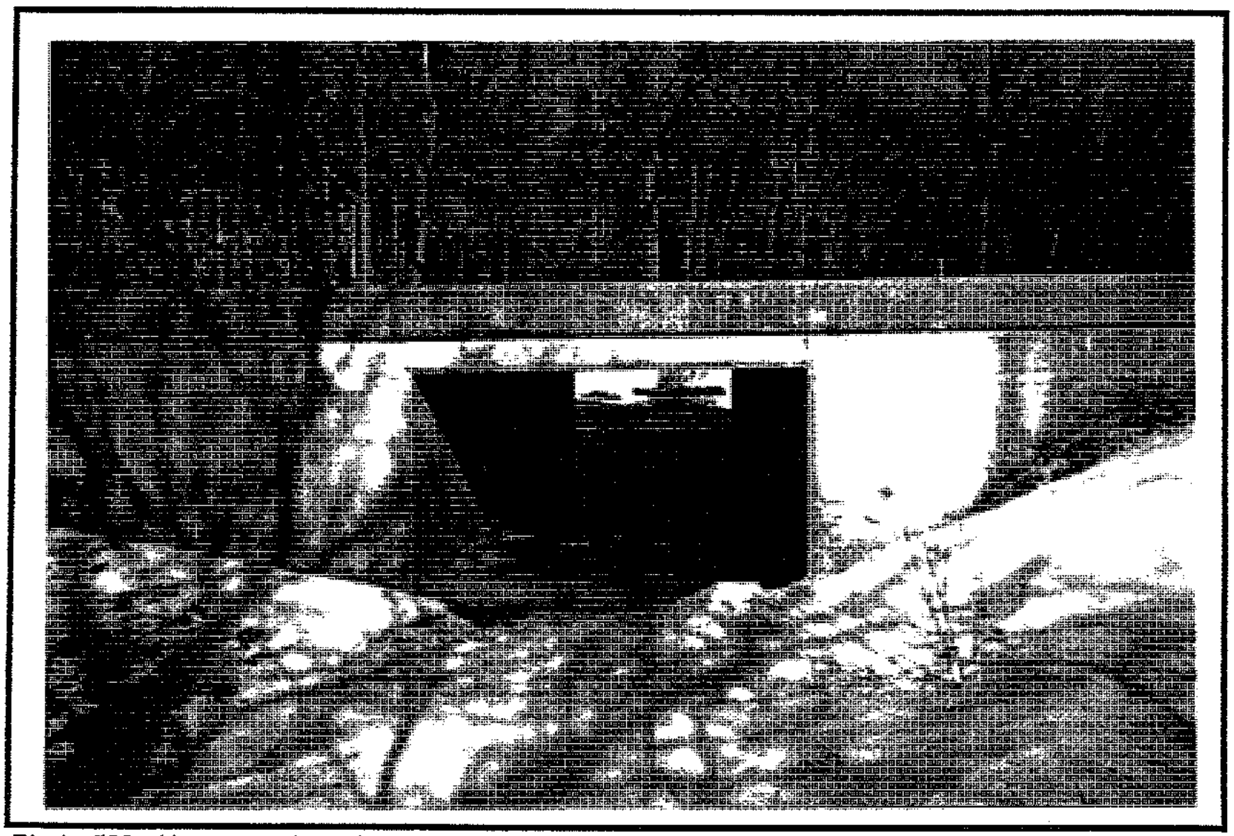


Photo #32: Upstream view of the culvert from the west side of Fifth Line North.

Culvert Assessment Summary

Survey Date: Mar. 30/99

Culvert Identification

Culvert ID: 28
Location: James Snow Parkway at Steeles Avenue West
Watercourse: Ditch Drainage

Culvert Data

Shape:	Circular	Manning's n:	0.024
Material:	Corrugated Steel	Ke:	0.9
Size (h*w/dia):	750 mm	Flood Criteria:	N/A
Length:	38.0 m	EP Elevation:	101.23 m
Skew No.:	30	AHW:	100.93 m

	Inlet	Outlet
Type:	Projecting	Projecting
Obvert:	100.53 m	100.45 m
Design Invert:	99.78 m	99.70 m
Actual Invert:	100.00 m	100.00 m
Sediment Depth:	0.22 m	0.30 m

Comments: Culvert is in good condition.

Note: An elevation of 100.0 m was assumed at the upstream invert (West side).

Photo #33: Inlet of cross culvert at James Snow Parkway and Steeles Avenue.

Culvert Assessment Summary

Survey Date: Mar. 30/99, Apr. 6/99

Culvert Identification

Culvert ID: 29

Location: Fifth Line South, 175 m South of Highway 401

Watercourse: Drain 3-1/401 Tributary

Culvert Data

Shape:	Box	Manning's n:	0.013
Material:	Concrete	Ke:	0.5
Size (h*w/dia):	1.95 x 2.95 m	Flood Criteria:	25 year
Length:	17.3 m	EP Elevation:	193.20 m
Skew No.:	90	AHW:	192.9 m

	Inlet	**Outlet**
Type:	Projecting	Projecting
Obvert:	192.20 m	192.10 m
Design Invert:	N/A	N/A
Actual Invert:	190.40 m	190.30 m
Sediment Depth:	N/A	N/A

Comments: Culvert is in fair condition, some spalling and cracking on both the upstream and downstream sides. Heavy sediment build up inside the culvert.

Photo #34: Upstream view of the culvert from the West side of Fifth Line.

Culvert Assessment Summary

Survey Date: Mar. 30/99

Culvert Identification

Culvert ID: 30
Location: Sixth Line South at Highway 401
Watercourse: Drain 4-1

Culvert Data

Shape:	Circular	Manning's n:	0.024
Material:	Corrugated Steel	Ke:	0.9
Size (h*w/dia):	900 mm	Flood Criteria:	N/A
Length:	48.0 m	EP Elevation:	192.5 m
Skew No.:	90	AHW:	192.2 m

	Inlet	**Outlet**
Type:	Projecting	Projecting
Obvert:	190.65 m	190.45 m
Design Invert:	N/A	N/A
Actual Invert:	189.75 m	189.55 m
Sediment Depth:	N/A	N/A

Comments: Culvert is in fair condition.

Photo #35: View of the inlet from the North side of Highway 401 and West side of Sixth Line.

Culvert Assessment Summary

Survey Date: Mar. 30/99, Apr. 13/99

Culvert Identification

Culvert ID: 31

Location: Highway 401, 125 m East of James Snow Parkway

Watercourse: Ditch Drainage

Culvert Data

Shape:	Box	Manning's n:	0.013
Material:	Concrete	Ke:	0.5
Size (h*w/dia):	1.22 x 1.22 m	Flood Criteria:	50 year
Length:	N/A	EP Elevation:	101.70 m
Skew No.:	N/A	AHW:	100.70 m

	Inlet	Outlet
Type:	Projecting	Projecting
Obvert:	100.86 m	N/A
Design Invert:	99.64 m	N/A
Actual Invert:	100.00 m	N/A
Sediment Depth:	0.36 m	N/A

Comments: Culvert is in fair condition.

Note: An elevation of 100.0 m was assumed from the upstream invert.

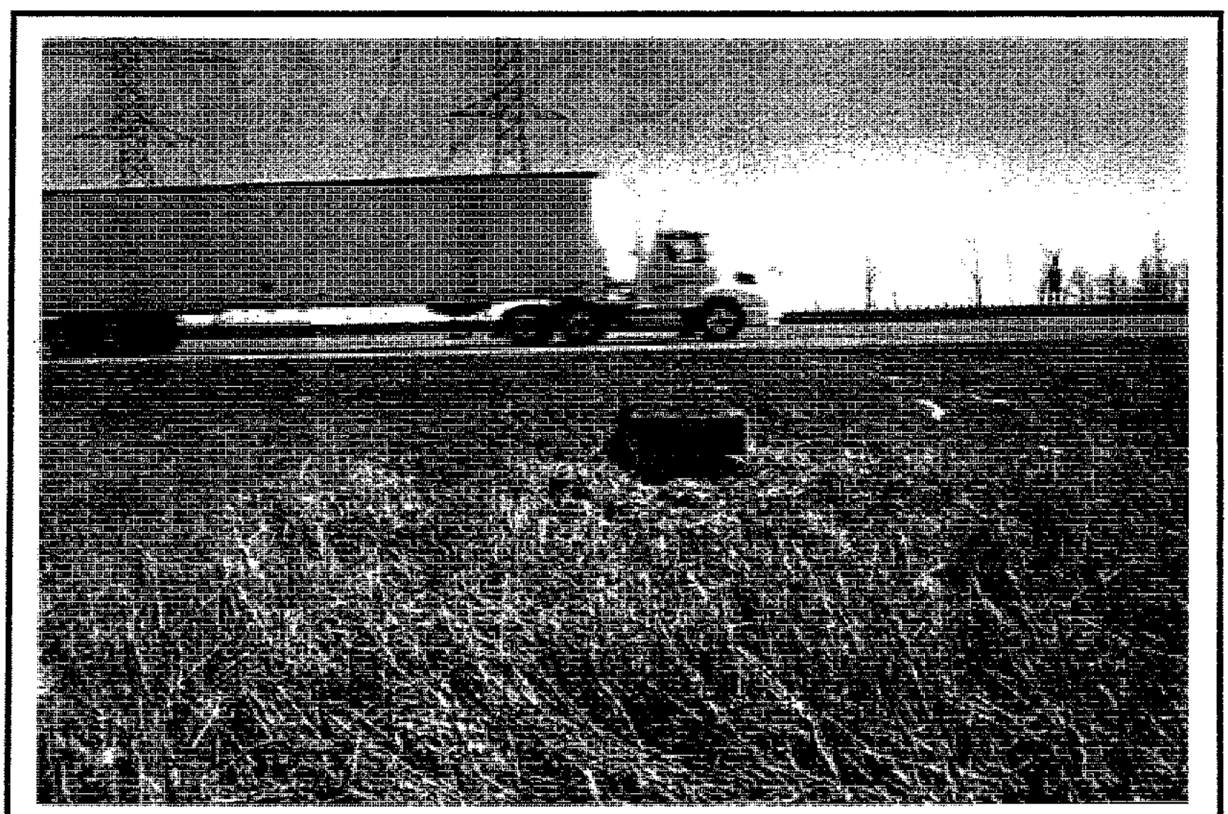


Photo #36: Looking at the upstream face of the culvert from the North side of Highway 401.

Culvert Assessment Summary

Survey Date: Mar. 30/99

Culvert Identification

Culvert ID: 32
Location: Highway 401, 550 m West of Fifth Line South
Watercourse: Drain 3-1

Culvert Data

Shape:	Box	Manning's n:	0.013
Material:	Concrete	Ke:	0.5
Size (h*w/dia):	1.55 x 3.10 m	Flood Criteria:	50 year
Length:	66.0 m	EP Elevation:	200.37 m
Skew No.:	N/A	AHW:	199.37 m

	Inlet	**Outlet**
Type:	Projecting	Projecting
Obvert:	199.00 m	197.94 m
Design Invert:	N/A	N/A
Actual Invert:	197.45 m	196.39 m
Sediment Depth:	N/A	N/A

Comments: Culvert is in fair condition.

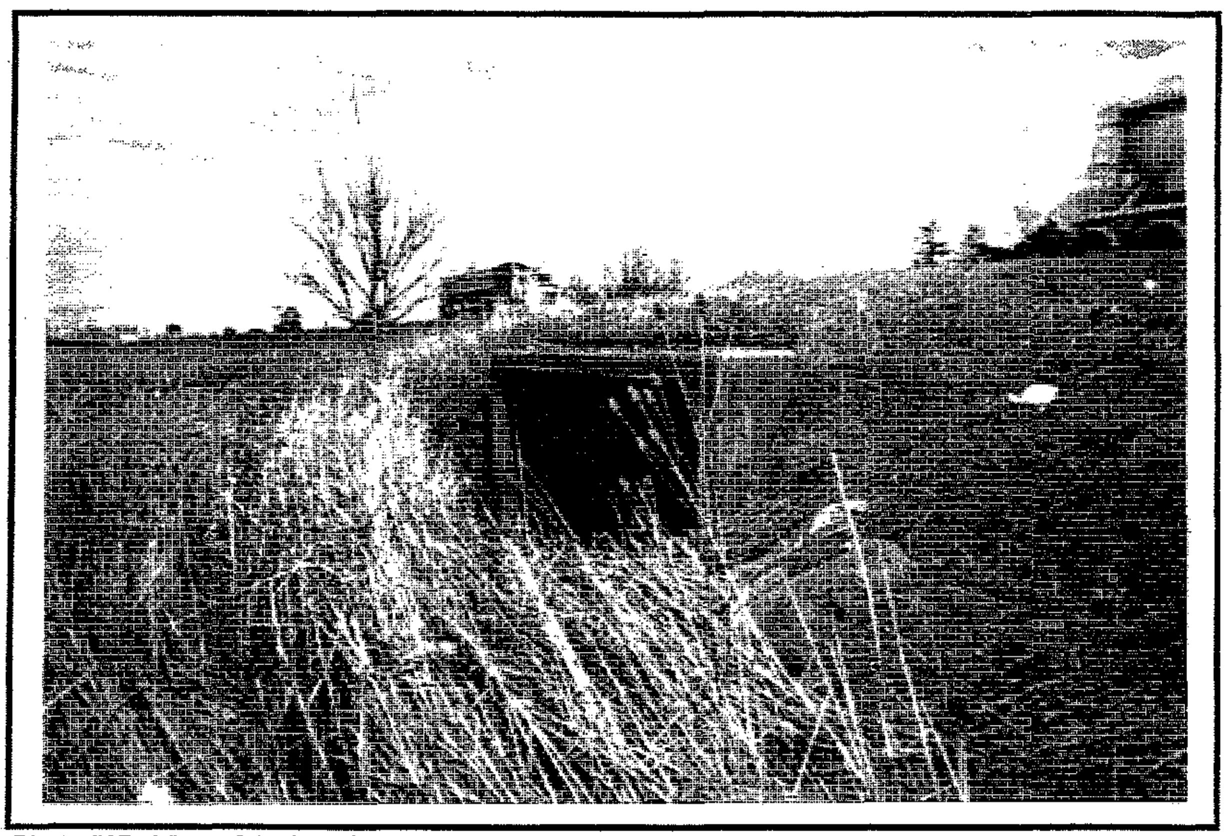


Photo #37: View of the inlet from the North side of Highway 401.

Culvert Assessment Summary

Survey Date: Apr. 13/99

Culvert Identification

Culvert ID: 33

Location: Highway 401, 50 m East of Fifth Line

Watercourse: Middle Sixteen Mile Creek

Culvert Data

Shape:	Bridge	Manning's n:	0.013
Material:	Concrete	Ke:	0.5
Size (h*w/dia):	7.9 x 21.3 m	Flood Criteria:	100 year
Length:	48.0 m	EP Elevation:	201.3 m
Skew No.:	N/A	AHW:	200.3 m

	Inlet	Outlet
Type:	Projecting	Projecting
Obvert:	N/A	N/A
Design Invert:	N/A	N/A
Actual Invert:	191.7 m	191.6 m
Sediment Depth:	N/A	N/A

Comments: Bridge is in good condition.

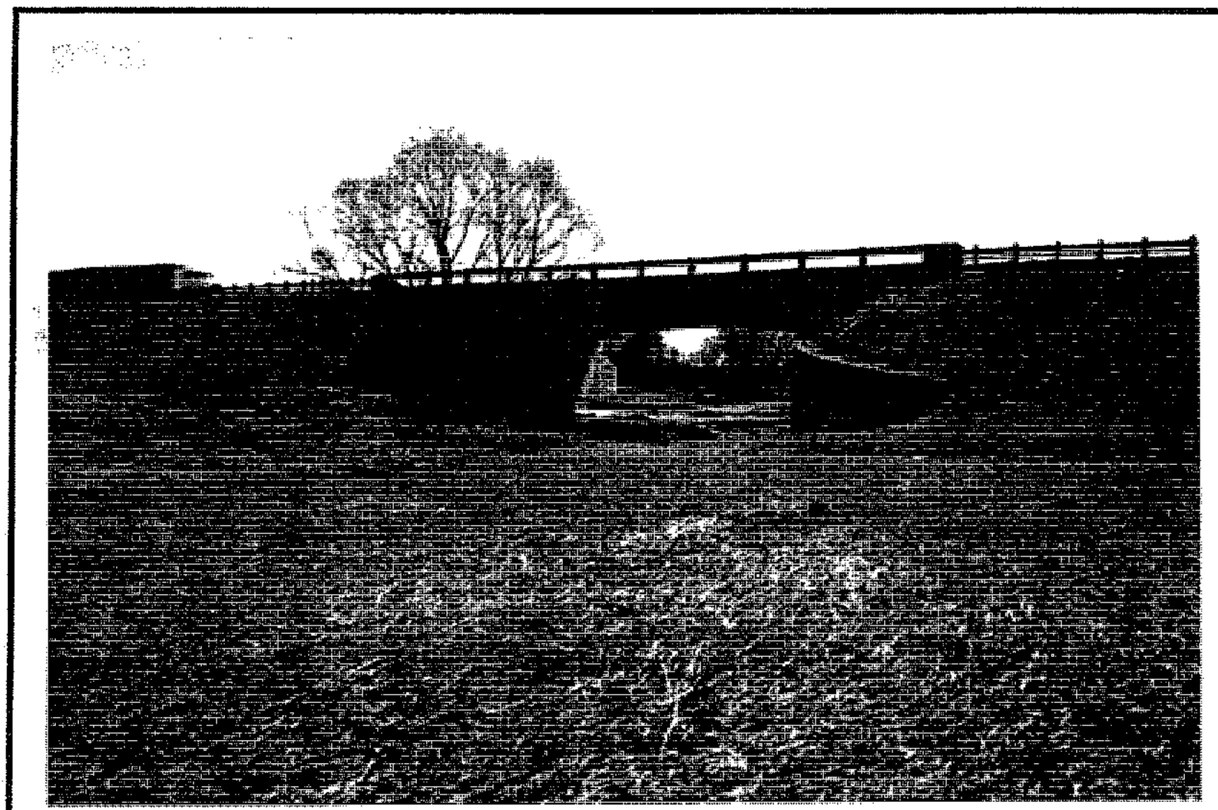


Photo #38: Upstream face of structure from Fifth Line South.

Culvert Assessment Summary

Survey Date: Apr. 13/99

Culvert Identification

Culvert ID:	34
Location:	Highway 401, 100 m East of Sixth Line
Watercourse:	Middle Sixteen Mile Creek Tributary

Culvert Data

Shape:	Bridge	Manning's n:	0.013
Material:	Concrete	Ke:	0.5
Size (h*w/dia):	4.0 x 12.2 m	Flood Criteria:	100 year
Length:	40.0 m	EP Elevation:	192.70 m
Skew No.:	90	AHW:	191.70 m

	Inlet	Outlet
Type:	Projecting	Projecting
Obvert:	192.15 m	192.15 m
Design Invert:	N/A	N/A
Actual Invert:	188.20 m	188.13 m
Sediment Depth:	N/A	N/A

Comments: Bridge is in good condition.

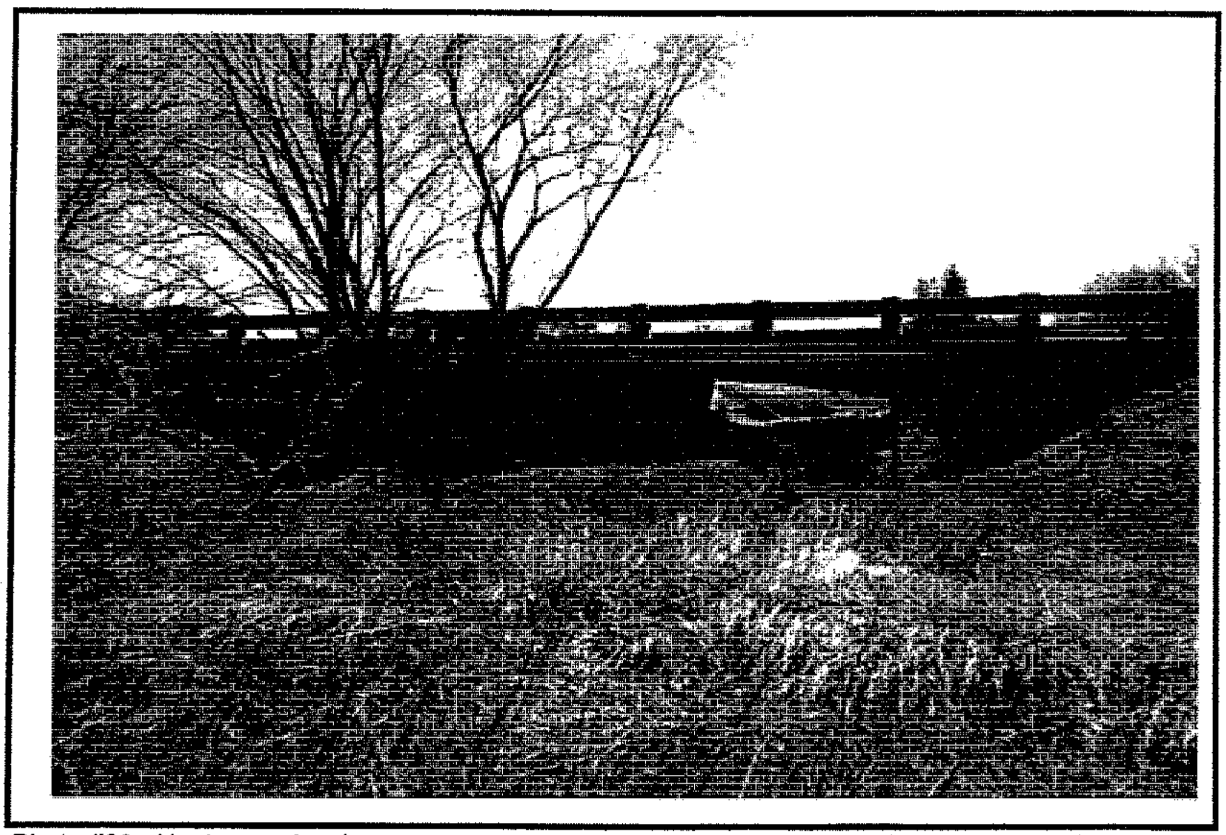


Photo #39: Upstream view from the North side of Highway 401.

Culvert Assessment Summary

Survey Date: Apr. 13/99

Culvert Identification

Culvert ID: 35

Location: Highway 401, 500 m East of Trafalgar Road

Watercourse: East Sixteen Mile Creek

Culvert Data

Shape:	Twin Box	Manning's n:	0.013
Material:	Concrete	Ke:	0.5
Size (h*w/dia):	3.4 x 6.35 m	Flood Criteria:	100 year
Length:	60.0 m	EP Elevation:	202.40 m
Skew No.:	N/A	AHW:	201.40 m

	Inlet	**Outlet**
Type:	Projecting	Projecting
Obvert:	199.69 m	199.69 m
Design Invert:	N/A	N/A
Actual Invert:	196.46 m	196.19 m
Sediment Depth:	N/A	N/A

Comments: Culvert is in fair condition.

Photo #40: View of the inlet from the North side of Highway 401.

Culvert Assessment Summary

Survey Date: Mar. 30/99, Apr. 13/99

Culvert Identification

Culvert ID: 36

Location: Highway 401, 870 m East of Trafalgar Road

Watercourse: Ditch Inlet

Culvert Data

Shape:	Circular	Manning's n:	0.024
Material:	Corrugated Steel	Ke:	0.9
Size (h*w/dia):	900 mm	Flood Criteria:	N/A
Length:	74.6 m	EP Elevation:	103.10 m
Skew No.:	N/A	AHW:	N/A

	Inlet	**Outlet**
Type:	Ditch Inlet	Projecting
Obvert:	98.39 m	97.69 m
Design Invert:	N/A	N/A
Actual Invert:	97.49 m	96.79 m
Sediment Depth:	N/A	N/A

Comments: Culvert is in good condition.

Photo #41: View of the ditch inlet structure from the North side of Highway 401.

Culvert Assessment Summary

Survey Date: Mar. 30/99

Culvert Identification

Culvert ID: 37

Location: Highway 401,1500 m East of Trafalgar Road

Watercourse: Ditch Drainage

Culvert Data

Shape:	Box	Manning's n:	0.013
Material:	Concrete	Ke:	0.5
Size (h*w/dia):	1.22 x 2.44 m	Flood Criteria:	50 year
Length:	57.3 m	EP Elevation:	102.92 m
Skew No.:	N/A	AHW:	101.92

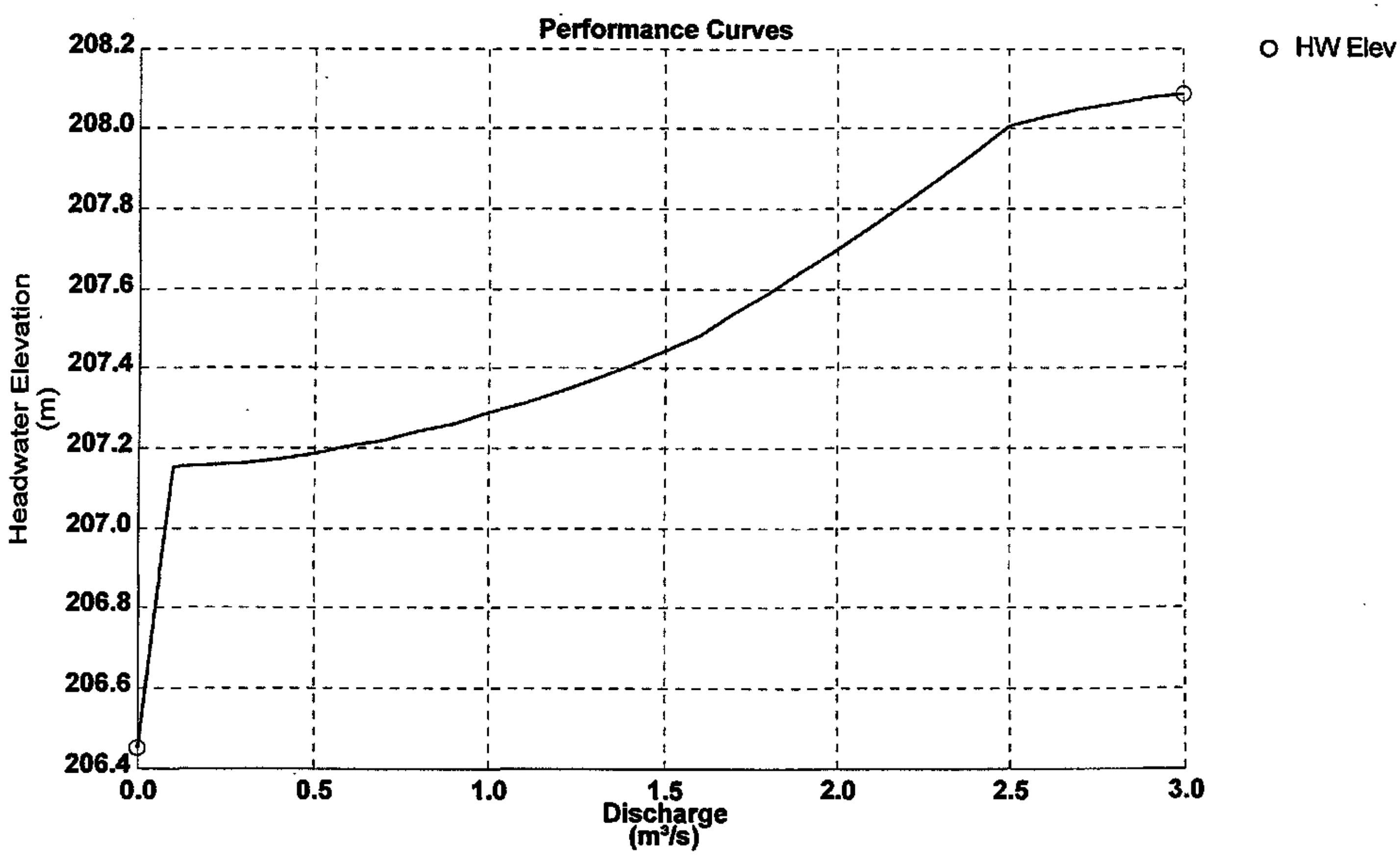
	Inlet	Outlet
Type:	Projecting	Projecting
Obvert:	101.22 m	N/A
Design Invert:	N/A	N/A
Actual Invert:	100.00 m	N/A
Sediment Depth:	N/A	N/A

Comments: Culvert is in good condition.

Photo #42: View of upstream face from North side of Highway 401.

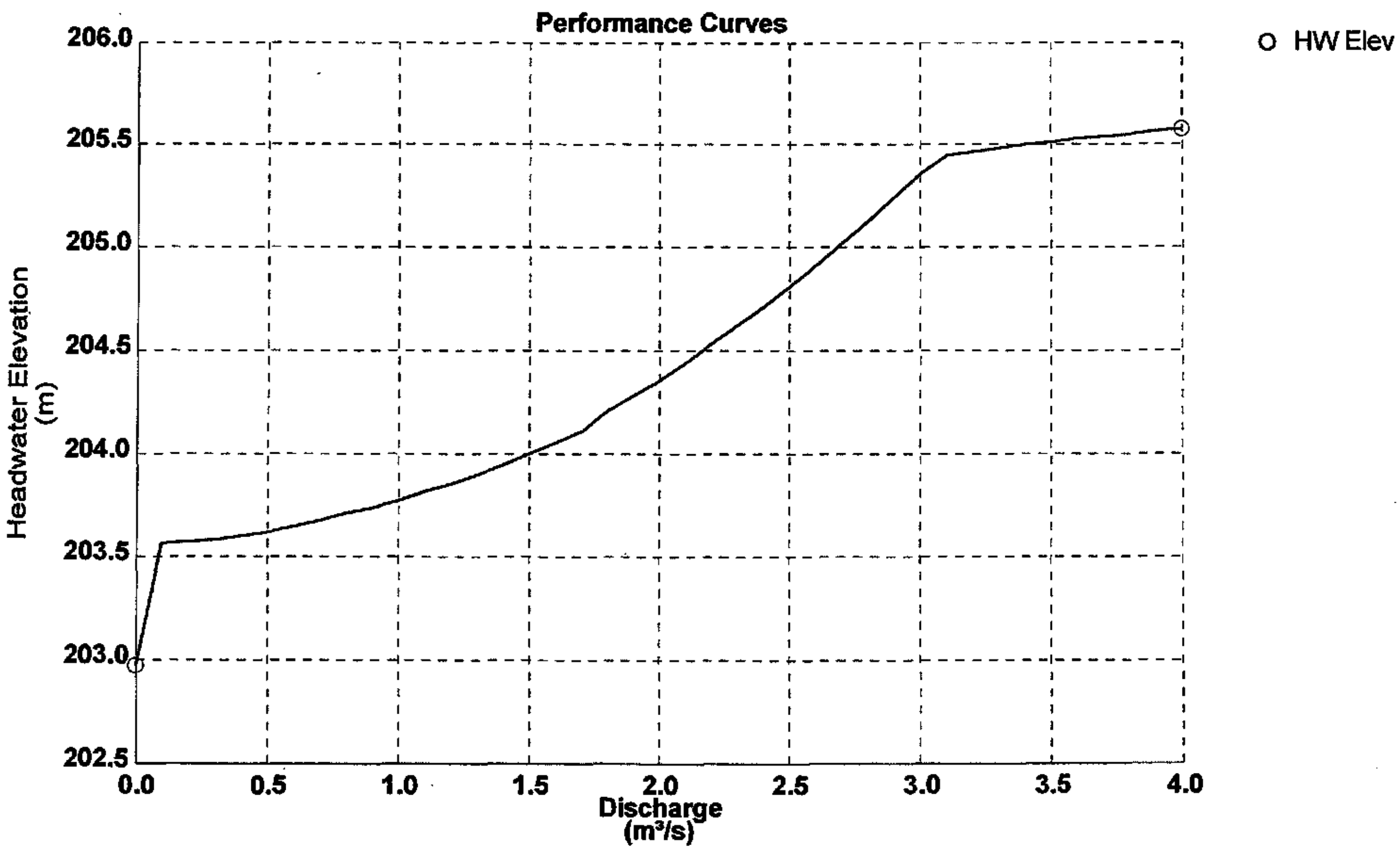
Performance Curves Report
Culvert #01

Range Data:			
	Minimum	Maximum	Increment
Discharge	0.0000	3.0000	0.1000 m³/s



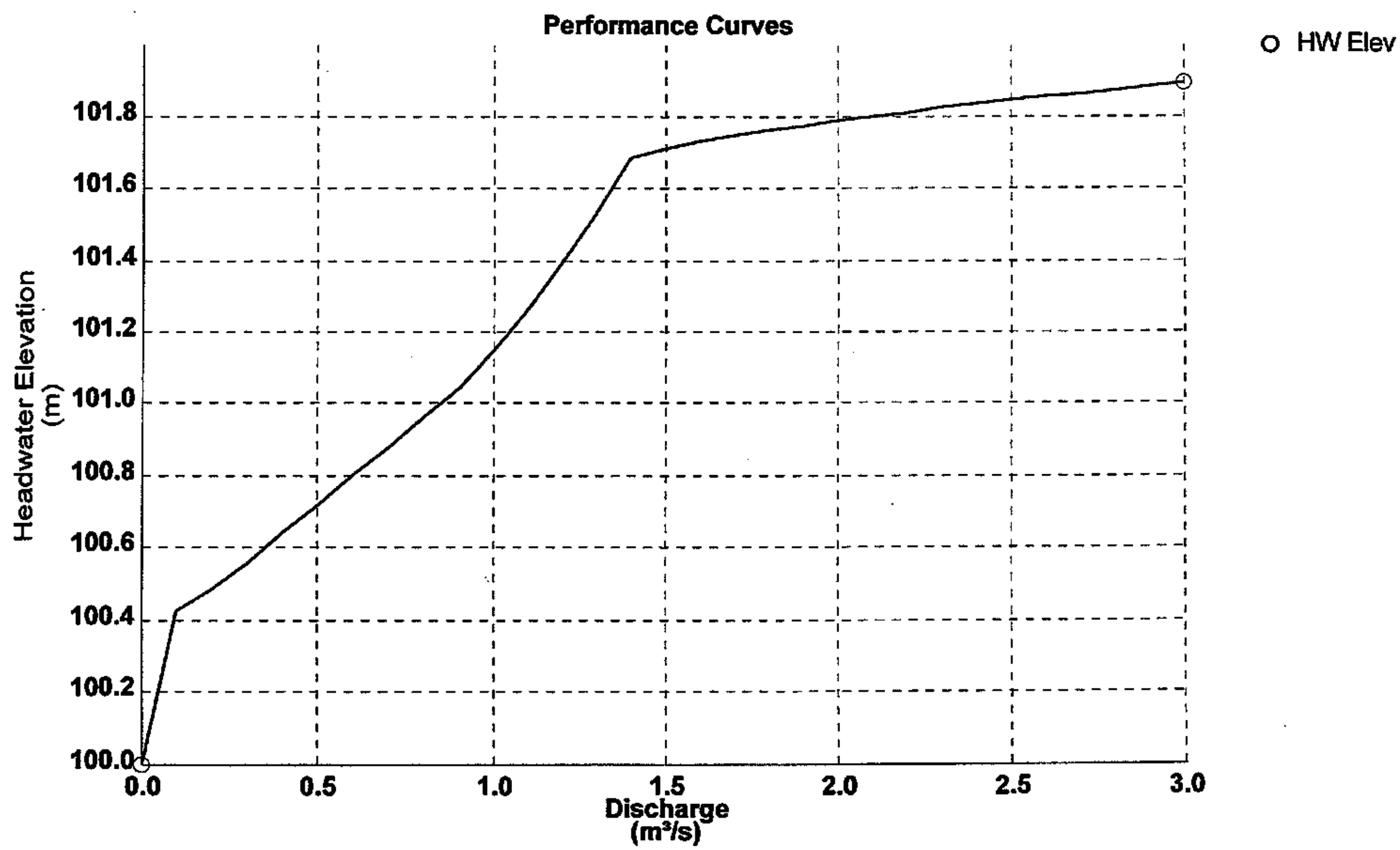
Performance Curves Report
Culvert #02

Range Data:			
	Minimum	Maximum	Increment
Discharge	0.0000	4.0000	0.1000 m³/s



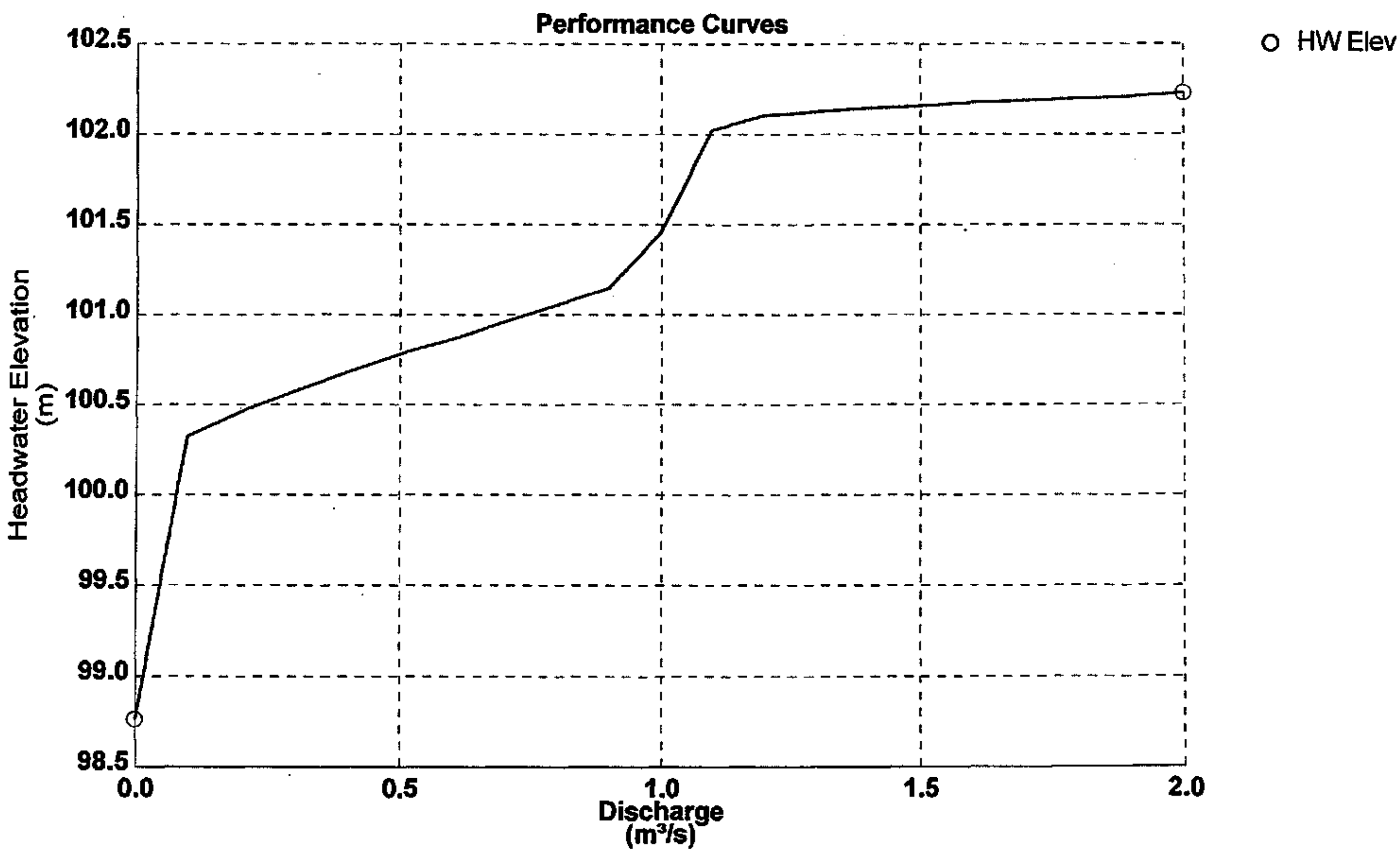
Performance Curves Report
Culvert #04

Range Data:				
	Minimum	Maximum	Increment	
Discharge	0.0000	3.0000	0.1000	m^3/s



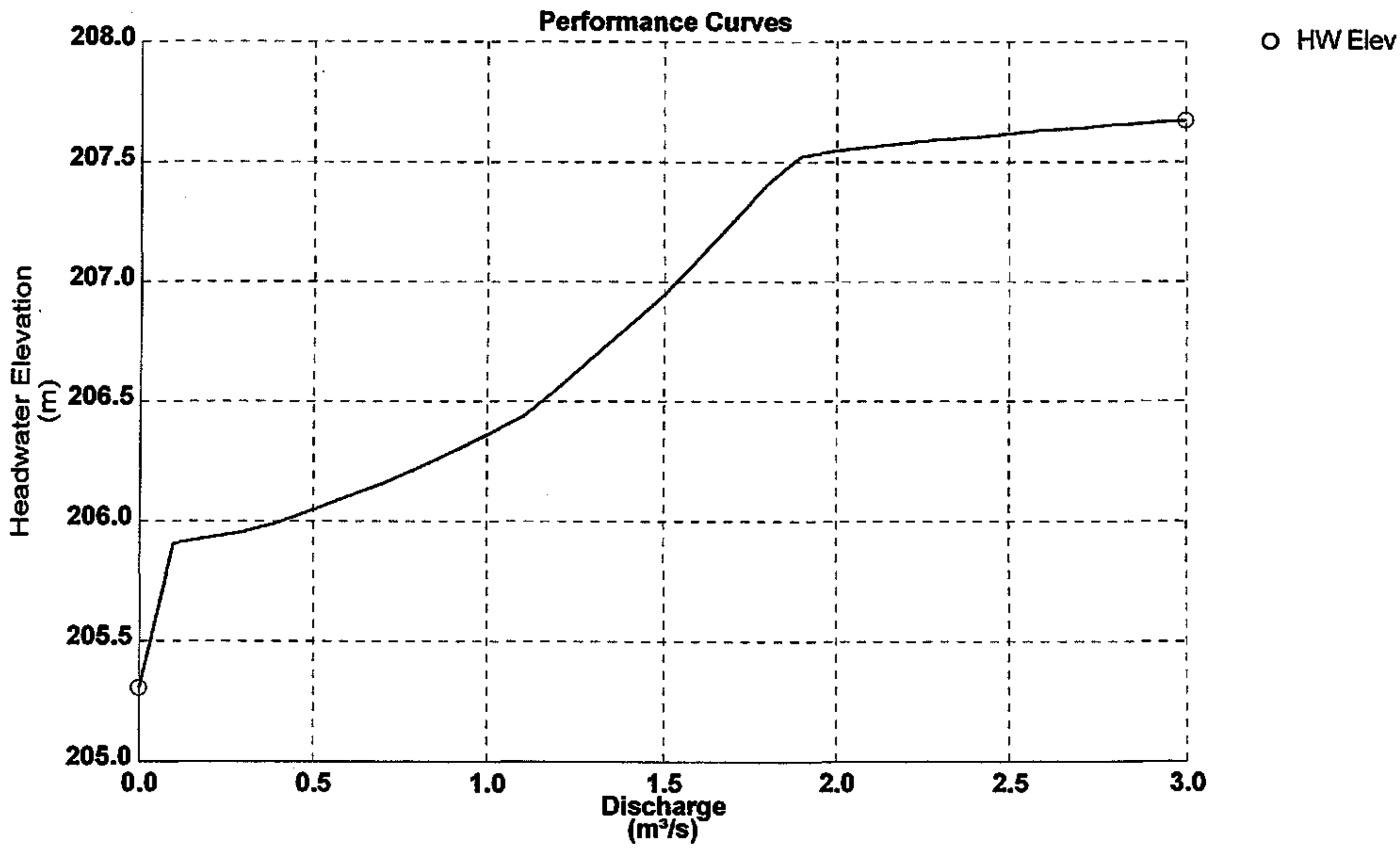
Performance Curves Report
Culvert #07

Range Data:				
	Minimum	Maximum	Increment	
Discharge	0.0000	2.0000	0.1000	m^3/s



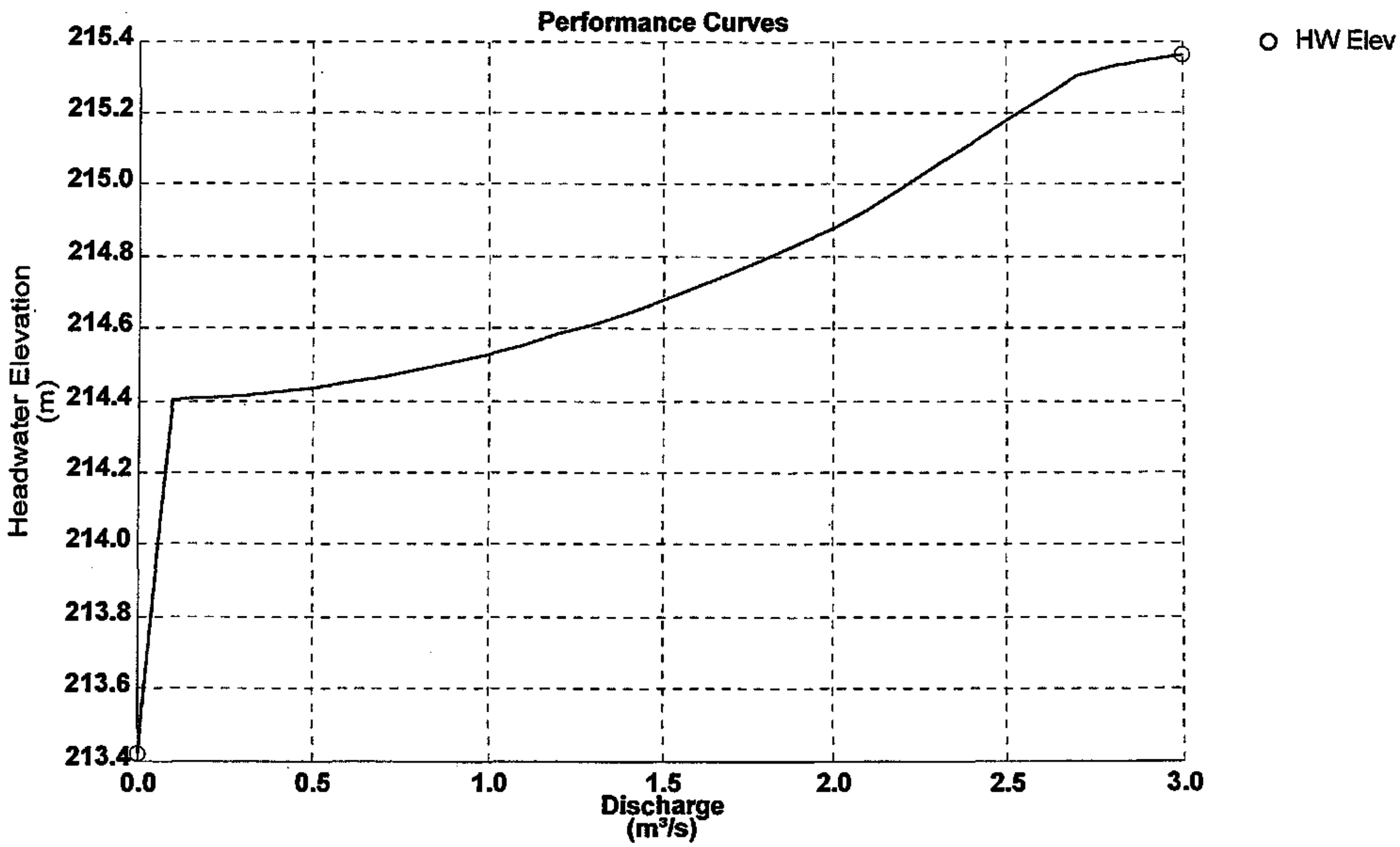
Performance Curves Report
Culvert #09

Range Data:				
	Minimum	Maximum	Increment	
Discharge	0.0000	3.0000	0.1000	m³/s



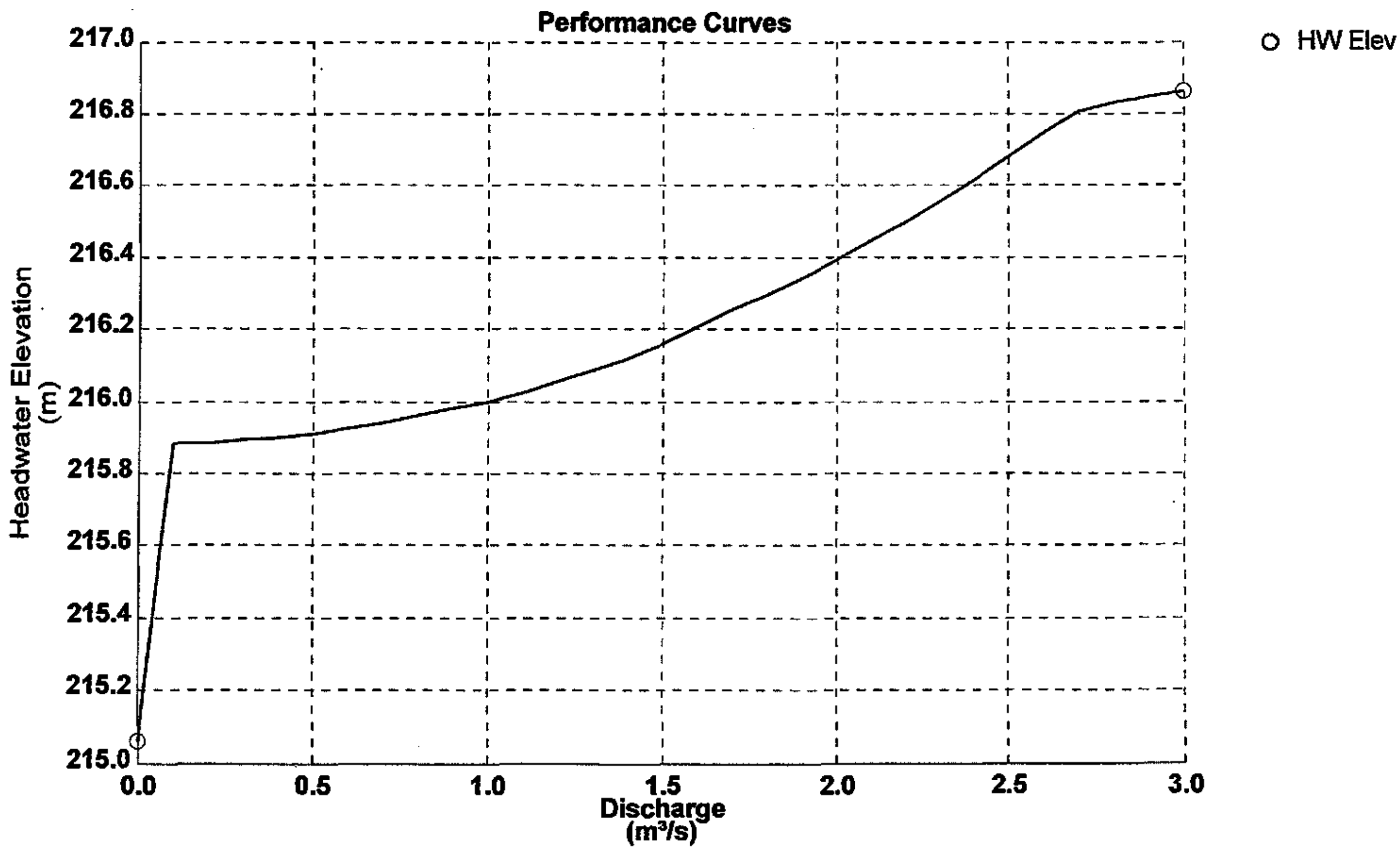
Performance Curves Report
Culvert #13

Range Data:				
	Minimum	Maximum	Increment	
Discharge	0.0000	3.0000	0.1000	m³/s



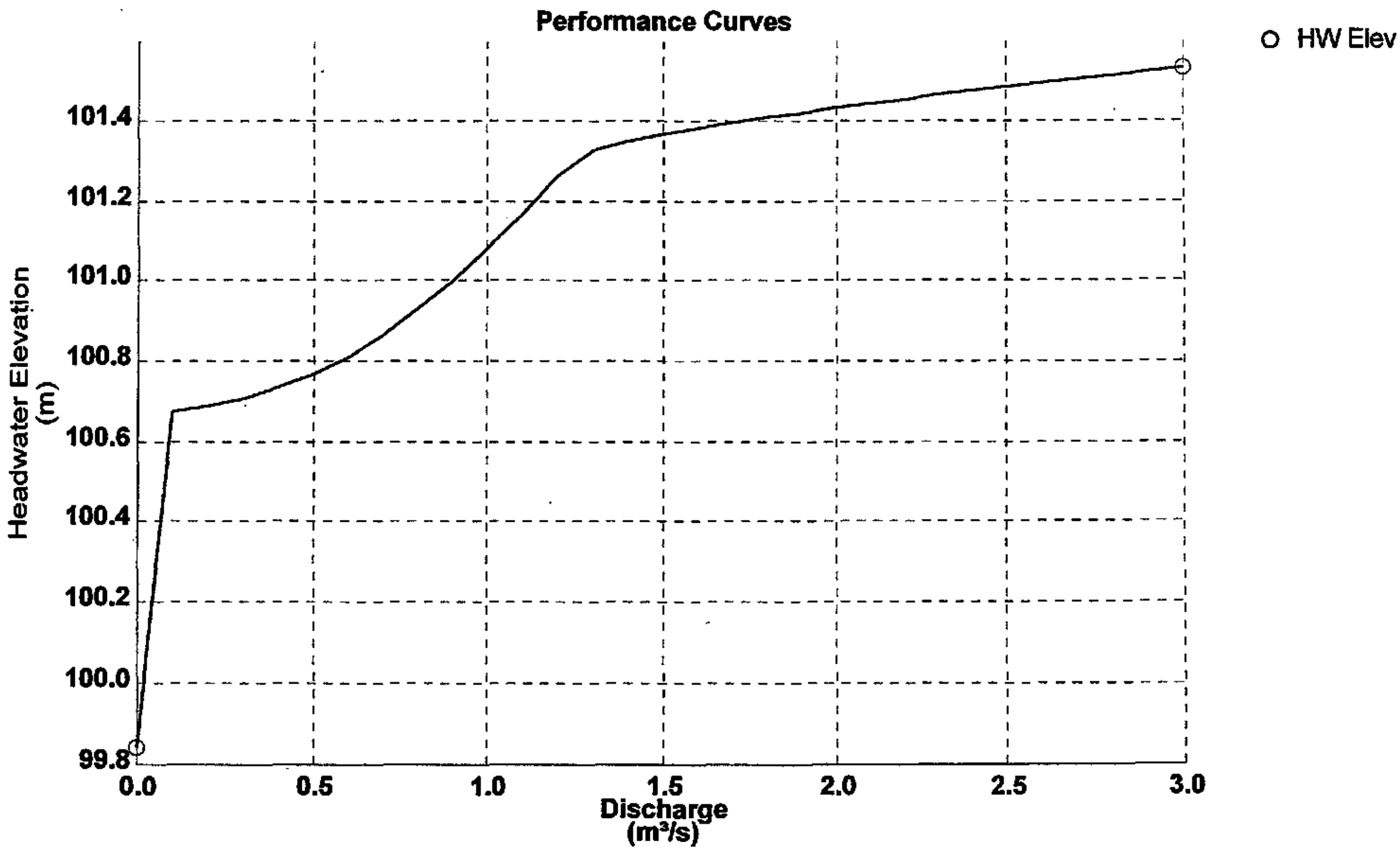
Performance Curves Report
Culvert #14

Range Data:			
	Minimum	Maximum	Increment
Discharge	0.0000	3.0000	0.1000 m³/s



Performance Curves Report
Culvert #16

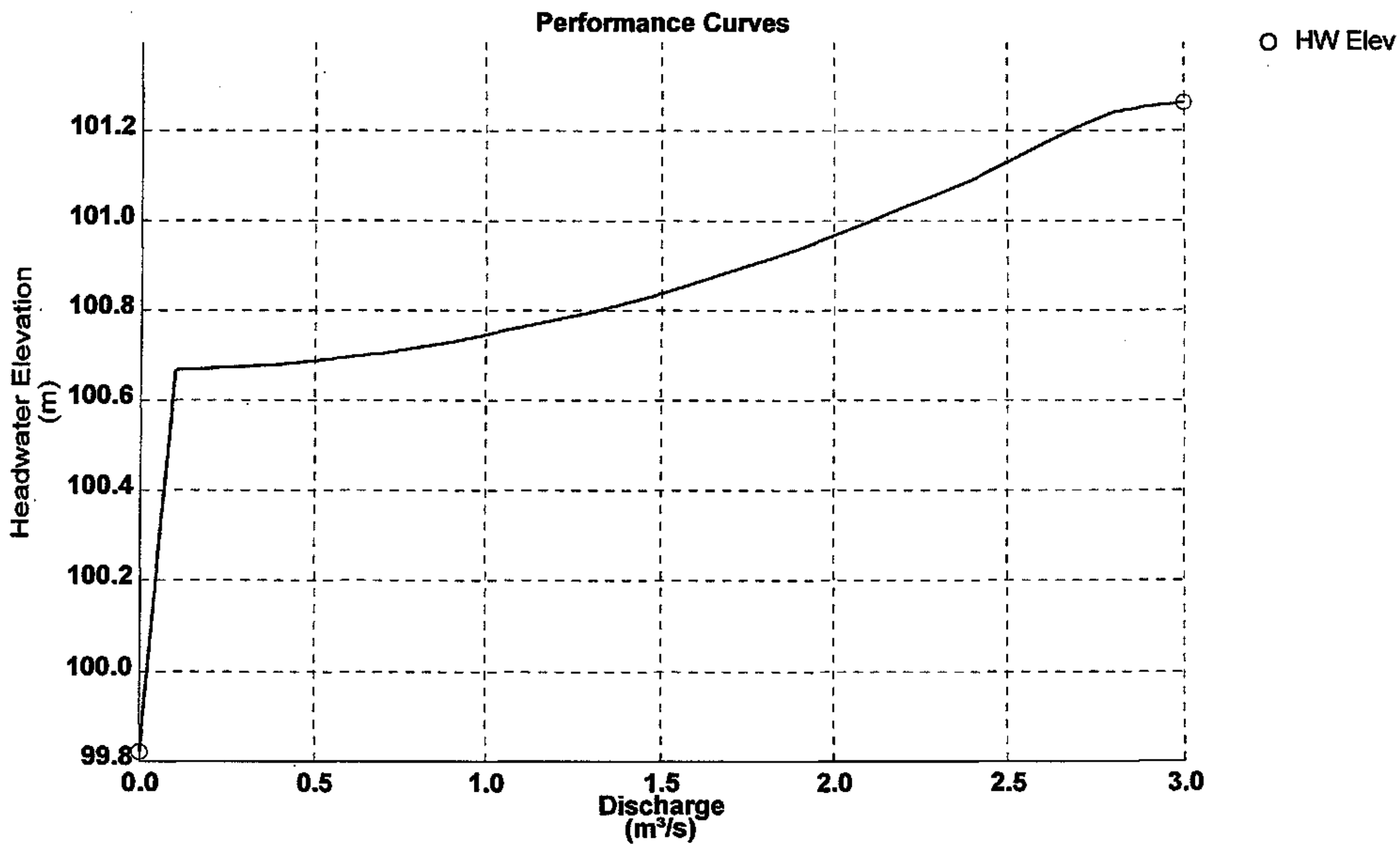
Range Data:				
	Minimum	Maximum	Increment	
Discharge	0.0000	3.0000	0.1000	m^3/s



Performance Curves Report
Culvert #16/17

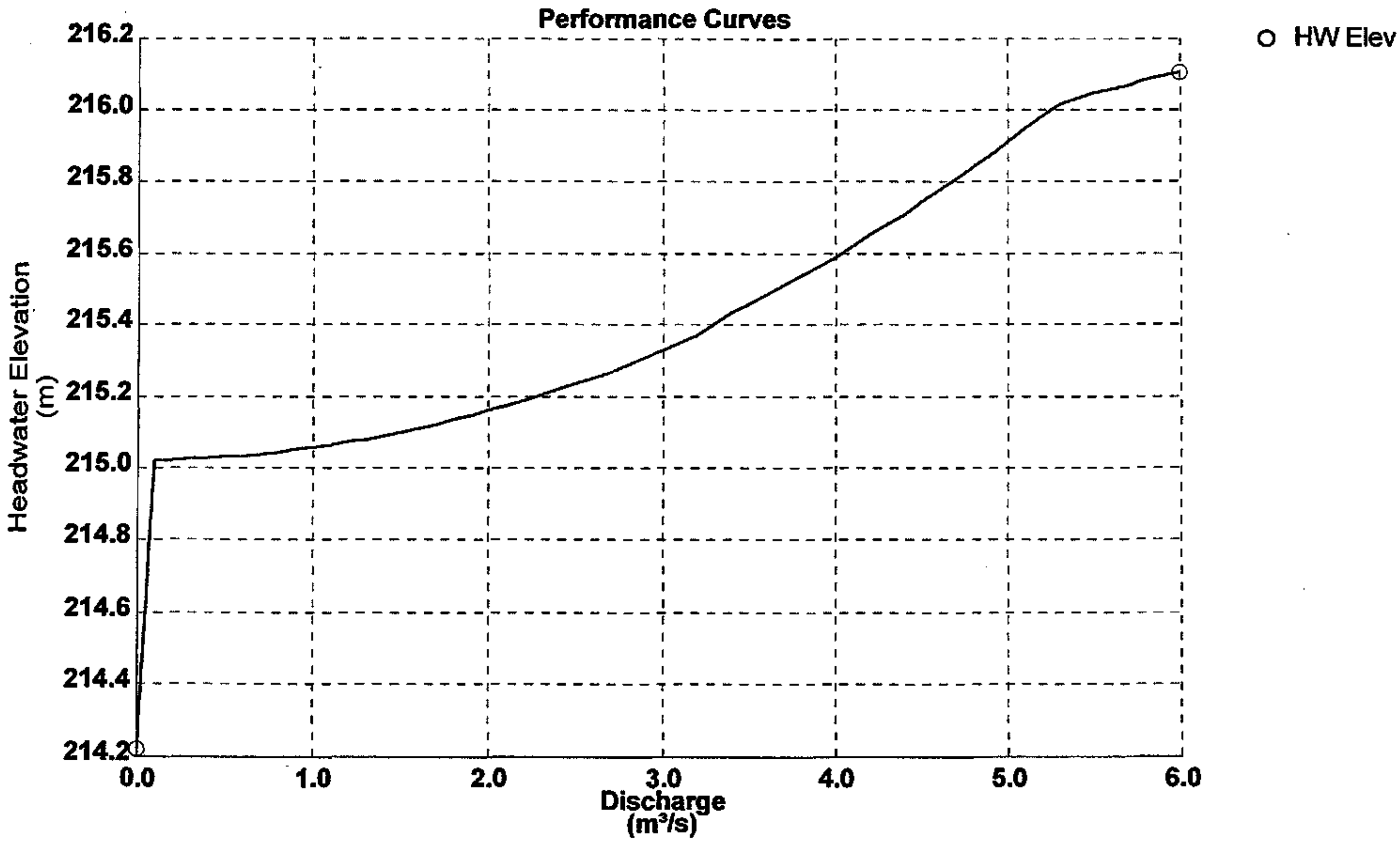
Range Data:

	Minimum	Maximum	Increment
Discharge	0.0000	3.0000	0.1000 m³/s



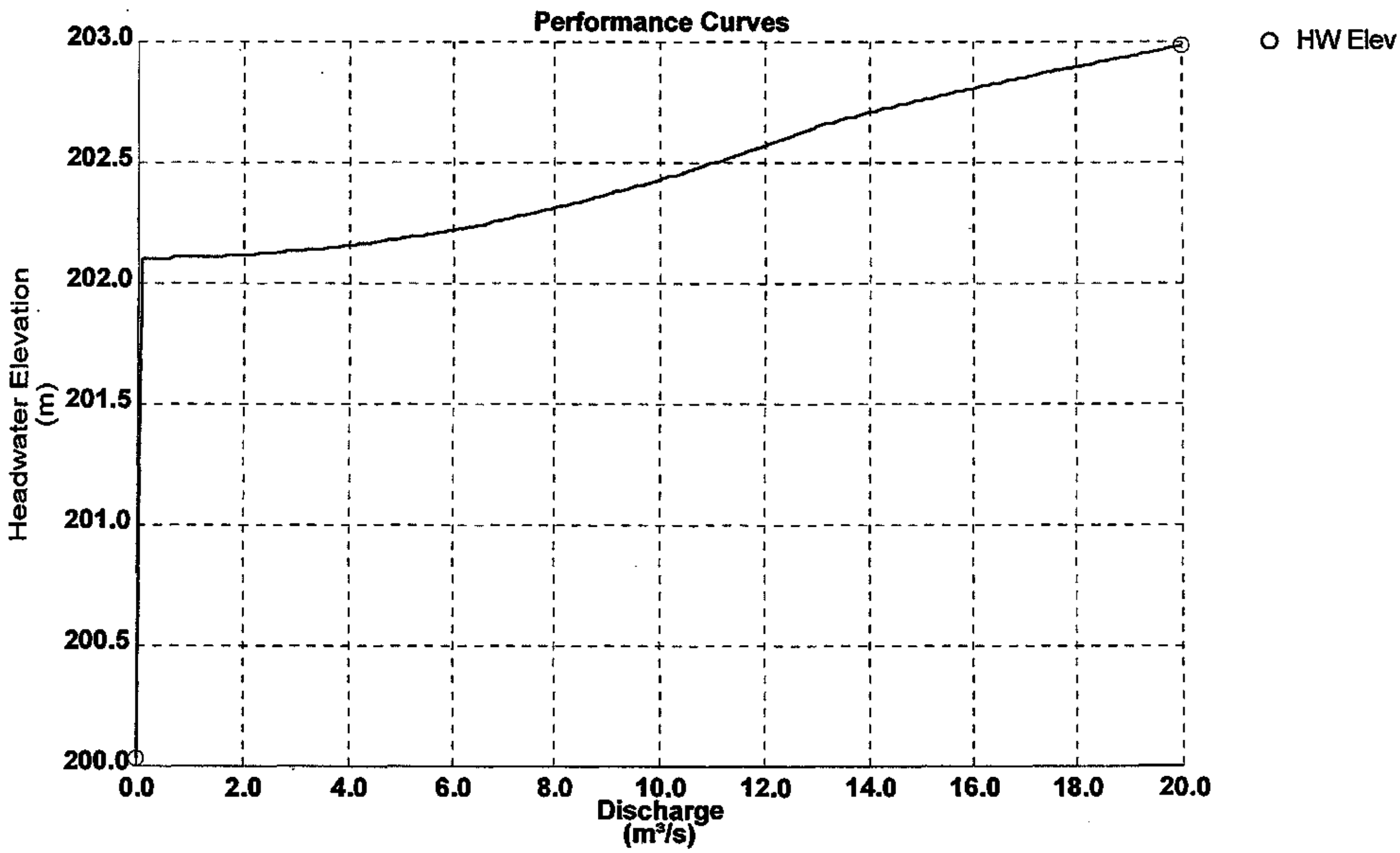
Performance Curves Report
Culvert #19

Range Data:				
	Minimum	Maximum	Increment	
Discharge	0.0000	6.0000	0.1000	m^3/s



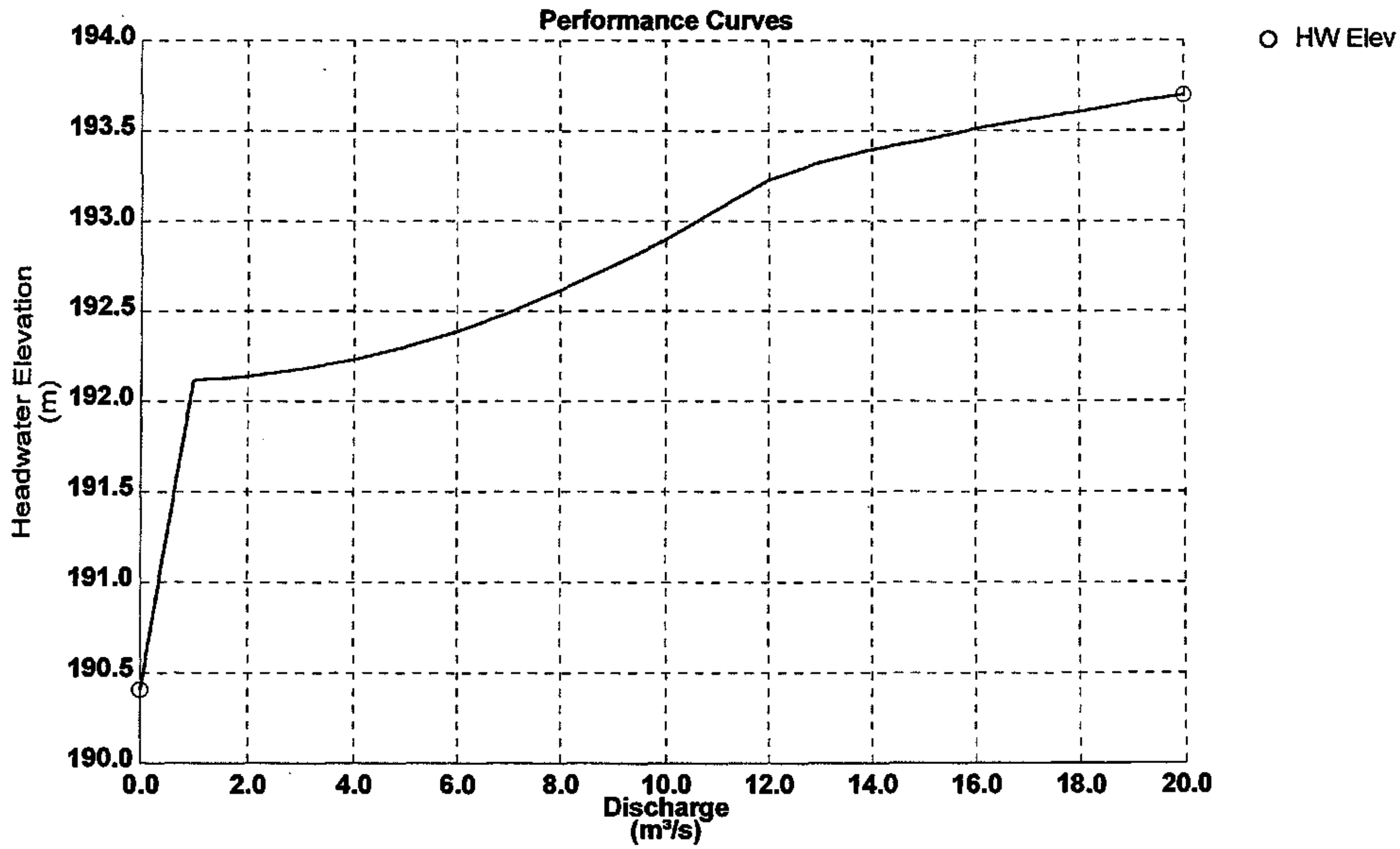
Performance Curves Report
Culvert #27

Range Data:			
	Minimum	Maximum	Increment
Discharge	0.0000	20.0000	0.1000 m³/s



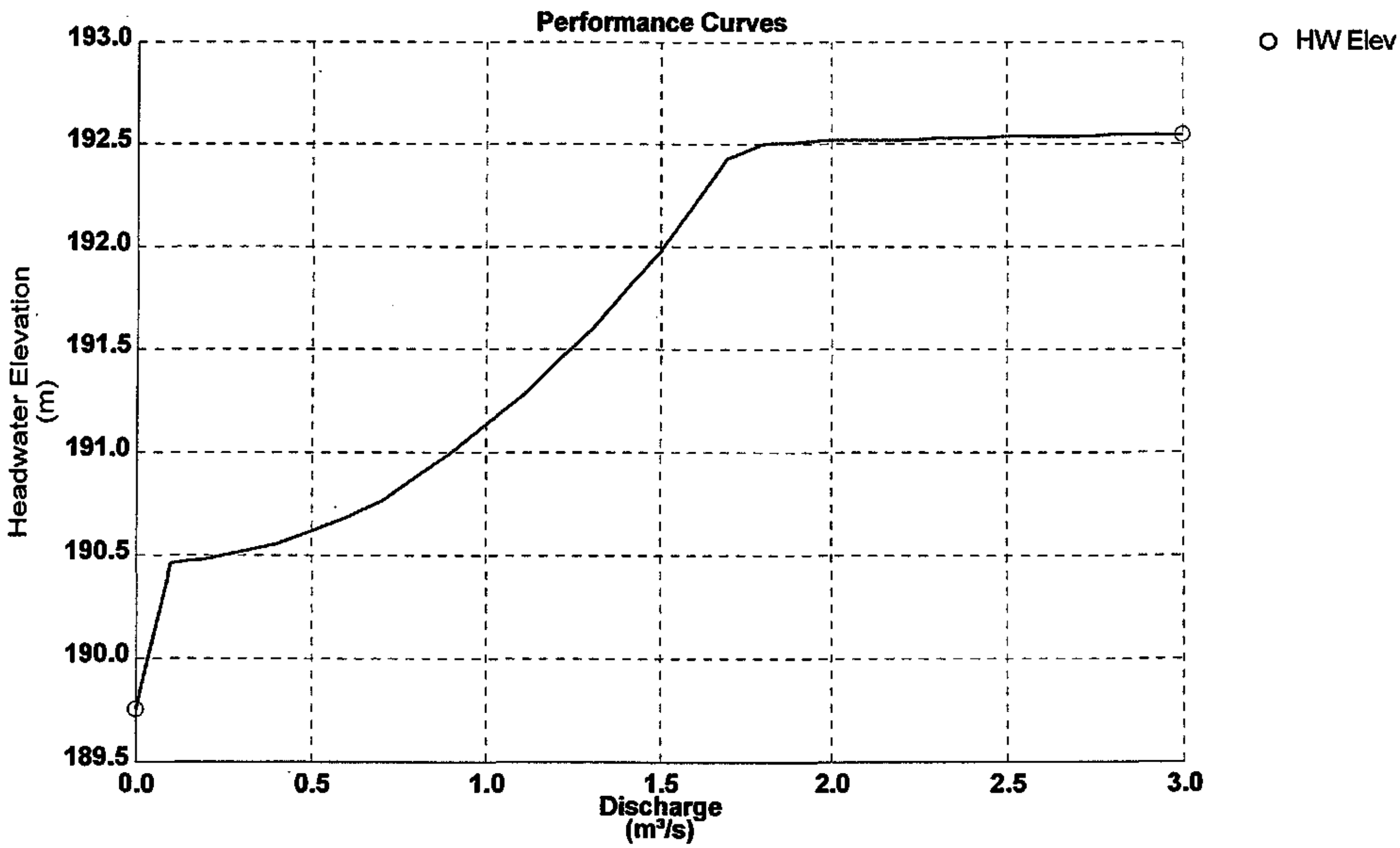
Performance Curves Report
Culvert #29

Range Data:			
	Minimum	Maximum	Increment
Discharge	0.0000	20.0000	1.0000 m³/s



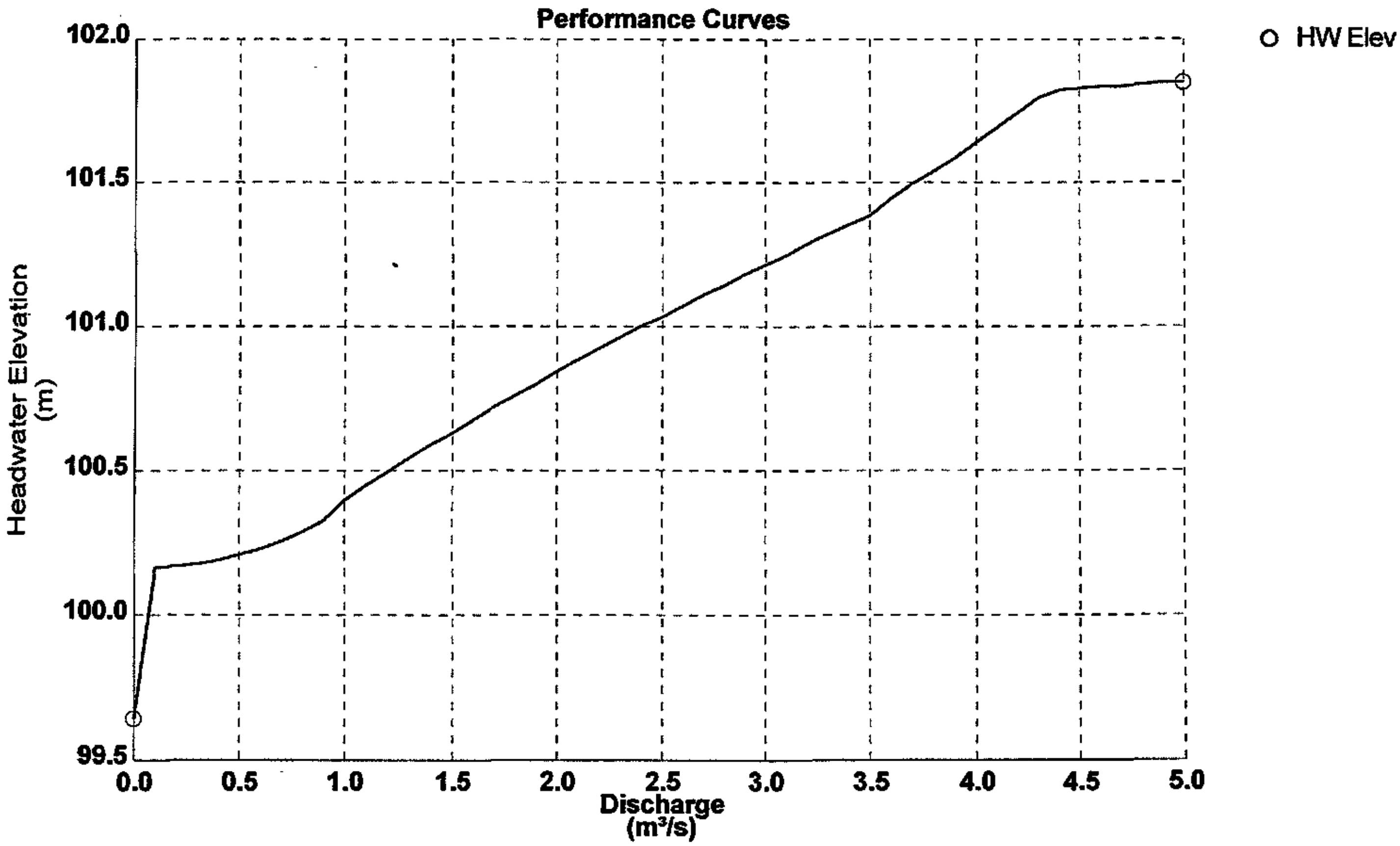
Performance Curves Report
Culvert #30

Range Data:				
	Minimum	Maximum	Increment	
Discharge	0.0000	3.0000	0.1000	m^3/s



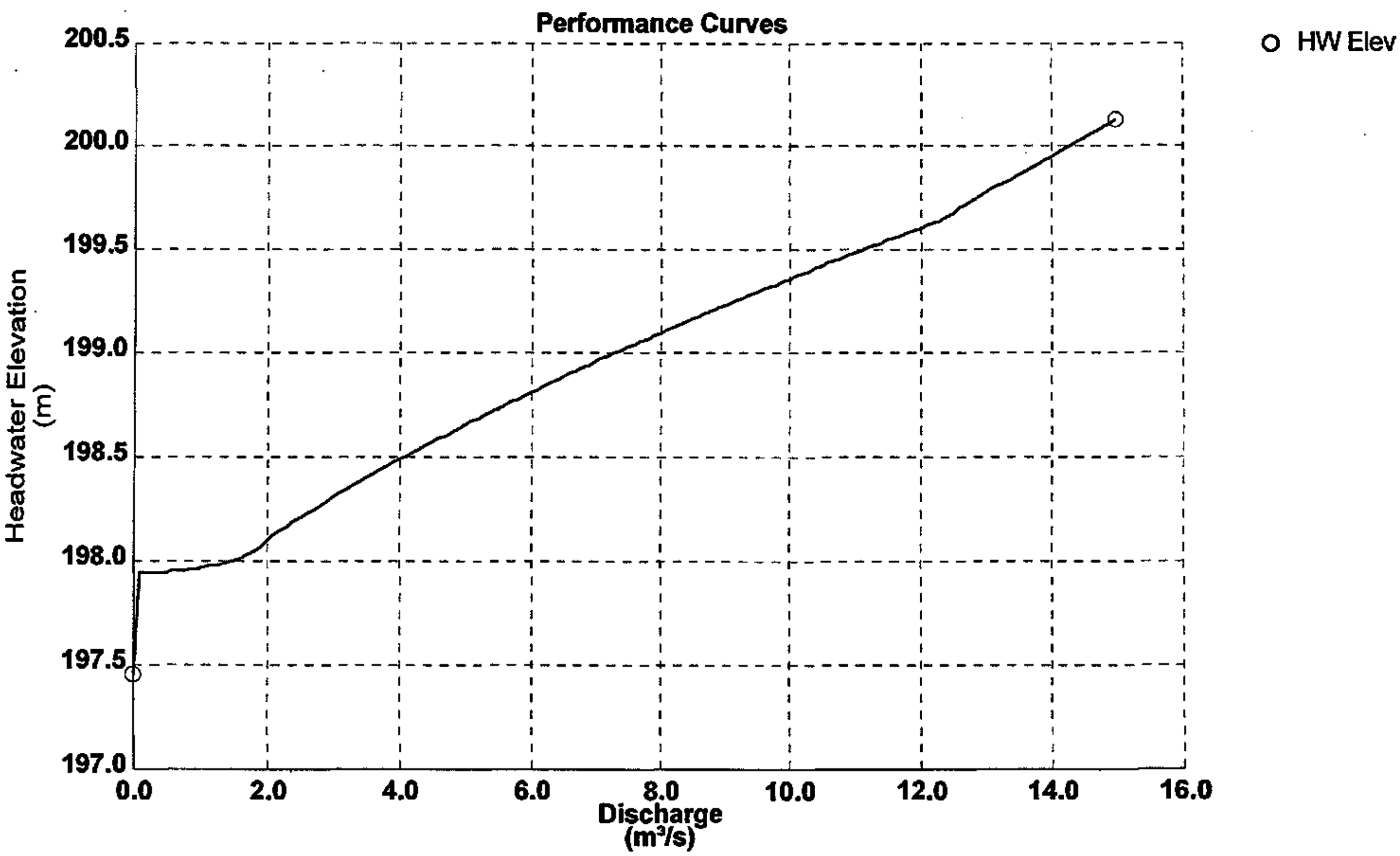
Performance Curves Report
Culvert #31

Range Data:				
	Minimum	Maximum	Increment	
Discharge	0.0000	5.0000	0.1000	m^3/s



Performance Curves Report
Culvert #32

Range Data:				
	Minimum	Maximum	Increment	
Discharge	0.0000	15.0000	0.1000	m^3/s



APPENDIX D

OTTHYMO89 INPUT AND SUMMARY OUTPUT

```
2
******************************************************************************
*                 OTTHYMO (version 89b - November 1989)
*                 BY : DILLON CONSULTING LIMITED  DATE : APR 14, 1999
*                      RJM
*
*                HWY 401 INTEGRATED PLANNING STUDY - TOWN OF HALTON HILLS
*
*                FILE : HHEXT.DAT - EXISTING CONDITIONS
*
*                       EXISTING CONDITIONS INCLUDING EXISTING
*                       SWM FACILITIES:
*                       MILTON BUSINESS PARK
*                       CASHWAY DISTRIBUTION CENTRE
*                       HWY407/HWY401 INTERCHANGE PONDS 1 TO 5
*
******************************************************************************
*
*       PRECIPITATION :  TOWN OF HALTON HILLS DESIGN STANDARDS
*                        COMPILATION OF TORONTO INT'L A., FERGUS SHAND DAM AND
*                        HEAT LAKE (WEIGHTED BY YEARS OF RECORD)
*                        CHICAGO RAINFALL DISTRIBUTION
*
******************************************************************************
*
START               START= 0.0 HRS   METOUT=0  NSTORM=1  NRUN=1
                    25MM.STM
*
READ STORM          STORM.001
*
******************************************************************************
*                        SIXTEEN MILE CREEK SUBWATERSHED 3                  *
******************************************************************************
*
*   MANSEWOOD TRIBUTARY - TRIBUTARY OF MIDDLE SIXTEEN MILE CREEK
*
* SUBCATCHMENT 1 - WEST OF FOURTH LINE
*
CALIB NASHYD        ID=1 NHYD=900  DT=5.0   DA= 109.73 HA
                    DWF=0.0 CN=82  IA=5 N=3 TP=1.45HR END=-1
*
*  ROUTE THROUGH SUBCATCHMENT 2 - FOURTH LINE TO HYDRO CORRIDOR
*  HEC-2 SECTION 732.5
*
ROUTE CHANNEL       IDOUT=2        NHYD=901         IDIN=1       DT=5 MIN
                    CHLGTH=1200 M  CHSLOPE=0.6       FPSLOPE=0.6
                    VSN=1000       NSEG=3
                    N        DIST(M)
                    0.035    170
                    -0.035   174
                    0.035    240
                    DIST(M)  ELEV(M)
                    120      210.32
                    140      209.79
                    165      209.14
                    170      208.2
                    172.75   207.80
                    174      208.24
                    185      208.26
                    210      209.16
                    240      210.24
*
* SUBCATCHMENT 2 - FOURTH LINE TO HYDRO CORRIDOR
*
CALIB NASHYD        ID=1 NHYD=902  DT=5.0   DA= 27.5 HA
                    DWF=0.0 CN=82  IA=5 N=3 TP=0.45HR END=-1
*
ADD HYD             ID=3    NHYD=903    IDONE=1    IDTWO=2
*
*  ROUTE THROUGH SUBCATCHMENT 2 - FOURTH LINE TO HYDRO CORRIDOR
*  HEC-2 SECTION 380
*
ROUTE CHANNEL       IDOUT=1        NHYD=904         IDIN=3       DT=5 MIN
                    CHLGTH=1100 M  CHSLOPE=0.5       FPSLOPE=0.5
                    VSN=1000       NSEG=3
                    N        DIST(M)
                    0.035    166
                    -0.035   170
                    0.035    182
                    DIST(M)  ELEV(M)
                    123      206.96
                    132      205.94
                    147      205.68
                    162      206.17
                    165      206.30
                    166      205.58
                    166.5    205.56
                    167      205.54
                    168      205.02
                    169      205.53
                    169.5    205.54
                    170      205.56
                    171      206.27
                    182      206.45
*
* SUBCATCHMENT 3 - HYDRO CORRIDOR TO CONFLUENCE WITH MIDDLE 16 MI. CR
*
CALIB NASHYD        ID=2 NHYD=905  DT=5.0   DA= 29.0 HA
                    DWF=0.0 CN=82  IA=5 N=3 TP=0.74HR END=-1
*
```

```
ADD HYD              ID=3     NHYD=906     IDONE=1     IDTWO=2
*
*
* MILTON BUSINESS PARKS INDUSTRIAL SUBDIVISION
* BASED ON OTTHYMO MODEL BY F.J. REINDERS (1988 SWM PLAN)
* URBHYD COMMAND CONVERTED TO CALIB STANDHYD
*
* SUBCATCHMENT 202B - CONTROLLED MILTON BUSINESS PARK AREA
*
CALIB STANDHYD       ID=1 NHYD=100  DT=5.0    DA= 61.89HA
                     XIMP=0.47  TIMP=0.87  DWF=0.0  LOSS=2     CN=80
                     DPSP=1.5   SLP=0.5%   LGP=80   MNP=0.25   SCP=0.0
                     DPSI=-1    SLI=0.5%   LGI=642  MNI=0.013  SCI=0.0
                     END=-1
*
ROUTE RESERVOIR      ID=2  NHYD=500  IDIN=1
                     DISCHG(CMS)     STORAGE(HA M)
                          0.000     0.000
                          0.146     0.615
                          0.179     1.473
                          0.206     2.414
                          0.790     3.377
                          1.601     3.868
                          2.152     4.114
                     -1
*
* SUBCATCHMENT 202B - UNCONTROLLED MILTON BUSINESS PARK AREA
*
CALIB STANDHYD       ID=1 NHYD=101  DT=5.0    DA= 1.91HA
                     XIMP=0.47  TIMP=0.87  DWF=0.0  LOSS=2     CN=80
                     DPSP=1.5   SLP=0.5%   LGP=80   MNP=0.25   SCP=0.0
                     DPSI=-1    SLI=0.5%   LGI=113  MNI=0.013  SCI=0.0
                     END=-1
*
ADD HYD              ID=3     NHYD=501     IDONE=1     IDTWO=2
*
* SUBCATCHMENT 202E - STUDY AREA NORTH OF STEELES AVE ("DRAIN 2")
*
CALIB NASHYD         ID=1 NHYD=102  DT=5.0    DA= 23.59 HA
                     DWF=0.0 CN=80  IA=5 N=3 TP=0.59HR END=-1
*
ADD HYD              ID=2     NHYD=502     IDONE=1     IDTWO=3
*
* SUBCATCHMENT 202F - CASHWAY DISTRIBUTION CENTRE (DRAIN 1 AND 2)
*
CALIB STANDHYD       ID=1 NHYD=103  DT=5.0    DA= 38.58HA
                     XIMP=0.13  TIMP=0.261 DWF=0.0  LOSS=2     CN=80.0
                     DPSP=1.5   SLP=0.5%   LGP=80   MNP=0.25   SCP=0.0
                     DPSI=-1    SLI=0.5%   LGI=507  MNI=0.013  SCI=0.0
                     END=-1
*
ADD HYD              ID=3     NHYD=503     IDONE=1     IDTWO=2
*
* EXISTING WATER QUALITY MANAGEMENT POND
* BASED ON MIDUSS MODEL BY MTE (1997 SWM PLAN)
*
ROUTE RESERVOIR      ID=1 NHYD=504 IDIN=3  DT=5min
                     OUTFLOW (cms)       STORAGE (ha m)
                      0.0                 0.0
                      0.0585              0.3331
                      0.0906              0.7830
                      20.058              0.9960
                      21.660              1.0327
                      27.130              1.1828
                       -1
*
* SUBCATCHMENT 202G - STUDY AREA NORTH-EAST OF JAMES SNOW PKWY INTERCHANGE
*
CALIB NASHYD         ID=2 NHYD=104  DT=5.0    DA= 11.79 HA
                     DWF=0.0 CN=80  IA=5 N=3 TP=0.69HR END=-1
*
ADD HYD              ID=7     NHYD=505     IDONE=1     IDTWO=2
*
* SUBCATCHMENT 202I - STUDY AREA WEST OF FIFTH LINE
*
CALIB STANDHYD       ID=1 NHYD=105  DT=5.0    DA= 28.73HA
                     XIMP=0.01  TIMP=0.137 DWF=0.0  LOSS=2     CN=82.0
                     DPSP=1.5   SLP=0.5%   LGP=40   MNP=0.25   SCP=0.0
                     DPSI=-1    SLI=0.5%   LGI=408  MNI=0.013  SCI=0.0
                     END=-1
*
ADD HYD              ID=2     NHYD=506    IDONE=1    IDTWO=7
*
* SUBCATCHMENT 202C - STUDY AREA NORTH OF STEELES AND WEST OF FIFTH LINE
*
CALIB NASHYD         ID=1 NHYD=106  DT=5.0    DA= 28.35 HA
                     DWF=0.0 CN=78  IA=5 N=3 TP=0.87HR END=-1
*
* SUBCATCHMENT 202D - STUDY AREA NORTH OF STEELES
*
CALIB NASHYD         ID=5 NHYD=107  DT=5.0    DA= 46.9 HA
                     DWF=0.0 CN=80  IA=5 N=3 TP=0.56HR END=-1
*
ADD HYD              ID=4     NHYD=507     IDONE=1     IDTWO=5
*
ADD HYD              ID=1     NHYD=508     IDONE=2     IDTWO=4
*
* SUBCATCHMENT 202J - STUDY AREA EAST OF MIDDLE BRANCH
*
CALIB NASHYD         ID=2 NHYD=108  DT=5.0    DA= 12.49 HA
```

```
                    DWF=0.0 CN=85  IA=5 N=3 TP=0.46HR END=-1
*
ADD HYD             ID=3    NHYD=509    IDONE=1    IDTWO=2
*
* SUBCATCHMENT 202H - STUDY AREA WITHIN JAMES SNOW PKWY INTERCHANGE
*                     AND EXTERNAL AREA WEST OF INTERCHANGE
*
CALIB NASHYD        ID=1 NHYD=109  DT=5.0   DA= 21.75 HA
                    DWF=0.0 CN=82  IA=5 N=3 TP=0.80HR END=-1
*
* SUBCATCHMENT 202K - SOUTH OF STUDY AREA, WEST OF FIFTH LINE
*
CALIB NASHYD        ID=2 NHYD=110  DT=5.0   DA= 56.6 HA
                    DWF=0.0 CN=85  IA=5 N=3 TP=1.03HR END=-1
*
ADD HYD             ID=4    NHYD=510   IDONE=1   IDTWO=2
*
ADD HYD             ID=1    NHYD=511   IDONE=3   IDTWO=4
*
*  ROUTE SUBAREA 202L - FIFTH LINE TO OUTLET
*
ROUTE CHANNEL       IDOUT=8        NHYD=511        IDIN=1       DT=5 MIN
                    CHLGTH=2400 M  CHSLOPE=0.25     FPSLOPE=0.25
                    VSN=1000       NSEG=3
                    N       DIST(M)
                    0.045   50
                    -0.035  57
                    0.045   107
                    DIST(M) ELEV(M)
                    0       10.0
                    6       7.0
                    50      6.5
                    52      4.5
                    55      4.5
                    57      6.5
                    101     7.0
                    107     10.0
*
* SUBCATCHMENT 202L - SOUTH OF STUDY AREA, EAST OF FIFTH LINE
*
CALIB NASHYD        ID=2 NHYD=110  DT=5.0   DA= 148.6HA
                    DWF=0.0 CN=74  IA=5 N=3 TP=1.61HR END=-1
*
ADD HYD             ID=10   NHYD=512   IDONE=8   IDTWO=2
*
*  FLOW TO FIFTH LINE CULVERT, SOUTH OF HWY 401
*
ADD HYD             ID=1    NHYD=513   IDONE=7   IDTWO=4
*
*******************************************************************************
*                        SIXTEEN MILE CREEK SUBWATERSHED 4                    *
*******************************************************************************
*
* WEST TRIBUTARY *
*
* SUBCATCHMENT 204B - STUDY AREA NORTH OF STEELES
*
CALIB NASHYD        ID=1 NHYD=200  DT=5.0   DA= 4.28 HA
                    DWF=0.0 CN=85  IA=5 N=3 TP=0.57HR END=-1
*
* SUBCATCHMENT 204C - STUDY AREA WEST OF TRIBUTARY
*
CALIB NASHYD        ID=2 NHYD=201  DT=5.0   DA= 53.85 HA
                    DWF=0.0 CN=83  IA=5 N=3 TP=1.24HR END=-1
*
ADD HYD             ID=3    NHYD=600   IDONE=1   IDTWO=2
*
* SUBCATCHMENT 204D - STUDY AREA WEST OF TRIBUTARY
*
CALIB NASHYD        ID=1 NHYD=202  DT=5.0   DA= 10.45 HA
                    DWF=0.0 CN=83  IA=5 N=3 TP=0.82HR END=-1
*
ADD HYD             ID=2    NHYD=601   IDONE=1   IDTWO=3
*
* SUBCATCHMENT 204E - STUDY AREA EAST OF TRIBUTARY
*
CALIB NASHYD        ID=1 NHYD=203  DT=5.0   DA= 15.59 HA
                    DWF=0.0 CN=78  IA=5 N=3 TP=0.76HR END=-1
*
* SUBCATCHMENT 204A' - STUDY AREA NORTH OF STEELES
*
CALIB NASHYD        ID=6 NHYD=208  DT=5.0   DA= 12.18 HA
                    DWF=0.0 CN=82  IA=5 N=3 TP=0.34HR END=-1
*
* EAST TRIBUTARY *
*
* SUBCATCHMENT 205C - STUDY AREA WEST OF TRIBUTARY
*
CALIB NASHYD        ID=3 NHYD=204  DT=5.0   DA= 11.89 HA
                    DWF=0.0 CN=78  IA=5 N=3 TP=0.42HR END=-1
*
ADD HYD             ID=4    NHYD=602   IDONE=1   IDTWO=3
*
ADD HYD             ID=1    NHYD=603   IDONE=2   IDTWO=4
*
* SUBCATCHMENT 205B - STUDY AREA EAST OF TRIBUTARY AND EAST OF TRAFALGAR
*
CALIB STANDHYD      ID=2 NHYD=205  DT=5.0    DA= 4.45HA
                    XIMP=0.01   TIMP=0.135 DWF=0.0  LOSS=2    CN=84.0
                    DPSP=1.5    SLP=0.5%   LGP=40   MNP=0.25  SCP=0.0
```

```
                    DPSI=-1     SLI=0.5%    LGI=172   MNI=0.013 SCI=0.0
                    END=-1
*
* SUBCATCHMENT 205D - STUDY AREA EAST OF TRIBUTARY AND WEST OF TRAFALGAR
*
CALIB NASHYD        ID=3 NHYD=206  DT=5.0    DA= 51.16 HA
                    DWF=0.0 CN=82  IA=5 N=3 TP=0.71HR END=-1
*
* (NOTE: 205B FLOWS AWAY FROM 205D - HYDS ADDED TO PROVIDE STUDY AREA SUMMARY)
*
ADD HYD             ID=4     NHYD=604    IDONE=2    IDTWO=3
*
ADD HYD             ID=2     NHYD=605    IDONE=1    IDTWO=4
*
ADD HYD             ID=7     NHYD=609    IDONE=2    IDTWO=6
*
* SUBCATCHMENT 205E - SOUTH OF STUDY AREA
*
CALIB NASHYD        ID=3 NHYD=207  DT=5.0    DA= 79.86 HA
                    DWF=0.0 CN=72  IA=5 N=3 TP=0.74HR END=-1
*
ADD HYD             ID=9     NHYD=606    IDONE=7    IDTWO=3
*
* ADD SUBWATERSHED 3 TO SUBWATERSHED 4 (STUDY AREA SUBCATCHMENTS ONLY)
*
ADD HYD             ID=1     NHYD=607    IDONE=9    IDTWO=10
*
******************************************************************************
*                       SIXTEEN MILE CREEK SUBWATERSHED 5                    *
******************************************************************************
*
* SUBCATCHMENT 300B - STUDY AREA WEST OF CREEK
*
CALIB NASHYD        ID=1 NHYD=300  DT=5.0    DA= 30.20 HA
                    DWF=0.0 CN=82  IA=5 N=3 TP=0.45HR END=-1
*
* SUBCATCHMENT 300C - STUDY AREA EAST OF CREEK
*
CALIB NASHYD        ID=2 NHYD=301  DT=5.0    DA= 40.29 HA
                    DWF=0.0 CN=80  IA=5 N=3 TP=0.65HR END=-1
*
* SUBCATCHMENT 300D - STUDY AREA EAST OF EIGHTH LINE
*
CALIB NASHYD        ID=3 NHYD=302  DT=5.0    DA= 25.98 HA
                    DWF=0.0 CN=82  IA=5 N=3 TP=0.72HR END=-1
*
ADD HYD             ID=4     NHYD=700    IDONE=2    IDTWO=3
*
ADD HYD             ID=2     NHYD=701    IDONE=1    IDTWO=4
*
*
******************************************************************************
*                       SIXTEEN MILE CREEK SUBWATERSHED 6                    *
******************************************************************************
*
* TRIBUTARY 1
*
* SUBCATCHMENT 303A - UNDEVELOPED AREA NORTH OF STEELES
*
CALIB NASHYD        ID=1 NHYD=400  DT=5.0    DA= 22.91 HA
                    DWF=0.0 CN=82  IA=5 N=3 TP=0.72HR END=-1
*
* SUBCATCHMENT 303B - STUDY AREA SOUTH OF STEELES
*
CALIB NASHYD        ID=2 NHYD=401  DT=5.0    DA= 27.66 HA
                    DWF=0.0 CN=82  IA=5 N=3 TP=0.55HR END=-1
*
ADD HYD             ID=3     NHYD=800     IDONE=1    IDTWO=2
*
* SUBCATCHMENT 303C - STUDY AREA - HIGHWAY 407/401 INTERCHANGE
*
CALIB STANDHYD      ID=1 NHYD=402  DT=5.0    DA= 9.99HA
                    XIMP=0.04  TIMP=0.37  DWF=0.0  LOSS=2   CN=79
                    DPSP=1.5   SLP=0.5%   LGP=10   MNP=0.25  SCP=0.0
                    DPSI=-1    SLI=0.5%   LGI=250  MNI=0.013 SCI=0.0
                    END=-1
*
ADD HYD             ID=2     NHYD=801     IDONE=1    IDTWO=3
*
*  EXISTING HIGHWAY 407/401 INTERCHANGE POND
*
ROUTE RESERVOIR     ID=3  NHYD=802  IDIN=2
                    DISCHG(CMS)      STORAGE(HA M)
                         0.000     0.000
                         0.022     0.077
                         0.031     0.153
                         0.038     0.230
                         0.044     0.307
                         0.049     0.383
                         0.053     0.460
                         0.059     0.590
                         1.170     0.783
                         3.000     1.033
                         5.100     1.283
                         8.670     1.531
                    -1
*
* TRIBUTARY 2
*
* SUBCATCHMENT 304A - UNDEVELOPED AREA NORTH OF STEELES
```

```
*
CALIB NASHYD          ID=1 NHYD=403  DT=5.0   DA= 47.88 HA
                      DWF=0.0 CN=81  IA=5 N=3 TP=0.75HR END=-1
*
* SUBCATCHMENT 304B - STUDY AREA SOUTH OF STEELES
*
CALIB NASHYD          ID=2 NHYD=404  DT=5.0   DA= 12.73 HA
                      DWF=0.0 CN=81  IA=5 N=3 TP=0.29HR END=-1
*
ADD HYD               ID=3     NHYD=803     IDONE=1    IDTWO=2
*
* SUBCATCHMENT 304C - STUDY AREA - HIGHWAY 407/401 INTERCHANGE
*
CALIB STANDHYD        ID=1 NHYD=405  DT=5.0    DA= 12.72HA
                      XIMP=0.03   TIMP=0.253  DWF=0.0  LOSS=2    CN=79.0
                      DPSP=1.5    SLP=0.5%    LGP=10   MNP=0.25  SCP=0.0
                      DPSI=-1     SLI=0.5%    LGI=220  MNI=0.013 SCI=0.0
                      END=-1
*
ADD HYD               ID=2     NHYD=804     IDONE=1    IDTWO=3
*
*  EXISTING HIGHWAY 407/401 INTERCHANGE POND
*
ROUTE RESERVOIR       ID=3  NHYD=805  IDIN=2
                      DISCHG(CMS)     STORAGE(HA M)
                            0.000     0.000
                            0.037     0.1125
                            0.053     0.2275
                            0.065     0.3450
                            0.075     0.4630
                            0.083     0.5800
                            1.900     0.7700
                            6.400     1.1000
                            9.200     1.2500
                      -1
*
* TRIBUTARY 3
*
* SUBCATCHMENT 304D - UNDEVELOPED AREA NORTH OF STEELES
*
CALIB NASHYD          ID=1 NHYD=406  DT=5.0   DA= 52.69 HA
                      DWF=0.0 CN=81  IA=5 N=3 TP=0.66HR END=-1
*
* SUBCATCHMENT 304E - STUDY AREA SOUTH OF STEELES
*
CALIB NASHYD          ID=2 NHYD=407  DT=5.0   DA= 13.56 HA
                      DWF=0.0 CN=82  IA=5 N=3 TP=0.26HR END=-1
*
ADD HYD               ID=3     NHYD=806     IDONE=1    IDTWO=2
*
* SUBCATCHMENT 304F - STUDY AREA - HIGHWAY 407/401 INTERCHANGE
*
CALIB STANDHYD        ID=1 NHYD=408  DT=5.0    DA= 15.41HA
                      XIMP=0.04   TIMP=0.442  DWF=0.0  LOSS=2    CN=79.0
                      DPSP=1.5    SLP=0.5%    LGP=10   MNP=0.25  SCP=0.0
                      DPSI=-1     SLI=0.5%    LGI=250  MNI=0.013 SCI=0.0
                      END=-1
*
ADD HYD               ID=2     NHYD=807     IDONE=1    IDTWO=3
*
*  EXISTING HIGHWAY 407/401 INTERCHANGE POND
*
ROUTE RESERVOIR       ID=3  NHYD=808  IDIN=2
                      DISCHG(CMS)     STORAGE(HA M)
                            0.000     0.000
                            0.045     0.075
                            0.063     0.162
                            0.089     0.246
                            0.100     0.393
                            0.118     0.560
                            0.133     0.720
                            1.680     0.883
                            3.871     1.008
                            7.383     1.200
                            9.610     1.360
                            14.25     1.880
                      -1
*
* TRIBUTARY 4
*
* SUBCATCHMENT 304G - UNDEVELOPED AREA NORTH OF STEELES
*
CALIB NASHYD          ID=1 NHYD=409  DT=5.0   DA= 32.76 HA
                      DWF=0.0 CN=81  IA=5 N=3 TP=0.79HR END=-1
*
* SUBCATCHMENT 304H - STUDY AREA SOUTH OF STEELES
*
CALIB NASHYD          ID=2 NHYD=410  DT=5.0   DA= 15.07 HA
                      DWF=0.0 CN=81  IA=5 N=3 TP=0.43HR END=-1
*
ADD HYD               ID=3     NHYD=809     IDONE=1    IDTWO=2
*
* SUBCATCHMENT 304I - STUDY AREA - HIGHWAY 407/401 INTERCHANGE
*
CALIB STANDHYD        ID=1 NHYD=411  DT=5.0    DA= 5.88HA
                      XIMP=0.05   TIMP=0.461  DWF=0.0  LOSS=2    CN=79.0
                      DPSP=1.5    SLP=0.5%    LGP=10   MNP=0.25  SCP=0.0
                      DPSI=-1     SLI=0.5%    LGI=250  MNI=0.013 SCI=0.0
                      END=-1
*
```

```
ADD HYD              ID=2    NHYD=810    IDONE=1   IDTWO=3
*
*  EXISTING HIGHWAY 407/401 INTERCHANGE POND
*
ROUTE RESERVOIR      ID=3  NHYD=811  IDIN=2
                     DISCHG(CMS)     STORAGE(HA M)
                          0.000    0.000
                          0.020    0.040
                          0.035    0.154
                          0.045    0.234
                          0.054    0.316
                          0.061    0.400
                          0.068    0.500
                          0.450    0.570
                          0.930    0.575
                          1.500    0.650
                          2.600    0.730
                          5.200    1.020
                          7.700    1.200
                     -1
*
* TRIBUTARY 5
*
* SUBCATCHMENT 304J - STUDY AREA SOUTH OF STEELES
*
CALIB NASHYD         ID=3 NHYD=412  DT=5.0   DA= 27.55 HA
                     DWF=0.0 CN=80  IA=5 N=3 TP=0.62HR END=-1
*
* SUBCATCHMENT 304K - STUDY AREA - HIGHWAY 407/401 INTERCHANGE
*
CALIB STANDHYD       ID=1 NHYD=413  DT=5.0   DA= 9.99HA
                     XIMP=0.02  TIMP=0.212 DWF=0.0  LOSS=2   CN=79.0
                     DPSP=1.5   SLP=0.5%   LGP=10   MNP=0.25  SCP=0.0
                     DPSI=-1    SLI=0.5%   LGI=400  MNI=0.013 SCI=0.0
                     END=-1
*
ADD HYD              ID=2    NHYD=812    IDONE=1   IDTWO=3
*
*  EXISTING HIGHWAY 407/401 INTERCHANGE POND
*
ROUTE RESERVOIR      ID=3  NHYD=813  IDIN=2
                     DISCHG(CMS)     STORAGE(HA M)
                          0.000    0.000
                          0.023    0.050
                          0.033    0.061
                          0.040    0.087
                          0.046    0.124
                          0.051    0.340
                          1.100    0.400
                          1.980    0.430
                          2.310    0.440
                          2.920    0.460
                          3.200    0.470
                          3.770    0.490
                          7.200    0.594
                     -1
*
******************************************************************************
*                     CREDIT RIVER/MULLETT CREEK SUBWATERSHED 6              *
******************************************************************************
*
* SUBCATCHMENT 310 - STUDY AREA WEST OF WINSTON CHURCHILL BLVD
*
CALIB NASHYD         ID=1 NHYD=414  DT=5.0   DA= 21.71 HA
                     DWF=0.0 CN=82  IA=5 N=3 TP=1.13HR END=-1
*
START                START= 0.0 HRS   METOUT=0  NSTORM=1  NRUN=2
                     HHILL2.STM
*
START                START= 0.0 HRS   METOUT=0  NSTORM=1  NRUN=3
                     HHILL5.STM
*
START                START= 0.0 HRS   METOUT=0  NSTORM=1  NRUN=4
                     HHILL10.STM
*
START                START= 0.0 HRS   METOUT=0  NSTORM=1  NRUN=5
                     HHILL25.STM
*
START                START= 0.0 HRS   METOUT=0  NSTORM=1  NRUN=6
                     HHILL50.STM
*
START                START= 0.0 HRS   METOUT=0  NSTORM=1  NRUN=7
                     HHILL100.STM
*
FINISH
```

```
 OOO    TTTTT   TTTTT   H    H   Y    Y   M    M    OOO     I N T E R H Y M O
O   O     T       T     H    H    Y Y     MM MM    O   O    * * * 1989b * * *
O   O     T       T     HHHHH      Y      M M M    O   O
O   O     T       T     H    H     Y      M    M   O   O
 OOO      T       T     H    H     Y      M    M    OOO     00025
```


***** S U M M A R Y   O U T P U T *****

Input filename: HHEXT.DAT
Output filename: HHEXT.OUT
Summary filename: HHEXT.SUM

DATE: 01-20-1999 TIME: 14:52:50

USER: ______________________________

===<comment>=== 1

===<comment>=== 2

===<comment>=== 3

****
** SIMULATION NUMBER: 1 **
****

W/E	COMMAND	HYD	ID	DT min	AREA ha	Qpeak cms	Tpeak hrs	R.V. mm	R.C.	Qbase cms
	START @ .00 hrs									
	READ STORM [Ptot= 25.30 mm] fname :25MM.STM remark: 25MM STOR			10.0						
	CALIB NASHYD [CN=82.0] [N= 3.0:Tp= 1.45]	0900	1	5.0	109.73	.52	3.83	5.41	.21	.000
	CHANNEL[1 : 0900]	0901	2	5.0	109.73	.49	4.25	5.41	n/a	.000
	CALIB NASHYD [CN=82.0] [N= 3.0:Tp= .45]	0902	1	5.0	27.50	.31	2.50	5.41	.21	.000
	ADD [0902 + 0901]	0903	3	5.0	137.23	.56	4.00	5.41	n/a	.000
	CHANNEL[3 : 0903]	0904	1	5.0	137.23	.54	4.33	5.41	n/a	.000
	CALIB NASHYD [CN=82.0] [N= 3.0:Tp= .74]	0905	2	5.0	29.00	.23	2.92	5.41	.21	.000
	ADD [0904 + 0905]	0906	3	5.0	166.23	.64	4.08	5.41	n/a	.000
	CALIB STANDHYD [I%=47.0:S%= .50]	0100	1	5.0	61.89	3.14	2.17	19.51	.77	.000
	RESRVR [1 : 0100] {ST= 1.05 ha.m }	0500	2	5.0	61.89	.16	4.42	19.49	n/a	.000
*	CALIB STANDHYD [I%=47.0:S%= .50]	0101	1	5.0	1.91	.15	2.00	19.46	.77	.000
	ADD [0101 + 0500]	0501	3	5.0	63.80	.20	2.50	19.49	n/a	.000
	CALIB NASHYD [CN=80.0] [N= 3.0:Tp= .59]	0102	1	5.0	23.59	.20	2.67	4.91	.19	.000
	ADD [0102 + 0501]	0502	2	5.0	87.39	.39	2.67	15.55	n/a	.000
*	CALIB STANDHYD [I%=13.0:S%= .50]	0103	1	5.0	38.58	.53	2.08	9.58	.38	.000
	ADD [0103 + 0502]	0503	3	5.0	125.97	.76	2.83	13.72	n/a	.000
	RESRVR [3 : 0503] {ST= .78 ha.m }	0504	1	5.0	125.97	.15	11.25	13.40	n/a	.000
	CALIB NASHYD [CN=80.0] [N= 3.0:Tp= .69]	0104	2	5.0	11.79	.09	2.83	4.90	.19	.000
	ADD [0504 + 0104]	0505	7	5.0	137.76	.15	11.25	12.67	n/a	.000
*	CALIB STANDHYD [I%= 1.0:S%= .50]	0105	1	5.0	28.73	.44	2.50	8.09	.32	.000

ADD [0105 + 0505]	0506	2	5.0	166.49	.55	2.50	11.88	n/a	.000
CALIB NASHYD [CN=78.0] [N= 3.0:Tp= .87]	0106	1	5.0	28.35	.16	3.08	4.47	.18	.000
CALIB NASHYD [CN=80.0] [N= 3.0:Tp= .56]	0107	5	5.0	46.90	.41	2.67	4.91	.19	.000
ADD [0106 + 0107]	0507	4	5.0	75.25	.55	2.75	4.75	n/a	.000
ADD [0506 + 0507]	0508	1	5.0	241.74	1.08	2.67	9.66	n/a	.000
CALIB NASHYD [CN=85.0] [N= 3.0:Tp= .46]	0108	2	5.0	12.49	.16	2.50	6.32	.25	.000
ADD [0508 + 0108]	0509	3	5.0	254.23	1.24	2.58	9.50	n/a	.000
CALIB NASHYD [CN=82.0] [N= 3.0:Tp= .80]	0109	1	5.0	21.75	.16	2.92	5.41	.21	.000
CALIB NASHYD [CN=85.0] [N= 3.0:Tp= 1.03]	0110	2	5.0	56.60	.41	3.25	6.32	.25	.000
ADD [0109 + 0110]	0510	4	5.0	78.35	.56	3.17	6.07	n/a	.000
ADD [0509 + 0510]	0511	1	5.0	332.58	1.70	2.75	8.69	n/a	.000
CHANNEL[1 : 0511]	0511	8	5.0	332.58	1.13	3.50	8.68	n/a	.000
CALIB NASHYD [CN=74.0] [N= 3.0:Tp= 1.61]	0110	2	5.0	148.60	.45	4.00	3.76	.15	.000
ADD [0511 + 0110]	0512	10	5.0	481.18	1.56	3.67	7.16	n/a	.000
ADD [0505 + 0510]	0513	1	5.0	216.11	.70	3.17	10.28	n/a	.000
CALIB NASHYD [CN=85.0] [N= 3.0:Tp= .57]	0200	1	5.0	4.28	.05	2.67	6.30	.25	.000
CALIB NASHYD [CN=83.0] [N= 3.0:Tp= 1.24]	0201	2	5.0	53.85	.30	3.50	5.69	.22	.000
ADD [0200 + 0201]	0600	3	5.0	58.13	.33	3.42	5.74	n/a	.000
CALIB NASHYD [CN=83.0] [N= 3.0:Tp= .82]	0202	1	5.0	10.45	.08	3.00	5.68	.22	.000
ADD [0202 + 0600]	0601	2	5.0	68.58	.40	3.33	5.73	n/a	.000
CALIB NASHYD [CN=78.0] [N= 3.0:Tp= .76]	0203	1	5.0	15.59	.10	2.92	4.47	.18	.000
CALIB NASHYD [CN=82.0] [N= 3.0:Tp= .34]	0208	6	5.0	12.18	.17	2.33	5.41	.21	.000
CALIB NASHYD [CN=78.0] [N= 3.0:Tp= .42]	0204	3	5.0	11.89	.11	2.50	4.47	.18	.000
ADD [0203 + 0204]	0602	4	5.0	27.48	.20	2.58	4.47	n/a	.000
ADD [0601 + 0602]	0603	1	5.0	96.06	.56	3.00	5.37	n/a	.000
* CALIB STANDHYD [I%= 1.0:S%= .50]	0205	2	5.0	4.45	.08	2.42	8.81	.35	.000
CALIB NASHYD [CN=82.0] [N= 3.0:Tp= .71]	0206	3	5.0	51.16	.41	2.83	5.41	.21	.000
ADD [0205 + 0206]	0604	4	5.0	55.61	.47	2.75	5.69	n/a	.000
ADD [0603 + 0604]	0605	2	5.0	151.67	1.02	2.92	5.48	n/a	.000
ADD [0605 + 0208]	0609	7	5.0	163.85	1.11	2.75	5.48	n/a	.000
CALIB NASHYD [CN=72.0] [N= 3.0:Tp= .74]	0207	3	5.0	79.86	.40	2.92	3.46	.14	.000
ADD [0609 + 0207]	0606	9	5.0	243.71	1.51	2.83	4.82	n/a	.000
ADD [0606 + 0512]	0607	1	5.0	724.89	2.83	3.25	6.37	n/a	.000
CALIB NASHYD [CN=82.0] [N= 3.0:Tp= .45]	0300	1	5.0	30.20	.34	2.50	5.41	.21	.000
CALIB NASHYD	0301	2	5.0	40.29	.31	2.75	4.91	.19	.000

	[CN=80.0] [N= 3.0:Tp= .65]									
	CALIB NASHYD [CN=82.0] [N= 3.0:Tp= .72]	0302	3	5.0	25.98	.21	2.83	5.41	.21	.000
	ADD [0301 + 0302]	0700	4	5.0	66.27	.52	2.83	5.11	n/a	.000
	ADD [0300 + 0700]	0701	2	5.0	96.47	.83	2.67	5.20	n/a	.000
	CALIB NASHYD [CN=82.0] [N= 3.0:Tp= .72]	0400	1	5.0	22.91	.18	2.83	5.41	.21	.000
	CALIB NASHYD [CN=82.0] [N= 3.0:Tp= .55]	0401	2	5.0	27.66	.27	2.67	5.41	.21	.000
	ADD [0400 + 0401]	0800	3	5.0	50.57	.44	2.67	5.41	n/a	.000
*	CALIB STANDHYD [I%= 4.0:S%= .50]	0402	1	5.0	9.99	.31	2.17	9.23	.36	.000
	ADD [0402 + 0800]	0801	2	5.0	60.56	.58	2.50	6.04	n/a	.000
	RESRVR [2 : 0801] {ST= .32 ha.m }	0802	3	5.0	60.56	.04	5.00	6.03	n/a	.000
	CALIB NASHYD [CN=81.0] [N= 3.0:Tp= .75]	0403	1	5.0	47.88	.35	2.92	5.15	.20	.000
	CALIB NASHYD [CN=81.0] [N= 3.0:Tp= .29]	0404	2	5.0	12.73	.18	2.25	5.15	.20	.000
	ADD [0403 + 0404]	0803	3	5.0	60.61	.45	2.67	5.15	n/a	.000
*	CALIB STANDHYD [I%= 3.0:S%= .50]	0405	1	5.0	12.72	.34	2.17	8.15	.32	.000
	ADD [0405 + 0803]	0804	2	5.0	73.33	.65	2.33	5.67	n/a	.000
	RESRVR [2 : 0804] {ST= .35 ha.m }	0805	3	5.0	73.33	.07	5.00	5.66	n/a	.000
	CALIB NASHYD [CN=81.0] [N= 3.0:Tp= .66]	0406	1	5.0	52.69	.43	2.75	5.16	.20	.000
	CALIB NASHYD [CN=82.0] [N= 3.0:Tp= .26]	0407	2	5.0	13.56	.22	2.25	5.41	.21	.000
	ADD [0406 + 0407]	0806	3	5.0	66.25	.54	2.58	5.21	n/a	.000
*	CALIB STANDHYD [I%= 4.0:S%= .50]	0408	1	5.0	15.41	.52	2.17	9.96	.39	.000
	ADD [0408 + 0806]	0807	2	5.0	81.66	.90	2.25	6.10	n/a	.000
	RESRVR [2 : 0807] {ST= .40 ha.m }	0808	3	5.0	81.66	.10	4.67	6.10	n/a	.000
	CALIB NASHYD [CN=81.0] [N= 3.0:Tp= .79]	0409	1	5.0	32.76	.23	2.92	5.15	.20	.000
	CALIB NASHYD [CN=81.0] [N= 3.0:Tp= .43]	0410	2	5.0	15.07	.17	2.50	5.15	.20	.000
	ADD [0409 + 0410]	0809	3	5.0	47.83	.37	2.67	5.15	n/a	.000
*	CALIB STANDHYD [I%= 5.0:S%= .50]	0411	1	5.0	5.88	.21	2.17	10.24	.40	.000
	ADD [0411 + 0809]	0810	2	5.0	53.71	.45	2.50	5.71	n/a	.000
	RESRVR [2 : 0810] {ST= .26 ha.m }	0811	3	5.0	53.71	.05	5.08	5.70	n/a	.000
	CALIB NASHYD [CN=80.0] [N= 3.0:Tp= .62]	0412	3	5.0	27.55	.22	2.75	4.91	.19	.000
*	CALIB STANDHYD [I%= 2.0:S%= .50]	0413	1	5.0	9.99	.22	2.25	7.73	.31	.000
	ADD [0413 + 0412]	0812	2	5.0	37.54	.37	2.42	5.66	n/a	.000
	RESRVR [2 : 0812] {ST= .17 ha.m }	0813	3	5.0	37.54	.05	4.67	5.65	n/a	.000
	CALIB NASHYD [CN=82.0] [N= 3.0:Tp= 1.13]	0414	1	5.0	21.71	.12	3.42	5.41	.21	.000

** END OF SIMULATION : 1

```
*****************************************************************************************

 ****************************
 ** SIMULATION NUMBER:   2 **
 ****************************
 W/E COMMAND              HYD  ID   DT     AREA    Qpeak Tpeak   R.V.  R.C.    Qbase
                                    min     ha      cms   hrs     mm            cms
     START @   .00 hrs
     ------------------
     READ STORM                    10.0
     [ Ptot= 55.87 mm ]
     fname :HHILL2.STM
     remark:24HR 2YR CHICAGO - HALTON HILL 88 STDS
     ------------------
     CALIB NASHYD         0900  1   5.0   109.73    1.34  9.75  24.27  .43      .000
     [CN=82.0          ]
     [ N= 3.0:Tp= 1.45]
     ------------------
     CHANNEL[ 1 : 0900]  0901  2   5.0   109.73    1.27 10.25  24.26  n/a      .000
     ------------------
     CALIB NASHYD         0902  1   5.0    27.50     .76  8.50  24.26  .43      .000
     [CN=82.0          ]
     [ N= 3.0:Tp=  .45]
     ------------------
     ADD [0902 + 0901]    0903  3   5.0   137.23    1.44 10.08  24.26  n/a      .000
     ------------------
     CHANNEL[ 3 : 0903]  0904  1   5.0   137.23    1.41 10.50  24.26  n/a      .000
     ------------------
     CALIB NASHYD         0905  2   5.0    29.00     .57  8.83  24.26  .43      .000
     [CN=82.0          ]
     [ N= 3.0:Tp=  .74]
     ------------------
     ADD [0904 + 0905]    0906  3   5.0   166.23    1.67  9.83  24.26  n/a      .000
     ------------------
     CALIB STANDHYD       0100  1   5.0    61.89    4.89  8.08  48.72  .87      .000
     [I%=47.0:S%=  .50]
     ------------------
     RESRVR [ 1 : 0100]   0500  2   5.0    61.89     .20 14.58  48.36  n/a      .000
     {ST=  2.05 ha.m }
     ------------------
 *   CALIB STANDHYD       0101  1   5.0     1.91     .22  8.00  48.67  .87      .000
     [I%=47.0:S%=  .50]
     ------------------
     ADD [0101 + 0500]    0501  3   5.0    63.80     .34  8.00  48.37  n/a      .000
     ------------------
     CALIB NASHYD         0102  1   5.0    23.59     .50  8.67  22.62  .40      .000
     [CN=80.0          ]
     [ N= 3.0:Tp=  .59]
     ------------------
     ADD [0102 + 0501]    0502  2   5.0    87.39     .73  8.58  41.42  n/a      .000
     ------------------
 *   CALIB STANDHYD       0103  1   5.0    38.58    1.05  8.58  31.01  .56      .000
     [I%=13.0:S%=  .50]
     ------------------
     ADD [0103 + 0502]    0503  3   5.0   125.97    1.79  8.58  38.23  n/a      .000
     ------------------
     RESRVR [ 3 : 0503]   0504  1   5.0   125.97    1.45  9.17  36.16  n/a      .000
     {ST=   .80 ha.m }
     ------------------
     CALIB NASHYD         0104  2   5.0    11.79     .22  8.83  22.61  .40      .000
     [CN=80.0          ]
     [ N= 3.0:Tp=  .69]
     ------------------
     ADD [0504 + 0104]    0505  7   5.0   137.76    1.65  9.17  35.00  n/a      .000
     ------------------
 *   CALIB STANDHYD       0105  1   5.0    28.73    1.05  8.42  29.11  .52      .000
     [I%= 1.0:S%=  .50]
     ------------------
     ADD [0105 + 0505]    0506  2   5.0   166.49    2.15  9.17  33.98  n/a      .000
     ------------------
     CALIB NASHYD         0106  1   5.0    28.35     .42  9.00  21.11  .38      .000
     [CN=78.0          ]
     [ N= 3.0:Tp=  .87]
     ------------------
     CALIB NASHYD         0107  5   5.0    46.90    1.02  8.58  22.62  .40      .000
     [CN=80.0          ]
     [ N= 3.0:Tp=  .56]
     ------------------
     ADD [0106 + 0107]    0507  4   5.0    75.25    1.39  8.67  22.05  n/a      .000
     ------------------
     ADD [0506 + 0507]    0508  1   5.0   241.74    3.33  9.17  30.27  n/a      .000
     ------------------
     CALIB NASHYD         0108  2   5.0    12.49     .39  8.50  27.03  .48      .000
     [CN=85.0          ]
     [ N= 3.0:Tp=  .46]
     ------------------
     ADD [0508 + 0108]    0509  3   5.0   254.23    3.55  9.17  30.11  n/a      .000
     ------------------
     CALIB NASHYD         0109  1   5.0    21.75     .40  8.92  24.26  .43      .000
     [CN=82.0          ]
     [ N= 3.0:Tp=  .80]
     ------------------
     CALIB NASHYD         0110  2   5.0    56.60    1.01  9.25  27.04  .48      .000
```

[CN=85.0] [N= 3.0:Tp= 1.03]									
ADD [0109 + 0110]	0510	4	5.0	78.35	1.39	9.17	26.27	n/a	.000
ADD [0509 + 0510]	0511	1	5.0	332.58	4.94	9.17	29.20	n/a	.000
CHANNEL[1 : 0511]	0511	8	5.0	332.58	3.78	9.50	29.14	n/a	.000
CALIB NASHYD [CN=74.0] [N= 3.0:Tp= 1.61]	0110	2	5.0	148.60	1.23	10.00	18.47	.33	.000
ADD [0511 + 0110]	0512	10	5.0	481.18	4.94	9.58	25.84	n/a	.000
ADD [0505 + 0510]	0513	1	5.0	216.11	3.05	9.17	31.83	n/a	.000
CALIB NASHYD [CN=85.0] [N= 3.0:Tp= .57]	0200	1	5.0	4.28	.11	8.58	27.01	.48	.000
CALIB NASHYD [CN=83.0] [N= 3.0:Tp= 1.24]	0201	2	5.0	53.85	.77	9.50	25.14	.45	.000
ADD [0200 + 0201]	0600	3	5.0	58.13	.83	9.42	25.28	n/a	.000
CALIB NASHYD [CN=83.0] [N= 3.0:Tp= .82]	0202	1	5.0	10.45	.20	8.92	25.13	.45	.000
ADD [0202 + 0600]	0601	2	5.0	68.58	1.02	9.25	25.26	n/a	.000
CALIB NASHYD [CN=78.0] [N= 3.0:Tp= .76]	0203	1	5.0	15.59	.25	8.92	21.11	.38	.000
CALIB NASHYD [CN=82.0] [N= 3.0:Tp= .34]	0208	6	5.0	12.18	.40	8.33	24.26	.43	.000
CALIB NASHYD [CN=78.0] [N= 3.0:Tp= .42]	0204	3	5.0	11.89	.29	8.42	21.11	.38	.000
ADD [0203 + 0204]	0602	4	5.0	27.48	.50	8.58	21.11	n/a	.000
ADD [0601 + 0602]	0603	1	5.0	96.06	1.41	9.00	24.07	n/a	.000
* CALIB STANDHYD [I%= 1.0:S%= .50]	0205	2	5.0	4.45	.20	8.33	30.95	.55	.000
CALIB NASHYD [CN=82.0] [N= 3.0:Tp= .71]	0206	3	5.0	51.16	1.03	8.83	24.26	.43	.000
ADD [0205 + 0206]	0604	4	5.0	55.61	1.15	8.75	24.80	n/a	.000
ADD [0603 + 0604]	0605	2	5.0	151.67	2.53	8.83	24.34	n/a	.000
ADD [0605 + 0208]	0609	7	5.0	163.85	2.78	8.75	24.33	n/a	.000
CALIB NASHYD [CN=72.0] [N= 3.0:Tp= .74]	0207	3	5.0	79.86	1.05	8.92	17.29	.31	.000
ADD [0609 + 0207]	0606	9	5.0	243.71	3.82	8.83	22.02	n/a	.000
ADD [0606 + 0512]	0607	1	5.0	724.89	8.11	9.33	24.56	n/a	.000
CALIB NASHYD [CN=82.0] [N= 3.0:Tp= .45]	0300	1	5.0	30.20	.83	8.50	24.26	.43	.000
CALIB NASHYD [CN=80.0] [N= 3.0:Tp= .65]	0301	2	5.0	40.29	.80	8.75	22.62	.40	.000
CALIB NASHYD [CN=82.0] [N= 3.0:Tp= .72]	0302	3	5.0	25.98	.52	8.83	24.26	.43	.000
ADD [0301 + 0302]	0700	4	5.0	66.27	1.31	8.75	23.26	n/a	.000
ADD [0300 + 0700]	0701	2	5.0	96.47	2.07	8.67	23.58	n/a	.000
CALIB NASHYD [CN=82.0] [N= 3.0:Tp= .72]	0400	1	5.0	22.91	.46	8.83	24.26	.43	.000
CALIB NASHYD [CN=82.0] [N= 3.0:Tp= .55]	0401	2	5.0	27.66	.67	8.58	24.26	.43	.000
ADD [0400 + 0401]	0800	3	5.0	50.57	1.11	8.67	24.26	n/a	.000
* CALIB STANDHYD [I%= 4.0:S%= .50]	0402	1	5.0	9.99	.63	8.17	31.34	.56	.000
ADD [0402 + 0800]	0801	2	5.0	60.56	1.36	8.50	25.43	n/a	.000

W/E	COMMAND	HYD	ID	DT	AREA	Qpeak	Tpeak	R.V.	R.C.	Qbase
	RESRVR [2 : 0801] {ST= .67 ha.m }	0802	3	5.0	60.56	.51	10.08	25.32	n/a	.000
	CALIB NASHYD [CN=81.0] [N= 3.0:Tp= .75]	0403	1	5.0	47.88	.89	8.83	23.42	.42	.000
	CALIB NASHYD [CN=81.0] [N= 3.0:Tp= .29]	0404	2	5.0	12.73	.44	8.25	23.41	.42	.000
	ADD [0403 + 0404]	0803	3	5.0	60.61	1.13	8.67	23.42	n/a	.000
*	CALIB STANDHYD [I%= 3.0:S%= .50]	0405	1	5.0	12.72	.72	8.17	28.85	.52	.000
	ADD [0405 + 0803]	0804	2	5.0	73.33	1.54	8.33	24.36	n/a	.000
	RESRVR [2 : 0804] {ST= .65 ha.m }	0805	3	5.0	73.33	.79	9.67	24.34	n/a	.000
	CALIB NASHYD [CN=81.0] [N= 3.0:Tp= .66]	0406	1	5.0	52.69	1.07	8.75	23.42	.42	.000
	CALIB NASHYD [CN=82.0] [N= 3.0:Tp= .26]	0407	2	5.0	13.56	.53	8.25	24.25	.43	.000
	ADD [0406 + 0407]	0806	3	5.0	66.25	1.36	8.58	23.59	n/a	.000
*	CALIB STANDHYD [I%= 4.0:S%= .50]	0408	1	5.0	15.41	1.04	8.17	33.00	.59	.000
	ADD [0408 + 0806]	0807	2	5.0	81.66	2.05	8.17	25.37	n/a	.000
	RESRVR [2 : 0807] {ST= .80 ha.m }	0808	3	5.0	81.66	.87	9.67	25.36	n/a	.000
	CALIB NASHYD [CN=81.0] [N= 3.0:Tp= .79]	0409	1	5.0	32.76	.59	8.92	23.42	.42	.000
	CALIB NASHYD [CN=81.0] [N= 3.0:Tp= .43]	0410	2	5.0	15.07	.41	8.42	23.42	.42	.000
	ADD [0409 + 0410]	0809	3	5.0	47.83	.92	8.67	23.42	n/a	.000
*	CALIB STANDHYD [I%= 5.0:S%= .50]	0411	1	5.0	5.88	.41	8.17	33.54	.60	.000
	ADD [0411 + 0809]	0810	2	5.0	53.71	1.08	8.50	24.53	n/a	.000
	RESRVR [2 : 0810] {ST= .56 ha.m }	0811	3	5.0	53.71	.42	10.25	24.52	n/a	.000
	CALIB NASHYD [CN=80.0] [N= 3.0:Tp= .62]	0412	3	5.0	27.55	.56	8.67	22.62	.40	.000
*	CALIB STANDHYD [I%= 2.0:S%= .50]	0413	1	5.0	9.99	.51	8.17	27.96	.50	.000
	ADD [0413 + 0412]	0812	2	5.0	37.54	.83	8.33	24.04	n/a	.000
	RESRVR [2 : 0812] {ST= .36 ha.m }	0813	3	5.0	37.54	.39	9.67	24.03	n/a	.000
	CALIB NASHYD [CN=82.0] [N= 3.0:Tp= 1.13]	0414	1	5.0	21.71	.32	9.33	24.26	.43	.000

** END OF SIMULATION : 2

****

****
** SIMULATION NUMBER: 3 **
****

W/E	COMMAND	HYD	ID	DT min	AREA ha	Qpeak cms	Tpeak hrs	R.V. mm	R.C.	Qbase cms
	START @ .00 hrs									
	READ STORM [Ptot= 71.72 mm] fname :HHILL5.STM remark:24HR 5YR CHICAGO - HALTON HILL 88 STDS			10.0						
	CALIB NASHYD [CN=82.0] [N= 3.0:Tp= 1.45]	0900	1	5.0	109.73	2.30	9.75	36.34	.51	.000

	CHANNEL[1 : 0900]	0901	2	5.0	109.73	2.18	10.17	36.34	n/a	.000
	CALIB NASHYD [CN=82.0] [N= 3.0:Tp= .45]	0902	1	5.0	27.50	1.32	8.50	36.34	.51	.000
	ADD [0902 + 0901]	0903	3	5.0	137.23	2.45	10.00	36.34	n/a	.000
	CHANNEL[3 : 0903]	0904	1	5.0	137.23	2.39	10.33	36.34	n/a	.000
	CALIB NASHYD [CN=82.0] [N= 3.0:Tp= .74]	0905	2	5.0	29.00	.99	8.83	36.34	.51	.000
	ADD [0904 + 0905]	0906	3	5.0	166.23	2.84	9.75	36.34	n/a	.000
	CALIB STANDHYD [I%=47.0:S%= .50]	0100	1	5.0	61.89	7.98	8.08	64.24	.90	.000
	RESRVR [1 : 0100] {ST= 2.73 ha.m }	0500	2	5.0	61.89	.40	11.42	63.63	n/a	.000
*	CALIB STANDHYD [I%=47.0:S%= .50]	0101	1	5.0	1.91	.33	8.00	64.20	.90	.000
	ADD [0101 + 0500]	0501	3	5.0	63.80	.48	8.00	63.64	n/a	.000
	CALIB NASHYD [CN=80.0] [N= 3.0:Tp= .59]	0102	1	5.0	23.59	.88	8.67	34.18	.48	.000
	ADD [0102 + 0501]	0502	2	5.0	87.39	1.15	8.67	55.69	n/a	.000
*	CALIB STANDHYD [I%=13.0:S%= .50]	0103	1	5.0	38.58	1.95	8.50	43.89	.61	.000
	ADD [0103 + 0502]	0503	3	5.0	125.97	3.09	8.50	52.08	n/a	.000
*	RESRVR [3 : 0503] {ST= .82 ha.m }	0504	1	5.0	125.97	3.31	8.67	49.16	n/a	.000
	CALIB NASHYD [CN=80.0] [N= 3.0:Tp= .69]	0104	2	5.0	11.79	.39	8.75	34.17	.48	.000
	ADD [0504 + 0104]	0505	7	5.0	137.76	3.69	8.67	47.88	n/a	.000
*	CALIB STANDHYD [I%= 1.0:S%= .50]	0105	1	5.0	28.73	1.94	8.33	41.94	.58	.000
	ADD [0105 + 0505]	0506	2	5.0	166.49	5.08	8.67	46.86	n/a	.000
	CALIB NASHYD [CN=78.0] [N= 3.0:Tp= .87]	0106	1	5.0	28.35	.75	9.00	32.17	.45	.000
	CALIB NASHYD [CN=80.0] [N= 3.0:Tp= .56]	0107	5	5.0	46.90	1.81	8.67	34.18	.48	.000
	ADD [0106 + 0107]	0507	4	5.0	75.25	2.47	8.75	33.42	n/a	.000
	ADD [0506 + 0507]	0508	1	5.0	241.74	7.55	8.67	42.67	n/a	.000
	CALIB NASHYD [CN=85.0] [N= 3.0:Tp= .46]	0108	2	5.0	12.49	.67	8.50	39.90	.56	.000
	ADD [0508 + 0108]	0509	3	5.0	254.23	8.18	8.67	42.54	n/a	.000
	CALIB NASHYD [CN=82.0] [N= 3.0:Tp= .80]	0109	1	5.0	21.75	.71	8.92	36.34	.51	.000
	CALIB NASHYD [CN=85.0] [N= 3.0:Tp= 1.03]	0110	2	5.0	56.60	1.71	9.17	39.91	.56	.000
	ADD [0109 + 0110]	0510	4	5.0	78.35	2.39	9.08	38.92	n/a	.000
	ADD [0509 + 0510]	0511	1	5.0	332.58	10.21	8.67	41.68	n/a	.000
	CHANNEL[1 : 0511]	0511	8	5.0	332.58	7.46	9.17	41.60	n/a	.000
	CALIB NASHYD [CN=74.0] [N= 3.0:Tp= 1.61]	0110	2	5.0	148.60	2.18	10.00	28.54	.40	.000
	ADD [0511 + 0110]	0512	10	5.0	481.18	9.29	9.25	37.57	n/a	.000
	ADD [0505 + 0510]	0513	1	5.0	216.11	5.73	8.67	44.63	n/a	.000
	CALIB NASHYD [CN=85.0] [N= 3.0:Tp= .57]	0200	1	5.0	4.28	.20	8.67	39.87	.56	.000
	CALIB NASHYD [CN=83.0] [N= 3.0:Tp= 1.24]	0201	2	5.0	53.85	1.32	9.50	37.49	.52	.000

	ADD [0200 + 0201]	0600	3	5.0	58.13	1.43	9.33	37.66	n/a	.000
	CALIB NASHYD [CN=83.0] [N= 3.0:Tp= .82]	0202	1	5.0	10.45	.35	8.92	37.47	.52	.000
	ADD [0202 + 0600]	0601	2	5.0	68.58	1.75	9.25	37.63	n/a	.000
	CALIB NASHYD [CN=78.0] [N= 3.0:Tp= .76]	0203	1	5.0	15.59	.45	8.92	32.16	.45	.000
	CALIB NASHYD [CN=82.0] [N= 3.0:Tp= .34]	0208	6	5.0	12.18	.70	8.33	36.33	.51	.000
	CALIB NASHYD [CN=78.0] [N= 3.0:Tp= .42]	0204	3	5.0	11.89	.51	8.42	32.16	.45	.000
	ADD [0203 + 0204]	0602	4	5.0	27.48	.90	8.58	32.16	n/a	.000
	ADD [0601 + 0602]	0603	1	5.0	96.06	2.46	9.00	36.07	n/a	.000
*	CALIB STANDHYD [I%= 1.0:S%= .50]	0205	2	5.0	4.45	.36	8.25	44.24	.62	.000
	CALIB NASHYD [CN=82.0] [N= 3.0:Tp= .71]	0206	3	5.0	51.16	1.81	8.83	36.34	.51	.000
	ADD [0205 + 0206]	0604	4	5.0	55.61	1.98	8.75	36.98	n/a	.000
	ADD [0603 + 0604]	0605	2	5.0	151.67	4.39	8.83	36.40	n/a	.000
	ADD [0605 + 0208]	0609	7	5.0	163.85	4.82	8.75	36.40	n/a	.000
	CALIB NASHYD [CN=72.0] [N= 3.0:Tp= .74]	0207	3	5.0	79.86	1.92	8.83	26.90	.38	.000
	ADD [0609 + 0207]	0606	9	5.0	243.71	6.72	8.83	33.28	n/a	.000
	ADD [0606 + 0512]	0607	1	5.0	724.89	15.46	9.08	36.13	n/a	.000
	CALIB NASHYD [CN=82.0] [N= 3.0:Tp= .45]	0300	1	5.0	30.20	1.45	8.50	36.34	.51	.000
	CALIB NASHYD [CN=80.0] [N= 3.0:Tp= .65]	0301	2	5.0	40.29	1.41	8.75	34.18	.48	.000
	CALIB NASHYD [CN=82.0] [N= 3.0:Tp= .72]	0302	3	5.0	25.98	.91	8.83	36.34	.51	.000
	ADD [0301 + 0302]	0700	4	5.0	66.27	2.31	8.75	35.03	n/a	.000
	ADD [0300 + 0700]	0701	2	5.0	96.47	3.63	8.67	35.44	n/a	.000
	CALIB NASHYD [CN=82.0] [N= 3.0:Tp= .72]	0400	1	5.0	22.91	.80	8.83	36.34	.51	.000
	CALIB NASHYD [CN=82.0] [N= 3.0:Tp= .55]	0401	2	5.0	27.66	1.16	8.58	36.34	.51	.000
	ADD [0400 + 0401]	0800	3	5.0	50.57	1.94	8.67	36.34	n/a	.000
*	CALIB STANDHYD [I%= 4.0:S%= .50]	0402	1	5.0	9.99	1.04	8.17	44.57	.62	.000
	ADD [0402 + 0800]	0801	2	5.0	60.56	2.33	8.50	37.70	n/a	.000
	RESRVR [2 : 0801] {ST= .82 ha.m }	0802	3	5.0	60.56	1.40	9.42	37.59	n/a	.000
	CALIB NASHYD [CN=81.0] [N= 3.0:Tp= .75]	0403	1	5.0	47.88	1.57	8.83	35.24	.49	.000
	CALIB NASHYD [CN=81.0] [N= 3.0:Tp= .29]	0404	2	5.0	12.73	.77	8.25	35.23	.49	.000
	ADD [0403 + 0404]	0803	3	5.0	60.61	1.99	8.67	35.24	n/a	.000
*	CALIB STANDHYD [I%= 3.0:S%= .50]	0405	1	5.0	12.72	1.21	8.17	41.52	.58	.000
	ADD [0405 + 0803]	0804	2	5.0	73.33	2.66	8.33	36.33	n/a	.000
	RESRVR [2 : 0804] {ST= .76 ha.m }	0805	3	5.0	73.33	1.84	9.17	36.31	n/a	.000
	CALIB NASHYD [CN=81.0] [N= 3.0:Tp= .66]	0406	1	5.0	52.69	1.89	8.75	35.24	.49	.000

```
    ------------------
    CALIB NASHYD         0407  2  5.0    13.56      .91  8.25  36.32  .51    .000
    [CN=82.0          ]
    [ N= 3.0:Tp=   .26]
    ------------------
    ADD [0406 + 0407]    0806  3  5.0    66.25     2.40  8.58  35.46  n/a    .000
    ------------------
 *  CALIB STANDHYD       0408  1  5.0    15.41     1.81  8.08  46.59  .65    .000
    [I%= 4.0:S%=   .50]
    ------------------
    ADD [0408 + 0806]    0807  2  5.0    81.66     3.35  8.25  37.56  n/a    .000
    ------------------
    RESRVR [ 2 : 0807]   0808  3  5.0    81.66     2.32  9.00  37.56  n/a    .000
    {ST=    .92 ha.m }
    ------------------
    CALIB NASHYD         0409  1  5.0    32.76     1.03  8.92  35.24  .49    .000
    [CN=81.0          ]
    [ N= 3.0:Tp=   .79]
    ------------------
    CALIB NASHYD         0410  2  5.0    15.07      .72  8.50  35.24  .49    .000
    [CN=81.0          ]
    [ N= 3.0:Tp=   .43]
    ------------------
    ADD [0409 + 0410]    0809  3  5.0    47.83     1.62  8.67  35.24  n/a    .000
    ------------------
 *  CALIB STANDHYD       0411  1  5.0     5.88      .70  8.08  47.22  .66    .000
    [I%= 5.0:S%=   .50]
    ------------------
    ADD [0411 + 0809]    0810  2  5.0    53.71     1.82  8.58  36.55  n/a    .000
    ------------------
    RESRVR [ 2 : 0810]   0811  3  5.0    53.71     1.29  9.33  36.54  n/a    .000
    {ST=    .62 ha.m }
    ------------------
    CALIB NASHYD         0412  3  5.0    27.55      .99  8.67  34.18  .48    .000
    [CN=80.0          ]
    [ N= 3.0:Tp=   .62]
    ------------------
 *  CALIB STANDHYD       0413  1  5.0     9.99      .86  8.17  40.45  .56    .000
    [I%= 2.0:S%=   .50]
    ------------------
    ADD [0413 + 0412]    0812  2  5.0    37.54     1.44  8.33  35.85  n/a    .000
    ------------------
    RESRVR [ 2 : 0812]   0813  3  5.0    37.54     1.08  9.00  35.83  n/a    .000
    {ST=    .40 ha.m }
    ------------------
    CALIB NASHYD         0414  1  5.0    21.71      .55  9.33  36.34  .51    .000
    [CN=82.0          ]
    [ N= 3.0:Tp= 1.13]
    ------------------
 ** END OF SIMULATION :   3
****************************************************************************************


 ******************************
 ** SIMULATION NUMBER:    4 **
 ******************************

 W/E COMMAND             HYD ID   DT     AREA    Qpeak Tpeak   R.V. R.C.    Qbase
                                  min     ha      cms   hrs     mm           cms

    START @    .00 hrs
    ------------------
    READ STORM                   10.0
    [ Ptot= 84.96 mm ]
    fname :HHILL10.STM
    remark:24HR 10YR CHICAGO - HALTON HILL 88 STDS
    ------------------
    CALIB NASHYD         0900  1  5.0   109.73     3.08  9.75  47.10  .55    .000
    [CN=82.0          ]
    [ N= 3.0:Tp= 1.45]
    ------------------
    CHANNEL[ 1 : 0900]   0901  2  5.0   109.73     2.94 10.17  47.10  n/a    .000
    ------------------
    CALIB NASHYD         0902  1  5.0    27.50     1.77  8.50  47.10  .55    .000
    [CN=82.0          ]
    [ N= 3.0:Tp=   .45]
    ------------------
    ADD [0902 + 0901]    0903  3  5.0   137.23     3.31  9.92  47.10  n/a    .000
    ------------------
    CHANNEL[ 3 : 0903]   0904  1  5.0   137.23     3.21 10.25  47.10  n/a    .000
    ------------------
    CALIB NASHYD         0905  2  5.0    29.00     1.33  8.83  47.10  .55    .000
    [CN=82.0          ]
    [ N= 3.0:Tp=   .74]
    ------------------
    ADD [0904 + 0905]    0906  3  5.0   166.23     3.85  9.75  47.10  n/a    .000
    ------------------
    CALIB STANDHYD       0100  1  5.0    61.89     9.79  8.08  77.28  .91    .000
    [I%=47.0:S%=   .50]
    ------------------
    RESRVR [ 1 : 0100]   0500  2  5.0    61.89      .66 10.42  76.60  n/a    .000
    {ST=  3.16 ha.m }
    ------------------
 *  CALIB STANDHYD       0101  1  5.0     1.91      .40  8.00  77.24  .91    .000
    [I%=47.0:S%=   .50]
    ------------------
```

	ADD [0101 + 0500]	0501	3	5.0	63.80	.68	10.33	76.62	n/a	.000
	CALIB NASHYD [CN=80.0] [N= 3.0:Tp= .59]	0102	1	5.0	23.59	1.19	8.67	44.56	.52	.000
	ADD [0102 + 0501]	0502	2	5.0	87.39	1.62	8.83	67.96	n/a	.000
*	CALIB STANDHYD [I%=13.0:S%= .50]	0103	1	5.0	38.58	2.76	8.42	55.17	.65	.000
	ADD [0103 + 0502]	0503	3	5.0	125.97	4.16	8.42	64.04	n/a	.000
*	RESRVR [3 : 0503] {ST= .83 ha.m }	0504	1	5.0	125.97	4.37	8.50	60.95	n/a	.000
	CALIB NASHYD [CN=80.0] [N= 3.0:Tp= .69]	0104	2	5.0	11.79	.53	8.75	44.55	.52	.000
	ADD [0504 + 0104]	0505	7	5.0	137.76	4.84	8.50	59.55	n/a	.000
*	CALIB STANDHYD [I%= 1.0:S%= .50]	0105	1	5.0	28.73	2.67	8.25	53.21	.63	.000
	ADD [0105 + 0505]	0506	2	5.0	166.49	6.97	8.50	58.45	n/a	.000
	CALIB NASHYD [CN=78.0] [N= 3.0:Tp= .87]	0106	1	5.0	28.35	1.02	9.00	42.16	.50	.000
	CALIB NASHYD [CN=80.0] [N= 3.0:Tp= .56]	0107	5	5.0	46.90	2.44	8.58	44.56	.52	.000
	ADD [0106 + 0107]	0507	4	5.0	75.25	3.34	8.67	43.66	n/a	.000
	ADD [0506 + 0507]	0508	1	5.0	241.74	10.10	8.50	53.85	n/a	.000
	CALIB NASHYD [CN=85.0] [N= 3.0:Tp= .46]	0108	2	5.0	12.49	.88	8.50	51.22	.60	.000
	ADD [0508 + 0108]	0509	3	5.0	254.23	10.98	8.50	53.72	n/a	.000
	CALIB NASHYD [CN=82.0] [N= 3.0:Tp= .80]	0109	1	5.0	21.75	.95	8.92	47.10	.55	.000
	CALIB NASHYD [CN=85.0] [N= 3.0:Tp= 1.03]	0110	2	5.0	56.60	2.27	9.17	51.23	.60	.000
	ADD [0109 + 0110]	0510	4	5.0	78.35	3.18	9.08	50.08	n/a	.000
	ADD [0509 + 0510]	0511	1	5.0	332.58	13.23	8.50	52.86	n/a	.000
	CHANNEL[1 : 0511]	0511	8	5.0	332.58	10.51	9.08	52.78	n/a	.000
	CALIB NASHYD [CN=74.0] [N= 3.0:Tp= 1.61]	0110	2	5.0	148.60	2.99	9.92	37.78	.44	.000
	ADD [0511 + 0110]	0512	10	5.0	481.18	12.91	9.17	48.15	n/a	.000
	ADD [0505 + 0510]	0513	1	5.0	216.11	7.19	8.75	56.12	n/a	.000
	CALIB NASHYD [CN=85.0] [N= 3.0:Tp= .57]	0200	1	5.0	4.28	.26	8.58	51.20	.60	.000
	CALIB NASHYD [CN=83.0] [N= 3.0:Tp= 1.24]	0201	2	5.0	53.85	1.76	9.42	48.43	.57	.000
	ADD [0200 + 0201]	0600	3	5.0	58.13	1.91	9.33	48.64	n/a	.000
	CALIB NASHYD [CN=83.0] [N= 3.0:Tp= .82]	0202	1	5.0	10.45	.46	8.92	48.42	.57	.000
	ADD [0202 + 0600]	0601	2	5.0	68.58	2.33	9.25	48.60	n/a	.000
	CALIB NASHYD [CN=78.0] [N= 3.0:Tp= .76]	0203	1	5.0	15.59	.62	8.92	42.16	.50	.000
	CALIB NASHYD [CN=82.0] [N= 3.0:Tp= .34]	0208	6	5.0	12.18	.93	8.33	47.09	.55	.000
	CALIB NASHYD [CN=78.0] [N= 3.0:Tp= .42]	0204	3	5.0	11.89	.70	8.42	42.16	.50	.000
	ADD [0203 + 0204]	0602	4	5.0	27.48	1.22	8.58	42.16	n/a	.000
	ADD [0601 + 0602]	0603	1	5.0	96.06	3.31	9.00	46.76	n/a	.000
*	CALIB STANDHYD	0205	2	5.0	4.45	.48	8.25	55.83	.66	.000

[I%= 1.0:S%= .50]									
CALIB NASHYD [CN=82.0] [N= 3.0:Tp= .71]	0206	3	5.0	51.16	2.42	8.83	47.10	.55	.000
ADD [0205 + 0206]	0604	4	5.0	55.61	2.64	8.75	47.80	n/a	.000
ADD [0603 + 0604]	0605	2	5.0	151.67	5.89	8.83	47.14	n/a	.000
ADD [0605 + 0208]	0609	7	5.0	163.85	6.47	8.75	47.14	n/a	.000
CALIB NASHYD [CN=72.0] [N= 3.0:Tp= .74]	0207	3	5.0	79.86	2.65	8.83	35.77	.42	.000
ADD [0609 + 0207]	0606	9	5.0	243.71	9.08	8.83	43.41	n/a	.000
ADD [0606 + 0512]	0607	1	5.0	724.89	21.42	9.00	46.56	n/a	.000
CALIB NASHYD [CN=82.0] [N= 3.0:Tp= .45]	0300	1	5.0	30.20	1.94	8.50	47.10	.55	.000
CALIB NASHYD [CN=80.0] [N= 3.0:Tp= .65]	0301	2	5.0	40.29	1.90	8.75	44.56	.52	.000
CALIB NASHYD [CN=82.0] [N= 3.0:Tp= .72]	0302	3	5.0	25.98	1.22	8.83	47.10	.55	.000
ADD [0301 + 0302]	0700	4	5.0	66.27	3.11	8.75	45.56	n/a	.000
ADD [0300 + 0700]	0701	2	5.0	96.47	4.88	8.67	46.04	n/a	.000
CALIB NASHYD [CN=82.0] [N= 3.0:Tp= .72]	0400	1	5.0	22.91	1.07	8.83	47.10	.55	.000
CALIB NASHYD [CN=82.0] [N= 3.0:Tp= .55]	0401	2	5.0	27.66	1.56	8.58	47.10	.55	.000
ADD [0400 + 0401]	0800	3	5.0	50.57	2.60	8.67	47.10	n/a	.000
* CALIB STANDHYD [I%= 4.0:S%= .50]	0402	1	5.0	9.99	1.43	8.08	56.12	.66	.000
ADD [0402 + 0800]	0801	2	5.0	60.56	3.02	8.58	48.59	n/a	.000
RESRVR [2 : 0801] {ST= .92 ha.m }	0802	3	5.0	60.56	2.15	9.25	48.47	n/a	.000
CALIB NASHYD [CN=81.0] [N= 3.0:Tp= .75]	0403	1	5.0	47.88	2.11	8.83	45.81	.54	.000
CALIB NASHYD [CN=81.0] [N= 3.0:Tp= .29]	0404	2	5.0	12.73	1.03	8.25	45.79	.54	.000
ADD [0403 + 0404]	0803	3	5.0	60.61	2.67	8.67	45.81	n/a	.000
* CALIB STANDHYD [I%= 3.0:S%= .50]	0405	1	5.0	12.72	1.68	8.08	52.67	.62	.000
ADD [0405 + 0803]	0804	2	5.0	73.33	3.39	8.25	47.00	n/a	.000
RESRVR [2 : 0804] {ST= .83 ha.m }	0805	3	5.0	73.33	2.74	9.00	46.98	n/a	.000
CALIB NASHYD [CN=81.0] [N= 3.0:Tp= .66]	0406	1	5.0	52.69	2.54	8.75	45.81	.54	.000
CALIB NASHYD [CN=82.0] [N= 3.0:Tp= .26]	0407	2	5.0	13.56	1.21	8.25	47.07	.55	.000
ADD [0406 + 0407]	0806	3	5.0	66.25	3.22	8.58	46.07	n/a	.000
* CALIB STANDHYD [I%= 4.0:S%= .50]	0408	1	5.0	15.41	2.34	8.08	58.39	.69	.000
ADD [0408 + 0806]	0807	2	5.0	81.66	4.43	8.25	48.39	n/a	.000
RESRVR [2 : 0807] {ST= .99 ha.m }	0808	3	5.0	81.66	3.48	8.83	48.39	n/a	.000
CALIB NASHYD [CN=81.0] [N= 3.0:Tp= .79]	0409	1	5.0	32.76	1.39	8.92	45.81	.54	.000
CALIB NASHYD [CN=81.0] [N= 3.0:Tp= .43]	0410	2	5.0	15.07	.96	8.42	45.81	.54	.000
ADD [0409 + 0410]	0809	3	5.0	47.83	2.18	8.67	45.81	n/a	.000

W/E	COMMAND	HYD	ID	DT min	AREA ha	Qpeak cms	Tpeak hrs	R.V. mm	R.C.	Qbase cms
*	CALIB STANDHYD [I%= 5.0:S%= .50]	0411	1	5.0	5.88	.91	8.08	59.08	.70	.000
	ADD [0411 + 0809]	0810	2	5.0	53.71	2.44	8.58	47.26	n/a	.000
	RESRVR [2 : 0810] {ST= .68 ha.m }	0811	3	5.0	53.71	1.97	9.17	47.25	n/a	.000
	CALIB NASHYD [CN=80.0] [N= 3.0:Tp= .62]	0412	3	5.0	27.55	1.34	8.67	44.56	.52	.000
*	CALIB STANDHYD [I%= 2.0:S%= .50]	0413	1	5.0	9.99	1.15	8.17	51.47	.61	.000
	ADD [0413 + 0412]	0812	2	5.0	37.54	1.92	8.33	46.40	n/a	.000
	RESRVR [2 : 0812] {ST= .42 ha.m }	0813	3	5.0	37.54	1.67	8.83	46.38	n/a	.000
	CALIB NASHYD [CN=82.0] [N= 3.0:Tp= 1.13]	0414	1	5.0	21.71	.74	9.33	47.10	.55	.000

** END OF SIMULATION : 4

****

****
** SIMULATION NUMBER: 5 **
****

W/E	COMMAND	HYD	ID	DT min	AREA ha	Qpeak cms	Tpeak hrs	R.V. mm	R.C.	Qbase cms
	START @ .00 hrs									
	READ STORM [Ptot=101.79 mm] fname :HHILL25.STM remark:24HR 25YR CHICAGO - HALTON HILL 88 STDS			10.0						
	CALIB NASHYD [CN=82.0] [N= 3.0:Tp= 1.45]	0900	1	5.0	109.73	4.11	9.67	61.41	.60	.000
	CHANNEL[1 : 0900]	0901	2	5.0	109.73	3.95	10.08	61.40	n/a	.000
	CALIB NASHYD [CN=82.0] [N= 3.0:Tp= .45]	0902	1	5.0	27.50	2.36	8.50	61.40	.60	.000
	ADD [0902 + 0901]	0903	3	5.0	137.23	4.46	9.83	61.40	n/a	.000
	CHANNEL[3 : 0903]	0904	1	5.0	137.23	4.34	10.17	61.40	n/a	.000
	CALIB NASHYD [CN=82.0] [N= 3.0:Tp= .74]	0905	2	5.0	29.00	1.78	8.83	61.40	.60	.000
	ADD [0904 + 0905]	0906	3	5.0	166.23	5.25	9.67	61.40	n/a	.000
	CALIB STANDHYD [I%=47.0:S%= .50]	0100	1	5.0	61.89	12.10	8.08	93.93	.92	.000
	RESRVR [1 : 0100] {ST= 3.66 ha.m }	0500	2	5.0	61.89	1.25	9.67	93.19	n/a	.000
*	CALIB STANDHYD [I%=47.0:S%= .50]	0101	1	5.0	1.91	.48	8.00	93.90	.92	.000
	ADD [0101 + 0500]	0501	3	5.0	63.80	1.29	9.67	93.21	n/a	.000
	CALIB NASHYD [CN=80.0] [N= 3.0:Tp= .59]	0102	1	5.0	23.59	1.59	8.67	58.44	.57	.000
	ADD [0102 + 0501]	0502	2	5.0	87.39	2.44	9.00	83.82	n/a	.000
*	CALIB STANDHYD [I%=13.0:S%= .50]	0103	1	5.0	38.58	3.68	8.42	69.99	.69	.000
	ADD [0103 + 0502]	0503	3	5.0	125.97	5.68	8.50	79.59	n/a	.000
*	RESRVR [3 : 0503] {ST= .84 ha.m }	0504	1	5.0	125.97	5.70	8.50	76.36	n/a	.000
	CALIB NASHYD [CN=80.0] [N= 3.0:Tp= .69]	0104	2	5.0	11.79	.72	8.75	58.43	.57	.000
	ADD [0504 + 0104]	0505	7	5.0	137.76	6.34	8.50	74.83	n/a	.000
*	CALIB STANDHYD [I%= 1.0:S%= .50]	0105	1	5.0	28.73	3.61	8.25	68.05	.67	.000

	ADD [0105 + 0505]	0506	2	5.0	166.49	9.58	8.33	73.66	n/a	.000
	CALIB NASHYD [CN=78.0] [N= 3.0:Tp= .87]	0106	1	5.0	28.35	1.38	9.00	55.61	.55	.000
	CALIB NASHYD [CN=80.0] [N= 3.0:Tp= .56]	0107	5	5.0	46.90	3.28	8.58	58.44	.57	.000
	ADD [0106 + 0107]	0507	4	5.0	75.25	4.50	8.67	57.37	n/a	.000
	ADD [0506 + 0507]	0508	1	5.0	241.74	13.35	8.50	68.59	n/a	.000
	CALIB NASHYD [CN=85.0] [N= 3.0:Tp= .46]	0108	2	5.0	12.49	1.16	8.50	66.14	.65	.000
	ADD [0508 + 0108]	0509	3	5.0	254.23	14.51	8.50	68.47	n/a	.000
	CALIB NASHYD [CN=82.0] [N= 3.0:Tp= .80]	0109	1	5.0	21.75	1.26	8.92	61.40	.60	.000
	CALIB NASHYD [CN=85.0] [N= 3.0:Tp= 1.03]	0110	2	5.0	56.60	3.00	9.17	66.15	.65	.000
	ADD [0109 + 0110]	0510	4	5.0	78.35	4.22	9.08	64.83	n/a	.000
	ADD [0509 + 0510]	0511	1	5.0	332.58	17.66	8.58	67.61	n/a	.000
	CHANNEL[1 : 0511]	0511	8	5.0	332.58	14.95	9.08	67.53	n/a	.000
	CALIB NASHYD [CN=74.0] [N= 3.0:Tp= 1.61]	0110	2	5.0	148.60	4.08	9.92	50.35	.49	.000
	ADD [0511 + 0110]	0512	10	5.0	481.18	18.14	9.08	62.22	n/a	.000
	ADD [0505 + 0510]	0513	1	5.0	216.11	9.80	8.75	71.20	n/a	.000
	CALIB NASHYD [CN=85.0] [N= 3.0:Tp= .57]	0200	1	5.0	4.28	.34	8.58	66.11	.65	.000
	CALIB NASHYD [CN=83.0] [N= 3.0:Tp= 1.24]	0201	2	5.0	53.85	2.34	9.42	62.95	.62	.000
	ADD [0200 + 0201]	0600	3	5.0	58.13	2.54	9.33	63.18	n/a	.000
	CALIB NASHYD [CN=83.0] [N= 3.0:Tp= .82]	0202	1	5.0	10.45	.62	8.92	62.93	.62	.000
	ADD [0202 + 0600]	0601	2	5.0	68.58	3.10	9.25	63.14	n/a	.000
	CALIB NASHYD [CN=78.0] [N= 3.0:Tp= .76]	0203	1	5.0	15.59	.83	8.83	55.61	.55	.000
	CALIB NASHYD [CN=82.0] [N= 3.0:Tp= .34]	0208	6	5.0	12.18	1.24	8.33	61.39	.60	.000
	CALIB NASHYD [CN=78.0] [N= 3.0:Tp= .42]	0204	3	5.0	11.89	.94	8.42	55.60	.55	.000
	ADD [0203 + 0204]	0602	4	5.0	27.48	1.65	8.58	55.61	n/a	.000
	ADD [0601 + 0602]	0603	1	5.0	96.06	4.42	9.00	60.99	n/a	.000
*	CALIB STANDHYD [I%= 1.0:S%= .50]	0205	2	5.0	4.45	.66	8.17	71.00	.70	.000
	CALIB NASHYD [CN=82.0] [N= 3.0:Tp= .71]	0206	3	5.0	51.16	3.23	8.83	61.41	.60	.000
	ADD [0205 + 0206]	0604	4	5.0	55.61	3.49	8.75	62.17	n/a	.000
	ADD [0603 + 0604]	0605	2	5.0	151.67	7.84	8.83	61.42	n/a	.000
	ADD [0605 + 0208]	0609	7	5.0	163.85	8.61	8.75	61.42	n/a	.000
	CALIB NASHYD [CN=72.0] [N= 3.0:Tp= .74]	0207	3	5.0	79.86	3.64	8.83	47.90	.47	.000
	ADD [0609 + 0207]	0606	9	5.0	243.71	12.21	8.75	56.99	n/a	.000
	ADD [0606 + 0512]	0607	1	5.0	724.89	29.75	9.00	60.46	n/a	.000
	CALIB NASHYD [CN=82.0] [N= 3.0:Tp= .45]	0300	1	5.0	30.20	2.59	8.50	61.40	.60	.000
	CALIB NASHYD	0301	2	5.0	40.29	2.55	8.75	58.44	.57	.000

	[CN=80.0] [N= 3.0:Tp= .65]									
	CALIB NASHYD [CN=82.0] [N= 3.0:Tp= .72]	0302	3	5.0	25.98	1.63	8.83	61.40	.60	.000
	ADD [0301 + 0302]	0700	4	5.0	66.27	4.17	8.75	59.60	n/a	.000
	ADD [0300 + 0700]	0701	2	5.0	96.47	6.53	8.67	60.16	n/a	.000
	CALIB NASHYD [CN=82.0] [N= 3.0:Tp= .72]	0400	1	5.0	22.91	1.43	8.83	61.40	.60	.000
	CALIB NASHYD [CN=82.0] [N= 3.0:Tp= .55]	0401	2	5.0	27.66	2.08	8.58	61.40	.60	.000
	ADD [0400 + 0401]	0800	3	5.0	50.57	3.47	8.67	61.40	n/a	.000
*	CALIB STANDHYD [I%= 4.0:S%= .50]	0402	1	5.0	9.99	1.87	8.08	71.24	.70	.000
	ADD [0402 + 0800]	0801	2	5.0	60.56	3.99	8.58	63.03	n/a	.000
	RESRVR [2 : 0801] {ST= 1.05 ha.m }	0802	3	5.0	60.56	3.11	9.08	62.91	n/a	.000
	CALIB NASHYD [CN=81.0] [N= 3.0:Tp= .75]	0403	1	5.0	47.88	2.83	8.83	59.90	.59	.000
	CALIB NASHYD [CN=81.0] [N= 3.0:Tp= .29]	0404	2	5.0	12.73	1.38	8.25	59.88	.59	.000
	ADD [0403 + 0404]	0803	3	5.0	60.61	3.59	8.58	59.90	n/a	.000
*	CALIB STANDHYD [I%= 3.0:S%= .50]	0405	1	5.0	12.72	2.23	8.08	67.38	.66	.000
	ADD [0405 + 0803]	0804	2	5.0	73.33	4.51	8.25	61.20	n/a	.000
	RESRVR [2 : 0804] {ST= .92 ha.m }	0805	3	5.0	73.33	3.88	8.83	61.17	n/a	.000
	CALIB NASHYD [CN=81.0] [N= 3.0:Tp= .66]	0406	1	5.0	52.69	3.40	8.75	59.90	.59	.000
	CALIB NASHYD [CN=82.0] [N= 3.0:Tp= .26]	0407	2	5.0	13.56	1.61	8.25	61.36	.60	.000
	ADD [0406 + 0407]	0806	3	5.0	66.25	4.31	8.50	60.20	n/a	.000
*	CALIB STANDHYD [I%= 4.0:S%= .50]	0408	1	5.0	15.41	3.05	8.08	73.78	.72	.000
	ADD [0408 + 0806]	0807	2	5.0	81.66	5.84	8.25	62.76	n/a	.000
	RESRVR [2 : 0807] {ST= 1.07 ha.m }	0808	3	5.0	81.66	4.94	8.67	62.76	n/a	.000
	CALIB NASHYD [CN=81.0] [N= 3.0:Tp= .79]	0409	1	5.0	32.76	1.86	8.92	59.90	.59	.000
	CALIB NASHYD [CN=81.0] [N= 3.0:Tp= .43]	0410	2	5.0	15.07	1.29	8.42	59.90	.59	.000
	ADD [0409 + 0410]	0809	3	5.0	47.83	2.93	8.67	59.90	n/a	.000
*	CALIB STANDHYD [I%= 5.0:S%= .50]	0411	1	5.0	5.88	1.18	8.08	74.53	.73	.000
	ADD [0411 + 0809]	0810	2	5.0	53.71	3.24	8.58	61.50	n/a	.000
	RESRVR [2 : 0810] {ST= .75 ha.m }	0811	3	5.0	53.71	2.80	9.00	61.49	n/a	.000
	CALIB NASHYD [CN=80.0] [N= 3.0:Tp= .62]	0412	3	5.0	27.55	1.80	8.67	58.44	.57	.000
*	CALIB STANDHYD [I%= 2.0:S%= .50]	0413	1	5.0	9.99	1.53	8.17	66.02	.65	.000
	ADD [0413 + 0412]	0812	2	5.0	37.54	2.56	8.33	60.46	n/a	.000
	RESRVR [2 : 0812] {ST= .44 ha.m }	0813	3	5.0	37.54	2.37	8.67	60.44	n/a	.000
	CALIB NASHYD [CN=82.0] [N= 3.0:Tp= 1.13]	0414	1	5.0	21.71	.98	9.33	61.40	.60	.000

** END OF SIMULATION : 5

```
********************************************************************************

 ****************************
 ** SIMULATION NUMBER:   6 **
 ****************************

 W/E COMMAND              HYD ID   DT      AREA    Qpeak  Tpeak   R.V.  R.C.    Qbase
                                   min     ha      cms    hrs     mm            cms

     START @    .00 hrs
     ------------------
     READ STORM                    10.0
     [ Ptot=114.35 mm ]
     fname :HHILL50.STM
     remark:24HR 50YR CHICAGO - HALTON HILL 88 STDS
     ------------------
     CALIB NASHYD         0900  1   5.0   109.73    4.90   9.67  72.42   .63     .000
     [CN=82.0          ]
     [ N= 3.0:Tp= 1.45]
     ------------------
     CHANNEL[ 1 : 0900]   0901  2   5.0   109.73    4.75  10.00  72.41   n/a     .000
     CALIB NASHYD         0902  1   5.0    27.50    2.81   8.50  72.41   .63     .000
     [CN=82.0          ]
     [ N= 3.0:Tp=  .45]
     ------------------
     ADD [0902 + 0901]    0903  3   5.0   137.23    5.36   9.83  72.41   n/a     .000
     ------------------
     CHANNEL[ 3 : 0903]   0904  1   5.0   137.23    5.23  10.08  72.41   n/a     .000
     ------------------
     CALIB NASHYD         0905  2   5.0    29.00    2.12   8.83  72.41   .63     .000
     [CN=82.0          ]
     [ N= 3.0:Tp=  .74]
     ------------------
     ADD [0904 + 0905]    0906  3   5.0   166.23    6.35   9.67  72.41   n/a     .000
     ------------------
     CALIB STANDHYD       0100  1   5.0    61.89   13.83   8.08 106.38   .93     .000
     [I%=47.0:S%=  .50]
     ------------------
     RESRVR [ 1 : 0100]   0500  2   5.0    61.89    1.85   9.42 105.61   n/a     .000
     {ST=   3.98 ha.m }
     ------------------
 *   CALIB STANDHYD       0101  1   5.0     1.91     .54   8.00 106.35   .93     .000
     [I%=47.0:S%=  .50]
     ------------------
     ADD [0101 + 0500]    0501  3   5.0    63.80    1.89   9.33 105.63   n/a     .000
     ------------------
     CALIB NASHYD         0102  1   5.0    23.59    1.91   8.67  69.17   .60     .000
     [CN=80.0          ]
     [ N= 3.0:Tp=  .59]
     ------------------
     ADD [0102 + 0501]    0502  2   5.0    87.39    3.40   8.92  95.79   n/a     .000
     ------------------
 *   CALIB STANDHYD       0103  1   5.0    38.58    4.65   8.33  81.32   .71     .000
     [I%=13.0:S%=  .50]
     ------------------
     ADD [0103 + 0502]    0503  3   5.0   125.97    6.90   8.42  91.36   n/a     .000
     ------------------
 *   RESRVR [ 3 : 0503]   0504  1   5.0   125.97    6.94   8.42  88.06   n/a     .000
     {ST=    .86 ha.m }
     ------------------
     CALIB NASHYD         0104  2   5.0    11.79     .86   8.75  69.16   .60     .000
     [CN=80.0          ]
     [ N= 3.0:Tp=  .69]
     ------------------
     ADD [0504 + 0104]    0505  7   5.0   137.76    7.64   8.42  86.44   n/a     .000
     ------------------
 *   CALIB STANDHYD       0105  1   5.0    28.73    4.42   8.25  79.39   .69     .000
     [I%= 1.0:S%=  .50]
     ------------------
     ADD [0105 + 0505]    0506  2   5.0   166.49   11.53   8.25  85.23   n/a     .000
     ------------------
     CALIB NASHYD         0106  1   5.0    28.35    1.66   9.00  66.05   .58     .000
     [CN=78.0          ]
     [ N= 3.0:Tp=  .87]
     ------------------
     CALIB NASHYD         0107  5   5.0    46.90    3.92   8.58  69.17   .60     .000
     [CN=80.0          ]
     [ N= 3.0:Tp=  .56]
     ------------------
     ADD [0106 + 0107]    0507  4   5.0    75.25    5.40   8.67  68.00   n/a     .000
     ------------------
     ADD [0506 + 0507]    0508  1   5.0   241.74   16.11   8.42  79.86   n/a     .000
     ------------------
     CALIB NASHYD         0108  2   5.0    12.49    1.37   8.50  77.54   .68     .000
     [CN=85.0          ]
     [ N= 3.0:Tp=  .46]
     ------------------
     ADD [0508 + 0108]    0509  3   5.0   254.23   17.47   8.42  79.75   n/a     .000
     ------------------
     CALIB NASHYD         0109  1   5.0    21.75    1.51   8.92  72.41   .63     .000
     [CN=82.0          ]
     [ N= 3.0:Tp=  .80]
     ------------------
     CALIB NASHYD         0110  2   5.0    56.60    3.55   9.17  77.55   .68     .000
```

	[CN=85.0] [N= 3.0:Tp= 1.03]									
	ADD [0109 + 0110]	0510	4	5.0	78.35	5.01	9.08	76.12	n/a	.000
	ADD [0509 + 0510]	0511	1	5.0	332.58	21.06	8.58	78.89	n/a	.000
	CHANNEL[1 : 0511]	0511	8	5.0	332.58	17.81	9.25	78.81	n/a	.000
	CALIB NASHYD [CN=74.0] [N= 3.0:Tp= 1.61]	0110	2	5.0	148.60	4.94	9.92	60.20	.53	.000
	ADD [0511 + 0110]	0512	10	5.0	481.18	22.10	9.33	73.06	n/a	.000
	ADD [0505 + 0510]	0513	1	5.0	216.11	11.89	8.75	82.70	n/a	.000
	CALIB NASHYD [CN=85.0] [N= 3.0:Tp= .57]	0200	1	5.0	4.28	.41	8.58	77.52	.68	.000
	CALIB NASHYD [CN=83.0] [N= 3.0:Tp= 1.24]	0201	2	5.0	53.85	2.78	9.42	74.09	.65	.000
	ADD [0200 + 0201]	0600	3	5.0	58.13	3.02	9.33	74.34	n/a	.000
	CALIB NASHYD [CN=83.0] [N= 3.0:Tp= .82]	0202	1	5.0	10.45	.73	8.92	74.07	.65	.000
	ADD [0202 + 0600]	0601	2	5.0	68.58	3.69	9.25	74.30	n/a	.000
	CALIB NASHYD [CN=78.0] [N= 3.0:Tp= .76]	0203	1	5.0	15.59	1.00	8.83	66.05	.58	.000
	CALIB NASHYD [CN=82.0] [N= 3.0:Tp= .34]	0208	6	5.0	12.18	1.48	8.33	72.40	.63	.000
	CALIB NASHYD [CN=78.0] [N= 3.0:Tp= .42]	0204	3	5.0	11.89	1.13	8.42	66.05	.58	.000
	ADD [0203 + 0204]	0602	4	5.0	27.48	1.99	8.58	66.05	n/a	.000
	ADD [0601 + 0602]	0603	1	5.0	96.06	5.28	8.92	71.94	n/a	.000
*	CALIB STANDHYD [I%= 1.0:S%= .50]	0205	2	5.0	4.45	.81	8.17	82.56	.72	.000
	CALIB NASHYD [CN=82.0] [N= 3.0:Tp= .71]	0206	3	5.0	51.16	3.85	8.83	72.41	.63	.000
	ADD [0205 + 0206]	0604	4	5.0	55.61	4.14	8.75	73.23	n/a	.000
	ADD [0603 + 0604]	0605	2	5.0	151.67	9.34	8.83	72.41	n/a	.000
	ADD [0605 + 0208]	0609	7	5.0	163.85	10.26	8.75	72.41	n/a	.000
	CALIB NASHYD [CN=72.0] [N= 3.0:Tp= .74]	0207	3	5.0	79.86	4.42	8.83	57.45	.50	.000
	ADD [0609 + 0207]	0606	9	5.0	243.71	14.63	8.75	67.51	n/a	.000
	ADD [0606 + 0512]	0607	1	5.0	724.89	35.32	9.08	71.20	n/a	.000
	CALIB NASHYD [CN=82.0] [N= 3.0:Tp= .45]	0300	1	5.0	30.20	3.08	8.50	72.41	.63	.000
	CALIB NASHYD [CN=80.0] [N= 3.0:Tp= .65]	0301	2	5.0	40.29	3.05	8.75	69.17	.60	.000
	CALIB NASHYD [CN=82.0] [N= 3.0:Tp= .72]	0302	3	5.0	25.98	1.94	8.83	72.41	.63	.000
	ADD [0301 + 0302]	0700	4	5.0	66.27	4.98	8.75	70.44	n/a	.000
	ADD [0300 + 0700]	0701	2	5.0	96.47	7.79	8.67	71.06	n/a	.000
	CALIB NASHYD [CN=82.0] [N= 3.0:Tp= .72]	0400	1	5.0	22.91	1.71	8.83	72.41	.63	.000
	CALIB NASHYD [CN=82.0] [N= 3.0:Tp= .55]	0401	2	5.0	27.66	2.48	8.58	72.41	.63	.000
	ADD [0400 + 0401]	0800	3	5.0	50.57	4.13	8.67	72.41	n/a	.000
*	CALIB STANDHYD [I%= 4.0:S%= .50]	0402	1	5.0	9.99	2.21	8.08	82.77	.72	.000
	ADD [0402 + 0800]	0801	2	5.0	60.56	4.74	8.58	74.12	n/a	.000

```
    -----------------
    RESRVR [ 2 : 0801] 0802  3  5.0    60.56     3.85  9.08  74.00  n/a    .000
    {ST=  1.14 ha.m }
    -----------------
    CALIB NASHYD       0403  1  5.0    47.88     3.38  8.83  70.77  .62    .000
    [CN=81.0         ]
    [ N= 3.0:Tp=  .75]
    -----------------
    CALIB NASHYD       0404  2  5.0    12.73     1.64  8.25  70.74  .62    .000
    [CN=81.0         ]
    [ N= 3.0:Tp=  .29]
    -----------------
    ADD [0403 + 0404]  0803  3  5.0    60.61     4.29  8.58  70.77  n/a    .000
    -----------------
 *  CALIB STANDHYD     0405  1  5.0    12.72     2.65  8.08  78.63  .69    .000
    [I%= 3.0:S%=  .50]
    -----------------
    ADD [0405 + 0803]  0804  2  5.0    73.33     5.37  8.25  72.13  n/a    .000
    -----------------
    RESRVR [ 2 : 0804] 0805  3  5.0    73.33     4.72  8.83  72.11  n/a    .000
    {ST=   .98 ha.m }
    -----------------
    CALIB NASHYD       0406  1  5.0    52.69     4.06  8.75  70.78  .62    .000
    [CN=81.0         ]
    [ N= 3.0:Tp=  .66]
    -----------------
    CALIB NASHYD       0407  2  5.0    13.56     1.91  8.25  72.37  .63    .000
    [CN=82.0         ]
    [ N= 3.0:Tp=  .26]
    -----------------
    ADD [0406 + 0407]  0806  3  5.0    66.25     5.15  8.50  71.10  n/a    .000
    -----------------
 *  CALIB STANDHYD     0408  1  5.0    15.41     3.58  8.08  85.47  .75    .000
    [I%= 4.0:S%=  .50]
    -----------------
    ADD [0408 + 0806]  0807  2  5.0    81.66     6.91  8.25  73.81  n/a    .000
    -----------------
    RESRVR [ 2 : 0807] 0808  3  5.0    81.66     6.02  8.67  73.81  n/a    .000
    {ST=  1.13 ha.m }
    -----------------
    CALIB NASHYD       0409  1  5.0    32.76     2.23  8.92  70.77  .62    .000
    [CN=81.0         ]
    [ N= 3.0:Tp=  .79]
    -----------------
    CALIB NASHYD       0410  2  5.0    15.07     1.54  8.42  70.77  .62    .000
    [CN=81.0         ]
    [ N= 3.0:Tp=  .43]
    -----------------
    ADD [0409 + 0410]  0809  3  5.0    47.83     3.50  8.67  70.77  n/a    .000
    -----------------
 *  CALIB STANDHYD     0411  1  5.0     5.88     1.38  8.08  86.26  .75    .000
    [I%= 5.0:S%=  .50]
    -----------------
    ADD [0411 + 0809]  0810  2  5.0    53.71     3.86  8.58  72.47  n/a    .000
    -----------------
    RESRVR [ 2 : 0810] 0811  3  5.0    53.71     3.36  9.00  72.46  n/a    .000
    {ST=   .82 ha.m }
    -----------------
    CALIB NASHYD       0412  3  5.0    27.55     2.15  8.67  69.17  .60    .000
    [CN=80.0         ]
    [ N= 3.0:Tp=  .62]
    -----------------
 *  CALIB STANDHYD     0413  1  5.0     9.99     1.82  8.17  77.18  .67    .000
    [I%= 2.0:S%=  .50]
    -----------------
    ADD [0413 + 0412]  0812  2  5.0    37.54     3.05  8.33  71.30  n/a    .000
    -----------------
    RESRVR [ 2 : 0812] 0813  3  5.0    37.54     2.88  8.58  71.29  n/a    .000
    {ST=   .46 ha.m }
    -----------------
    CALIB NASHYD       0414  1  5.0    21.71     1.17  9.33  72.41  .63    .000
    [CN=82.0         ]
    [ N= 3.0:Tp= 1.13]
    -----------------
 ** END OF SIMULATION :   6
*********************************************************************************


 *****************************
 ** SIMULATION NUMBER:   7 **
 *****************************

 W/E COMMAND                HYD ID   DT    AREA   Qpeak Tpeak   R.V. R.C.    Qbase
                                    min     ha     cms   hrs     mm           cms

    START @   .00 hrs
    -----------------
    READ STORM                     10.0
    [ Ptot=124.95 mm ]
    fname :HHILL100.STM
    remark:24HR 100YR CHICAGO - HALTON HILL 88 STDS
    -----------------
    CALIB NASHYD       0900  1  5.0   109.73     5.69  9.67  81.89  .66    .000
    [CN=82.0         ]
    [ N= 3.0:Tp= 1.45]
    -----------------
```

	CHANNEL[1 : 0900]	0901	2	5.0	109.73	5.49	10.00	81.88	n/a	.000
	CALIB NASHYD [CN=82.0] [N= 3.0:Tp= .45]	0902	1	5.0	27.50	3.25	8.50	81.88	.66	.000
	ADD [0902 + 0901]	0903	3	5.0	137.23	6.21	9.75	81.88	n/a	.000
	CHANNEL[3 : 0903]	0904	1	5.0	137.23	6.08	10.08	81.88	n/a	.000
	CALIB NASHYD [CN=82.0] [N= 3.0:Tp= .74]	0905	2	5.0	29.00	2.47	8.83	81.88	.66	.000
	ADD [0904 + 0905]	0906	3	5.0	166.23	7.45	9.58	81.88	n/a	.000
	CALIB STANDHYD [I%=47.0:S%= .50]	0100	1	5.0	61.89	15.51	8.08	116.91	.94	.000
*	RESRVR [1 : 0100] {ST= 4.27 ha.m }	0500	2	5.0	61.89	2.51	9.17	116.13	n/a	.000
*	CALIB STANDHYD [I%=47.0:S%= .50]	0101	1	5.0	1.91	.60	8.00	116.88	.94	.000
	ADD [0101 + 0500]	0501	3	5.0	63.80	2.57	9.17	116.16	n/a	.000
	CALIB NASHYD [CN=80.0] [N= 3.0:Tp= .59]	0102	1	5.0	23.59	2.22	8.67	78.42	.63	.000
	ADD [0102 + 0501]	0502	2	5.0	87.39	4.49	8.92	105.97	n/a	.000
*	CALIB STANDHYD [I%=13.0:S%= .50]	0103	1	5.0	38.58	5.43	8.33	91.02	.73	.000
	ADD [0103 + 0502]	0503	3	5.0	125.97	8.35	8.50	101.39	n/a	.000
	RESRVR [3 : 0503] {ST= .87 ha.m }	0504	1	5.0	125.97	8.29	8.58	98.07	n/a	.000
	CALIB NASHYD [CN=80.0] [N= 3.0:Tp= .69]	0104	2	5.0	11.79	1.00	8.75	78.42	.63	.000
	ADD [0504 + 0104]	0505	7	5.0	137.76	9.24	8.58	96.39	n/a	.000
*	CALIB STANDHYD [I%= 1.0:S%= .50]	0105	1	5.0	28.73	5.14	8.25	89.10	.71	.000
	ADD [0105 + 0505]	0506	2	5.0	166.49	13.46	8.33	95.13	n/a	.000
	CALIB NASHYD [CN=78.0] [N= 3.0:Tp= .87]	0106	1	5.0	28.35	1.94	9.00	75.09	.60	.000
	CALIB NASHYD [CN=80.0] [N= 3.0:Tp= .56]	0107	5	5.0	46.90	4.57	8.58	78.43	.63	.000
	ADD [0106 + 0107]	0507	4	5.0	75.25	6.29	8.67	77.17	n/a	.000
	ADD [0506 + 0507]	0508	1	5.0	241.74	18.86	8.50	89.54	n/a	.000
	CALIB NASHYD [CN=85.0] [N= 3.0:Tp= .46]	0108	2	5.0	12.49	1.58	8.50	87.31	.70	.000
	ADD [0508 + 0108]	0509	3	5.0	254.23	20.44	8.50	89.43	n/a	.000
	CALIB NASHYD [CN=82.0] [N= 3.0:Tp= .80]	0109	1	5.0	21.75	1.75	8.92	81.88	.66	.000
	CALIB NASHYD [CN=85.0] [N= 3.0:Tp= 1.03]	0110	2	5.0	56.60	4.10	9.17	87.32	.70	.000
	ADD [0109 + 0110]	0510	4	5.0	78.35	5.79	9.08	85.81	n/a	.000
	ADD [0509 + 0510]	0511	1	5.0	332.58	24.88	8.58	88.58	n/a	.000
	CHANNEL[1 : 0511]	0511	8	5.0	332.58	20.46	9.25	88.49	n/a	.000
	CALIB NASHYD [CN=74.0] [N= 3.0:Tp= 1.61]	0110	2	5.0	148.60	5.80	9.92	68.78	.55	.000
	ADD [0511 + 0110]	0512	10	5.0	481.18	25.66	9.42	82.40	n/a	.000
	ADD [0505 + 0510]	0513	1	5.0	216.11	14.29	8.75	92.55	n/a	.000
	CALIB NASHYD [CN=85.0] [N= 3.0:Tp= .57]	0200	1	5.0	4.28	.47	8.58	87.29	.70	.000
	CALIB NASHYD [CN=83.0] [N= 3.0:Tp= 1.24]	0201	2	5.0	53.85	3.23	9.42	83.66	.67	.000

ADD [0200 + 0201]	0600	3	5.0	58.13	3.50	9.33	83.93	n/a	.000
CALIB NASHYD [CN=83.0] [N= 3.0:Tp= .82]	0202	1	5.0	10.45	.85	8.92	83.65	.67	.000
ADD [0202 + 0600]	0601	2	5.0	68.58	4.28	9.25	83.88	n/a	.000
CALIB NASHYD [CN=78.0] [N= 3.0:Tp= .76]	0203	1	5.0	15.59	1.17	8.83	75.09	.60	.000
CALIB NASHYD [CN=82.0] [N= 3.0:Tp= .34]	0208	6	5.0	12.18	1.71	8.33	81.86	.66	.000
CALIB NASHYD [CN=78.0] [N= 3.0:Tp= .42]	0204	3	5.0	11.89	1.32	8.42	75.08	.60	.000
ADD [0203 + 0204]	0602	4	5.0	27.48	2.33	8.58	75.09	n/a	.000
ADD [0601 + 0602]	0603	1	5.0	96.06	6.14	8.92	81.37	n/a	.000
* CALIB STANDHYD [I%= 1.0:S%= .50]	0205	2	5.0	4.45	.93	8.17	92.44	.74	.000
CALIB NASHYD [CN=82.0] [N= 3.0:Tp= .71]	0206	3	5.0	51.16	4.47	8.83	81.88	.66	.000
ADD [0205 + 0206]	0604	4	5.0	55.61	4.79	8.75	82.73	n/a	.000
ADD [0603 + 0604]	0605	2	5.0	151.67	10.85	8.83	81.87	n/a	.000
ADD [0605 + 0208]	0609	7	5.0	163.85	11.91	8.75	81.87	n/a	.000
CALIB NASHYD [CN=72.0] [N= 3.0:Tp= .74]	0207	3	5.0	79.86	5.22	8.83	65.78	.53	.000
ADD [0609 + 0207]	0606	9	5.0	243.71	17.07	8.75	76.59	n/a	.000
ADD [0606 + 0512]	0607	1	5.0	724.89	40.76	9.08	80.45	n/a	.000
CALIB NASHYD [CN=82.0] [N= 3.0:Tp= .45]	0300	1	5.0	30.20	3.57	8.50	81.88	.66	.000
CALIB NASHYD [CN=80.0] [N= 3.0:Tp= .65]	0301	2	5.0	40.29	3.55	8.75	78.43	.63	.000
CALIB NASHYD [CN=82.0] [N= 3.0:Tp= .72]	0302	3	5.0	25.98	2.25	8.83	81.88	.66	.000
ADD [0301 + 0302]	0700	4	5.0	66.27	5.80	8.75	79.78	n/a	.000
ADD [0300 + 0700]	0701	2	5.0	96.47	9.05	8.67	80.44	n/a	.000
CALIB NASHYD [CN=82.0] [N= 3.0:Tp= .72]	0400	1	5.0	22.91	1.98	8.83	81.88	.66	.000
CALIB NASHYD [CN=82.0] [N= 3.0:Tp= .55]	0401	2	5.0	27.66	2.88	8.58	81.88	.66	.000
ADD [0400 + 0401]	0800	3	5.0	50.57	4.80	8.67	81.88	n/a	.000
* CALIB STANDHYD [I%= 4.0:S%= .50]	0402	1	5.0	9.99	2.54	8.08	92.62	.74	.000
ADD [0402 + 0800]	0801	2	5.0	60.56	5.48	8.58	83.65	n/a	.000
RESRVR [2 : 0801] {ST= 1.22 ha.m }	0802	3	5.0	60.56	4.57	9.00	83.54	n/a	.000
CALIB NASHYD [CN=81.0] [N= 3.0:Tp= .75]	0403	1	5.0	47.88	3.93	8.83	80.14	.64	.000
CALIB NASHYD [CN=81.0] [N= 3.0:Tp= .29]	0404	2	5.0	12.73	1.90	8.25	80.10	.64	.000
ADD [0403 + 0404]	0803	3	5.0	60.61	4.99	8.58	80.13	n/a	.000
* CALIB STANDHYD [I%= 3.0:S%= .50]	0405	1	5.0	12.72	3.06	8.08	88.27	.71	.000
ADD [0405 + 0803]	0804	2	5.0	73.33	6.21	8.25	81.54	n/a	.000
RESRVR [2 : 0804] {ST= 1.04 ha.m }	0805	3	5.0	73.33	5.56	8.75	81.52	n/a	.000
CALIB NASHYD [CN=81.0] [N= 3.0:Tp= .66]	0406	1	5.0	52.69	4.72	8.75	80.14	.64	.000

	CALIB NASHYD [CN=82.0] [N= 3.0:Tp= .26]	0407	2	5.0	13.56	2.21	8.25	81.83	.65	.000
	ADD [0406 + 0407]	0806	3	5.0	66.25	5.99	8.50	80.49	n/a	.000
*	CALIB STANDHYD [I%= 4.0:S%= .50]	0408	1	5.0	15.41	4.09	8.08	95.45	.76	.000
	ADD [0408 + 0806]	0807	2	5.0	81.66	7.97	8.25	83.31	n/a	.000
	RESRVR [2 : 0807] {ST= 1.19 ha.m }	0808	3	5.0	81.66	7.11	8.58	83.30	n/a	.000
	CALIB NASHYD [CN=81.0] [N= 3.0:Tp= .79]	0409	1	5.0	32.76	2.59	8.92	80.14	.64	.000
	CALIB NASHYD [CN=81.0] [N= 3.0:Tp= .43]	0410	2	5.0	15.07	1.78	8.42	80.13	.64	.000
	ADD [0409 + 0410]	0809	3	5.0	47.83	4.07	8.67	80.14	n/a	.000
*	CALIB STANDHYD [I%= 5.0:S%= .50]	0411	1	5.0	5.88	1.57	8.08	96.27	.77	.000
	ADD [0411 + 0809]	0810	2	5.0	53.71	4.48	8.58	81.90	n/a	.000
	RESRVR [2 : 0810] {ST= .88 ha.m }	0811	3	5.0	53.71	3.93	9.00	81.89	n/a	.000
	CALIB NASHYD [CN=80.0] [N= 3.0:Tp= .62]	0412	3	5.0	27.55	2.51	8.67	78.43	.63	.000
*	CALIB STANDHYD [I%= 2.0:S%= .50]	0413	1	5.0	9.99	2.20	8.08	86.76	.69	.000
	ADD [0413 + 0412]	0812	2	5.0	37.54	3.35	8.25	80.64	n/a	.000
	RESRVR [2 : 0812] {ST= .47 ha.m }	0813	3	5.0	37.54	3.25	8.58	80.63	n/a	.000
	CALIB NASHYD [CN=82.0] [N= 3.0:Tp= 1.13]	0414	1	5.0	21.71	1.36	9.33	81.88	.66	.000

FINISH

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APPENDIX E

HEC-2 MODEL RESULTS FOR FLOOD LINE EXTENSIONS

```
C
C     8
C 1.000   ***********************************************************
C 1.000   SECTIONS 1.0 TO 6.0 COMPILED FROM 1:2000 HRCA MAPPING
C 94.20   ***********************************************************
C 94.20   SECTIONS 0-7 COMPILED FROM FIELD SURVEY DATA - MARCH 10/99
C 94.20   ***********************************************************
C 94.20   SECTION 0A - DOWNSTREAM SECTION FITH LINE STRUCTURE
C 105.8   SECTION 0/0B - UPSTREAM SECTION FIFTH LINE STRUCTURE
C 730.0   ***********************************************************
T1    401 CORRIDOR INTEGRATED PLANNING STUDY
T2    MANSEWOOD TRIBUTARY OF MIDDLE SIXTEEN MILE CREEK AT FIFTH LINE NORTH
T3    MANSEWD.DAT - REGIONAL STORM PROFILE
J1            2                                1                  198.84
J2      1             -1
J3     38      39      40      41      42      43       8       1       2       3
J3     25      26       4       0      38       1       8      43      26      38
QT      1   15.02
NC   0.10    0.10   0.040     0.1     0.3
X1  1.000      12   146.0   150.0     0.0     0.0     0.0
GR  201.0   100.0   200.0   120.0   199.0   131.0   198.0   139.0   198.0   146.0
GR197.25   148.0   198.0   150.0   198.0   164.0   199.0   190.0   200.0   196.0
GR  201.0   202.0   202.0   255.0
X1  2.000      10   128.0   132.0    75.0    75.0    75.0
GR  201.0   100.0   200.0   103.0   199.0   105.0  198.40   128.0  197.65   130.0
GR198.40   132.0   199.0   153.0   200.0   156.0   201.0   158.0   202.0   187.0
X1  3.000      12   134.0   138.0    54.0    54.0    54.0
GR  202.0   100.0   201.0   106.0   200.0   109.0   199.0   124.0   198.8   134.0
GR198.05   136.0   198.8   138.0   199.0   156.0   200.0   160.0   201.0   168.0
GR  202.0   184.0   203.0   216.0
X1  4.000      11   110.5   114.5   105.0   105.0   105.0
GR  203.0   100.0   202.0   105.0   201.0   108.0   200.0   110.0  199.20   110.5
GR198.45   112.5  199.20   114.5   200.0   150.0   201.0   158.0   202.0   168.0
GR  203.0   180.0
X1  5.000      11   132.0   136.0    72.0    72.0    72.0
GR  203.0   100.0   202.0   108.0   201.0   112.0   200.0   124.0   199.6   132.0
GR198.85   134.0   199.6   136.0   200.0   138.0   201.0   164.0   202.0   174.0
GR  203.0   190.0
X1  6.000       9   136.0   140.0    44.0    44.0    44.0
GR  203.0   100.0   202.0   120.0   201.0   122.0  200.00   136.0  199.25   138.0
GR200.00   140.0   201.0   167.0   202.0   170.0  203.00   176.0
NC   0.04    0.04   0.013     0.3     0.5
X1  94.20      17   164.0  166.40      15      15      15           -2.57
X3     10                                                202.10  202.10
GR205.83   100.0  205.09   130.0  204.38   145.0  203.80   152.0  203.55   155.0
GR203.50   157.0  203.46   159.0  202.70  160.95  202.69   161.0  202.68   163.0
GR202.67   164.0  202.60   165.2  202.97   166.4  203.57  169.45  203.80   185.0
GR204.16   195.0  205.06   220.0
SB           1.50    1.70             2.4             4.80           199.98  200.03
X1  105.8      19   164.0  166.40    11.6    11.6    11.6
X2                      1  202.10  202.62
X3     10                                                202.62  202.62
BT    -19   100.0  203.88  203.88   130.0  203.05  203.05   145.0  202.87  202.87
BT          152.0  202.79  202.61   155.0  202.76  202.08   157.0  202.74  201.72
BT          159.0  202.71  201.53  160.95  202.62  201.33   161.0  202.62  201.30
BT          163.0  202.62  201.14  163.99  202.62  200.59   164.0  202.62  202.10
BT          165.2  202.62  202.10  166.40  202.62  202.10  166.41  202.62  200.58
BT         169.45  202.62  201.09   185.0  202.70  201.59   195.0  202.70  201.88
BT          220.0  202.94  202.59
GR203.88   100.0  203.05   130.0  202.87   145.0  202.61   152.0  202.08   155.0
GR201.72   157.0  201.53   159.0  201.33  160.95  201.30   161.0  201.14   163.0
GR200.59  163.99  200.10   164.0  199.98   165.2  200.10  166.40  200.58  166.41
GR201.09  169.45  201.59   185.0  201.88   195.0  202.59   220.0
X1  110.8      20   164.0  166.40     5.0     5.0     5.0           -2.57
GR206.42   100.0  205.93   130.0  205.45   145.0  205.18   152.0  204.65   155.0
GR204.29   157.0  204.09   159.0  203.90  160.95  203.90   161.0  203.71   163.0
GR203.16  163.99  202.79   164.0  202.79   165.2  202.79  166.39  203.15   166.4
GR203.66  169.45  204.16   185.0  204.45   195.0  205.16   220.0  205.30   240.0
NC   0.03    0.03    0.04     0.1     0.3
X1  132.5      13   153.0   159.0    26.7    25.5    26.7           -2.57
GR206.73   100.0  206.30   115.0  205.87   130.0  204.35   145.0  203.89   153.0
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GR202.95   155.0  202.90   155.8  203.10   156.3  203.78   159.0  203.86   175.0
GR204.29   184.0  205.30   188.0  205.50   205.0
X1 173.0      15   191.0   196.5    39.1    41.9    40.5           -2.57
GR206.99   100.0  206.73   120.0  206.28   140.0  205.65   160.0  204.98   180.0
GR204.41   191.0  203.44   193.0  203.35   194.5  203.40   195.0  204.04   196.5
GR204.26   205.0  204.70   220.0  205.39   240.0  205.51   260.0  205.34   280.0
X1 285.7      17   167.0   171.0   111.5   113.8   112.7           -2.57
GR207.48   100.0  207.47   120.0  207.17   135.0  206.85   150.0  205.60   160.0
GR204.84   165.0  204.94   167.0  204.61   168.0  204.25   169.0  204.30   169.5
GR204.87   169.8  205.01   171.0  204.91   185.0  205.12   200.0  205.94   220.0
GR206.98   240.0  207.56   260.0
X1 380.0      19   166.0   170.0    95.4    93.3    94.3           -2.57
X3    10                                                  203.73
GR208.59   100.0  207.69   120.0  206.96   123.0  205.94   132.0  205.68   147.0
GR206.17   162.0  206.30   165.0  205.58   166.0  205.56   166.5  205.54   167.0
GR205.02   168.0  205.53   169.0  205.54   169.5  205.56   170.0  206.27   171.0
GR206.45   182.0  207.90   192.0  208.85   202.0  209.23   217.0
X1 384.4      19   166.0   170.0     4.4     4.4     4.4           -2.57
X3    10                                                  203.73
GR208.59   100.0  207.69   120.0  206.96   123.0  205.94   132.0  205.68   147.0
GR206.17   162.0  206.30   165.0  205.58   166.0  205.56   166.5  205.54   167.0
GR205.02   168.0  205.53   169.0  205.54   169.5  205.56   170.0  206.27   171.0
GR206.45   182.0  207.90   192.0  208.85   202.0  209.23   217.0
X1 389.4      19   166.0   170.0     5.0     5.0     5.0
GR205.73   100.0  204.83   120.0  204.10   123.0  203.08   132.0  202.82   147.0
GR203.31   162.0  203.44   165.0  203.11   166.0  202.91   166.5  202.71   167.0
GR202.42   168.0  202.80   169.0  202.85   169.5  202.90   170.0  203.41   171.0
GR203.59   182.0  205.04   192.0  205.99   202.0  206.37   217.0
X1 392.0      19   166.0   170.0     2.6     2.6     2.6           -2.57
X3    10                                                  203.73
GR208.59   100.0  207.69   120.0  206.96   123.0  205.94   132.0  205.68   147.0
GR206.17   162.0  206.30   165.0  205.97   166.0  205.77   166.5  205.57   167.0
GR205.28   168.0  205.66   169.0  205.71   169.5  205.76   170.0  206.27   171.0
GR206.45   182.0  207.90   192.0  208.85   202.0  209.23   217.0
QT     1   14.00
X1 446.4      15   171.5   175.0    54.4    54.4    54.4           -2.57
GR208.92   100.0  208.67   120.0  208.00   140.0  207.24   160.0  206.89   170.0
GR206.65   171.5  205.94   172.5  205.64   173.2  205.64   174.2  206.09   175.0
GR206.37   177.0  206.30   190.0  206.44   204.0  208.90   221.0  209.07   240.0
X1 496.5      15   169.0   173.0    50.1    50.1    50.1           -2.57
GR209.63   100.0  209.31   120.0  209.00   140.0  208.96   151.0  207.41   155.0
GR206.79   160.0  206.77   169.0  206.34   169.5  206.10  170.25  205.97  170.75
GR206.35   171.0  206.77   173.0  206.77   190.0  208.53   210.0  208.12   225.0
X1 559.4      17   192.0   194.0    62.9    62.9    62.9           -2.57
GR209.53   100.0  208.97   120.0  207.51   140.0  207.03   160.0  207.06   180.0
GR207.21   189.0  207.32   192.0  206.33  192.25  206.34   192.6  206.41   192.9
GR206.77   193.0  207.00   194.0  207.09   197.0  208.67   210.0  209.20   225.0
GR209.35   250.0  209.48   275.0
X1 642.2      16   180.0   182.5    83.0    82.6    82.8           -2.57
GR209.98   100.0  209.69   120.0  208.44   140.0  207.78   150.0  207.76   155.0
GR207.40   159.0  207.82   164.0  207.62   175.0  207.52   180.0  206.96   181.0
GR207.44   182.5  207.86   183.5  209.60   200.0  209.78   220.0  209.89   240.0
GR210.19   260.0
X1 717.0      11   170.0   174.0    74.6    74.0    74.8           -2.57
GR210.75   100.0  210.32   120.0  209.79   140.0  209.14   165.0  208.26   170.0
GR207.71  172.75  208.17   174.0  208.26   185.0  209.16   210.0  210.24   240.0
GR210.70   260.0
X1 721.5      11   170.0   174.0     4.5     4.5     4.5           -2.57
GR210.75   100.0  210.32   120.0  209.79   140.0  209.14   165.0  208.26   170.0
GR207.71  172.75  208.17   174.0  208.26   185.0  209.16   210.0  210.24   240.0
GR210.70   260.0
X1 730.0      11   170.0   174.0     8.5     8.5     8.5
GR207.89   100.0  207.46   120.0  206.93   140.0  206.28   165.0  205.35   170.0
GR204.94  172.75  205.38   174.0  205.40   185.0  206.30   210.0  207.38   240.0
GR207.84   260.0
X1 732.5      11   170.0   174.0     2.5     2.5     2.5           -2.57
GR210.75   100.0  210.32   120.0  209.79   140.0  209.14   165.0  208.20   170.0
GR207.80  172.75  208.24   174.0  208.26   185.0  209.16   210.0  210.24   240.0
GR210.70   260.0
EJ
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|           S U M P O               |
|                                   |
|   Interactive Summary Printout    |
|   for MS/PC-DOS micro computers   |
|          September 1990           |
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NOTE - Asterisk (*) at left of profile number indicates message in summary of errors list

MANSEWD.DAT - REGIONAL STORM

Summary Printout

	SECNO	Q	ELMIN	DEPTH	CWSEL	CRIWS	EG	TOPWID
	1.00	15.02	197.25	1.59	198.84	.00	198.87	53.56
*	2.00	15.02	197.65	1.36	199.01	199.01	199.17	48.03
*	3.00	15.02	198.05	1.41	199.46	.00	199.54	40.79
	4.00	15.02	198.45	1.53	199.98	.00	200.12	39.03
	5.00	15.02	198.85	1.56	200.41	.00	200.59	29.67
	6.00	15.02	199.25	1.48	200.73	.00	200.91	33.98
*	94.20	15.02	200.03	1.69	201.72	201.72	202.52	2.40
*	105.80	15.02	199.98	2.02	202.00	.00	202.52	2.40
*	110.80	15.02	200.22	2.44	202.66	.00	202.67	78.24
	132.50	15.02	200.33	2.34	202.67	.00	202.67	51.49
*	173.00	15.02	200.78	1.89	202.67	.00	202.68	63.43
*	285.70	15.02	201.68	.99	202.67	.00	202.76	40.92
*	380.00	15.02	202.45	1.30	203.75	203.75	203.78	45.22
	384.40	15.02	202.45	1.31	203.76	.00	203.79	45.73
*	389.40	15.02	202.42	1.36	203.78	.00	203.79	57.38
*	392.00	15.02	202.71	1.06	203.77	.00	203.80	47.33
*	446.40	14.00	203.07	.93	204.00	204.00	204.14	33.29
*	496.50	14.00	203.40	1.11	204.51	.00	204.58	35.81
	559.40	14.00	203.76	1.08	204.84	.00	204.88	55.43
*	642.20	14.00	204.39	.93	205.32	205.32	205.46	35.45
	717.00	14.00	205.14	.93	206.07	.00	206.18	27.71
	721.50	14.00	205.14	.98	206.12	.00	206.21	29.28
*	730.00	14.00	204.94	1.27	206.21	.00	206.22	42.05
*	732.50	14.00	205.23	.95	206.18	.00	206.24	31.48

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C
C      16
C     1.0 ***********************************************************
C     1.0 CROSS SECTION GEOMETRY COMPILED FROM 1:2000 HRCA MAPPING
C     1.0 STRUCURE DATA COMPILED FROM FIELD SURVEYS MAR.30 & APR.6/99
C     1.0 ***********************************************************
C     1.0 DOWNSTREAM SECTION FITH LINE SOUTH STRUCTURE
C     2.0 UPSTREAM SECTION FIFTH LINE SOUTH STRUCTURE
C     3.0 SECTION AT STUDY LIMIT FROM MAP #  , HRCA MAPPING
C     4.0 DOWNSTREAM SECTION OF PRIVATE CROSSING AT MATCH LINE
C     5.0 UPSTREAM SECTION OF PRIVATE CROSSING AT MATCH LINE
C     6.0 SECTION A FROM APRIL 6 SURVEY
C     7.0 SECTION B FROM APRIL 6 SURVEY
C     8.0 DOWNSTREAM SECTION OF HWY 401 STRUCTURE #32
C     9.0 UPSTREAM SECTION OF HWY 401 STRUCTURE #32
C     9.0 ***********************************************************
C     9.0 STARTING WSELV OBTAINED FROM HEC-2 SECTION 38.688 FOAK4.DAT
C     9.0
T1    401 CORRIDOR INTEGRATED PLANNING STUDY
T2    401 TRIBUTARY OF MIDDLE SIXTEEN MILE CREEK AT FIFTH LINE SOUTH
T3    401TRIB.DAT - 2 YEAR - REGIONAL STORM PROFILES
J1              2                               1                     191.62
J2       1               -1
J3      38     39        40      41      42      43       8       1       2       3
J3      25     26         4       0      38       1       8      43      26      38
QT       7   3.05      5.73    7.19    9.80   11.89   14.29   23.00
NC 0.035    0.035     0.013     0.3     0.5
X1     1.0     11     152.5   157.5     0.0     0.0     0.0
X3      10                                                    192.2   192.2
GR 193.2    100.0     192.1   151.5   191.1   152.5   191.1  153.54   190.4   154.0
GR 190.4    155.0     190.4   156.0   191.1  156.46   191.1   157.5   192.1   158.5
GR 193.2    186.0
X1     2.0     13     151.5   158.5    17.3    17.3    17.3
BT     -13  100.0     193.2   193.2   151.5   193.2   192.1   152.5   193.2   191.1
BT         153.54     193.2   191.1  153.55   193.2   192.2   154.0   193.2   192.2
BT          155.0     193.2   192.2   156.0   193.2   192.2  156.45   193.2   192.0
BT         156.46     193.2   191.1   157.5   193.2   191.1   158.5   193.2   192.1
BT          186.0     193.2   193.2
GR 193.2    100.0     192.1   151.5   191.1   152.5   191.1  153.54   191.0  153.55
GR 190.4    154.0     190.4   155.0   190.4   156.0   191.0  156.45   191.1  156.46
GR 191.1    157.5     192.1   158.5   193.2   186.0
NC 0.035    0.035      0.04     0.1     0.3
X1     3.0     17     127.0   150.5    48.0    48.0    48.0
GR 196.0    100.0     195.0   103.0   194.0   109.0   193.0   127.0   192.0   144.5
GR 192.0    146.0     191.3  146.01   191.3   147.0   191.3  147.99   192.0   148.0
GR 192.0    149.5     193.0   150.5   193.0   152.0   194.0   163.0   195.0   166.0
GR 196.0    171.0     197.0   182.0
NC 0.035    0.035     0.013     0.3     0.5
X1     4.0     18     121.5   128.5    57.0    57.0    57.0
X3      10                                                    195.1   195.1
GR 197.0    100.0     196.0   112.0   195.0   118.0   194.0   120.0   194.0   121.5
GR 193.0    122.5     193.0  123.99   192.3   124.0   192.3   125.0   192.3   126.0
GR 193.0   126.01     193.0   127.5   194.0   128.5   194.0   132.0   195.0   136.0
GR 196.0    143.0     197.0   150.0   198.0   169.0
SB           3.69      1.79             1.5             4.2           192.3   192.3
X1     5.0     26     131.5   138.5     7.0     7.0     7.0
X2                        1   195.1   195.5
X3      10                                                    195.1   195.1
BT     -26  100.0     198.0   198.0   108.0   197.0   197.0   116.0   197.0   197.0
BT          118.0     196.0   196.0   122.0   196.0   196.0   126.0   195.7   195.0
BT          130.0     195.5   194.3   131.5   195.5   194.0   132.5   195.5   193.0
BT         133.99     195.5   193.0   134.0   195.5   192.3  134.25   195.5   192.3
BT         134.26     195.5   195.1   135.0   195.5   195.1  135.74   195.5   195.1
BT         135.75     195.5   192.3   136.0   195.5   192.3  136.01   195.5   193.0
BT          137.5     195.5   193.0   138.5   195.5   194.0   140.0   195.5   194.0
BT          146.0     195.9   194.0   147.0   196.0   194.3   149.0   196.2   195.0
BT          151.0     196.4   196.0   158.0   197.0   197.0
GR 198.0    100.0     197.0   108.0   197.0   116.0   196.0   118.0   196.0   122.0
GR 195.0    126.0     194.3   130.0   194.0   131.5   193.0   132.5   193.0  133.99
GR 192.3    134.0     192.3  134.25   192.3  134.26   192.3   135.0   192.3  135.74
GR 192.3   135.75     192.3   136.0   193.0  136.01   193.0   137.5   194.0   138.5
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GR 194.0    140.0    194.0    146.0    194.3    147.0    195.0    149.0    196.0    151.0
GR 197.0    158.0
QT     7     1.65     3.69     4.84     6.34     7.64     8.58    14.80
NC 0.035    0.035     0.04      0.1      0.3
X1   6.0       12    127.0    129.0     80.0     80.0     80.0
GR 198.0    100.0    197.0    106.0    196.0    110.0    195.0    113.0    194.9    127.0
GR 194.2   127.01    194.2   128.99    194.9    129.0    195.0    132.0    196.0    136.0
GR 197.0    138.0    198.0    141.0
NC 0.035    0.050    0.040
X1   7.0       10    113.0    115.0     70.0     70.0     70.0
GR 198.0    100.0    197.0    107.0    196.0    110.0    195.5    113.0    194.8   113.01
GR 194.8   114.99    195.5    115.0    196.0    131.0    197.0    142.0    198.0    157.0
NC 0.035    0.035    0.013      0.1      0.3
X1   8.0        2   123.44   126.56     70.0     70.0     70.0
X3    10                                                         197.94   197.94
GR196.39   123.44   196.39   126.56
SB           2.79     1.70               3.1               4.8            197.45   196.39
X1   9.0        4   123.44   126.56     66.0     66.0     66.0
X2                       1    199.0   200.37
X3    10                                                         199.00   199.00
BT    -4   123.44   200.37   197.45   123.45   200.37   199.00   126.55   200.37   199.00
BT         126.56   200.37   197.45
GR197.45   123.44   197.45   123.45   197.45   126.55   197.45   126.56
EJ
T1    401 CORRIDOR INTEGRATED PLANNING STUDY
T2    SOUTH TRIBUTARY OF MIDDLE SIXTEEN MILE CREEK AT FIFTH LINE NORTH
T3    401TRIB.DAT - 5 YEAR FLOW PROFILE
J1                3                                1                        192.27
J2      2                -1
T1    401 CORRIDOR INTEGRATED PLANNING STUDY
T2    SOUTH TRIBUTARY OF MIDDLE SIXTEEN MILE CREEK AT FIFTH LINE NORTH
T3    401TRIB.DAT - 10 YEAR FLOW PROFILE
J1                4                                1                        192.44
J2      3                -1
T1    401 CORRIDOR INTEGRATED PLANNING STUDY
T2    SOUTH TRIBUTARY OF MIDDLE SIXTEEN MILE CREEK AT FIFTH LINE NORTH
T3    401TRIB.DAT - 25 YEAR FLOW PROFILE
J1                5                                1                        192.72
J2      4                -1
T1    401 CORRIDOR INTEGRATED PLANNING STUDY
T2    SOUTH TRIBUTARY OF MIDDLE SIXTEEN MILE CREEK AT FIFTH LINE NORTH
T3    401TRIB.DAT - 50 YEAR FLOW PROFILE
J1                6                                1                        192.90
J2      5                -1
T1    401 CORRIDOR INTEGRATED PLANNING STUDY
T2    SOUTH TRIBUTARY OF MIDDLE SIXTEEN MILE CREEK AT FIFTH LINE NORTH
T3    401TRIB.DAT - 100 YEAR FLOW PROFILE
J1                7                                1                        193.06
J2      6                -1
T1    401 CORRIDOR INTEGRATED PLANNING STUDY
T2    SOUTH TRIBUTARY OF MIDDLE SIXTEEN MILE CREEK AT FIFTH LINE NORTH
T3    401TRIB.DAT - REGIONAL FLOW PROFILE
J1                8                                1                        194.19
J2      7                -1


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|             S U M P O             |
|                                   |
|   Interactive Summary Printout    |
|   for MS/PC-DOS micro computers   |
|          September 1990           |
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NOTE - Asterisk (*) at left of profile number
indicates message in summary of errors
list

401TRIB.DAT - 2 YEAR - REGIONAL STORM

Summary Printout

	SECNO	Q	ELMIN	DEPTH	CWSEL	CRIWS	EG	TOPWID
	1.00	6.10	190.40	1.20	191.60	.00	191.71	5.00
	1.00	5.73	190.40	1.87	192.27	.00	192.30	19.21
	1.00	7.19	190.40	2.04	192.44	.00	192.47	31.42
	1.00	9.80	190.40	2.32	192.72	.00	192.75	51.53
	1.00	11.89	190.40	2.50	192.90	.00	192.93	64.45
	1.00	14.29	190.40	2.66	193.06	.00	193.08	75.95
	1.00	23.00	190.40	3.79	194.19	.00	194.19	86.00
	2.00	6.10	190.40	1.17	191.57	.00	191.76	5.93
*	2.00	5.73	190.40	1.85	192.25	.00	192.32	17.79
*	2.00	7.19	190.40	2.00	192.40	191.35	192.51	28.71
*	2.00	9.80	190.40	2.23	192.63	191.54	192.84	45.42
*	2.00	11.89	190.40	2.37	192.77	191.69	193.07	54.83
*	2.00	14.29	190.40	2.46	192.86	191.84	193.29	61.50
*	2.00	23.00	190.40	3.79	194.19	.00	194.20	86.00
*	3.00	6.10	191.30	.96	192.26	192.26	192.43	9.73
*	3.00	5.73	191.30	.94	192.24	192.24	192.41	9.52
*	3.00	7.19	191.30	1.22	192.52	.00	192.58	14.53
	3.00	9.80	191.30	1.59	192.89	.00	192.92	21.68
	3.00	11.89	191.30	1.83	193.13	.00	193.15	29.00
*	3.00	14.29	191.30	2.06	193.36	.00	193.38	35.47
*	3.00	23.00	191.30	2.89	194.19	.00	194.20	55.72
*	4.00	6.10	192.30	.95	193.25	193.25	193.51	5.50
*	4.00	5.73	192.30	.92	193.22	193.22	193.48	5.45
*	4.00	7.19	192.30	1.01	193.31	193.31	193.59	5.62
*	4.00	9.80	192.30	1.14	193.44	193.44	193.78	5.89
*	4.00	11.89	192.30	1.24	193.54	193.54	193.91	6.08
*	4.00	14.29	192.30	1.34	193.64	193.64	194.05	6.29
*	4.00	23.00	192.30	1.67	193.97	193.97	194.49	6.94
*	5.00	6.10	192.30	1.19	193.49	193.49	194.08	5.97
*	5.00	5.73	192.30	1.14	193.44	193.44	194.01	5.87
*	5.00	7.19	192.30	1.32	193.62	193.62	194.29	6.24
*	5.00	9.80	192.30	1.63	193.93	193.93	194.75	6.85
*	5.00	11.89	192.30	1.85	194.15	194.15	195.08	7.00
*	5.00	14.29	192.30	2.09	194.39	194.39	195.45	7.00
*	5.00	23.00	192.30	3.63	195.93	195.93	196.29	28.57
*	6.00	3.30	194.20	.65	194.85	194.85	195.18	2.00
*	6.00	3.69	194.20	.86	195.06	195.06	195.14	19.39
*	6.00	4.84	194.20	.89	195.09	195.09	195.19	19.64
*	6.00	6.34	194.20	.93	195.13	195.13	195.24	19.94
	6.00	7.64	194.20	1.17	195.37	195.16	195.40	21.57
	6.00	8.58	194.20	1.45	195.65	195.18	195.67	23.54
*	6.00	14.80	194.20	2.16	196.36	.00	196.37	28.12

*	7.00	3.30	194.80	1.03	195.83	.00	195.88	14.47
	7.00	3.69	194.80	.92	195.72	195.69	195.86	10.48
	7.00	4.84	194.80	1.01	195.81	195.79	195.94	13.66
	7.00	6.34	194.80	1.09	195.89	.00	196.03	16.63
*	7.00	7.64	194.80	1.13	195.93	195.93	196.08	18.21
*	7.00	8.58	194.80	1.16	195.96	195.96	196.12	19.64
*	7.00	14.80	194.80	1.56	196.36	.00	196.41	25.99
*	8.00	3.30	196.39	.48	196.87	196.87	197.12	3.12
*	8.00	3.69	196.39	.52	196.91	196.91	197.17	3.12
*	8.00	4.84	196.39	.62	197.01	197.01	197.33	3.12
*	8.00	6.34	196.39	.75	197.14	197.14	197.51	3.12
*	8.00	7.64	196.39	.85	197.24	197.24	197.66	3.12
*	8.00	8.58	196.39	.91	197.30	197.30	197.76	3.12
*	8.00	14.80	196.39	1.32	197.71	197.71	198.37	3.12
*	9.00	3.30	197.45	.48	197.93	197.93	198.18	3.12
*	9.00	3.69	197.45	.52	197.97	197.97	198.23	3.12
*	9.00	4.84	197.45	.62	198.07	198.07	198.39	3.12
*	9.00	6.34	197.45	.75	198.20	198.20	198.57	3.12
*	9.00	7.64	197.45	.85	198.30	198.30	198.72	3.12
*	9.00	8.58	197.45	.91	198.36	198.36	198.82	3.12
*	9.00	14.80	197.45	1.32	198.77	198.77	199.43	3.12

APPENDIX F
HEC-2 MODEL RESULTS
FOR IMPACT ASSESSMENT

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|            S U M P O             |
|                                  |
|   Interactive Summary Printout   |
|   for MS/PC-DOS micro computers  |
|          September 1990          |
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NOTE - Asterisk (*) at left of profile number indicates message in summary of errors list

FOAK4.DAT - REGIONAL TO 2 YEAR FLOWS
MIDDLE SIXTEEN MILE CREEK - ORIGINAL MODEL

Summary Printout

	SECNO	Q	CWSEL	QCH	QWEIR	TOPWID	XLCH
	37.01	261.99	191.08	19.20	.00	538.42	.00
	37.01	49.26	188.77	10.04	.00	404.96	.00
	37.01	43.91	188.77	8.95	.00	404.96	.00
	37.01	36.68	188.77	7.48	.00	404.96	.00
	37.01	29.09	188.77	5.93	.00	404.96	.00
	37.01	23.76	188.77	4.84	.00	404.96	.00
	37.01	8.86	188.77	1.81	.00	404.96	.00
*	37.26	261.99	191.04	41.54	.00	163.19	220.00
*	37.26	49.26	189.58	23.01	.00	107.57	220.00
*	37.26	43.91	189.53	22.79	.00	106.91	220.00
*	37.26	36.68	189.51	20.19	.00	106.57	220.00
*	37.26	29.09	189.43	18.31	.00	92.53	220.00
*	37.26	23.76	189.38	16.37	.00	82.19	220.00
*	37.26	8.86	188.84	8.85	.00	7.05	220.00
*	37.69	261.99	191.30	26.40	.00	264.13	247.00
*	37.69	49.26	190.18	13.88	.00	225.96	247.00
*	37.69	43.91	190.15	13.07	.00	224.86	247.00
*	37.69	36.68	190.08	12.56	.00	222.24	247.00
*	37.69	29.09	190.01	11.59	.00	219.60	247.00
*	37.69	23.76	189.94	10.73	.00	143.26	247.00
*	37.69	8.86	189.60	5.86	.00	47.61	247.00
*	37.85	261.99	191.35	150.37	.00	198.31	163.00
	37.85	49.26	190.33	35.39	.00	82.59	163.00
	37.85	43.91	190.29	31.80	.00	79.66	163.00
	37.85	36.68	190.23	26.86	.00	75.78	163.00
	37.85	29.09	190.15	21.65	.00	70.59	163.00
	37.85	23.76	190.08	17.95	.00	66.13	163.00
	37.85	8.86	189.73	7.46	.00	43.10	163.00
	38.03	264.66	191.65	58.20	.00	230.03	160.00
*	38.03	50.24	190.84	32.71	.00	80.00	160.00
*	38.03	44.86	190.80	30.64	.00	76.81	160.00
*	38.03	37.72	190.73	28.00	.00	71.24	160.00
*	38.03	29.93	190.63	24.71	.00	63.84	160.00
*	38.03	24.42	190.33	23.57	.00	16.20	160.00
*	38.03	9.12	189.90	9.12	.00	7.62	160.00
	38.25	264.66	192.23	207.21	.00	101.69	200.00
*	38.25	50.24	191.43	48.88	.00	59.31	200.00
*	38.25	44.86	191.37	43.96	.00	56.43	200.00
*	38.25	37.72	191.29	37.27	.00	52.35	200.00
*	38.25	29.93	191.18	29.81	.00	47.11	200.00
*	38.25	24.42	191.11	24.38	.00	44.38	200.00
*	38.25	9.12	190.59	9.12	.00	25.17	200.00
	38.42	264.66	192.78	134.50	.00	87.53	160.00
*	38.42	50.24	191.66	45.95	.00	71.78	160.00
*	38.42	44.86	191.57	43.32	.00	70.05	160.00
*	38.42	37.72	191.49	37.46	.00	20.46	160.00
*	38.42	29.93	191.39	29.80	.00	19.56	160.00
*	38.42	24.42	191.30	24.35	.00	18.69	160.00
	38.42	9.12	190.88	9.12	.00	10.18	160.00
	38.60	264.66	193.56	112.36	.00	143.03	180.00
	38.60	50.24	192.37	38.84	.00	75.48	180.00
*	38.60	44.86	192.33	35.60	.00	75.32	180.00
*	38.60	37.72	192.23	32.18	.00	74.89	180.00

*	38.60	29.93	192.08	27.94	.00	74.32	180.00
	38.60	24.42	191.96	23.52	.00	17.72	180.00
	38.60	9.12	191.40	9.02	.00	14.42	180.00
*	38.63	264.66	193.65	119.86	.00	147.88	33.00
*	38.63	50.24	192.32	50.24	.00	10.20	33.00
*	38.63	44.86	192.30	44.86	.00	10.20	33.00
	38.63	37.72	192.24	37.72	.00	10.20	33.00
	38.63	29.93	192.13	29.93	.00	10.20	33.00
	38.63	24.42	192.01	24.42	.00	10.20	33.00
	38.63	9.12	191.48	9.12	.00	10.20	33.00
	38.63	264.66	193.97	71.95	.00	161.38	2.00
	38.63	50.24	192.51	48.25	.00	41.24	2.00
	38.63	44.86	192.39	44.07	.00	35.53	2.00
	38.63	37.72	192.26	37.59	.00	28.95	2.00
	38.63	29.93	192.14	29.93	.00	23.33	2.00
	38.63	24.42	192.02	24.42	.00	17.94	2.00
	38.63	9.12	191.49	9.12	.00	13.52	2.00
	38.64	264.66	194.00	71.42	.00	161.76	3.00
	38.64	50.24	192.59	47.13	.00	45.65	3.00
	38.64	44.86	192.44	43.65	.00	38.24	3.00
	38.64	37.72	192.30	37.43	.00	31.68	3.00
	38.64	29.93	192.15	29.93	.00	24.11	3.00
	38.64	24.42	192.04	24.42	.00	18.59	3.00
	38.64	9.12	191.50	9.12	.00	13.58	3.00
*	38.64	264.66	193.99	100.11	.00	161.70	2.00
	38.64	50.24	192.57	50.24	.00	10.20	2.00
	38.64	44.86	192.44	44.86	.00	10.20	2.00
	38.64	37.72	192.31	37.72	.00	10.20	2.00
	38.64	29.93	192.17	29.93	.00	10.20	2.00
	38.64	24.42	192.05	24.42	.00	10.20	2.00
	38.64	9.12	191.50	9.12	.00	10.20	2.00
*	38.69	264.66	194.19	221.61	.00	145.72	45.00
*	38.69	50.24	193.06	49.42	.00	69.01	45.00
*	38.69	44.86	192.90	44.26	.00	66.57	45.00
*	38.69	37.72	192.72	37.31	.00	65.62	45.00
*	38.69	29.93	192.44	29.84	.00	24.01	45.00
*	38.69	24.42	192.27	24.39	.00	22.58	45.00
*	38.69	9.12	191.62	9.12	.00	16.73	45.00
	38.94	264.66	194.40	55.31	.00	180.27	190.00
*	38.94	50.24	193.21	22.29	.00	106.49	190.00
*	38.94	44.86	193.11	21.82	.00	84.04	190.00
*	38.94	37.72	193.02	19.93	.00	64.31	190.00
*	38.94	29.93	192.69	20.00	.00	43.74	190.00
*	38.94	24.42	192.61	17.38	.00	39.31	190.00
*	38.94	9.12	192.23	8.59	.00	18.34	190.00
*	38.99	264.66	194.76	264.66	.00	33.04	54.00
	38.99	50.24	193.30	50.24	.00	21.01	54.00
	38.99	44.86	193.23	44.86	.00	21.01	54.00
	38.99	37.72	193.16	37.72	.00	21.01	54.00
*	38.99	29.93	193.05	29.93	.00	21.01	54.00
*	38.99	24.42	192.96	24.42	.00	21.01	54.00
*	38.99	9.12	192.59	9.12	.00	21.00	54.00
*	39.04	264.66	195.50	264.66	.00	33.42	48.00
	39.04	50.24	193.45	50.24	.00	19.48	48.00
	39.04	44.86	193.37	44.86	.00	19.28	48.00
	39.04	37.72	193.27	37.72	.00	18.96	48.00
*	39.04	29.93	193.15	29.93	.00	18.58	48.00
*	39.04	24.42	193.05	24.42	.00	18.27	48.00
*	39.04	9.12	192.64	9.12	.00	17.70	48.00
*	39.09	264.66	196.06	57.45	.00	221.45	50.00
*	39.09	50.24	193.65	45.37	.00	25.59	50.00
*	39.09	44.86	193.57	41.38	.00	23.89	50.00
*	39.09	37.72	193.45	35.80	.00	21.38	50.00
*	39.09	29.93	193.30	29.25	.00	18.20	50.00
*	39.09	24.42	193.19	24.26	.00	15.89	50.00
*	39.09	9.12	192.72	9.11	.00	8.81	50.00
*	39.15	264.66	195.94	149.33	.00	128.99	65.00
*	39.15	50.24	194.22	50.06	.00	20.54	65.00
*	39.15	44.86	194.14	44.82	.00	18.90	65.00
*	39.15	37.72	194.03	37.72	.00	16.68	65.00
*	39.15	29.93	193.88	29.93	.00	15.30	65.00
*	39.15	24.42	193.75	24.42	.00	14.46	65.00
*	39.15	9.12	193.19	9.12	.00	11.15	65.00

*	39.21	264.66	196.24	102.65	.00	140.57	55.00
*	39.21	50.24	194.46	50.00	.00	25.15	55.00
*	39.21	44.86	194.37	44.73	.00	22.93	55.00
*	39.21	37.72	194.23	37.71	.00	19.31	55.00
*	39.21	29.93	194.03	29.93	.00	13.82	55.00
*	39.21	24.42	193.88	24.42	.00	12.28	55.00
*	39.21	9.12	193.29	9.12	.00	8.79	55.00
	39.38	264.66	196.31	33.74	.00	155.07	170.00
*	39.38	50.24	195.06	14.86	.00	114.98	170.00
*	39.38	44.86	194.99	14.67	.00	111.98	170.00
*	39.38	37.72	194.87	14.04	.00	99.73	170.00
*	39.38	29.93	194.72	13.39	.00	83.98	170.00
*	39.38	24.42	194.60	12.70	.00	72.13	170.00
	39.38	9.12	194.20	8.28	.00	28.65	170.00
	39.42	264.66	196.35	64.72	.00	183.47	45.00
	39.42	50.24	195.12	24.56	.00	136.31	45.00
	39.42	44.86	195.06	23.87	.00	134.45	45.00
	39.42	37.72	194.95	24.23	.00	119.75	45.00
*	39.42	29.93	194.78	29.93	.00	16.12	45.00
*	39.42	24.42	194.71	24.42	.00	15.94	45.00
	39.42	9.12	194.46	9.12	.00	15.18	45.00
*	39.43	264.66	196.27	98.78	.00	178.66	4.00
*	39.43	50.24	195.05	49.91	.00	134.44	4.00
*	39.43	44.86	194.88	44.86	.00	104.03	4.00
	39.43	37.72	194.82	37.72	.00	92.56	4.00
*	39.43	29.93	194.88	29.93	.00	106.79	4.00
*	39.43	24.42	194.76	24.42	.00	80.71	4.00
*	39.43	9.12	194.47	9.12	.00	23.92	4.00
*	39.44	264.66	196.85	53.95	.00	200.34	11.00
*	39.44	50.24	195.18	48.74	.00	135.23	11.00
*	39.44	44.86	195.01	44.73	.00	110.88	11.00
*	39.44	37.72	194.87	37.72	.00	81.28	11.00
	39.44	29.93	194.90	29.93	.00	87.62	11.00
	39.44	24.42	194.78	24.42	.00	63.72	11.00
	39.44	9.12	194.49	9.12	.00	21.14	11.00
*	39.44	264.66	197.03	72.72	.00	206.75	5.00
*	39.44	50.24	195.62	21.12	.00	148.41	5.00
*	39.44	44.86	195.56	19.44	.00	146.80	5.00
*	39.44	37.72	195.42	18.07	.00	142.26	5.00
*	39.44	29.93	195.20	17.53	.00	135.68	5.00
	39.44	24.42	194.85	24.42	.00	16.07	5.00
	39.44	9.12	194.50	9.12	.00	14.99	5.00
*	39.55	264.66	197.01	151.18	.00	120.74	95.00
*	39.55	50.24	195.63	45.66	.00	72.08	95.00
*	39.55	44.86	195.57	41.37	.00	68.27	95.00
*	39.55	37.72	195.43	35.99	.00	58.24	95.00
	39.55	29.93	195.25	29.52	.00	44.70	95.00
*	39.55	24.42	195.18	24.26	.00	39.59	95.00
*	39.55	9.12	194.70	9.12	.00	22.00	95.00
*	39.63	264.66	197.16	41.01	.00	177.24	80.00
	39.63	50.24	195.72	16.01	.00	135.23	80.00
	39.63	44.86	195.66	15.01	.00	129.80	80.00
	39.63	37.72	195.52	14.19	.00	117.61	80.00
	39.63	29.93	195.34	13.46	.00	101.52	80.00
	39.63	24.42	195.26	12.08	.00	93.85	80.00
*	39.63	9.12	194.76	7.09	.00	22.89	80.00
	39.69	264.66	197.17	67.45	.00	179.35	64.00
*	39.69	50.24	195.59	50.24	.00	12.20	64.00
*	39.69	44.86	195.56	44.86	.00	12.20	64.00
*	39.69	37.72	195.46	37.72	.00	12.20	64.00
*	39.69	29.93	195.34	29.93	.00	12.20	64.00
*	39.69	24.42	195.27	24.42	.00	12.20	64.00
	39.69	9.12	194.84	9.12	.00	9.76	64.00
*	39.71	264.66	197.98	44.20	218.76	199.43	12.00
*	39.71	50.24	195.65	50.24	.00	12.20	12.00
*	39.71	44.86	195.59	44.86	.00	12.20	12.00
*	39.71	37.72	195.53	37.72	.00	12.20	12.00
*	39.71	29.93	195.46	29.93	.00	12.20	12.00
*	39.71	24.42	195.35	24.42	.00	12.20	12.00
*	39.71	9.12	194.96	9.12	.00	10.01	12.00
	39.75	264.66	197.99	38.50	.00	198.25	44.00
*	39.75	50.24	196.76	10.93	.00	158.89	44.00
*	39.75	44.86	196.55	10.94	.00	153.87	44.00
*	39.75	37.72	196.29	11.24	.00	147.17	44.00

*	39.75	29.93	196.03	11.66	.00	140.86	44.00
*	39.75	24.42	195.87	11.60	.00	116.10	44.00
*	39.75	9.12	195.33	7.97	.00	34.13	44.00
	39.97	264.66	198.04	53.97	.00	322.63	220.00
*	39.97	50.24	196.78	24.53	.00	295.76	220.00
*	39.97	44.86	196.57	29.61	.00	279.33	220.00
*	39.97	37.72	196.32	31.84	.00	79.95	220.00
*	39.97	29.93	196.12	28.46	.00	56.82	220.00
*	39.97	24.42	196.02	24.35	.00	55.29	220.00
	39.97	9.12	195.64	9.12	.00	14.74	220.00
*	40.16	264.66	198.09	63.76	.00	159.42	180.00
	40.16	50.24	196.87	20.31	.00	123.30	180.00
	40.16	44.86	196.74	19.75	.00	113.83	180.00
	40.16	37.72	196.61	18.23	.00	104.80	180.00
*	40.16	29.93	196.50	15.99	.00	96.44	180.00
*	40.16	24.42	196.41	14.27	.00	89.97	180.00
*	40.16	9.12	195.98	9.12	.00	15.63	180.00
*	40.21	264.66	198.02	103.20	.00	119.93	50.00
*	40.21	50.24	196.84	33.94	.00	73.81	50.00
*	40.21	44.86	196.70	32.70	.00	64.54	50.00
*	40.21	37.72	196.59	29.39	.00	56.56	50.00
*	40.21	29.93	196.49	24.69	.00	49.75	50.00
*	40.21	24.42	196.43	20.94	.00	45.04	50.00
	40.21	9.12	196.18	8.85	.00	27.23	50.00
	40.42	264.66	198.29	179.69	.00	119.57	98.00
*	40.42	50.24	197.28	40.16	.00	101.14	98.00
	40.42	44.86	197.27	35.92	.00	101.11	98.00
*	40.42	37.72	197.17	31.89	.00	100.39	98.00
	40.42	29.93	197.17	25.34	.00	100.37	98.00
*	40.42	24.42	197.12	21.51	.00	99.98	98.00
*	40.42	9.12	196.61	9.12	.00	9.10	98.00
*	40.84	264.66	198.77	197.72	.00	196.67	234.00
*	40.84	50.24	197.83	44.96	.00	156.25	234.00
*	40.84	44.86	197.79	40.50	.00	150.54	234.00
*	40.84	37.72	197.75	34.28	.00	145.95	234.00
*	40.84	29.93	197.68	27.59	.00	135.75	234.00
*	40.84	24.42	197.62	22.65	.00	130.53	234.00
*	40.84	9.12	197.39	8.62	.00	101.40	234.00
*	41.06	264.66	198.91	60.65	.00	134.27	164.00
*	41.06	50.24	198.31	23.17	.00	115.76	164.00
*	41.06	44.86	198.31	20.97	.00	115.56	164.00
*	41.06	37.72	198.28	18.91	.00	114.54	164.00
*	41.06	29.93	198.23	16.74	.00	113.09	164.00
*	41.06	24.42	198.17	15.77	.00	111.39	164.00
*	41.06	9.12	197.69	9.12	.00	7.46	164.00
*	41.24	264.66	199.87	75.28	.00	128.28	170.00
	41.24	50.24	199.02	31.47	.00	123.65	170.00
	41.24	44.86	198.97	30.78	.00	116.64	170.00
	41.24	37.72	198.90	28.20	.00	102.05	170.00
	41.24	29.93	198.83	24.75	.00	83.79	170.00
	41.24	24.42	198.78	21.25	.00	73.45	170.00
*	41.24	9.12	198.53	9.12	.00	17.99	170.00
*	41.38	264.66	200.21	220.11	.00	138.45	140.00
*	41.38	50.24	199.32	49.45	.00	89.84	140.00
*	41.38	44.86	199.29	44.33	.00	86.87	140.00
*	41.38	37.72	199.22	37.47	.00	82.33	140.00
*	41.38	29.93	199.14	29.86	.00	76.62	140.00
*	41.38	24.42	199.06	24.41	.00	71.47	140.00
*	41.38	9.12	198.68	9.12	.00	48.88	140.00
	41.46	264.66	200.35	68.91	.00	196.89	80.00
*	41.46	50.24	199.22	50.24	.00	12.50	80.00
*	41.46	44.86	199.22	44.86	.00	12.50	80.00
*	41.46	37.72	199.19	37.72	.00	12.50	80.00
*	41.46	29.93	199.14	29.93	.00	12.50	80.00
*	41.46	24.42	199.07	24.42	.00	12.50	80.00
*	41.46	9.12	198.72	9.12	.00	12.50	80.00
*	41.46	264.66	200.66	81.66	.00	214.66	1.00
	41.46	50.24	199.22	50.24	.00	83.14	1.00
	41.46	44.86	199.23	44.86	.00	83.67	1.00
	41.46	37.72	199.19	37.72	.00	73.62	1.00
	41.46	29.93	199.14	29.93	.00	57.07	1.00
	41.46	24.42	199.07	24.42	.00	36.44	1.00
	41.46	9.12	198.72	9.12	.00	14.29	1.00

*	41.47	264.66	201.01	55.43	.00	236.33	9.00
	41.47	50.24	199.48	50.24	.00	153.61	9.00
	41.47	44.86	199.41	44.86	.00	150.38	9.00
	41.47	37.72	199.32	37.72	.00	139.60	9.00
	41.47	29.93	199.21	29.93	.00	111.08	9.00
	41.47	24.42	199.13	24.42	.00	83.97	9.00
	41.47	9.12	198.74	9.12	.00	14.56	9.00
*	41.47	264.66	201.15	51.66	.00	238.18	2.00
*	41.47	50.24	199.52	50.24	.00	12.50	2.00
	41.47	44.86	199.42	44.86	.00	12.50	2.00
	41.47	37.72	199.32	37.72	.00	12.50	2.00
	41.47	29.93	199.22	29.93	.00	12.50	2.00
	41.47	24.42	199.13	24.42	.00	12.50	2.00
	41.47	9.12	198.74	9.12	.00	12.50	2.00
*	41.54	264.66	201.03	79.49	.00	152.50	66.00
*	41.54	50.24	199.79	32.13	.00	95.06	66.00
*	41.54	44.86	199.74	29.87	.00	94.14	66.00
*	41.54	37.72	199.67	26.86	.00	92.65	66.00
*	41.54	29.93	199.58	23.30	.00	90.74	66.00
*	41.54	24.42	199.35	22.43	.00	49.91	66.00
*	41.54	9.12	198.71	9.12	.00	5.51	66.00
*	41.72	264.66	201.53	62.87	.00	142.09	153.00
*	41.72	50.24	200.29	20.75	.00	118.13	153.00
*	41.72	44.86	200.22	19.50	.00	116.53	153.00
*	41.72	37.72	200.13	17.76	.00	114.26	153.00
*	41.72	29.93	200.02	15.81	.00	111.42	153.00
*	41.72	24.42	199.95	13.82	.00	108.11	153.00
	41.72	9.12	199.37	8.84	.00	15.40	153.00
	41.86	264.66	201.77	84.17	.00	166.05	140.00
	41.86	50.24	200.47	23.85	.00	136.09	140.00
	41.86	44.86	200.41	22.11	.00	133.08	140.00
	41.86	37.72	200.32	19.72	.00	128.83	140.00
	41.86	29.93	200.22	17.02	.00	123.67	140.00
	41.86	24.42	200.14	14.92	.00	119.87	140.00
	41.86	9.12	199.78	8.09	.00	52.75	140.00
*	42.04	264.66	201.93	94.03	.00	127.07	180.00
*	42.04	50.24	200.74	29.41	.00	111.66	180.00
*	42.04	44.86	200.69	27.49	.00	111.24	180.00
*	42.04	37.72	200.63	24.75	.00	110.67	180.00
*	42.04	29.93	200.55	21.38	.00	110.01	180.00
*	42.04	24.42	200.49	18.72	.00	84.01	180.00
	42.04	9.12	200.25	8.39	.00	49.13	180.00
*	42.20	264.66	202.37	114.43	.00	325.61	160.00
*	42.20	50.24	201.30	30.06	.00	313.07	160.00
*	42.20	44.86	201.25	27.64	.00	312.56	160.00
*	42.20	37.72	201.20	24.42	.00	311.81	160.00
*	42.20	29.93	201.13	20.67	.00	288.89	160.00
*	42.20	24.42	201.09	17.94	.00	269.41	160.00
	42.20	9.12	200.73	9.03	.00	33.08	160.00
*	42.30	264.66	202.55	84.31	.00	162.73	100.00
*	42.30	50.24	201.62	27.77	.00	142.78	100.00
*	42.30	44.86	201.58	26.19	.00	142.21	100.00
*	42.30	37.72	201.53	23.73	.00	141.50	100.00
*	42.30	29.93	201.46	20.73	.00	132.68	100.00
*	42.30	24.42	201.42	17.82	.00	121.43	100.00
	42.30	9.12	201.09	8.97	.00	37.58	100.00
	42.46	264.66	202.88	194.06	.00	149.55	110.00
*	42.46	50.24	201.96	46.79	.00	90.68	110.00
*	42.46	44.86	201.91	42.08	.00	86.83	110.00
*	42.46	37.72	201.85	35.80	.00	79.99	110.00
*	42.46	29.93	201.77	28.80	.00	71.07	110.00
*	42.46	24.42	201.70	23.72	.00	63.32	110.00
*	42.46	9.12	201.38	9.03	.00	39.66	110.00
	42.65	261.48	203.45	89.52	.00	215.06	155.00
*	42.65	47.90	202.53	36.81	.00	183.06	155.00
*	42.65	42.63	202.48	34.84	.00	160.20	155.00
*	42.65	35.56	202.34	32.30	.00	73.20	155.00
*	42.65	27.85	202.18	27.11	.00	46.89	155.00
*	42.65	22.68	202.04	22.67	.00	22.30	155.00
*	42.65	5.90	201.60	5.90	.00	10.36	155.00
	42.84	261.48	203.81	73.31	.00	166.14	92.00
*	42.84	47.90	202.92	18.35	.00	147.96	92.00
*	42.84	42.63	202.88	16.78	.00	146.85	92.00
*	42.84	35.56	202.82	14.72	.00	145.05	92.00

*	42.84	27.85	202.71	12.50	.00	142.61	92.00
*	42.84	22.68	202.63	11.05	.00	140.58	92.00
*	42.84	5.90	202.22	4.95	.00	68.83	92.00
*	43.07	261.48	204.18	90.71	.00	161.30	210.00
*	43.07	47.90	203.08	31.05	.00	94.63	210.00
*	43.07	42.63	203.03	28.71	.00	90.99	210.00
*	43.07	35.56	202.95	25.11	.00	85.63	210.00
*	43.07	27.85	202.84	21.00	.00	77.02	210.00
*	43.07	22.68	202.75	17.94	.00	70.62	210.00
*	43.07	5.90	202.30	5.68	.00	37.51	210.00
*	43.35	261.48	204.49	121.41	.00	223.69	180.00
*	43.35	47.90	203.74	38.35	.00	110.87	180.00
*	43.35	42.63	203.72	34.20	.00	97.78	180.00
*	43.35	35.56	203.67	28.37	.00	84.18	180.00
*	43.35	27.85	203.61	21.82	.00	79.43	180.00
*	43.35	22.68	203.59	17.49	.00	77.16	180.00
*	43.35	5.90	203.19	5.70	.00	13.99	180.00
	43.50	261.48	204.94	198.04	.00	168.80	140.00
*	43.50	47.90	204.38	44.64	.00	131.31	140.00
*	43.50	42.63	204.33	40.39	.00	120.63	140.00
*	43.50	35.56	204.27	34.34	.00	106.98	140.00
*	43.50	27.85	204.18	27.47	.00	86.76	140.00
*	43.50	22.68	204.09	22.61	.00	68.29	140.00
*	43.50	5.90	203.62	5.90	.00	32.67	140.00
*	43.65	261.48	205.43	139.38	.00	134.63	140.00
*	43.65	47.90	204.62	40.66	.00	68.23	140.00
*	43.65	42.63	204.58	36.93	.00	61.29	140.00
*	43.65	35.56	204.50	31.99	.00	48.51	140.00
*	43.65	27.85	204.40	25.87	.00	42.51	140.00
*	43.65	22.68	204.30	21.68	.00	36.50	140.00
*	43.65	5.90	203.81	5.90	.00	12.63	140.00
	43.81	261.48	206.35	76.79	.00	151.44	130.00
*	43.81	47.90	205.51	32.26	.00	143.59	130.00
*	43.81	42.63	205.44	31.33	.00	128.39	130.00
*	43.81	35.56	205.38	28.25	.00	111.47	130.00
*	43.81	27.85	205.23	25.68	.00	71.88	130.00
	43.81	22.68	205.12	22.27	.00	43.28	130.00
*	43.81	5.90	204.62	5.90	.00	8.92	130.00
	43.99	261.48	206.77	39.30	.00	190.94	170.00
	43.99	47.90	206.00	15.33	.00	184.00	170.00
*	43.99	42.63	205.98	14.15	.00	158.38	170.00
*	43.99	35.56	205.92	12.98	.00	152.05	170.00
*	43.99	27.85	205.86	11.15	.00	146.39	170.00
*	43.99	22.68	205.79	10.34	.00	139.23	170.00
	43.99	5.90	205.25	5.68	.00	13.32	170.00
*	44.18	261.48	207.23	54.40	.00	253.15	180.00
	44.18	47.90	206.39	20.07	.00	198.83	180.00
	44.18	42.63	206.35	19.07	.00	195.48	180.00
	44.18	35.56	206.29	17.65	.00	190.71	180.00
	44.18	27.85	206.21	16.30	.00	184.32	180.00
	44.18	22.68	206.16	15.02	.00	180.17	180.00
*	44.18	5.90	205.81	5.90	.00	16.67	180.00
*	44.26	261.48	207.30	83.20	.00	146.28	80.00
*	44.26	47.90	206.67	34.24	.00	120.59	80.00
*	44.26	42.63	206.64	32.09	.00	118.84	80.00
*	44.26	35.56	206.59	28.96	.00	116.09	80.00
*	44.26	27.85	206.31	26.86	.00	22.66	80.00
*	44.26	22.68	206.29	21.95	.00	22.12	80.00
	44.26	5.90	205.93	5.90	.00	10.61	80.00
*	44.34	261.48	207.76	80.78	.00	180.56	60.00
*	44.34	47.90	206.95	30.41	.00	140.41	60.00
	44.34	42.63	206.82	42.63	.00	14.00	60.00
	44.34	35.56	206.78	35.56	.00	14.00	60.00
*	44.34	27.85	206.71	27.85	.00	14.00	60.00
*	44.34	22.68	206.58	22.68	.00	14.00	60.00
*	44.34	5.90	206.01	5.90	.00	14.00	60.00
*	44.35	261.48	208.30	103.81	.00	205.44	6.00
	44.35	47.90	206.86	47.90	.00	129.29	6.00
	44.35	42.63	206.85	42.63	.00	124.33	6.00
	44.35	35.56	206.79	35.56	.00	110.88	6.00
	44.35	27.85	206.72	27.85	.00	93.42	6.00
	44.35	22.68	206.59	22.68	.00	59.83	6.00
	44.35	5.90	206.02	5.90	.00	16.67	6.00

	44.36	261.48	208.54	71.99	.00	214.83	11.00
	44.36	47.90	206.90	47.90	.00	135.54	11.00
	44.36	42.63	206.87	42.63	.00	131.23	11.00
	44.36	35.56	206.81	35.56	.00	115.56	11.00
	44.36	27.85	206.73	27.85	.00	95.16	11.00
	44.36	22.68	206.60	22.68	.00	60.91	11.00
	44.36	5.90	206.02	5.90	.00	16.77	11.00
*	44.36	261.48	208.66	69.67	.00	220.14	3.00
*	44.36	47.90	207.17	27.73	.00	150.38	3.00
	44.36	42.63	206.88	42.63	.00	14.00	3.00
	44.36	35.56	206.82	35.56	.00	14.00	3.00
	44.36	27.85	206.73	27.85	.00	14.00	3.00
	44.36	22.68	206.60	22.68	.00	14.00	3.00
	44.36	5.90	206.02	5.90	.00	14.00	3.00
*	44.40	261.48	208.67	63.77	.00	155.00	40.00
*	44.40	47.90	207.18	26.62	.00	118.25	40.00
	44.40	42.63	207.11	25.41	.00	115.89	40.00
*	44.40	35.56	206.96	23.78	.00	46.65	40.00
*	44.40	27.85	206.80	19.98	.00	40.76	40.00
*	44.40	22.68	206.65	17.61	.00	34.61	40.00
*	44.40	5.90	206.07	5.90	.00	13.76	40.00
	44.58	261.48	208.79	116.70	.00	262.31	170.00
	44.58	47.90	207.56	45.64	.00	85.61	170.00
	44.58	42.63	207.52	40.83	.00	82.95	170.00
	44.58	35.56	207.46	34.25	.00	80.15	170.00
	44.58	27.85	207.38	27.11	.00	74.49	170.00
	44.58	22.68	207.31	22.19	.00	71.74	170.00
*	44.58	5.90	206.84	5.90	.00	9.38	170.00
*	44.73	261.48	208.81	138.79	.00	118.60	150.00
	44.73	47.90	207.98	35.17	.00	66.76	150.00
	44.73	42.63	207.93	31.90	.00	64.10	150.00
	44.73	35.56	207.83	27.57	.00	59.22	150.00
	44.73	27.85	207.75	22.39	.00	54.26	150.00
	44.73	22.68	207.66	18.92	.00	49.22	150.00
	44.73	5.90	207.14	5.85	.00	20.64	150.00
*	44.96	261.48	209.93	80.96	.00	202.37	170.00
	44.96	47.90	208.61	35.66	.00	107.43	170.00
	44.96	42.63	208.54	33.42	.00	96.88	170.00
	44.96	35.56	208.44	30.03	.00	81.01	170.00
*	44.96	27.85	208.31	25.51	.00	61.31	170.00
*	44.96	22.68	208.22	21.76	.00	46.72	170.00
*	44.96	5.90	207.71	5.90	.00	10.11	170.00
	45.18	261.48	210.22	87.01	.00	245.74	130.00
*	45.18	47.90	209.11	25.89	.00	120.07	130.00
*	45.18	42.63	209.05	23.87	.00	118.57	130.00
*	45.18	35.56	208.97	21.06	.00	112.75	130.00
*	45.18	27.85	208.86	17.96	.00	91.84	130.00
*	45.18	22.68	208.76	15.70	.00	77.30	130.00
*	45.18	5.90	208.21	5.65	.00	29.78	130.00
*	45.36	261.48	210.74	225.21	.00	107.08	144.00
*	45.36	47.90	209.40	47.90	.00	26.21	144.00
*	45.36	42.63	209.35	42.63	.00	26.07	144.00
*	45.36	35.56	209.28	35.56	.00	25.83	144.00
*	45.36	27.85	209.18	27.85	.00	25.52	144.00
*	45.36	22.68	209.10	22.68	.00	25.27	144.00
*	45.36	5.90	208.63	5.90	.00	15.41	144.00
*	45.38	261.48	211.37	116.35	.00	127.89	20.00
	45.38	47.90	209.46	47.90	.00	9.40	20.00
	45.38	42.63	209.41	42.63	.00	9.40	20.00
	45.38	35.56	209.34	35.56	.00	9.40	20.00
	45.38	27.85	209.23	27.85	.00	9.40	20.00
*	45.38	22.68	209.15	22.68	.00	9.40	20.00
*	45.38	5.90	208.70	5.90	.00	9.40	20.00
*	45.39	261.48	212.66	84.95	177.28	171.26	13.00
*	45.39	47.90	209.81	47.90	.00	9.40	13.00
*	45.39	42.63	209.66	42.63	.00	9.40	13.00
	45.39	35.56	209.50	35.56	.00	9.40	13.00
	45.39	27.85	209.33	27.85	.00	9.40	13.00
	45.39	22.68	209.21	22.68	.00	9.40	13.00
	45.39	5.90	208.71	5.90	.00	9.40	13.00
	45.43	261.48	212.69	79.16	.00	142.65	30.00
*	45.43	47.90	210.30	25.82	.00	81.77	30.00
	45.43	42.63	210.08	25.98	.00	80.51	30.00
*	45.43	35.56	209.64	27.89	.00	55.13	30.00

*	45.43	27.85	209.49	23.65	.00	44.92	30.00
*	45.43	22.68	209.40	20.18	.00	38.64	30.00
*	45.43	5.90	208.92	5.90	.00	9.68	30.00
*	45.57	261.48	212.74	220.15	.00	117.47	78.00
	45.57	47.90	210.40	45.75	.00	94.41	78.00
*	45.57	42.63	210.25	41.49	.00	93.48	78.00
*	45.57	35.56	210.09	35.33	.00	92.52	78.00
*	45.57	27.85	209.99	27.85	.00	61.26	78.00
*	45.57	22.68	209.89	22.68	.00	56.14	78.00
*	45.57	5.90	209.41	5.90	.00	29.93	78.00
*	45.77	261.48	212.78	67.59	.00	93.52	180.00
*	45.77	47.90	210.77	31.32	.00	62.36	180.00
*	45.77	42.63	210.70	29.29	.00	57.39	180.00
*	45.77	35.56	210.60	26.09	.00	50.76	180.00
*	45.77	27.85	210.46	22.30	.00	41.51	180.00
*	45.77	22.68	210.34	19.46	.00	33.27	180.00
*	45.77	5.90	209.85	5.74	.00	8.99	180.00
	46.02	261.48	213.02	194.19	.00	92.39	190.00
*	46.02	47.90	211.51	46.30	.00	59.12	190.00
*	46.02	42.63	211.44	41.53	.00	55.88	190.00
*	46.02	35.56	211.34	35.03	.00	50.79	190.00
*	46.02	27.85	211.21	27.70	.00	44.42	190.00
*	46.02	22.68	211.11	22.65	.00	39.55	190.00
*	46.02	5.90	210.51	5.90	.00	21.84	190.00
*	46.20	261.48	213.14	126.74	.00	83.57	120.00
*	46.20	47.90	211.64	41.56	.00	52.59	120.00
*	46.20	42.63	211.58	37.87	.00	48.62	120.00
*	46.20	35.56	211.49	32.65	.00	42.73	120.00
*	46.20	27.85	211.37	26.44	.00	35.92	120.00
*	46.20	22.68	211.28	22.04	.00	29.98	120.00
	46.20	5.90	210.77	5.90	.00	10.16	120.00
*	46.22	261.48	213.49	118.10	.00	84.98	24.00
*	46.22	47.90	211.88	47.90	.00	14.20	24.00
*	46.22	42.63	211.82	42.63	.00	14.20	24.00
*	46.22	35.56	211.72	35.56	.00	14.20	24.00
*	46.22	27.85	211.57	27.85	.00	14.20	24.00
*	46.22	22.68	211.46	22.68	.00	14.20	24.00
*	46.22	5.90	210.84	5.90	.00	14.20	24.00
*	46.23	261.48	214.69	106.09	93.40	99.30	9.00
	46.23	47.90	211.89	47.90	.00	14.20	9.00
	46.23	42.63	211.82	42.63	.00	14.20	9.00
	46.23	35.56	211.72	35.56	.00	14.20	9.00
	46.23	27.85	211.58	27.85	.00	14.20	9.00
	46.23	22.68	211.47	22.68	.00	14.20	9.00
	46.23	5.90	210.84	5.90	.00	14.20	9.00
*	46.27	261.48	214.73	79.11	.00	100.30	40.00
*	46.27	47.90	212.13	27.34	.00	79.11	40.00
*	46.27	42.63	212.03	26.07	.00	78.26	40.00
*	46.27	35.56	211.88	23.70	.00	71.26	40.00
	46.27	27.85	211.70	20.66	.00	60.09	40.00
	46.27	22.68	211.55	18.28	.00	51.64	40.00
*	46.27	5.90	210.87	5.90	.00	14.50	40.00
	46.40	261.48	214.76	52.25	.00	136.67	124.00
*	46.40	47.90	212.56	33.93	.00	64.56	124.00
*	46.40	42.63	212.51	31.63	.00	60.07	124.00
*	46.40	35.56	212.42	28.65	.00	51.87	124.00
*	46.40	27.85	212.30	24.88	.00	40.38	124.00
*	46.40	22.68	212.19	21.79	.00	29.49	124.00
*	46.40	5.90	211.77	5.90	.00	9.72	124.00
	46.51	261.48	214.76	67.47	.00	107.26	90.00
*	46.51	47.90	212.93	27.46	.00	79.01	90.00
*	46.51	42.63	212.88	25.29	.00	75.63	90.00
*	46.51	35.56	212.81	22.19	.00	70.77	90.00
*	46.51	27.85	212.72	18.62	.00	64.27	90.00
*	46.51	22.68	212.64	16.04	.00	59.04	90.00
*	46.51	5.90	212.09	5.87	.00	21.08	90.00
*	46.68	261.48	214.79	184.67	.00	85.31	116.00
	46.68	47.90	213.14	43.43	.00	56.83	116.00
	46.68	42.63	213.09	39.22	.00	56.15	116.00
*	46.68	35.56	213.02	33.50	.00	55.15	116.00
*	46.68	27.85	212.92	26.85	.00	51.12	116.00
*	46.68	22.68	212.84	22.18	.00	47.83	116.00
*	46.68	5.90	212.47	5.90	.00	28.51	116.00

*	46.98	261.48	215.11	134.78	.00	77.82	227.00
	46.98	47.90	213.81	39.91	.00	37.91	227.00
	46.98	42.63	213.76	36.21	.00	36.32	227.00
	46.98	35.56	213.67	31.02	.00	34.15	227.00
	46.98	27.85	213.57	25.09	.00	31.36	227.00
	46.98	22.68	213.48	20.96	.00	29.04	227.00
*	46.98	5.90	213.06	5.90	.00	17.64	227.00
*	47.22	261.48	215.73	140.96	.00	92.19	210.00
*	47.22	47.90	214.34	37.48	.00	87.36	210.00
*	47.22	42.63	214.27	34.65	.00	87.11	210.00
	47.22	35.56	214.18	30.81	.00	86.73	210.00
	47.22	27.85	214.07	26.21	.00	86.27	210.00
	47.22	22.68	213.98	22.46	.00	75.41	210.00
	47.22	5.90	213.44	5.90	.00	20.90	210.00
*	47.32	261.48	215.92	47.83	.00	227.44	100.00
*	47.32	47.90	214.57	29.79	.00	158.95	100.00
*	47.32	42.63	214.52	29.31	.00	147.68	100.00
*	47.32	35.56	214.45	26.58	.00	71.21	100.00
*	47.32	27.85	214.36	22.71	.00	60.54	100.00
*	47.32	22.68	214.29	19.53	.00	53.62	100.00
*	47.32	5.90	213.91	5.90	.00	16.75	100.00
*	47.42	235.37	215.96	194.45	.00	140.43	100.00
*	47.42	42.98	214.88	41.56	.00	115.89	100.00
*	47.42	38.16	214.85	37.03	.00	113.94	100.00
*	47.42	31.73	214.79	31.07	.00	109.07	100.00
*	47.42	24.71	214.72	24.41	.00	103.40	100.00
*	47.42	20.05	214.66	19.93	.00	98.45	100.00
*	47.42	4.72	214.34	4.72	.00	56.00	100.00
*	47.47	235.37	216.06	28.06	.00	264.99	55.00
	47.47	42.98	214.93	17.98	.00	194.75	55.00
	47.47	38.16	214.89	16.99	.00	175.33	55.00
	47.47	31.73	214.84	15.40	.00	142.67	55.00
*	47.47	24.71	214.71	24.71	.00	7.70	55.00
*	47.47	20.05	214.67	20.05	.00	7.70	55.00
*	47.47	4.72	214.37	4.72	.00	7.70	55.00
*	47.48	235.37	216.04	25.81	.00	264.63	1.00
*	47.48	42.98	215.10	31.35	.00	232.50	1.00
*	47.48	38.16	215.10	27.84	.00	232.50	1.00
*	47.48	31.73	214.66	31.73	.00	88.71	1.00
*	47.48	24.71	214.87	24.56	.00	161.90	1.00
	47.48	20.05	214.67	20.05	.00	92.20	1.00
	47.48	4.72	214.37	4.72	.00	33.42	1.00
	47.48	235.37	216.06	25.41	.00	266.49	6.00
*	47.48	42.98	215.26	22.02	.00	241.25	6.00
	47.48	38.16	215.20	21.66	.00	239.47	6.00
	47.48	31.73	214.83	31.67	.00	201.21	6.00
	47.48	24.71	214.98	22.22	.00	231.88	6.00
	47.48	20.05	214.72	20.05	.00	130.95	6.00
	47.48	4.72	214.37	4.72	.00	38.37	6.00
*	47.49	235.37	216.12	35.78	.00	267.46	3.00
*	47.49	42.98	215.33	11.34	.00	244.18	3.00
*	47.49	38.16	215.28	10.60	.00	242.46	3.00
*	47.49	31.73	215.19	9.78	.00	239.29	3.00
*	47.49	24.71	215.11	8.45	.00	236.38	3.00
	47.49	20.05	214.72	20.05	.00	7.70	3.00
	47.49	4.72	214.37	4.72	.00	7.70	3.00
*	47.52	235.37	216.13	30.44	.00	325.66	32.00
*	47.52	42.98	215.34	8.47	.00	315.07	32.00
*	47.52	38.16	215.29	7.90	.00	314.32	32.00
*	47.52	31.73	215.20	7.27	.00	312.98	32.00
*	47.52	24.71	215.11	6.30	.00	311.79	32.00
	47.52	20.05	214.89	7.45	.00	205.73	32.00
*	47.52	4.72	214.36	3.61	.00	10.02	32.00
*	47.73	235.37	216.38	181.11	.00	87.22	145.00
*	47.73	42.98	215.63	41.07	.00	77.77	145.00
*	47.73	38.16	215.59	37.12	.00	77.53	145.00
*	47.73	31.73	215.47	31.73	.00	34.26	145.00
*	47.73	24.71	215.39	24.71	.00	30.02	145.00
*	47.73	20.05	215.35	20.05	.00	28.36	145.00
*	47.73	4.72	215.09	4.72	.00	14.62	145.00
*	47.86	235.37	217.56	133.13	.00	92.88	130.00
*	47.86	42.98	216.48	38.86	.00	53.17	130.00
*	47.86	38.16	216.44	35.06	.00	50.07	130.00
*	47.86	31.73	216.41	29.45	.00	47.98	130.00

*	47.86	24.71	216.30	23.74	.00	40.18	130.00
*	47.86	20.05	216.19	19.72	.00	32.96	130.00
*	47.86	4.72	215.58	4.72	.00	11.14	130.00
	48.00	235.37	218.15	226.48	.00	60.67	118.00
	48.00	42.98	217.14	42.97	.00	49.60	118.00
	48.00	38.16	217.08	38.15	.00	49.01	118.00
*	48.00	31.73	216.99	31.73	.00	47.19	118.00
*	48.00	24.71	216.88	24.71	.00	40.64	118.00
*	48.00	20.05	216.80	20.05	.00	35.87	118.00
	48.00	4.72	216.15	4.72	.00	4.64	118.00
	48.13	235.37	218.84	232.19	.00	90.83	116.00
	48.13	42.98	217.76	42.97	.00	61.96	116.00
	48.13	38.16	217.71	38.15	.00	58.41	116.00
	48.13	31.73	217.67	31.73	.00	55.48	116.00
	48.13	24.71	217.58	24.71	.00	49.08	116.00
*	48.13	20.05	217.51	20.05	.00	43.88	116.00
	48.13	4.72	216.67	4.72	.00	6.72	116.00
*	48.23	235.37	219.24	88.67	.00	77.29	78.00
*	48.23	42.98	218.10	42.98	.00	5.70	78.00
*	48.23	38.16	217.96	38.16	.00	5.70	78.00
*	48.23	31.73	217.76	31.73	.00	5.70	78.00
*	48.23	24.71	217.54	24.71	.00	5.70	78.00
*	48.23	20.05	217.50	20.05	.00	5.70	78.00
*	48.23	4.72	216.83	4.72	.00	5.70	78.00
*	48.27	235.37	226.44	26.99	83.20	475.54	45.00
*	48.27	42.98	218.73	42.98	.00	5.70	45.00
*	48.27	38.16	218.55	38.16	.00	5.70	45.00
*	48.27	31.73	218.30	31.73	.00	5.70	45.00
*	48.27	24.71	218.01	24.71	.00	5.70	45.00
*	48.27	20.05	217.80	20.05	.00	5.70	45.00
	48.27	4.72	216.88	4.72	.00	5.70	45.00
*	48.29	235.37	226.44	72.49	.00	372.47	19.00
*	48.29	42.98	219.41	32.87	.00	81.65	19.00
*	48.29	38.16	219.18	31.13	.00	76.77	19.00
*	48.29	31.73	218.85	28.28	.00	66.54	19.00
	48.29	24.71	218.47	23.76	.00	49.67	19.00
	48.29	20.05	218.19	19.95	.00	37.51	19.00
	48.29	4.72	217.05	4.72	.00	8.61	19.00
	48.50	235.37	226.44	155.55	.00	232.96	150.00
*	48.50	42.98	219.44	42.68	.00	67.09	150.00
*	48.50	38.16	219.22	38.09	.00	62.05	150.00
*	48.50	31.73	218.93	31.73	.00	53.35	150.00
*	48.50	24.71	218.60	24.71	.00	34.90	150.00
*	48.50	20.05	218.45	20.05	.00	26.13	150.00
*	48.50	4.72	217.79	4.72	.00	5.82	150.00

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|            S U M P O              |
|                                   |
|   Interactive Summary Printout    |
|   for MS/PC-DOS micro computers   |
|          September 1990           |
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NOTE - Asterisk (*) at left of profile number indicates message in summary of errors list

FOAK4d.DAT - REGIONAL TO 2 YEAR FLOWS
MIDDLE SIXTEEN MILE CREEK WITH
FILL ENCROACHMENT AT STEELES AND FIFTH LINE SOUTH

Summary Printout

	SECNO	Q	CWSEL	QCH	QWEIR	TOPWID	XLCH
	37.01	261.99	191.08	19.20	.00	538.42	.00
	37.01	49.26	188.77	10.04	.00	404.96	.00
*	37.01	43.91	188.59	15.29	.00	293.81	.00
*	37.01	36.68	188.57	13.52	.00	274.79	.00
*	37.01	29.09	188.56	11.42	.00	254.90	.00
*	37.01	23.76	188.54	10.07	.00	231.55	.00
*	37.01	8.86	188.44	5.93	.00	116.08	.00
*	37.26	261.99	191.04	41.54	.00	163.19	220.00
*	37.26	49.26	189.58	23.01	.00	107.57	220.00
*	37.26	43.91	189.63	18.96	.00	108.12	220.00
*	37.26	36.68	189.57	17.47	.00	107.45	220.00
*	37.26	29.09	189.51	15.96	.00	106.59	220.00
*	37.26	23.76	189.45	14.35	.00	97.22	220.00
*	37.26	8.86	189.21	7.86	.00	49.30	220.00
*	37.69	261.99	191.30	26.40	.00	264.13	247.00
*	37.69	49.26	190.18	13.88	.00	225.96	247.00
*	37.69	43.91	190.13	13.92	.00	223.66	247.00
*	37.69	36.68	190.06	13.26	.00	221.29	247.00
*	37.69	29.09	189.99	12.15	.00	209.03	247.00
*	37.69	23.76	189.92	11.11	.00	110.29	247.00
	37.69	8.86	189.56	6.06	.00	42.53	247.00
*	37.85	261.99	191.35	150.37	.00	198.31	163.00
	37.85	49.26	190.33	35.39	.00	82.59	163.00
	37.85	43.91	190.29	31.79	.00	79.81	163.00
	37.85	36.68	190.22	26.87	.00	75.61	163.00
	37.85	29.09	190.15	21.65	.00	70.53	163.00
	37.85	23.76	190.07	17.98	.00	65.79	163.00
	37.85	8.86	189.72	7.49	.00	42.30	163.00
	38.03	264.66	191.65	58.20	.00	230.03	160.00
*	38.03	50.24	190.84	32.71	.00	80.00	160.00
*	38.03	44.86	190.80	30.64	.00	76.79	160.00
*	38.03	37.72	190.73	28.00	.00	71.23	160.00
*	38.03	29.93	190.63	24.70	.00	63.88	160.00
*	38.03	24.42	190.33	23.57	.00	16.19	160.00
*	38.03	9.12	189.91	9.12	.00	7.64	160.00
	38.25	264.66	192.23	207.21	.00	101.69	200.00
*	38.25	50.24	191.43	48.88	.00	59.31	200.00
*	38.25	44.86	191.37	43.96	.00	56.44	200.00
*	38.25	37.72	191.29	37.27	.00	52.35	200.00
*	38.25	29.93	191.18	29.81	.00	47.11	200.00
*	38.25	24.42	191.11	24.38	.00	44.39	200.00
*	38.25	9.12	190.59	9.12	.00	25.15	200.00
	38.42	264.66	192.78	134.50	.00	87.53	160.00
*	38.42	50.24	191.66	45.95	.00	71.78	160.00
*	38.42	44.86	191.57	43.32	.00	70.05	160.00
*	38.42	37.72	191.49	37.46	.00	20.46	160.00
*	38.42	29.93	191.39	29.80	.00	19.56	160.00
*	38.42	24.42	191.30	24.35	.00	18.69	160.00
	38.42	9.12	190.88	9.12	.00	10.18	160.00
	38.60	264.66	193.56	112.36	.00	143.03	180.00
	38.60	50.24	192.37	38.84	.00	75.48	180.00
*	38.60	44.86	192.33	35.60	.00	75.32	180.00

*	38.60	37.72	192.23	32.18	.00	74.89	180.00
*	38.60	29.93	192.08	27.94	.00	74.32	180.00
	38.60	24.42	191.96	23.52	.00	17.72	180.00
	38.60	9.12	191.40	9.02	.00	14.42	180.00
*	38.63	264.66	193.65	119.86	.00	147.88	33.00
*	38.63	50.24	192.32	50.24	.00	10.20	33.00
*	38.63	44.86	192.30	44.86	.00	10.20	33.00
	38.63	37.72	192.24	37.72	.00	10.20	33.00
	38.63	29.93	192.13	29.93	.00	10.20	33.00
	38.63	24.42	192.01	24.42	.00	10.20	33.00
	38.63	9.12	191.48	9.12	.00	10.20	33.00
	38.63	264.66	193.97	71.95	.00	161.38	2.00
	38.63	50.24	192.51	48.25	.00	41.24	2.00
	38.63	44.86	192.39	44.07	.00	35.53	2.00
	38.63	37.72	192.26	37.59	.00	28.95	2.00
	38.63	29.93	192.14	29.93	.00	23.34	2.00
	38.63	24.42	192.02	24.42	.00	17.94	2.00
	38.63	9.12	191.49	9.12	.00	13.52	2.00
	38.64	264.66	194.00	71.42	.00	161.76	3.00
	38.64	50.24	192.59	47.13	.00	45.65	3.00
	38.64	44.86	192.44	43.65	.00	38.24	3.00
	38.64	37.72	192.30	37.43	.00	31.68	3.00
	38.64	29.93	192.15	29.93	.00	24.11	3.00
	38.64	24.42	192.04	24.42	.00	18.59	3.00
	38.64	9.12	191.50	9.12	.00	13.58	3.00
*	38.64	264.66	193.99	100.11	.00	161.70	2.00
	38.64	50.24	192.57	50.24	.00	10.20	2.00
	38.64	44.86	192.44	44.86	.00	10.20	2.00
	38.64	37.72	192.31	37.72	.00	10.20	2.00
	38.64	29.93	192.17	29.93	.00	10.20	2.00
	38.64	24.42	192.05	24.42	.00	10.20	2.00
	38.64	9.12	191.50	9.12	.00	10.20	2.00
*	38.69	264.66	194.19	221.61	.00	145.72	45.00
*	38.69	50.24	193.06	49.42	.00	69.01	45.00
*	38.69	44.86	192.90	44.26	.00	66.57	45.00
*	38.69	37.72	192.72	37.31	.00	65.62	45.00
*	38.69	29.93	192.44	29.84	.00	24.01	45.00
*	38.69	24.42	192.27	24.39	.00	22.58	45.00
*	38.69	9.12	191.62	9.12	.00	16.73	45.00
	38.94	264.66	194.40	55.31	.00	180.27	190.00
*	38.94	50.24	193.21	22.29	.00	106.49	190.00
*	38.94	44.86	193.11	21.82	.00	84.04	190.00
*	38.94	37.72	193.02	19.93	.00	64.31	190.00
*	38.94	29.93	192.69	20.00	.00	43.74	190.00
*	38.94	24.42	192.61	17.38	.00	39.31	190.00
*	38.94	9.12	192.23	8.59	.00	18.34	190.00
*	38.99	264.66	194.76	264.66	.00	33.04	54.00
	38.99	50.24	193.30	50.24	.00	21.01	54.00
	38.99	44.86	193.23	44.86	.00	21.01	54.00
	38.99	37.72	193.16	37.72	.00	21.01	54.00
*	38.99	29.93	193.05	29.93	.00	21.01	54.00
*	38.99	24.42	192.96	24.42	.00	21.01	54.00
*	38.99	9.12	192.59	9.12	.00	21.00	54.00
*	39.04	264.66	195.50	264.66	.00	33.42	48.00
	39.04	50.24	193.45	50.24	.00	19.48	48.00
	39.04	44.86	193.37	44.86	.00	19.28	48.00
	39.04	37.72	193.27	37.72	.00	18.96	48.00
*	39.04	29.93	193.15	29.93	.00	18.58	48.00
*	39.04	24.42	193.05	24.42	.00	18.27	48.00
*	39.04	9.12	192.64	9.12	.00	17.70	48.00
*	39.09	264.66	196.06	57.45	.00	221.45	50.00
*	39.09	50.24	193.65	45.37	.00	25.59	50.00
*	39.09	44.86	193.57	41.38	.00	23.89	50.00
*	39.09	37.72	193.45	35.80	.00	21.38	50.00
*	39.09	29.93	193.30	29.25	.00	18.20	50.00
*	39.09	24.42	193.19	24.26	.00	15.89	50.00
*	39.09	9.12	192.72	9.11	.00	8.81	50.00
*	39.15	264.66	195.94	149.33	.00	128.99	65.00
*	39.15	50.24	194.22	50.06	.00	20.54	65.00
*	39.15	44.86	194.14	44.82	.00	18.90	65.00
*	39.15	37.72	194.03	37.72	.00	16.68	65.00
*	39.15	29.93	193.88	29.93	.00	15.30	65.00
*	39.15	24.42	193.75	24.42	.00	14.46	65.00
*	39.15	9.12	193.19	9.12	.00	11.15	65.00

*	39.21	264.66	196.24	102.65	.00	140.57	55.00
*	39.21	50.24	194.46	50.00	.00	25.15	55.00
*	39.21	44.86	194.37	44.73	.00	22.93	55.00
*	39.21	37.72	194.23	37.71	.00	19.31	55.00
*	39.21	29.93	194.03	29.93	.00	13.82	55.00
*	39.21	24.42	193.88	24.42	.00	12.28	55.00
*	39.21	9.12	193.29	9.12	.00	8.79	55.00
	39.38	264.66	196.31	33.74	.00	155.07	170.00
*	39.38	50.24	195.06	14.86	.00	114.98	170.00
*	39.38	44.86	194.99	14.67	.00	111.98	170.00
*	39.38	37.72	194.87	14.04	.00	99.73	170.00
*	39.38	29.93	194.72	13.39	.00	83.98	170.00
*	39.38	24.42	194.60	12.70	.00	72.13	170.00
	39.38	9.12	194.20	8.28	.00	28.65	170.00
	39.42	264.66	196.35	64.72	.00	183.47	45.00
	39.42	50.24	195.12	24.56	.00	136.31	45.00
	39.42	44.86	195.06	23.87	.00	134.45	45.00
	39.42	37.72	194.95	24.23	.00	119.75	45.00
*	39.42	29.93	194.78	29.93	.00	16.12	45.00
*	39.42	24.42	194.71	24.42	.00	15.94	45.00
	39.42	9.12	194.46	9.12	.00	15.18	45.00
*	39.43	264.66	196.27	98.78	.00	178.66	4.00
*	39.43	50.24	195.05	49.91	.00	134.44	4.00
*	39.43	44.86	194.88	44.86	.00	104.03	4.00
	39.43	37.72	194.82	37.72	.00	92.56	4.00
*	39.43	29.93	194.88	29.93	.00	106.79	4.00
*	39.43	24.42	194.76	24.42	.00	80.71	4.00
*	39.43	9.12	194.47	9.12	.00	23.92	4.00
*	39.44	264.66	196.85	53.95	.00	200.34	11.00
*	39.44	50.24	195.18	48.74	.00	135.23	11.00
*	39.44	44.86	195.01	44.73	.00	110.88	11.00
*	39.44	37.72	194.87	37.72	.00	81.28	11.00
	39.44	29.93	194.90	29.93	.00	87.62	11.00
	39.44	24.42	194.78	24.42	.00	63.72	11.00
	39.44	9.12	194.49	9.12	.00	21.14	11.00
*	39.44	264.66	197.03	72.72	.00	206.75	5.00
*	39.44	50.24	195.62	21.12	.00	148.41	5.00
*	39.44	44.86	195.56	19.44	.00	146.80	5.00
*	39.44	37.72	195.42	18.07	.00	142.26	5.00
*	39.44	29.93	195.20	17.53	.00	135.68	5.00
	39.44	24.42	194.85	24.42	.00	16.07	5.00
	39.44	9.12	194.50	9.12	.00	14.99	5.00
*	39.55	264.66	197.01	154.01	.00	105.11	95.00
*	39.55	50.24	195.63	45.66	.00	72.08	95.00
*	39.55	44.86	195.57	41.37	.00	68.27	95.00
*	39.55	37.72	195.43	35.99	.00	58.24	95.00
	39.55	29.93	195.25	29.52	.00	44.70	95.00
*	39.55	24.42	195.18	24.26	.00	39.59	95.00
*	39.55	9.12	194.70	9.12	.00	22.00	95.00
	39.63	264.66	197.14	54.25	.00	129.41	80.00
	39.63	50.24	195.72	19.15	.00	98.51	80.00
	39.63	44.86	195.65	17.77	.00	94.58	80.00
	39.63	37.72	195.52	16.39	.00	85.70	80.00
	39.63	29.93	195.34	14.91	.00	73.97	80.00
	39.63	24.42	195.25	13.05	.00	68.42	80.00
*	39.63	9.12	194.76	7.09	.00	22.89	80.00
	39.69	264.66	197.19	66.92	.00	179.81	64.00
*	39.69	50.24	195.62	50.24	.00	12.20	64.00
*	39.69	44.86	195.58	44.86	.00	12.20	64.00
*	39.69	37.72	195.49	37.72	.00	12.20	64.00
*	39.69	29.93	195.35	29.93	.00	12.20	64.00
*	39.69	24.42	195.28	24.42	.00	12.20	64.00
	39.69	9.12	194.84	9.12	.00	9.76	64.00
*	39.71	264.66	197.98	44.19	219.05	199.45	12.00
	39.71	50.24	196.25	50.24	.00	12.20	12.00
*	39.71	44.86	195.59	44.86	.00	12.20	12.00
*	39.71	37.72	195.53	37.72	.00	12.20	12.00
*	39.71	29.93	195.46	29.93	.00	12.20	12.00
*	39.71	24.42	195.35	24.42	.00	12.20	12.00
*	39.71	9.12	194.96	9.12	.00	10.01	12.00
	39.75	264.66	197.99	38.50	.00	198.26	44.00
*	39.75	50.24	196.67	11.49	.00	156.55	44.00
*	39.75	44.86	196.55	10.94	.00	153.87	44.00

*	39.75	37.72	196.29	11.24	.00	147.17	44.00
*	39.75	29.93	196.03	11.66	.00	140.86	44.00
*	39.75	24.42	195.87	11.60	.00	116.10	44.00
*	39.75	9.12	195.33	7.97	.00	34.13	44.00
	39.97	264.66	198.04	53.96	.00	322.64	220.00
*	39.97	50.24	196.69	27.26	.00	289.74	220.00
*	39.97	44.86	196.57	29.61	.00	279.33	220.00
*	39.97	37.72	196.32	31.84	.00	79.95	220.00
*	39.97	29.93	196.12	28.46	.00	56.82	220.00
*	39.97	24.42	196.02	24.35	.00	55.29	220.00
	39.97	9.12	195.64	9.12	.00	14.74	220.00
*	40.16	264.66	198.09	63.75	.00	159.42	180.00
	40.16	50.24	196.81	21.06	.00	119.13	180.00
	40.16	44.86	196.74	19.75	.00	113.83	180.00
	40.16	37.72	196.61	18.23	.00	104.80	180.00
*	40.16	29.93	196.50	15.99	.00	96.44	180.00
*	40.16	24.42	196.41	14.27	.00	89.97	180.00
*	40.16	9.12	195.98	9.12	.00	15.63	180.00
*	40.21	264.66	198.02	103.18	.00	119.96	50.00
*	40.21	50.24	196.77	35.17	.00	69.41	50.00
*	40.21	44.86	196.70	32.70	.00	64.54	50.00
*	40.21	37.72	196.59	29.39	.00	56.56	50.00
*	40.21	29.93	196.49	24.69	.00	49.75	50.00
*	40.21	24.42	196.43	20.94	.00	45.04	50.00
	40.21	9.12	196.18	8.85	.00	27.23	50.00
	40.42	264.66	198.29	179.68	.00	119.58	98.00
	40.42	50.24	197.30	39.67	.00	101.36	98.00
	40.42	44.86	197.27	35.92	.00	101.11	98.00
*	40.42	37.72	197.17	31.89	.00	100.39	98.00
	40.42	29.93	197.17	25.34	.00	100.37	98.00
*	40.42	24.42	197.12	21.51	.00	99.98	98.00
*	40.42	9.12	196.61	9.12	.00	9.10	98.00
*	40.84	264.66	198.77	197.72	.00	196.68	234.00
*	40.84	50.24	197.82	45.05	.00	155.04	234.00
*	40.84	44.86	197.79	40.50	.00	150.54	234.00
*	40.84	37.72	197.75	34.28	.00	145.95	234.00
*	40.84	29.93	197.68	27.59	.00	135.75	234.00
*	40.84	24.42	197.62	22.65	.00	130.53	234.00
*	40.84	9.12	197.39	8.62	.00	101.40	234.00
*	41.06	264.66	198.91	60.65	.00	134.27	164.00
*	41.06	50.24	198.32	22.85	.00	115.98	164.00
*	41.06	44.86	198.31	20.97	.00	115.56	164.00
*	41.06	37.72	198.28	18.91	.00	114.54	164.00
*	41.06	29.93	198.23	16.74	.00	113.09	164.00
*	41.06	24.42	198.17	15.77	.00	111.39	164.00
*	41.06	9.12	197.69	9.12	.00	7.46	164.00
*	41.24	264.66	199.87	75.28	.00	128.28	170.00
	41.24	50.24	199.01	31.82	.00	123.62	170.00
	41.24	44.86	198.97	30.78	.00	116.64	170.00
	41.24	37.72	198.90	28.20	.00	102.05	170.00
	41.24	29.93	198.83	24.75	.00	83.79	170.00
	41.24	24.42	198.78	21.25	.00	73.45	170.00
*	41.24	9.12	198.53	9.12	.00	17.99	170.00
*	41.38	264.66	200.21	220.11	.00	138.45	140.00
*	41.38	50.24	199.32	49.45	.00	89.84	140.00
*	41.38	44.86	199.29	44.33	.00	86.87	140.00
*	41.38	37.72	199.22	37.47	.00	82.33	140.00
*	41.38	29.93	199.14	29.86	.00	76.62	140.00
*	41.38	24.42	199.06	24.41	.00	71.47	140.00
*	41.38	9.12	198.68	9.12	.00	48.88	140.00
	41.46	264.66	200.35	68.91	.00	196.89	80.00
*	41.46	50.24	199.22	50.24	.00	12.50	80.00
*	41.46	44.86	199.22	44.86	.00	12.50	80.00
*	41.46	37.72	199.19	37.72	.00	12.50	80.00
*	41.46	29.93	199.14	29.93	.00	12.50	80.00
*	41.46	24.42	199.07	24.42	.00	12.50	80.00
*	41.46	9.12	198.72	9.12	.00	12.50	80.00
*	41.46	264.66	200.66	81.66	.00	214.66	1.00
	41.46	50.24	199.22	50.24	.00	83.22	1.00
	41.46	44.86	199.23	44.86	.00	83.67	1.00
	41.46	37.72	199.19	37.72	.00	73.62	1.00
	41.46	29.93	199.14	29.93	.00	57.07	1.00
	41.46	24.42	199.07	24.42	.00	36.44	1.00
	41.46	9.12	198.72	9.12	.00	14.29	1.00

*	41.47	264.66	201.01	55.43	.00	236.33	9.00
	41.47	50.24	199.48	50.24	.00	153.60	9.00
	41.47	44.86	199.41	44.86	.00	150.38	9.00
	41.47	37.72	199.32	37.72	.00	139.60	9.00
	41.47	29.93	199.21	29.93	.00	111.08	9.00
	41.47	24.42	199.13	24.42	.00	83.97	9.00
	41.47	9.12	198.74	9.12	.00	14.56	9.00
*	41.47	264.66	201.15	51.66	.00	238.18	2.00
*	41.47	50.24	199.52	50.24	.00	12.50	2.00
	41.47	44.86	199.42	44.86	.00	12.50	2.00
	41.47	37.72	199.32	37.72	.00	12.50	2.00
	41.47	29.93	199.22	29.93	.00	12.50	2.00
	41.47	24.42	199.13	24.42	.00	12.50	2.00
	41.47	9.12	198.74	9.12	.00	12.50	2.00
*	41.54	264.66	201.03	79.49	.00	152.50	66.00
*	41.54	50.24	199.79	32.12	.00	95.07	66.00
*	41.54	44.86	199.74	29.87	.00	94.14	66.00
*	41.54	37.72	199.67	26.86	.00	92.65	66.00
*	41.54	29.93	199.58	23.30	.00	90.74	66.00
*	41.54	24.42	199.35	22.43	.00	49.91	66.00
*	41.54	9.12	198.71	9.12	.00	5.51	66.00
*	41.72	264.66	201.53	62.87	.00	142.09	153.00
*	41.72	50.24	200.29	20.75	.00	118.12	153.00
*	41.72	44.86	200.22	19.50	.00	116.53	153.00
*	41.72	37.72	200.13	17.76	.00	114.26	153.00
*	41.72	29.93	200.02	15.81	.00	111.42	153.00
*	41.72	24.42	199.95	13.82	.00	108.11	153.00
	41.72	9.12	199.37	8.84	.00	15.40	153.00
	41.86	264.66	201.77	84.17	.00	166.05	140.00
	41.86	50.24	200.47	23.85	.00	136.08	140.00
	41.86	44.86	200.41	22.11	.00	133.08	140.00
	41.86	37.72	200.32	19.72	.00	128.83	140.00
	41.86	29.93	200.22	17.02	.00	123.67	140.00
	41.86	24.42	200.14	14.92	.00	119.87	140.00
	41.86	9.12	199.78	8.09	.00	52.75	140.00
*	42.04	264.66	201.93	94.03	.00	127.07	180.00
*	42.04	50.24	200.74	29.41	.00	111.66	180.00
*	42.04	44.86	200.69	27.49	.00	111.24	180.00
*	42.04	37.72	200.63	24.75	.00	110.67	180.00
*	42.04	29.93	200.55	21.38	.00	110.01	180.00
*	42.04	24.42	200.49	18.72	.00	84.01	180.00
	42.04	9.12	200.25	8.39	.00	49.13	180.00
*	42.20	264.66	202.37	114.43	.00	325.61	160.00
*	42.20	50.24	201.30	30.06	.00	313.07	160.00
*	42.20	44.86	201.25	27.64	.00	312.56	160.00
*	42.20	37.72	201.20	24.42	.00	311.81	160.00
*	42.20	29.93	201.13	20.67	.00	288.89	160.00
*	42.20	24.42	201.09	17.94	.00	269.41	160.00
	42.20	9.12	200.73	9.03	.00	33.08	160.00
*	42.30	264.66	202.55	84.31	.00	162.73	100.00
*	42.30	50.24	201.62	27.77	.00	142.78	100.00
*	42.30	44.86	201.58	26.19	.00	142.21	100.00
*	42.30	37.72	201.53	23.73	.00	141.50	100.00
*	42.30	29.93	201.46	20.73	.00	132.68	100.00
*	42.30	24.42	201.42	17.82	.00	121.43	100.00
	42.30	9.12	201.09	8.97	.00	37.58	100.00
	42.46	264.66	202.88	194.06	.00	149.55	110.00
*	42.46	50.24	201.96	46.79	.00	90.68	110.00
*	42.46	44.86	201.91	42.08	.00	86.83	110.00
*	42.46	37.72	201.85	35.80	.00	79.99	110.00
*	42.46	29.93	201.77	28.80	.00	71.07	110.00
*	42.46	24.42	201.70	23.72	.00	63.32	110.00
*	42.46	9.12	201.38	9.03	.00	39.66	110.00
	42.65	261.48	203.45	89.52	.00	215.06	155.00
*	42.65	47.90	202.53	36.81	.00	183.06	155.00
*	42.65	42.63	202.48	34.84	.00	160.20	155.00
*	42.65	35.56	202.34	32.30	.00	73.20	155.00
*	42.65	27.85	202.18	27.11	.00	46.89	155.00
*	42.65	22.68	202.04	22.67	.00	22.30	155.00
*	42.65	5.90	201.60	5.90	.00	10.36	155.00
	42.84	261.48	203.81	73.31	.00	166.14	92.00
*	42.84	47.90	202.92	18.35	.00	147.96	92.00
*	42.84	42.63	202.88	16.78	.00	146.85	92.00

*	42.84	35.56	202.82	14.72	.00	145.05	92.00
*	42.84	27.85	202.71	12.50	.00	142.61	92.00
*	42.84	22.68	202.63	11.05	.00	140.58	92.00
*	42.84	5.90	202.22	4.95	.00	68.83	92.00
*	43.07	261.48	204.18	90.71	.00	161.30	210.00
*	43.07	47.90	203.08	31.05	.00	94.63	210.00
*	43.07	42.63	203.03	28.71	.00	90.99	210.00
*	43.07	35.56	202.95	25.11	.00	85.63	210.00
*	43.07	27.85	202.84	21.00	.00	77.02	210.00
*	43.07	22.68	202.75	17.94	.00	70.62	210.00
*	43.07	5.90	202.30	5.68	.00	37.51	210.00
*	43.35	261.48	204.49	121.41	.00	223.69	180.00
*	43.35	47.90	203.74	38.35	.00	110.87	180.00
*	43.35	42.63	203.72	34.20	.00	97.78	180.00
*	43.35	35.56	203.67	28.37	.00	84.18	180.00
*	43.35	27.85	203.61	21.82	.00	79.43	180.00
*	43.35	22.68	203.59	17.49	.00	77.16	180.00
*	43.35	5.90	203.19	5.70	.00	13.99	180.00
	43.50	261.48	204.94	198.04	.00	168.80	140.00
*	43.50	47.90	204.38	44.64	.00	131.31	140.00
*	43.50	42.63	204.33	40.39	.00	120.63	140.00
*	43.50	35.56	204.27	34.34	.00	106.98	140.00
*	43.50	27.85	204.18	27.47	.00	86.76	140.00
*	43.50	22.68	204.09	22.61	.00	68.29	140.00
*	43.50	5.90	203.62	5.90	.00	32.67	140.00
*	43.65	261.48	205.43	139.38	.00	134.63	140.00
*	43.65	47.90	204.62	40.66	.00	68.23	140.00
*	43.65	42.63	204.58	36.93	.00	61.29	140.00
*	43.65	35.56	204.50	31.99	.00	48.51	140.00
*	43.65	27.85	204.40	25.87	.00	42.51	140.00
*	43.65	22.68	204.30	21.68	.00	36.50	140.00
*	43.65	5.90	203.81	5.90	.00	12.63	140.00
	43.81	261.48	206.35	76.79	.00	151.44	130.00
*	43.81	47.90	205.51	32.26	.00	143.59	130.00
*	43.81	42.63	205.44	31.33	.00	128.39	130.00
*	43.81	35.56	205.38	28.25	.00	111.47	130.00
*	43.81	27.85	205.23	25.68	.00	71.88	130.00
	43.81	22.68	205.12	22.27	.00	43.28	130.00
*	43.81	5.90	204.62	5.90	.00	8.92	130.00
	43.99	261.48	206.77	39.30	.00	190.94	170.00
	43.99	47.90	206.00	15.33	.00	184.00	170.00
*	43.99	42.63	205.98	14.15	.00	158.38	170.00
*	43.99	35.56	205.92	12.98	.00	152.05	170.00
*	43.99	27.85	205.86	11.15	.00	146.39	170.00
*	43.99	22.68	205.79	10.34	.00	139.23	170.00
	43.99	5.90	205.25	5.68	.00	13.32	170.00
*	44.18	261.48	207.23	54.40	.00	253.15	180.00
	44.18	47.90	206.39	20.07	.00	198.83	180.00
	44.18	42.63	206.35	19.07	.00	195.48	180.00
	44.18	35.56	206.29	17.65	.00	190.71	180.00
	44.18	27.85	206.21	16.30	.00	184.32	180.00
	44.18	22.68	206.16	15.02	.00	180.17	180.00
*	44.18	5.90	205.81	5.90	.00	16.67	180.00
*	44.26	261.48	207.30	83.20	.00	146.28	80.00
*	44.26	47.90	206.67	34.24	.00	120.59	80.00
*	44.26	42.63	206.64	32.09	.00	118.84	80.00
*	44.26	35.56	206.59	28.96	.00	116.09	80.00
*	44.26	27.85	206.31	26.86	.00	22.66	80.00
*	44.26	22.68	206.29	21.95	.00	22.12	80.00
	44.26	5.90	205.93	5.90	.00	10.61	80.00
*	44.34	261.48	207.76	80.78	.00	180.56	60.00
*	44.34	47.90	206.95	30.41	.00	140.41	60.00
	44.34	42.63	206.82	42.63	.00	14.00	60.00
	44.34	35.56	206.78	35.56	.00	14.00	60.00
*	44.34	27.85	206.71	27.85	.00	14.00	60.00
*	44.34	22.68	206.58	22.68	.00	14.00	60.00
*	44.34	5.90	206.01	5.90	.00	14.00	60.00
*	44.35	261.48	208.30	103.81	.00	205.44	6.00
	44.35	47.90	206.86	47.90	.00	129.29	6.00
	44.35	42.63	206.85	42.63	.00	124.33	6.00
	44.35	35.56	206.79	35.56	.00	110.88	6.00
	44.35	27.85	206.72	27.85	.00	93.42	6.00
	44.35	22.68	206.59	22.68	.00	59.83	6.00
	44.35	5.90	206.02	5.90	.00	16.67	6.00

	44.36	261.48	208.54	71.99	.00	214.83	11.00
	44.36	47.90	206.90	47.90	.00	135.54	11.00
	44.36	42.63	206.87	42.63	.00	131.23	11.00
	44.36	35.56	206.81	35.56	.00	115.56	11.00
	44.36	27.85	206.73	27.85	.00	95.16	11.00
	44.36	22.68	206.60	22.68	.00	60.91	11.00
	44.36	5.90	206.02	5.90	.00	16.77	11.00
*	44.36	261.48	208.66	69.67	.00	220.14	3.00
*	44.36	47.90	207.17	27.73	.00	150.38	3.00
	44.36	42.63	206.88	42.63	.00	14.00	3.00
	44.36	35.56	206.82	35.56	.00	14.00	3.00
	44.36	27.85	206.73	27.85	.00	14.00	3.00
	44.36	22.68	206.60	22.68	.00	14.00	3.00
	44.36	5.90	206.02	5.90	.00	14.00	3.00
*	44.40	261.48	208.67	63.77	.00	155.00	40.00
*	44.40	47.90	207.18	26.62	.00	118.25	40.00
	44.40	42.63	207.11	25.41	.00	115.89	40.00
*	44.40	35.56	206.96	23.78	.00	46.65	40.00
*	44.40	27.85	206.80	19.98	.00	40.76	40.00
*	44.40	22.68	206.65	17.61	.00	34.61	40.00
*	44.40	5.90	206.07	5.90	.00	13.76	40.00
	44.58	261.48	208.79	116.70	.00	262.31	170.00
	44.58	47.90	207.56	45.64	.00	85.61	170.00
	44.58	42.63	207.52	40.83	.00	82.95	170.00
	44.58	35.56	207.46	34.25	.00	80.15	170.00
	44.58	27.85	207.38	27.11	.00	74.49	170.00
	44.58	22.68	207.31	22.19	.00	71.74	170.00
*	44.58	5.90	206.84	5.90	.00	9.38	170.00
*	44.73	261.48	208.81	138.79	.00	118.60	150.00
	44.73	47.90	207.98	35.17	.00	66.76	150.00
	44.73	42.63	207.93	31.90	.00	64.10	150.00
	44.73	35.56	207.83	27.57	.00	59.22	150.00
	44.73	27.85	207.75	22.39	.00	54.26	150.00
	44.73	22.68	207.66	18.92	.00	49.22	150.00
	44.73	5.90	207.14	5.85	.00	20.64	150.00
*	44.96	261.48	209.93	80.96	.00	202.37	170.00
	44.96	47.90	208.61	35.66	.00	107.43	170.00
	44.96	42.63	208.54	33.42	.00	96.88	170.00
	44.96	35.56	208.44	30.03	.00	81.01	170.00
*	44.96	27.85	208.31	25.51	.00	61.31	170.00
*	44.96	22.68	208.22	21.76	.00	46.72	170.00
*	44.96	5.90	207.71	5.90	.00	10.11	170.00
	45.18	261.48	210.22	87.01	.00	245.74	130.00
*	45.18	47.90	209.11	25.89	.00	120.07	130.00
*	45.18	42.63	209.05	23.87	.00	118.57	130.00
*	45.18	35.56	208.97	21.06	.00	112.75	130.00
*	45.18	27.85	208.86	17.96	.00	91.84	130.00
*	45.18	22.68	208.76	15.70	.00	77.30	130.00
*	45.18	5.90	208.21	5.65	.00	29.78	130.00
*	45.36	261.48	210.74	225.21	.00	107.08	144.00
*	45.36	47.90	209.40	47.90	.00	26.21	144.00
*	45.36	42.63	209.35	42.63	.00	26.07	144.00
*	45.36	35.56	209.28	35.56	.00	25.83	144.00
*	45.36	27.85	209.18	27.85	.00	25.52	144.00
*	45.36	22.68	209.10	22.68	.00	25.27	144.00
*	45.36	5.90	208.63	5.90	.00	15.41	144.00
*	45.38	261.48	211.37	116.35	.00	127.89	20.00
	45.38	47.90	209.46	47.90	.00	9.40	20.00
	45.38	42.63	209.41	42.63	.00	9.40	20.00
	45.38	35.56	209.34	35.56	.00	9.40	20.00
	45.38	27.85	209.23	27.85	.00	9.40	20.00
*	45.38	22.68	209.15	22.68	.00	9.40	20.00
*	45.38	5.90	208.70	5.90	.00	9.40	20.00
*	45.39	261.48	212.66	84.95	177.28	171.26	13.00
*	45.39	47.90	209.81	47.90	.00	9.40	13.00
*	45.39	42.63	209.66	42.63	.00	9.40	13.00
	45.39	35.56	209.50	35.56	.00	9.40	13.00
	45.39	27.85	209.33	27.85	.00	9.40	13.00
	45.39	22.68	209.21	22.68	.00	9.40	13.00
	45.39	5.90	208.71	5.90	.00	9.40	13.00
	45.43	261.48	212.69	79.16	.00	142.65	30.00
*	45.43	47.90	210.30	25.82	.00	81.77	30.00
	45.43	42.63	210.08	25.98	.00	80.51	30.00

*	45.43	35.56	209.64	27.89	.00	55.13	30.00
*	45.43	27.85	209.49	23.65	.00	44.92	30.00
*	45.43	22.68	209.40	20.18	.00	38.64	30.00
*	45.43	5.90	208.92	5.90	.00	9.68	30.00
*	45.57	261.48	212.74	220.15	.00	117.47	78.00
	45.57	47.90	210.40	45.75	.00	94.41	78.00
*	45.57	42.63	210.25	41.49	.00	93.48	78.00
*	45.57	35.56	210.09	35.33	.00	92.52	78.00
*	45.57	27.85	209.99	27.85	.00	61.26	78.00
*	45.57	22.68	209.89	22.68	.00	56.14	78.00
*	45.57	5.90	209.41	5.90	.00	29.93	78.00
*	45.77	261.48	212.78	67.59	.00	93.52	180.00
*	45.77	47.90	210.77	31.32	.00	62.36	180.00
*	45.77	42.63	210.70	29.29	.00	57.39	180.00
*	45.77	35.56	210.60	26.09	.00	50.76	180.00
*	45.77	27.85	210.46	22.30	.00	41.51	180.00
*	45.77	22.68	210.34	19.46	.00	33.27	180.00
*	45.77	5.90	209.85	5.74	.00	8.99	180.00
	46.02	261.48	213.02	194.19	.00	92.39	190.00
*	46.02	47.90	211.51	46.30	.00	59.12	190.00
*	46.02	42.63	211.44	41.53	.00	55.88	190.00
*	46.02	35.56	211.34	35.03	.00	50.79	190.00
*	46.02	27.85	211.21	27.70	.00	44.42	190.00
*	46.02	22.68	211.11	22.65	.00	39.55	190.00
*	46.02	5.90	210.51	5.90	.00	21.84	190.00
*	46.20	261.48	213.14	126.74	.00	83.57	120.00
*	46.20	47.90	211.64	41.56	.00	52.59	120.00
*	46.20	42.63	211.58	37.87	.00	48.62	120.00
*	46.20	35.56	211.49	32.65	.00	42.73	120.00
*	46.20	27.85	211.37	26.44	.00	35.92	120.00
*	46.20	22.68	211.28	22.04	.00	29.98	120.00
	46.20	5.90	210.77	5.90	.00	10.16	120.00
*	46.22	261.48	213.49	118.10	.00	84.98	24.00
*	46.22	47.90	211.88	47.90	.00	14.20	24.00
*	46.22	42.63	211.82	42.63	.00	14.20	24.00
*	46.22	35.56	211.72	35.56	.00	14.20	24.00
*	46.22	27.85	211.57	27.85	.00	14.20	24.00
*	46.22	22.68	211.46	22.68	.00	14.20	24.00
*	46.22	5.90	210.84	5.90	.00	14.20	24.00
*	46.23	261.48	214.69	106.09	93.40	99.30	9.00
	46.23	47.90	211.89	47.90	.00	14.20	9.00
	46.23	42.63	211.82	42.63	.00	14.20	9.00
	46.23	35.56	211.72	35.56	.00	14.20	9.00
	46.23	27.85	211.58	27.85	.00	14.20	9.00
	46.23	22.68	211.47	22.68	.00	14.20	9.00
	46.23	5.90	210.84	5.90	.00	14.20	9.00
*	46.27	261.48	214.73	79.11	.00	100.30	40.00
*	46.27	47.90	212.13	27.34	.00	79.11	40.00
*	46.27	42.63	212.03	26.07	.00	78.26	40.00
*	46.27	35.56	211.88	23.70	.00	71.26	40.00
	46.27	27.85	211.70	20.66	.00	60.09	40.00
	46.27	22.68	211.55	18.28	.00	51.64	40.00
*	46.27	5.90	210.87	5.90	.00	14.50	40.00
	46.40	261.48	214.76	52.25	.00	136.67	124.00
*	46.40	47.90	212.56	33.93	.00	64.56	124.00
*	46.40	42.63	212.51	31.63	.00	60.07	124.00
*	46.40	35.56	212.42	28.65	.00	51.87	124.00
*	46.40	27.85	212.30	24.88	.00	40.38	124.00
*	46.40	22.68	212.19	21.79	.00	29.49	124.00
*	46.40	5.90	211.77	5.90	.00	9.72	124.00
	46.51	261.48	214.76	67.47	.00	107.26	90.00
*	46.51	47.90	212.93	27.46	.00	79.01	90.00
*	46.51	42.63	212.88	25.29	.00	75.63	90.00
*	46.51	35.56	212.81	22.19	.00	70.77	90.00
*	46.51	27.85	212.72	18.62	.00	64.27	90.00
*	46.51	22.68	212.64	16.04	.00	59.04	90.00
*	46.51	5.90	212.09	5.87	.00	21.08	90.00
*	46.68	261.48	214.79	184.67	.00	85.31	116.00
	46.68	47.90	213.14	43.43	.00	56.83	116.00
	46.68	42.63	213.09	39.22	.00	56.15	116.00
*	46.68	35.56	213.02	33.50	.00	55.15	116.00
*	46.68	27.85	212.92	26.85	.00	51.12	116.00
*	46.68	22.68	212.84	22.18	.00	47.83	116.00
*	46.68	5.90	212.47	5.90	.00	28.51	116.00

*	46.98	261.48	215.11	134.78	.00	77.82	227.00
	46.98	47.90	213.81	39.91	.00	37.91	227.00
	46.98	42.63	213.76	36.21	.00	36.32	227.00
	46.98	35.56	213.67	31.02	.00	34.15	227.00
	46.98	27.85	213.57	25.09	.00	31.36	227.00
	46.98	22.68	213.48	20.96	.00	29.04	227.00
*	46.98	5.90	213.06	5.90	.00	17.64	227.00
*	47.22	261.48	215.73	140.96	.00	92.19	210.00
*	47.22	47.90	214.34	37.48	.00	87.36	210.00
*	47.22	42.63	214.27	34.65	.00	87.11	210.00
	47.22	35.56	214.18	30.81	.00	86.73	210.00
	47.22	27.85	214.07	26.21	.00	86.27	210.00
	47.22	22.68	213.98	22.46	.00	75.41	210.00
	47.22	5.90	213.44	5.90	.00	20.90	210.00
*	47.32	261.48	215.92	47.83	.00	227.44	100.00
*	47.32	47.90	214.57	29.79	.00	158.95	100.00
*	47.32	42.63	214.52	29.31	.00	147.68	100.00
*	47.32	35.56	214.45	26.58	.00	71.21	100.00
*	47.32	27.85	214.36	22.71	.00	60.54	100.00
*	47.32	22.68	214.29	19.53	.00	53.62	100.00
*	47.32	5.90	213.91	5.90	.00	16.75	100.00
*	47.42	235.37	215.96	194.45	.00	140.43	100.00
*	47.42	42.98	214.88	41.56	.00	115.89	100.00
*	47.42	38.16	214.85	37.03	.00	113.94	100.00
*	47.42	31.73	214.79	31.07	.00	109.07	100.00
*	47.42	24.71	214.72	24.41	.00	103.40	100.00
*	47.42	20.05	214.66	19.93	.00	98.45	100.00
*	47.42	4.72	214.34	4.72	.00	56.00	100.00
*	47.47	235.37	216.06	28.06	.00	264.99	55.00
	47.47	42.98	214.93	17.98	.00	194.75	55.00
	47.47	38.16	214.89	16.99	.00	175.33	55.00
	47.47	31.73	214.84	15.40	.00	142.67	55.00
*	47.47	24.71	214.71	24.71	.00	7.70	55.00
*	47.47	20.05	214.67	20.05	.00	7.70	55.00
*	47.47	4.72	214.37	4.72	.00	7.70	55.00
*	47.48	235.37	216.04	25.81	.00	264.63	1.00
*	47.48	42.98	215.10	31.35	.00	232.50	1.00
*	47.48	38.16	215.10	27.84	.00	232.50	1.00
*	47.48	31.73	214.66	31.73	.00	88.71	1.00
*	47.48	24.71	214.87	24.56	.00	161.90	1.00
	47.48	20.05	214.67	20.05	.00	92.20	1.00
	47.48	4.72	214.37	4.72	.00	33.42	1.00
	47.48	235.37	216.06	25.41	.00	266.49	6.00
*	47.48	42.98	215.26	22.02	.00	241.25	6.00
	47.48	38.16	215.20	21.66	.00	239.47	6.00
	47.48	31.73	214.83	31.67	.00	201.21	6.00
	47.48	24.71	214.98	22.22	.00	231.88	6.00
	47.48	20.05	214.72	20.05	.00	130.95	6.00
	47.48	4.72	214.37	4.72	.00	38.37	6.00
*	47.49	235.37	216.12	35.78	.00	267.46	3.00
*	47.49	42.98	215.33	11.34	.00	244.18	3.00
*	47.49	38.16	215.28	10.60	.00	242.46	3.00
*	47.49	31.73	215.19	9.78	.00	239.29	3.00
*	47.49	24.71	215.11	8.45	.00	236.38	3.00
	47.49	20.05	214.72	20.05	.00	7.70	3.00
	47.49	4.72	214.37	4.72	.00	7.70	3.00
*	47.52	235.37	216.13	30.44	.00	325.66	32.00
*	47.52	42.98	215.34	8.47	.00	315.07	32.00
*	47.52	38.16	215.29	7.90	.00	314.32	32.00
*	47.52	31.73	215.20	7.27	.00	312.98	32.00
*	47.52	24.71	215.11	6.30	.00	311.79	32.00
	47.52	20.05	214.89	7.45	.00	205.73	32.00
*	47.52	4.72	214.36	3.61	.00	10.02	32.00
*	47.73	235.37	216.38	181.11	.00	87.22	145.00
*	47.73	42.98	215.63	41.07	.00	77.77	145.00
*	47.73	38.16	215.59	37.12	.00	77.53	145.00
*	47.73	31.73	215.47	31.73	.00	34.26	145.00
*	47.73	24.71	215.39	24.71	.00	30.02	145.00
*	47.73	20.05	215.35	20.05	.00	28.36	145.00
*	47.73	4.72	215.09	4.72	.00	14.62	145.00
*	47.86	235.37	217.56	133.13	.00	92.88	130.00
*	47.86	42.98	216.48	38.86	.00	53.17	130.00
*	47.86	38.16	216.44	35.06	.00	50.07	130.00

*	47.86	31.73	216.41	29.45	.00	47.98	130.00
*	47.86	24.71	216.30	23.74	.00	40.18	130.00
*	47.86	20.05	216.19	19.72	.00	32.96	130.00
*	47.86	4.72	215.58	4.72	.00	11.14	130.00
	48.00	235.37	218.15	226.48	.00	60.67	118.00
	48.00	42.98	217.14	42.97	.00	49.60	118.00
	48.00	38.16	217.08	38.15	.00	49.01	118.00
*	48.00	31.73	216.99	31.73	.00	47.19	118.00
*	48.00	24.71	216.88	24.71	.00	40.64	118.00
*	48.00	20.05	216.80	20.05	.00	35.87	118.00
	48.00	4.72	216.15	4.72	.00	4.64	118.00
	48.13	235.37	218.84	232.19	.00	90.83	116.00
	48.13	42.98	217.76	42.97	.00	61.96	116.00
	48.13	38.16	217.71	38.15	.00	58.41	116.00
	48.13	31.73	217.67	31.73	.00	55.48	116.00
	48.13	24.71	217.58	24.71	.00	49.08	116.00
*	48.13	20.05	217.51	20.05	.00	43.88	116.00
	48.13	4.72	216.67	4.72	.00	6.72	116.00
*	48.23	235.37	219.24	88.67	.00	77.29	78.00
*	48.23	42.98	218.10	42.98	.00	5.70	78.00
*	48.23	38.16	217.96	38.16	.00	5.70	78.00
*	48.23	31.73	217.76	31.73	.00	5.70	78.00
*	48.23	24.71	217.54	24.71	.00	5.70	78.00
*	48.23	20.05	217.50	20.05	.00	5.70	78.00
*	48.23	4.72	216.83	4.72	.00	5.70	78.00
*	48.27	235.37	226.44	26.99	83.20	475.54	45.00
*	48.27	42.98	218.73	42.98	.00	5.70	45.00
*	48.27	38.16	218.55	38.16	.00	5.70	45.00
*	48.27	31.73	218.30	31.73	.00	5.70	45.00
*	48.27	24.71	218.01	24.71	.00	5.70	45.00
*	48.27	20.05	217.80	20.05	.00	5.70	45.00
	48.27	4.72	216.88	4.72	.00	5.70	45.00
*	48.29	235.37	226.44	72.49	.00	372.47	19.00
*	48.29	42.98	219.41	32.87	.00	81.65	19.00
*	48.29	38.16	219.18	31.13	.00	76.77	19.00
*	48.29	31.73	218.85	28.28	.00	66.54	19.00
	48.29	24.71	218.47	23.76	.00	49.67	19.00
	48.29	20.05	218.19	19.95	.00	37.51	19.00
	48.29	4.72	217.05	4.72	.00	8.61	19.00
	48.50	235.37	226.44	155.55	.00	232.96	150.00
*	48.50	42.98	219.44	42.68	.00	67.09	150.00
*	48.50	38.16	219.22	38.09	.00	62.05	150.00
*	48.50	31.73	218.93	31.73	.00	53.35	150.00
*	48.50	24.71	218.60	24.71	.00	34.90	150.00
*	48.50	20.05	218.45	20.05	.00	26.13	150.00
*	48.50	4.72	217.79	4.72	.00	5.82	150.00
	-38.69	235.37	194.19	201.78	.00	145.71	.00
	-38.69	42.98	193.06	42.37	.00	69.16	.00
	-38.69	38.16	192.90	37.72	.00	66.59	.00
	-38.69	31.73	192.72	31.43	.00	65.63	.00
	-38.69	24.71	192.44	24.65	.00	24.01	.00
	-38.69	20.05	192.27	20.04	.00	22.58	.00
	-38.69	4.72	191.62	4.72	.00	16.76	.00
	101.00	.65	194.30	.09	.00	138.50	2.00
*	101.00	.40	193.09	.10	.00	124.03	2.00
*	101.00	.34	192.93	.10	.00	103.63	2.00
*	101.00	.28	192.75	.10	.00	80.00	2.00
*	101.00	.20	192.49	.10	.00	45.82	2.00
*	101.00	.16	192.31	.10	.00	22.93	2.00
*	101.00	.09	192.23	.08	.00	11.84	2.00
*	102.00	.65	194.30	.09	.00	138.50	17.30
*	102.00	.40	193.23	.06	.00	138.50	17.30
*	102.00	.34	193.23	.05	.00	138.50	17.30
*	102.00	.28	193.23	.04	.00	138.50	17.30
*	102.00	.20	193.23	.03	.00	138.50	17.30
*	102.00	.16	193.23	.03	.00	138.50	17.30
*	102.00	.09	193.21	.02	.00	138.50	17.30
*	103.00	.65	194.30	.47	.00	56.74	48.00
*	103.00	.40	193.23	.40	.00	31.70	48.00
*	103.00	.34	193.23	.33	.00	31.69	48.00
*	103.00	.28	193.23	.27	.00	31.68	48.00
*	103.00	.20	193.23	.20	.00	31.85	48.00
*	103.00	.16	193.23	.16	.00	31.89	48.00
*	103.00	.09	193.21	.08	.00	31.11	48.00

*	104.00	.65	194.30	.65	.00	7.00	57.00
*	104.00	.40	193.23	.40	.00	5.46	57.00
*	104.00	.34	193.23	.34	.00	5.46	57.00
*	104.00	.28	193.23	.28	.00	5.47	57.00
*	104.00	.20	193.23	.20	.00	5.47	57.00
*	104.00	.16	193.23	.16	.00	5.47	57.00
*	104.00	.09	193.21	.09	.00	5.42	57.00
*	105.00	.65	194.30	.65	.00	7.00	7.00
*	105.00	.40	193.23	.40	.00	5.46	7.00
*	105.00	.34	193.23	.34	.00	5.46	7.00
*	105.00	.28	193.23	.28	.00	5.46	7.00
*	105.00	.20	193.23	.20	.00	5.46	7.00
*	105.00	.16	193.23	.16	.00	5.46	7.00
*	105.00	.09	193.21	.09	.00	5.42	7.00
*	106.00	.42	194.36	.42	.00	1.98	80.00
*	106.00	.24	194.31	.24	.00	1.98	80.00
*	106.00	.22	194.30	.21	.00	1.98	80.00
*	106.00	.18	194.29	.18	.00	1.98	80.00
*	106.00	.14	194.28	.13	.00	1.98	80.00
*	106.00	.10	194.26	.10	.00	1.98	80.00
*	106.00	.05	194.23	.04	.00	1.98	80.00
*	107.00	.42	195.13	.42	.00	1.99	70.00
*	107.00	.24	195.03	.24	.00	1.99	70.00
*	107.00	.22	195.02	.22	.00	1.99	70.00
*	107.00	.18	194.99	.18	.00	1.99	70.00
*	107.00	.14	194.96	.14	.00	1.98	70.00
*	107.00	.10	194.94	.10	.00	1.98	70.00
*	107.00	.05	194.89	.05	.00	1.98	70.00
*	108.00	.42	196.41	.42	.00	50.00	70.00
*	108.00	.24	196.40	.24	.00	50.00	70.00
*	108.00	.22	196.40	.22	.00	50.00	70.00
*	108.00	.18	196.40	.18	.00	50.00	70.00
*	108.00	.14	196.40	.14	.00	50.00	70.00
*	108.00	.10	196.40	.10	.00	50.00	70.00
*	108.00	.05	196.39	.05	.00	50.00	70.00
*	109.00	.42	197.57	.42	.00	3.12	66.00
*	109.00	.24	197.53	.24	.00	3.12	66.00
*	109.00	.22	197.53	.22	.00	3.12	66.00
*	109.00	.18	197.52	.18	.00	3.12	66.00
*	109.00	.14	197.51	.14	.00	3.12	66.00
*	109.00	.10	197.50	.10	.00	3.12	66.00
*	109.00	.05	197.48	.05	.00	3.12	66.00

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*----------------------------------*
|            S U M P O             |
|                                  |
|   Interactive Summary Printout   |
|   for MS/PC-DOS micro computers  |
|          September 1990          |
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NOTE - Asterisk (*) at left of profile number indicates message in summary of errors list

ORIGINAL MODEL SUMMARY OUTPUT
FOAK2124.DAT - REGIONAL TO 5 YEAR FLOWS
MIDDLE SIXTEEN MILE CREEK TRIBUATRY AND HORNBY TRIBUATRY
(ORIGINAL DATA FILES FOAK21.DAT AND FOAK24.DAT)

Summary Printout

	SECNO	Q	CWSEL	QCH	QWEIR	TOPWID	XLCH
	35.58	458.75	189.13	104.62	.00	388.60	.00
*	35.58	103.54	187.48	87.26	.00	178.79	.00
*	35.58	93.71	187.39	84.16	.00	147.05	.00
*	35.58	80.55	186.88	80.55	.00	16.42	.00
*	35.58	64.82	186.65	64.82	.00	15.39	.00
*	35.58	53.71	186.49	53.71	.00	14.62	.00
	.01	262.16	189.23	95.70	.00	226.13	230.00
*	.01	75.87	188.01	75.87	.00	17.80	230.00
*	.01	67.96	187.96	67.96	.00	17.80	230.00
*	.01	57.41	187.93	57.41	.00	17.80	230.00
*	.01	44.98	187.64	44.98	.00	17.80	230.00
*	.01	37.26	187.40	37.26	.00	17.80	230.00
*	.02	262.16	189.63	262.16	.00	17.80	8.00
	.02	75.87	188.01	75.87	.00	17.80	8.00
	.02	67.96	187.96	67.96	.00	17.80	8.00
	.02	57.41	187.93	57.41	.00	17.80	8.00
	.02	44.98	187.64	44.98	.00	17.80	8.00
	.02	37.26	187.41	37.26	.00	17.80	8.00
*	.08	262.16	190.36	8.14	.00	294.88	62.00
*	.08	75.87	188.17	4.14	.00	233.46	62.00
*	.08	67.96	188.09	3.85	.00	231.90	62.00
*	.08	57.41	188.02	3.38	.00	230.47	62.00
*	.08	44.98	187.71	2.99	.00	205.25	62.00
*	.08	37.26	187.47	2.75	.00	184.41	62.00
*	.50	262.16	190.36	243.73	.00	166.08	420.00
*	.50	75.87	188.18	75.84	.00	119.42	420.00
*	.50	67.96	188.11	67.95	.00	117.63	420.00
*	.50	57.41	188.04	57.41	.00	115.93	420.00
*	.50	44.98	187.73	44.98	.00	97.72	420.00
*	.50	37.26	187.49	37.26	.00	82.37	420.00
*	.80	262.16	190.37	183.73	.00	132.95	300.00
*	.80	75.87	188.29	74.93	.00	62.01	300.00
*	.80	67.96	188.23	67.45	.00	58.21	300.00
*	.80	57.41	188.16	57.23	.00	53.69	300.00
*	.80	44.98	187.98	44.98	.00	43.04	300.00
*	.80	37.26	187.93	37.26	.00	41.37	300.00
	1.10	262.16	190.55	18.28	.00	184.50	300.00
*	1.10	75.87	189.06	9.63	.00	142.78	300.00
*	1.10	67.96	189.00	9.08	.00	140.92	300.00
*	1.10	57.41	188.91	8.13	.00	132.35	300.00
*	1.10	44.98	188.80	6.80	.00	122.78	300.00
*	1.10	37.26	188.70	6.04	.00	113.46	300.00
*	1.64	254.96	190.82	133.56	.00	97.04	540.00
*	1.64	73.30	189.83	60.13	.00	58.98	540.00
*	1.64	66.66	189.78	55.76	.00	56.35	540.00
*	1.64	57.65	189.68	49.98	.00	51.41	540.00
*	1.64	46.59	189.54	42.43	.00	43.98	540.00
	1.64	38.96	189.45	36.50	.00	39.09	540.00
*	1.68	254.96	191.27	31.31	.00	272.38	40.00
*	1.68	73.30	189.74	73.30	.00	8.00	40.00
*	1.68	66.66	189.61	66.66	.00	8.00	40.00

*	1.68	57.65	189.56	57.65	.00	8.00	40.00
	1.68	46.59	189.51	46.59	.00	8.00	40.00
	1.68	38.96	189.45	38.96	.00	8.00	40.00
*	1.68	254.96	191.25	31.08	.00	272.27	4.00
	1.68	73.30	190.22	73.30	.00	8.00	4.00
	1.68	66.66	190.09	66.66	.00	8.00	4.00
	1.68	57.65	189.75	57.65	.00	8.00	4.00
	1.68	46.59	189.57	46.59	.00	8.00	4.00
	1.68	38.96	189.49	38.96	.00	8.00	4.00
*	1.73	254.96	191.33	116.09	.00	324.79	46.00
*	1.73	73.30	191.10	34.88	.00	320.73	46.00
*	1.73	66.66	190.90	33.23	.00	317.25	46.00
*	1.73	57.65	190.58	31.61	.00	311.98	46.00
*	1.73	46.59	190.22	30.22	.00	305.97	46.00
*	1.73	38.96	190.00	29.36	.00	301.32	46.00
*	1.90	254.96	191.17	80.76	.00	116.29	170.00
*	1.90	73.30	191.09	24.56	.00	114.34	170.00
*	1.90	66.66	190.87	25.89	.00	103.32	170.00
*	1.90	57.65	190.53	27.62	.00	80.25	170.00
*	1.90	46.59	190.16	28.25	.00	54.79	170.00
*	1.90	38.96	189.96	26.76	.00	42.02	170.00
*	1.96	254.96	191.18	254.96	.00	15.25	60.00
	1.96	73.30	191.07	73.30	.00	15.25	60.00
	1.96	66.66	190.88	66.66	.00	15.25	60.00
*	1.96	57.65	190.58	57.65	.00	15.25	60.00
*	1.96	46.59	190.33	46.59	.00	15.25	60.00
*	1.96	38.96	190.21	38.96	.00	15.25	60.00
	2.00	254.96	192.06	254.96	.00	15.25	40.00
	2.00	73.30	191.09	73.30	.00	15.25	40.00
	2.00	66.66	190.90	66.66	.00	15.25	40.00
	2.00	57.65	190.60	57.65	.00	15.25	40.00
	2.00	46.59	190.36	46.59	.00	15.25	40.00
	2.00	38.96	190.23	38.96	.00	15.25	40.00
*	2.06	192.29	193.44	45.73	.00	171.18	60.00
	2.06	53.31	191.27	28.68	.00	149.96	60.00
*	2.06	48.51	190.99	36.30	.00	148.11	60.00
*	2.06	41.94	190.62	41.40	.00	48.41	60.00
*	2.06	33.77	190.39	33.77	.00	15.86	60.00
*	2.06	28.18	190.29	28.18	.00	14.83	60.00
*	2.30	192.29	193.42	55.79	.00	111.38	240.00
*	2.30	53.31	191.88	37.96	.00	77.40	240.00
*	2.30	48.51	191.79	36.41	.00	65.11	240.00
*	2.30	41.94	191.79	31.47	.00	65.15	240.00
*	2.30	33.77	191.72	26.40	.00	54.28	240.00
*	2.30	28.18	191.59	23.25	.00	36.55	240.00
*	2.43	192.29	193.58	23.45	.00	159.04	130.00
*	2.43	53.31	192.39	14.42	.00	136.77	130.00
*	2.43	48.51	192.34	14.17	.00	135.15	130.00
*	2.43	41.94	192.24	14.30	.00	132.30	130.00
*	2.43	33.77	192.11	14.29	.00	129.01	130.00
	2.43	28.18	192.00	15.27	.00	124.85	130.00
*	2.58	185.24	193.51	92.37	.00	96.09	150.00
*	2.58	52.40	192.64	39.66	.00	47.69	150.00
*	2.58	46.98	192.57	36.88	.00	46.21	150.00
*	2.58	40.20	192.49	32.95	.00	44.57	150.00
*	2.58	32.29	192.38	28.14	.00	42.36	150.00
*	2.58	26.86	192.27	24.99	.00	40.09	150.00
*	2.62	185.24	193.67	105.92	.00	95.71	40.00
	2.62	52.40	192.73	52.40	.00	9.20	40.00
	2.62	46.98	192.68	46.98	.00	9.20	40.00
	2.62	40.20	192.62	40.20	.00	9.20	40.00
*	2.62	32.29	192.57	32.29	.00	9.20	40.00
*	2.62	26.86	192.53	26.86	.00	9.20	40.00
*	2.63	185.24	194.10	71.53	146.58	129.86	10.00
*	2.63	52.40	193.30	31.79	.00	98.30	10.00
*	2.63	46.98	193.15	30.61	.00	96.85	10.00
*	2.63	40.20	193.00	25.16	.00	95.37	10.00
	2.63	32.29	192.73	32.29	.00	9.20	10.00
	2.63	26.86	192.65	26.86	.00	9.20	10.00
	2.66	185.24	194.11	88.37	.00	98.14	30.00
*	2.66	52.40	193.35	32.89	.00	82.05	30.00
*	2.66	46.98	193.21	31.67	.00	78.97	30.00

*	2.66	40.20	193.02	30.00	.00	75.36	30.00
*	2.66	32.29	192.83	26.13	.00	65.01	30.00
	2.66	26.86	192.71	22.82	.00	57.79	30.00
*	2.69	185.24	194.27	22.48	.00	277.88	35.00
*	2.69	52.40	193.40	10.81	.00	262.10	35.00
*	2.69	46.98	193.26	11.25	.00	258.73	35.00
*	2.69	40.20	193.08	11.95	.00	254.83	35.00
*	2.69	32.29	192.89	12.41	.00	226.83	35.00
*	2.69	26.86	192.68	26.86	.00	9.00	35.00
	2.71	185.24	194.29	21.98	177.28	278.28	15.00
*	2.71	52.40	193.62	8.77	25.98	268.09	15.00
*	2.71	46.98	193.55	8.27	16.71	266.49	15.00
*	2.71	40.20	193.45	7.70	6.46	264.02	15.00
*	2.71	32.29	193.08	32.29	.00	9.00	15.00
*	2.71	26.86	192.72	26.86	.00	9.00	15.00
*	2.75	138.22	194.29	25.36	.00	182.49	40.00
*	2.75	38.62	193.62	10.06	.00	169.71	40.00
*	2.75	35.11	193.55	9.60	.00	167.99	40.00
*	2.75	30.30	193.45	8.98	.00	165.34	40.00
*	2.75	24.17	193.27	8.29	.00	127.46	40.00
*	2.75	20.00	192.94	9.57	.00	108.84	40.00
*	2.95	138.22	194.32	41.44	.00	98.90	200.00
*	2.95	38.62	193.64	15.37	.00	84.22	200.00
*	2.95	35.11	193.57	14.47	.00	81.78	200.00
*	2.95	30.30	193.46	13.22	.00	78.04	200.00
*	2.95	24.17	193.29	11.60	.00	72.28	200.00
*	2.95	20.00	192.99	11.65	.00	53.71	200.00
*	3.05	138.22	194.40	11.10	.00	168.06	100.00
*	3.05	38.62	193.67	4.40	.00	139.01	100.00
*	3.05	35.11	193.60	4.13	.00	134.30	100.00
*	3.05	30.30	193.49	3.75	.00	127.11	100.00
*	3.05	24.17	193.32	3.25	.00	115.68	100.00
*	3.05	20.00	193.05	3.15	.00	96.85	100.00
*	3.35	138.22	194.44	135.82	.00	83.74	300.00
*	3.35	38.62	193.69	38.62	.00	42.06	300.00
*	3.35	35.11	193.62	35.10	.00	39.73	300.00
*	3.35	30.30	193.51	30.30	.00	36.13	300.00
*	3.35	24.17	193.33	24.17	.00	30.21	300.00
*	3.35	20.00	193.19	20.00	.00	25.63	300.00
	3.55	132.93	195.12	30.03	.00	67.78	200.00
	3.55	38.59	194.33	12.26	.00	43.95	200.00
	3.55	34.88	194.28	11.31	.00	42.81	200.00
	3.55	30.00	194.23	10.03	.00	41.08	200.00
*	3.55	24.09	194.16	8.32	.00	39.27	200.00
*	3.55	20.05	194.12	7.11	.00	37.84	200.00
*	3.75	132.93	195.69	15.12	.00	165.07	200.00
*	3.75	38.59	194.80	6.91	.00	98.72	200.00
*	3.75	34.88	194.74	6.51	.00	94.19	200.00
*	3.75	30.00	194.66	5.87	.00	88.92	200.00
	3.75	24.09	194.55	5.09	.00	81.17	200.00
	3.75	20.05	194.48	4.51	.00	75.19	200.00
*	3.80	132.93	196.14	31.28	.00	104.21	50.00
*	3.80	38.59	195.24	38.59	.00	6.10	50.00
*	3.80	34.88	195.14	34.88	.00	6.10	50.00
*	3.80	30.00	195.00	30.00	.00	6.10	50.00
*	3.80	24.09	194.81	24.09	.00	6.10	50.00
*	3.80	20.05	194.68	20.05	.00	6.10	50.00
*	3.81	132.93	197.41	19.44	73.51	163.01	10.00
*	3.81	38.59	195.61	38.59	.00	6.10	10.00
*	3.81	34.88	195.50	34.88	.00	6.10	10.00
*	3.81	30.00	195.36	30.00	.00	6.10	10.00
*	3.81	24.09	195.17	24.09	.00	6.10	10.00
*	3.81	20.05	195.04	20.05	.00	6.10	10.00
*	3.85	132.93	197.40	25.21	.00	135.14	40.00
*	3.85	38.59	196.65	9.72	.00	91.17	40.00
*	3.85	34.88	196.49	9.45	.00	81.08	40.00
*	3.85	30.00	196.25	9.07	.00	67.07	40.00
*	3.85	24.09	195.96	8.48	.00	50.86	40.00
*	3.85	20.05	195.74	7.67	.00	45.11	40.00
*	4.13	132.93	197.67	42.99	.00	194.86	280.00
*	4.13	38.59	196.76	21.97	.00	95.33	280.00
*	4.13	34.88	196.59	22.91	.00	76.33	280.00

*	4.13	30.00	196.55	20.56	.00	70.98	280.00
*	4.13	24.09	196.47	17.66	.00	62.62	280.00
*	4.13	20.05	196.41	15.52	.00	55.97	280.00
	4.41	66.71	198.08	7.20	.00	204.10	280.00
	4.41	18.34	197.45	3.24	.00	122.58	280.00
*	4.41	16.56	197.47	2.86	.00	125.74	280.00
*	4.41	14.26	197.42	2.60	.00	117.98	280.00
*	4.41	11.37	197.35	2.23	.00	108.01	280.00
*	4.41	9.39	197.29	1.96	.00	100.51	280.00
*	4.50	66.71	198.17	10.38	.00	82.40	90.00
*	4.50	18.34	197.60	4.91	.00	47.39	90.00
*	4.50	16.56	197.58	4.51	.00	46.48	90.00
*	4.50	14.26	197.53	4.10	.00	43.38	90.00
*	4.50	11.37	197.46	3.55	.00	38.99	90.00
*	4.50	9.39	197.40	3.20	.00	34.72	90.00
	4.65	66.71	199.07	21.70	.00	75.35	150.00
	4.65	18.34	198.64	9.16	.00	47.04	150.00
	4.65	16.56	198.59	8.71	.00	44.27	150.00
	4.65	14.26	198.55	7.85	.00	41.84	150.00
	4.65	11.37	198.50	6.72	.00	38.12	150.00
*	4.65	9.39	198.46	5.80	.00	35.97	150.00
*	4.48	66.71	199.69	8.59	.00	113.21	190.00
*	4.48	18.34	199.08	3.53	.00	71.58	190.00
*	4.48	16.56	199.05	3.29	.00	69.12	190.00
*	4.48	14.26	198.99	2.97	.00	65.19	190.00
*	4.48	11.37	198.92	2.54	.00	60.12	190.00
*	4.48	9.39	198.86	2.23	.00	55.87	190.00
*	4.97	66.71	199.91	13.08	.00	89.60	130.00
*	4.97	18.34	199.30	5.53	.00	52.38	130.00
*	4.97	16.56	199.26	5.16	.00	50.10	130.00
*	4.97	14.26	199.21	4.67	.00	46.90	130.00
*	4.97	11.37	199.13	4.00	.00	42.49	130.00
*	4.97	9.39	199.08	3.51	.00	39.07	130.00
	5.12	66.71	200.58	19.44	.00	58.24	150.00
	5.12	18.34	199.98	7.92	.00	32.70	150.00
	5.12	16.56	199.95	7.32	.00	31.54	150.00
	5.12	14.26	199.90	6.50	.00	30.02	150.00
	5.12	11.37	199.82	5.44	.00	27.83	150.00
	5.12	9.39	199.76	4.67	.00	26.11	150.00
*	5.30	66.71	201.33	14.23	.00	58.92	180.00
	5.30	18.34	200.60	5.79	.00	36.29	180.00
	5.30	16.56	200.56	5.38	.00	34.94	180.00
	5.30	14.26	200.50	4.85	.00	32.85	180.00
	5.30	11.37	200.40	4.13	.00	30.10	180.00
	5.30	9.39	200.33	3.60	.00	27.91	180.00
*	5.50	66.71	202.72	12.95	.00	48.09	200.00
*	5.50	18.34	202.11	6.19	.00	19.34	200.00
*	5.50	16.56	202.07	5.83	.00	17.47	200.00
*	5.50	14.26	201.99	5.42	.00	13.92	200.00
*	5.50	11.37	201.88	4.68	.00	12.46	200.00
*	5.50	9.39	201.81	4.07	.00	11.58	200.00
*	5.75	66.71	203.93	11.50	.00	83.68	250.00
*	5.75	18.34	203.26	4.77	.00	51.20	250.00
*	5.75	16.56	203.21	4.44	.00	49.33	250.00
*	5.75	14.26	203.17	3.99	.00	46.77	250.00
*	5.75	11.37	203.09	3.40	.00	42.95	250.00
*	5.75	9.39	203.02	2.98	.00	39.72	250.00
	5.85	66.71	204.12	8.94	.00	103.02	100.00
	5.85	18.34	203.48	4.12	.00	60.44	100.00
	5.85	16.56	203.43	3.89	.00	57.23	100.00
	5.85	14.26	203.39	3.52	.00	53.89	100.00
	5.85	11.37	203.31	3.04	.00	48.81	100.00
	5.85	9.39	203.25	2.68	.00	44.93	100.00
*	5.95	66.71	204.36	18.50	.00	75.74	100.00
*	5.95	18.34	203.83	7.75	.00	50.61	100.00
	5.95	16.56	203.80	7.16	.00	48.91	100.00
	5.95	14.26	203.76	6.39	.00	46.20	100.00
	5.95	11.37	203.69	5.37	.00	42.55	100.00
	5.95	9.39	203.65	4.62	.00	39.75	100.00
	6.18	66.71	205.41	11.13	.00	91.65	230.00
	6.18	18.34	204.88	4.61	.00	56.29	230.00
	6.18	16.56	204.84	4.31	.00	54.00	230.00

	6.18	14.26	204.79	3.89	.00	50.87	230.00
	6.18	11.37	204.73	3.33	.00	46.41	230.00
	6.18	9.39	204.67	2.92	.00	42.88	230.00
	6.35	66.71	206.08	10.65	.00	100.40	170.00
	6.35	18.34	205.56	4.60	.00	60.48	170.00
	6.35	16.56	205.53	4.30	.00	58.09	170.00
	6.35	14.26	205.48	3.87	.00	54.86	170.00
	6.35	11.37	205.42	3.30	.00	50.29	170.00
	6.35	9.39	205.38	2.88	.00	46.80	170.00
*	6.45	66.71	206.62	50.99	.00	67.92	100.00
*	6.45	18.34	206.14	18.03	.00	30.53	100.00
*	6.45	16.56	206.11	16.40	.00	28.44	100.00
*	6.45	14.26	206.08	14.25	.00	25.43	100.00
*	6.45	11.37	206.02	11.37	.00	21.63	100.00
*	6.45	9.39	205.98	9.39	.00	19.23	100.00
*	6.67	66.71	207.75	10.83	.00	97.64	220.00
*	6.67	18.34	207.17	4.45	.00	60.66	220.00
*	6.67	16.56	207.13	4.15	.00	58.35	220.00
*	6.67	14.26	207.08	3.73	.00	55.15	220.00
*	6.67	11.37	207.00	3.21	.00	50.19	220.00
*	6.67	9.39	206.94	2.79	.00	46.90	220.00
*	6.83	66.71	208.30	15.46	.00	80.40	160.00
*	6.83	18.34	207.73	6.92	.00	34.08	160.00
*	6.83	16.56	207.70	6.43	.00	32.72	160.00
*	6.83	14.26	207.65	5.78	.00	30.77	160.00
*	6.83	11.37	207.59	4.86	.00	28.43	160.00
*	6.83	9.39	207.53	4.25	.00	26.06	160.00
*	6.92	66.71	208.93	50.50	.00	43.75	90.00
	6.92	18.34	208.40	16.90	.00	26.21	90.00
	6.92	16.56	208.37	15.44	.00	25.08	90.00
	6.92	14.26	208.32	13.50	.00	23.50	90.00
	6.92	11.37	208.25	11.01	.00	21.07	90.00
	6.92	9.39	208.20	9.19	.00	19.59	90.00
*	7.04	66.71	209.78	12.73	.00	96.34	120.00
*	7.04	18.34	209.03	5.47	.00	55.28	120.00
*	7.04	16.56	208.99	5.10	.00	52.96	120.00
*	7.04	14.26	208.93	4.60	.00	49.71	120.00
*	7.04	11.37	208.84	3.91	.00	45.48	120.00
	7.04	9.39	208.78	3.46	.00	41.34	120.00
*	7.12	66.71	210.00	16.10	.00	72.10	80.00
*	7.12	18.34	209.36	6.86	.00	40.45	80.00
*	7.12	16.56	209.33	6.34	.00	39.08	80.00
*	7.12	14.26	209.28	5.72	.00	36.52	80.00
*	7.12	11.37	209.21	4.90	.00	32.78	80.00
*	7.12	9.39	209.18	4.21	.00	30.85	80.00
	7.20	66.71	210.44	65.58	.00	60.46	80.00
*	7.20	18.34	209.96	18.34	.00	45.02	80.00
*	7.20	16.56	209.93	16.56	.00	42.77	80.00
*	7.20	14.26	209.89	14.26	.00	40.56	80.00
*	7.20	11.37	209.83	11.37	.00	37.45	80.00
*	7.20	9.39	209.78	9.39	.00	34.61	80.00
*	7.28	66.71	210.89	19.04	.00	58.53	80.00
*	7.28	18.34	210.42	7.20	.00	37.67	80.00
*	7.28	16.56	210.41	6.60	.00	36.90	80.00
*	7.28	14.26	210.36	5.88	.00	35.06	80.00
*	7.28	11.37	210.30	4.97	.00	32.09	80.00
	7.28	9.39	210.26	4.28	.00	30.05	80.00
*	7.40	66.71	211.91	12.41	.00	99.25	120.00
*	7.40	18.34	211.28	5.27	.00	58.03	120.00
*	7.40	16.56	211.23	4.93	.00	55.45	120.00
*	7.40	14.26	211.18	4.46	.00	51.83	120.00
*	7.40	11.37	211.11	3.80	.00	47.42	120.00
*	7.40	9.39	211.05	3.32	.00	43.81	120.00
	7.52	66.71	212.36	65.75	.00	62.21	120.00
	7.52	18.34	211.91	18.34	.00	43.24	120.00
	7.52	16.56	211.88	16.56	.00	41.43	120.00
	7.52	14.26	211.84	14.26	.00	39.28	120.00
	7.52	11.37	211.79	11.37	.00	35.80	120.00
	7.52	9.39	211.75	9.39	.00	33.23	120.00
*	7.68	66.71	213.56	18.08	.00	62.62	160.00
	7.68	18.34	213.10	6.77	.00	41.19	160.00
	7.68	16.56	213.08	6.27	.00	39.78	160.00

	7.68	14.26	213.03	5.61	.00	37.55	160.00
	7.68	11.37	212.97	4.72	.00	34.70	160.00
	7.68	9.39	212.92	4.08	.00	32.35	160.00
*	7.78	66.71	214.72	57.37	.00	49.22	100.00
	7.78	18.34	214.03	18.34	.00	17.23	100.00
*	7.78	16.56	213.99	16.56	.00	15.95	100.00
*	7.78	14.26	213.95	14.26	.00	15.10	100.00
*	7.78	11.37	213.87	11.37	.00	13.82	100.00
*	7.78	9.39	213.81	9.39	.00	12.89	100.00
	7.76	66.71	215.53	34.66	.00	46.19	80.00
*	7.76	18.34	214.87	12.02	.00	28.33	80.00
*	7.76	16.56	214.82	11.10	.00	27.00	80.00
*	7.76	14.26	214.76	9.84	.00	25.31	80.00
*	7.76	11.37	214.67	8.19	.00	22.98	80.00
*	7.76	9.39	214.60	7.03	.00	21.04	80.00
*	8.03	66.71	216.85	54.92	.00	46.29	170.00
*	8.03	18.34	216.20	18.06	.00	22.15	170.00
*	8.03	16.56	216.17	16.38	.00	21.17	170.00
*	8.03	14.26	216.12	14.18	.00	19.48	170.00
*	8.03	11.37	216.06	11.37	.00	17.09	170.00
*	8.03	9.39	216.01	9.39	.00	15.39	170.00
*	8.22	66.71	218.89	50.19	.00	47.01	190.00
	8.22	18.34	218.30	17.41	.00	24.51	190.00
	8.22	16.56	218.26	15.92	.00	22.96	190.00
	8.22	14.26	218.22	13.88	.00	21.20	190.00
	8.22	11.37	218.15	11.24	.00	18.83	190.00
	8.22	9.39	218.09	9.35	.00	16.89	190.00
*	8.30	49.68	219.58	11.08	.00	67.27	80.00
	8.30	11.92	218.86	4.16	.00	37.84	80.00
	8.30	10.71	218.82	3.86	.00	36.26	80.00
	8.30	9.15	218.76	3.46	.00	33.85	80.00
	8.30	7.32	218.67	2.97	.00	30.51	80.00
	8.30	6.04	218.61	2.61	.00	27.94	80.00
*	8.42	49.68	220.11	49.62	.00	38.79	120.00
*	8.42	11.92	219.65	11.92	.00	22.24	120.00
*	8.42	10.71	219.62	10.71	.00	21.31	120.00
*	8.42	9.15	219.59	9.15	.00	20.01	120.00
*	8.42	7.32	219.54	7.31	.00	18.30	120.00
*	8.42	6.04	219.50	6.04	.00	16.95	120.00
*	8.55	49.68	221.40	12.42	.00	58.47	130.00
*	8.55	11.92	220.85	4.44	.00	34.57	130.00
*	8.55	10.71	220.82	4.11	.00	33.19	130.00
*	8.55	9.15	220.77	3.65	.00	31.37	130.00
*	8.55	7.32	220.72	3.09	.00	28.88	130.00
*	8.55	6.04	220.68	2.67	.00	26.90	130.00
*	8.58	49.68	222.32	11.59	.00	55.01	30.00
*	8.58	11.92	221.46	11.92	.00	3.70	30.00
*	8.58	10.71	221.39	10.71	.00	3.70	30.00
*	8.58	9.15	221.29	9.15	.00	3.70	30.00
*	8.58	7.32	221.17	7.31	.00	3.70	30.00
*	8.58	6.04	221.08	6.04	.00	3.70	30.00
*	8.59	49.68	223.51	6.85	19.01	97.91	10.00
*	8.59	11.92	221.98	11.92	.00	3.70	10.00
*	8.59	10.71	221.89	10.71	.00	3.70	10.00
*	8.59	9.15	221.75	9.15	.00	3.70	10.00
*	8.59	7.32	221.58	7.31	.00	3.70	10.00
*	8.59	6.04	221.45	6.04	.00	3.70	10.00
	8.64	49.68	223.51	46.95	.00	75.14	50.00
*	8.64	11.92	222.20	11.91	.00	51.52	50.00
*	8.64	10.71	222.08	10.71	.00	49.45	50.00
*	8.64	9.15	221.93	9.15	.00	45.27	50.00
*	8.64	7.32	221.74	7.31	.00	37.87	50.00
*	8.64	6.04	221.61	6.04	.00	32.42	50.00
*	8.73	49.68	223.40	16.59	.00	40.11	90.00
*	8.73	11.92	222.60	6.34	.00	19.95	90.00
*	8.73	10.71	222.56	5.84	.00	19.10	90.00
*	8.73	9.15	222.52	5.15	.00	18.03	90.00
*	8.73	7.32	222.46	4.32	.00	16.51	90.00
*	8.73	6.04	222.41	3.72	.00	15.28	90.00
*	8.89	49.68	224.75	38.43	.00	40.74	160.00
	8.89	11.92	224.20	11.59	.00	19.93	160.00
*	8.89	10.71	224.17	10.50	.00	18.71	160.00

*	8.89	9.15	224.12	9.06	.00	16.92	160.00
*	8.89	7.32	224.07	7.31	.00	14.68	160.00
*	8.89	6.04	224.02	6.04	.00	12.97	160.00
*	9.05	49.68	225.92	13.58	.00	62.17	160.00
	9.05	11.92	225.21	5.01	.00	34.14	160.00
	9.05	10.71	225.18	4.64	.00	32.59	160.00
	9.05	9.15	225.13	4.13	.00	30.54	160.00
	9.05	7.32	225.06	3.50	.00	27.87	160.00
	9.05	6.04	225.01	3.04	.00	25.66	160.00
*	9.21	49.68	227.01	17.21	.00	58.87	160.00
*	9.21	11.92	226.52	6.75	.00	32.32	160.00
*	9.21	10.71	226.49	6.28	.00	30.78	160.00
*	9.21	9.15	226.45	5.64	.00	28.61	160.00
*	9.21	7.32	226.40	4.84	.00	25.71	160.00
*	9.21	6.04	226.35	4.23	.00	23.32	160.00
*	9.38	49.68	227.88	9.62	.00	94.69	170.00
*	9.38	11.92	227.23	3.54	.00	55.61	170.00
*	9.38	10.71	227.19	3.27	.00	53.44	170.00
*	9.38	9.15	227.14	2.93	.00	50.32	170.00
*	9.38	7.32	227.07	2.49	.00	46.11	170.00
*	9.38	6.04	227.01	2.17	.00	42.77	170.00
*	9.55	49.68	228.31	10.78	.00	61.84	170.00
*	9.55	11.92	227.71	4.52	.00	39.66	170.00
*	9.55	10.71	227.68	4.22	.00	37.54	170.00
*	9.55	9.15	227.63	3.79	.00	34.82	170.00
*	9.55	7.32	227.58	3.24	.00	31.38	170.00
*	9.55	6.04	227.53	2.83	.00	28.77	170.00
	9.73	49.68	229.39	16.87	.00	46.42	180.00
	9.73	11.92	228.89	5.46	.00	29.82	180.00
*	9.73	10.71	228.85	5.00	.00	28.91	180.00
*	9.73	9.15	228.81	4.41	.00	27.49	180.00
*	9.73	7.32	228.75	3.68	.00	25.50	180.00
*	9.73	6.04	228.69	3.16	.00	23.92	180.00
*	9.90	49.68	230.91	29.36	.00	40.31	170.00
*	9.90	11.92	230.32	10.53	.00	19.52	170.00
*	9.90	10.71	230.29	9.68	.00	18.19	170.00
*	9.90	9.15	230.23	8.56	.00	16.11	170.00
*	9.90	7.32	230.15	7.11	.00	13.35	170.00
*	9.90	6.04	230.10	5.99	.00	11.48	170.00
*	10.03	49.68	231.62	11.66	.00	51.43	130.00
*	10.03	11.92	230.90	4.14	.00	31.34	130.00
*	10.03	10.71	230.86	3.82	.00	30.23	130.00
*	10.03	9.15	230.81	3.41	.00	28.54	130.00
*	10.03	7.32	230.73	2.88	.00	26.46	130.00
*	10.03	6.04	230.67	2.50	.00	24.60	130.00
*	10.09	49.68	232.18	24.69	.00	19.77	60.00
*	10.09	11.92	231.21	11.92	.00	3.25	60.00
*	10.09	10.71	231.13	10.71	.00	3.25	60.00
*	10.09	9.15	231.03	9.15	.00	3.25	60.00
*	10.09	7.32	230.90	7.31	.00	3.25	60.00
*	10.09	6.04	230.81	6.04	.00	3.25	60.00
*	10.10	49.68	233.21	15.50	24.26	53.34	8.00
	10.10	11.92	231.64	11.92	.00	3.25	8.00
	10.10	10.71	231.54	10.71	.00	3.25	8.00
	10.10	9.15	231.41	9.15	.00	3.25	8.00
	10.10	7.32	231.25	7.31	.00	3.25	8.00
	10.10	6.04	231.13	6.04	.00	3.25	8.00
*	10.13	49.68	233.27	45.10	.00	72.36	32.00
*	10.13	11.92	232.03	11.92	.00	38.70	32.00
*	10.13	10.71	231.90	10.71	.00	35.92	32.00
*	10.13	9.15	231.73	9.15	.00	32.59	32.00
*	10.13	7.32	231.52	7.31	.00	28.03	32.00
*	10.13	6.04	231.37	6.04	.00	24.78	32.00
	10.19	49.68	233.28	41.06	.00	76.89	60.00
*	10.19	11.92	232.03	11.92	.00	29.32	60.00
*	10.19	10.71	231.91	10.71	.00	26.53	60.00
*	10.19	9.15	231.75	9.15	.00	23.76	60.00
*	10.19	7.32	231.55	7.31	.00	20.38	60.00
*	10.19	6.04	231.40	6.04	.00	17.92	60.00
	-2.06	49.68	193.44	9.82	.00	171.25	.00
	-2.06	11.92	191.27	5.79	.00	149.93	.00
	-2.06	10.71	190.99	7.54	.00	147.41	.00

	-2.06	9.15	190.62	9.00	.00	48.41	.00
	-2.06	7.32	190.39	7.31	.00	15.86	.00
	-2.06	6.04	190.29	6.04	.00	14.83	.00
*	.08	262.16	193.38	71.02	.00	91.95	.00
*	.08	75.87	191.20	40.25	.00	77.08	.00
*	.08	67.96	191.19	36.44	.00	76.99	.00
*	.08	57.41	191.13	32.43	.00	76.54	.00
*	.08	44.98	191.02	28.38	.00	75.66	.00
*	.08	37.26	190.96	24.95	.00	65.94	.00
	.16	262.16	193.47	68.65	.00	123.96	80.00
*	.16	75.87	191.83	38.10	.00	101.99	80.00
*	.16	67.96	191.76	36.01	.00	97.67	80.00
*	.16	57.41	191.68	32.45	.00	92.80	80.00
*	.16	44.98	191.59	27.44	.00	87.57	80.00
*	.16	37.26	191.51	24.49	.00	82.88	80.00
*	.28	262.16	193.46	95.83	.00	102.89	92.00
*	.28	75.87	192.66	47.84	.00	73.89	92.00
*	.28	67.96	192.62	44.22	.00	71.43	92.00
*	.28	57.41	192.55	39.89	.00	66.47	92.00
*	.28	44.98	192.45	34.05	.00	60.23	92.00
*	.28	37.26	192.38	30.24	.00	55.28	92.00
	.40	262.16	193.87	68.24	.00	92.33	85.00
	.40	75.87	193.14	33.18	.00	90.35	85.00
	.40	67.96	193.08	31.65	.00	90.19	85.00
	.40	57.41	193.00	29.25	.00	88.73	85.00
	.40	44.98	192.88	25.84	.00	71.21	85.00
	.40	37.26	192.80	23.23	.00	59.18	85.00
	.50	262.16	194.21	37.92	.00	77.53	90.00
	.50	75.87	193.44	15.13	.00	65.68	90.00
	.50	67.96	193.38	14.04	.00	64.97	90.00
	.50	57.41	193.31	12.51	.00	63.99	90.00
	.50	44.98	193.20	10.72	.00	62.59	90.00
	.50	37.26	193.12	9.60	.00	61.53	90.00
*	.67	262.16	194.75	86.54	.00	62.63	125.00
*	.67	75.87	194.05	37.37	.00	57.38	125.00
*	.67	67.96	194.01	34.86	.00	57.04	125.00
*	.67	57.41	193.94	31.35	.00	56.14	125.00
*	.67	44.98	193.85	27.03	.00	54.85	125.00
*	.67	37.26	193.79	23.79	.00	54.11	125.00
*	.81	262.16	195.57	65.34	.00	108.23	80.00
*	.81	75.87	194.58	30.56	.00	85.01	80.00
*	.81	67.96	194.52	28.50	.00	83.41	80.00
	.81	57.41	194.44	25.89	.00	80.76	80.00
	.81	44.98	194.33	22.46	.00	77.51	80.00
	.81	37.26	194.25	20.59	.00	74.68	80.00
*	.94	262.16	195.79	87.73	.00	73.47	107.00
*	.94	75.87	195.08	39.79	.00	61.44	107.00
*	.94	67.96	195.04	36.99	.00	60.76	107.00
*	.94	57.41	194.94	34.29	.00	55.69	107.00
*	.94	44.98	194.81	29.58	.00	47.37	107.00
*	.94	37.26	194.73	26.10	.00	41.83	107.00
*	1.04	262.16	196.63	50.76	.00	99.85	102.00
*	1.04	75.87	195.67	20.14	.00	88.35	102.00
*	1.04	67.96	195.61	18.72	.00	87.86	102.00
*	1.04	57.41	195.53	16.68	.00	87.24	102.00
*	1.04	44.98	195.42	14.37	.00	86.32	102.00
*	1.04	37.26	195.34	12.96	.00	85.66	102.00
	1.11	262.16	196.73	39.66	.00	145.29	65.00
	1.11	75.87	195.72	19.50	.00	117.83	65.00
	1.11	67.96	195.66	18.45	.00	114.20	65.00
	1.11	57.41	195.59	16.79	.00	109.84	65.00
	1.11	44.98	195.48	14.95	.00	103.48	65.00
	1.11	37.26	195.40	13.83	.00	98.96	65.00
	1.14	262.16	196.74	46.18	.00	145.44	28.00
*	1.14	75.87	196.41	15.11	.00	140.43	28.00
*	1.14	67.96	196.26	67.96	.00	7.70	28.00
*	1.14	57.41	196.08	57.41	.00	7.70	28.00
*	1.14	44.98	195.82	44.98	.00	7.70	28.00
*	1.14	37.26	195.63	37.26	.00	7.70	28.00
*	1.15	262.16	197.69	35.26	207.11	160.89	8.50
*	1.15	75.87	197.08	11.50	30.27	150.98	8.50
*	1.15	67.96	197.29	9.85	19.70	154.27	8.50

*	1.15	57.41	196.97	8.96	7.34	149.03	8.50
*	1.15	44.98	195.91	44.98	.00	7.70	8.50
*	1.15	37.26	195.73	37.26	.00	7.70	8.50
*	1.18	262.16	197.68	86.32	.00	116.45	33.00
*	1.18	75.87	197.08	31.22	.00	96.62	33.00
*	1.18	67.96	197.29	25.77	.00	113.30	33.00
*	1.18	57.41	196.97	24.89	.00	83.03	33.00
*	1.18	44.98	197.13	18.21	.00	102.26	33.00
*	1.18	37.26	196.81	17.48	.00	78.47	33.00
	1.30	262.16	197.95	62.83	.00	100.17	120.00
	1.30	75.87	197.20	26.45	.00	91.80	120.00
	1.30	67.96	197.34	21.52	.00	93.35	120.00
	1.30	57.41	197.07	22.33	.00	90.33	120.00
*	1.30	44.98	197.17	16.12	.00	91.41	120.00
*	1.30	37.26	196.89	16.93	.00	81.62	120.00
	1.50	262.16	198.33	79.87	.00	108.12	155.00
	1.50	75.87	197.49	29.02	.00	79.22	155.00
*	1.50	67.96	197.50	25.95	.00	79.52	155.00
*	1.50	57.41	197.36	22.79	.00	72.36	155.00
*	1.50	44.98	197.31	18.13	.00	69.65	155.00
*	1.50	37.26	197.17	15.63	.00	62.81	155.00
*	1.64	254.96	198.75	80.18	.00	86.47	140.00
*	1.64	73.30	198.02	29.00	.00	76.32	140.00
*	1.64	66.66	197.96	27.49	.00	72.48	140.00
*	1.64	57.65	197.91	24.31	.00	69.76	140.00
*	1.64	46.59	197.79	21.23	.00	61.37	140.00
*	1.64	38.96	197.77	18.13	.00	59.34	140.00
	1.73	254.96	199.34	72.32	.00	93.53	85.00
	1.73	73.30	198.61	34.21	.00	69.65	85.00
*	1.73	66.66	198.58	31.77	.00	69.09	85.00
	1.73	57.65	198.50	29.63	.00	67.19	85.00
*	1.73	46.59	198.43	26.16	.00	65.19	85.00
	1.73	38.96	198.35	24.39	.00	62.97	85.00
*	1.86	254.96	199.93	16.40	.00	979.06	100.00
*	1.86	73.30	199.37	19.34	.00	414.56	100.00
*	1.86	66.66	199.34	19.31	.00	390.26	100.00
*	1.86	57.65	199.32	18.14	.00	369.46	100.00
*	1.86	46.59	199.30	15.99	.00	348.20	100.00
*	1.86	38.96	199.27	15.32	.00	316.15	100.00
*	1.99	254.96	200.72	74.03	.00	107.75	90.00
*	1.99	73.30	200.06	33.48	.00	76.68	90.00
*	1.99	66.66	200.01	31.82	.00	74.65	90.00
*	1.99	57.65	199.92	29.67	.00	68.66	90.00
*	1.99	46.59	199.82	25.87	.00	62.28	90.00
*	1.99	38.96	199.75	23.01	.00	57.28	90.00
	2.11	64.73	201.65	27.48	.00	100.79	115.00
	2.11	19.98	200.75	14.56	.00	63.72	115.00
	2.11	18.15	200.71	13.61	.00	60.44	115.00
	2.11	15.72	200.65	12.25	.00	56.08	115.00
	2.11	12.82	200.54	10.66	.00	48.53	115.00
	2.11	10.78	200.45	9.41	.00	42.51	115.00
*	2.26	64.73	201.69	37.53	.00	61.62	140.00
*	2.26	19.98	200.89	16.22	.00	23.32	140.00
*	2.26	18.15	200.85	14.94	.00	22.52	140.00
*	2.26	15.72	200.79	13.19	.00	21.43	140.00
*	2.26	12.82	200.69	11.09	.00	19.70	140.00
*	2.26	10.78	200.61	9.55	.00	18.30	140.00
	2.32	64.73	201.89	35.45	.00	64.25	69.00
	2.32	19.98	201.09	15.44	.00	23.64	69.00
	2.32	18.15	201.04	14.27	.00	21.05	69.00
	2.32	15.72	200.97	12.62	.00	18.67	69.00
	2.32	12.82	200.87	10.53	.00	17.57	69.00
	2.32	10.78	200.79	9.02	.00	16.69	69.00
*	2.35	64.73	202.79	26.61	.00	105.13	37.00
*	2.35	19.98	201.37	19.98	.00	5.65	37.00
*	2.35	18.15	201.31	18.15	.00	5.65	37.00
*	2.35	15.72	201.21	15.72	.00	5.65	37.00
*	2.35	12.82	201.10	12.82	.00	5.65	37.00
*	2.35	10.78	201.01	10.78	.00	5.65	37.00
*	2.39	64.73	203.57	21.10	19.92	190.05	37.00
*	2.39	19.98	201.72	19.98	.00	5.65	37.00
*	2.39	18.15	201.63	18.15	.00	5.65	37.00

*	2.39	15.72	201.51	15.72	.00	5.65	37.00
*	2.39	12.82	201.36	12.82	.00	5.65	37.00
*	2.39	10.78	201.25	10.78	.00	5.65	37.00
*	2.42	64.73	203.58	30.46	.00	142.31	32.00
	2.42	19.98	202.15	13.88	.00	61.19	32.00
	2.42	18.15	202.03	13.41	.00	59.37	32.00
*	2.42	15.72	201.86	12.14	.00	40.69	32.00
*	2.42	12.82	201.54	10.74	.00	22.53	32.00
*	2.42	10.78	201.47	9.20	.00	20.58	32.00
*	2.55	64.73	203.61	58.80	.00	140.08	130.00
*	2.55	19.98	202.23	19.92	.00	78.51	130.00
*	2.55	18.15	202.14	18.13	.00	74.43	130.00
*	2.55	15.72	202.03	15.72	.00	69.19	130.00
*	2.55	12.82	201.90	12.82	.00	62.53	130.00
*	2.55	10.78	201.84	10.78	.00	58.56	130.00
*	2.75	41.12	203.62	7.13	.00	84.55	200.00
*	2.75	12.54	202.51	4.37	.00	29.95	200.00
*	2.75	11.39	202.48	4.03	.00	28.84	200.00
*	2.75	9.79	202.45	3.55	.00	27.25	200.00
*	2.75	7.94	202.41	2.96	.00	25.21	200.00
*	2.75	6.67	202.38	2.54	.00	23.66	200.00
*	2.86	41.12	204.14	10.08	.00	75.26	105.00
*	2.86	12.54	203.90	5.29	.00	52.39	105.00
*	2.86	11.39	203.88	5.00	.00	50.30	105.00
*	2.86	9.79	203.85	4.58	.00	47.15	105.00
*	2.86	7.94	203.82	4.02	.00	43.34	105.00
*	2.86	6.67	203.79	3.66	.00	39.58	105.00
*	2.90	41.12	204.41	7.80	.00	95.41	40.00
*	2.90	12.54	204.10	3.61	.00	72.02	40.00
*	2.90	11.39	204.07	3.42	.00	70.41	40.00
*	2.90	9.79	204.04	3.15	.00	67.97	40.00
*	2.90	7.94	204.01	2.75	.00	65.67	40.00
*	2.90	6.67	204.00	2.33	.00	65.33	40.00
*	2.90	41.12	204.65	6.36	32.22	113.65	3.00
*	2.90	12.54	204.30	2.64	4.48	87.99	3.00
*	2.90	11.39	204.27	2.49	3.45	85.72	3.00
*	2.90	9.79	204.22	2.27	2.16	82.19	3.00
*	2.90	7.94	204.16	2.02	.96	77.43	3.00
*	2.90	6.67	204.12	1.81	.49	74.46	3.00
*	2.93	41.12	204.57	35.00	.00	42.17	27.00
*	2.93	12.54	204.28	11.87	.00	30.18	27.00
*	2.93	11.39	204.25	10.88	.00	29.05	27.00
*	2.93	9.79	204.21	9.47	.00	27.27	27.00
*	2.93	7.94	204.15	7.80	.00	24.84	27.00
*	2.93	6.67	204.11	6.62	.00	23.37	27.00
	3.06	41.12	205.41	13.75	.00	48.96	124.00
*	3.06	12.54	204.93	6.87	.00	27.52	124.00
*	3.06	11.39	204.90	6.45	.00	26.35	124.00
*	3.06	9.79	204.86	5.83	.00	24.60	124.00
*	3.06	7.94	204.81	5.07	.00	22.32	124.00
	3.06	6.67	204.79	4.39	.00	21.27	124.00
	3.15	41.12	205.92	41.12	.00	50.05	81.00
	3.15	12.54	205.54	12.54	.00	31.34	81.00
	3.15	11.39	205.51	11.39	.00	30.01	81.00
	3.15	9.79	205.47	9.79	.00	28.00	81.00
	3.15	7.94	205.42	7.94	.00	25.38	81.00
	3.15	6.67	205.36	6.67	.00	22.89	81.00
*	3.32	41.12	207.16	25.10	.00	46.33	150.00
*	3.32	12.54	206.79	10.04	.00	26.17	150.00
*	3.32	11.39	206.76	9.33	.00	24.72	150.00
*	3.32	9.79	206.72	8.31	.00	22.44	150.00
*	3.32	7.94	206.66	7.09	.00	19.22	150.00
*	3.32	6.67	206.61	6.20	.00	16.36	150.00
*	3.50	41.12	208.10	14.86	.00	52.22	160.00
*	3.50	12.54	207.63	7.07	.00	33.27	160.00
*	3.50	11.39	207.60	6.63	.00	31.83	160.00
*	3.50	9.79	207.55	6.00	.00	29.66	160.00
*	3.50	7.94	207.49	5.21	.00	26.83	160.00
*	3.50	6.67	207.44	4.62	.00	24.64	160.00
	3.64	41.12	208.59	36.15	.00	43.72	140.00
*	3.64	12.54	208.19	12.24	.00	29.99	140.00
*	3.64	11.39	208.17	11.17	.00	29.06	140.00

*	3.64	9.79	208.14	9.66	.00	27.87	140.00
*	3.64	7.94	208.09	7.93	.00	26.37	140.00
*	3.64	6.67	208.06	6.66	.00	25.23	140.00
	3.79	41.12	209.17	23.02	.00	56.96	120.00
	3.79	12.54	208.75	9.54	.00	34.49	120.00
*	3.79	11.39	208.74	8.82	.00	33.28	120.00
*	3.79	9.79	208.70	7.78	.00	31.48	120.00
*	3.79	7.94	208.65	6.55	.00	28.94	120.00
*	3.79	6.67	208.61	5.67	.00	26.92	120.00
*	3.92	41.12	210.04	28.27	.00	70.91	127.00
*	3.92	12.54	209.75	11.00	.00	38.59	127.00
*	3.92	11.39	209.72	10.23	.00	35.53	127.00
*	3.92	9.79	209.69	9.01	.00	32.14	127.00
*	3.92	7.94	209.64	7.60	.00	26.12	127.00
*	3.92	6.67	209.59	6.55	.00	20.82	127.00

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|             S U M P O             |
|                                   |
|   Interactive Summary Printout    |
|   for MS/PC-DOS micro computers   |
|          September 1990           |
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NOTE - Asterisk (*) at left of profile number indicates message in summary of errors list

ABATTIOR.DAT - REGIONAL TO 5 YEAR FLOWS
HORNBY TRIBUTARY WITH ABATTIOR FILL ENCROACHMENT

Summary Printout

	SECNO	Q	CWSEL	QCH	QWEIR	TOPWID	XLCH
	35.58	458.75	189.13	104.62	.00	388.60	.00
*	35.58	103.54	187.48	87.26	.00	178.79	.00
*	35.58	93.71	187.39	84.16	.00	147.05	.00
*	35.58	80.55	186.88	80.55	.00	16.42	.00
*	35.58	64.82	186.65	64.82	.00	15.39	.00
*	35.58	53.71	186.49	53.71	.00	14.62	.00
	.01	262.16	189.23	95.70	.00	226.13	230.00
*	.01	75.87	188.01	75.87	.00	17.80	230.00
*	.01	67.96	187.96	67.96	.00	17.80	230.00
*	.01	57.41	187.93	57.41	.00	17.80	230.00
*	.01	44.98	187.64	44.98	.00	17.80	230.00
*	.01	37.26	187.40	37.26	.00	17.80	230.00
*	.02	262.16	189.63	262.16	.00	17.80	8.00
	.02	75.87	188.01	75.87	.00	17.80	8.00
	.02	67.96	187.96	67.96	.00	17.80	8.00
	.02	57.41	187.93	57.41	.00	17.80	8.00
	.02	44.98	187.64	44.98	.00	17.80	8.00
	.02	37.26	187.41	37.26	.00	17.80	8.00
*	.08	262.16	190.36	8.14	.00	294.88	62.00
*	.08	75.87	188.17	4.14	.00	233.46	62.00
*	.08	67.96	188.09	3.85	.00	231.90	62.00
*	.08	57.41	188.02	3.38	.00	230.47	62.00
*	.08	44.98	187.71	2.99	.00	205.25	62.00
*	.08	37.26	187.47	2.75	.00	184.41	62.00
*	.50	262.16	190.36	243.73	.00	166.08	420.00
*	.50	75.87	188.18	75.84	.00	119.42	420.00
*	.50	67.96	188.11	67.95	.00	117.63	420.00
*	.50	57.41	188.04	57.41	.00	115.93	420.00
*	.50	44.98	187.73	44.98	.00	97.72	420.00
*	.50	37.26	187.49	37.26	.00	82.37	420.00
*	.80	262.16	190.37	183.73	.00	132.95	300.00
*	.80	75.87	188.29	74.93	.00	62.01	300.00
*	.80	67.96	188.23	67.45	.00	58.21	300.00
*	.80	57.41	188.16	57.23	.00	53.69	300.00
*	.80	44.98	187.98	44.98	.00	43.04	300.00
*	.80	37.26	187.93	37.26	.00	41.37	300.00
	1.10	262.16	190.55	18.28	.00	184.50	300.00
*	1.10	75.87	189.06	9.63	.00	142.78	300.00
*	1.10	67.96	189.00	9.08	.00	140.92	300.00
*	1.10	57.41	188.91	8.13	.00	132.35	300.00
*	1.10	44.98	188.80	6.80	.00	122.78	300.00
*	1.10	37.26	188.70	6.04	.00	113.46	300.00
*	1.64	254.96	190.82	133.56	.00	97.04	540.00
*	1.64	73.30	189.83	60.13	.00	58.98	540.00
*	1.64	66.66	189.78	55.76	.00	56.35	540.00
*	1.64	57.65	189.68	49.98	.00	51.41	540.00
*	1.64	46.59	189.54	42.43	.00	43.98	540.00
	1.64	38.96	189.45	36.50	.00	39.09	540.00
*	1.68	254.96	191.27	31.31	.00	272.38	40.00
*	1.68	73.30	189.74	73.30	.00	8.00	40.00
*	1.68	66.66	189.61	66.66	.00	8.00	40.00
*	1.68	57.65	189.56	57.65	.00	8.00	40.00
	1.68	46.59	189.51	46.59	.00	8.00	40.00

	1.68	38.96	189.45	38.96	.00	8.00	40.00
*	1.68	254.96	191.25	31.08	.00	272.27	4.00
	1.68	73.30	190.22	73.30	.00	8.00	4.00
	1.68	66.66	190.09	66.66	.00	8.00	4.00
	1.68	57.65	189.75	57.65	.00	8.00	4.00
	1.68	46.59	189.57	46.59	.00	8.00	4.00
	1.68	38.96	189.49	38.96	.00	8.00	4.00
*	1.73	254.96	191.33	116.09	.00	324.79	46.00
*	1.73	73.30	191.10	34.88	.00	320.73	46.00
*	1.73	66.66	190.90	33.23	.00	317.25	46.00
*	1.73	57.65	190.58	31.61	.00	311.98	46.00
*	1.73	46.59	190.22	30.22	.00	305.97	46.00
*	1.73	38.96	190.00	29.36	.00	301.32	46.00
*	1.90	254.96	191.17	80.76	.00	116.29	170.00
*	1.90	73.30	191.09	24.56	.00	114.34	170.00
*	1.90	66.66	190.87	25.89	.00	103.32	170.00
*	1.90	57.65	190.53	27.62	.00	80.25	170.00
*	1.90	46.59	190.16	28.25	.00	54.79	170.00
*	1.90	38.96	189.96	26.76	.00	42.02	170.00
*	1.96	254.96	191.18	254.96	.00	15.25	60.00
	1.96	73.30	191.07	73.30	.00	15.25	60.00
	1.96	66.66	190.88	66.66	.00	15.25	60.00
*	1.96	57.65	190.58	57.65	.00	15.25	60.00
*	1.96	46.59	190.33	46.59	.00	15.25	60.00
*	1.96	38.96	190.21	38.96	.00	15.25	60.00
	2.00	254.96	192.06	254.96	.00	15.25	40.00
	2.00	73.30	191.09	73.30	.00	15.25	40.00
	2.00	66.66	190.90	66.66	.00	15.25	40.00
	2.00	57.65	190.60	57.65	.00	15.25	40.00
	2.00	46.59	190.36	46.59	.00	15.25	40.00
	2.00	38.96	190.23	38.96	.00	15.25	40.00
*	2.06	192.29	193.44	45.73	.00	171.18	60.00
	2.06	53.31	191.27	28.68	.00	149.96	60.00
*	2.06	48.51	190.99	36.30	.00	148.11	60.00
*	2.06	41.94	190.62	41.40	.00	48.41	60.00
*	2.06	33.77	190.39	33.77	.00	15.86	60.00
*	2.06	28.18	190.29	28.18	.00	14.83	60.00
*	2.30	192.29	193.42	55.79	.00	111.38	240.00
*	2.30	53.31	191.88	37.96	.00	77.40	240.00
*	2.30	48.51	191.79	36.41	.00	65.11	240.00
*	2.30	41.94	191.79	31.47	.00	65.15	240.00
*	2.30	33.77	191.72	26.40	.00	54.28	240.00
*	2.30	28.18	191.59	23.25	.00	36.55	240.00
*	2.43	192.29	193.58	23.45	.00	159.04	130.00
*	2.43	53.31	192.39	14.42	.00	136.77	130.00
*	2.43	48.51	192.34	14.17	.00	135.15	130.00
*	2.43	41.94	192.24	14.30	.00	132.30	130.00
*	2.43	33.77	192.11	14.29	.00	129.01	130.00
	2.43	28.18	192.00	15.27	.00	124.85	130.00
*	2.58	185.24	193.51	92.37	.00	96.09	150.00
*	2.58	52.40	192.64	39.66	.00	47.69	150.00
*	2.58	46.98	192.57	36.88	.00	46.21	150.00
*	2.58	40.20	192.49	32.95	.00	44.57	150.00
*	2.58	32.29	192.38	28.14	.00	42.36	150.00
*	2.58	26.86	192.27	24.99	.00	40.09	150.00
*	2.62	185.24	193.67	105.92	.00	95.71	40.00
	2.62	52.40	192.73	52.40	.00	9.20	40.00
	2.62	46.98	192.68	46.98	.00	9.20	40.00
	2.62	40.20	192.62	40.20	.00	9.20	40.00
*	2.62	32.29	192.57	32.29	.00	9.20	40.00
*	2.62	26.86	192.53	26.86	.00	9.20	40.00
*	2.63	185.24	194.10	71.53	146.58	129.86	10.00
*	2.63	52.40	193.30	31.79	.00	98.30	10.00
*	2.63	46.98	193.15	30.61	.00	96.85	10.00
*	2.63	40.20	193.00	25.16	.00	95.37	10.00
	2.63	32.29	192.73	32.29	.00	9.20	10.00
	2.63	26.86	192.65	26.86	.00	9.20	10.00
	2.66	185.24	194.11	88.37	.00	98.14	30.00
*	2.66	52.40	193.35	32.89	.00	82.05	30.00
*	2.66	46.98	193.21	31.67	.00	78.97	30.00
*	2.66	40.20	193.02	30.00	.00	75.36	30.00
*	2.66	32.29	192.83	26.13	.00	65.01	30.00

	2.66	26.86	192.71	22.82	.00	57.79	30.00
*	2.69	185.24	194.27	22.48	.00	277.88	35.00
*	2.69	52.40	193.40	10.81	.00	262.10	35.00
*	2.69	46.98	193.26	11.25	.00	258.73	35.00
*	2.69	40.20	193.08	11.95	.00	254.83	35.00
*	2.69	32.29	192.89	12.41	.00	226.83	35.00
*	2.69	26.86	192.68	26.86	.00	9.00	35.00
	2.71	185.24	194.29	21.98	177.28	278.28	15.00
*	2.71	52.40	193.62	8.77	25.98	268.09	15.00
*	2.71	46.98	193.55	8.27	16.71	266.49	15.00
*	2.71	40.20	193.45	7.70	6.46	264.02	15.00
*	2.71	32.29	193.08	32.29	.00	9.00	15.00
*	2.71	26.86	192.72	26.86	.00	9.00	15.00
*	2.75	138.22	194.29	25.36	.00	182.49	40.00
*	2.75	38.62	193.62	10.06	.00	169.71	40.00
*	2.75	35.11	193.55	9.60	.00	167.99	40.00
*	2.75	30.30	193.45	8.98	.00	165.34	40.00
*	2.75	24.17	193.27	8.29	.00	127.46	40.00
*	2.75	20.00	192.94	9.57	.00	108.84	40.00
*	2.95	138.22	194.32	41.44	.00	98.90	200.00
*	2.95	38.62	193.64	15.37	.00	84.22	200.00
*	2.95	35.11	193.57	14.47	.00	81.78	200.00
*	2.95	30.30	193.46	13.22	.00	78.04	200.00
*	2.95	24.17	193.29	11.60	.00	72.28	200.00
*	2.95	20.00	192.99	11.65	.00	53.71	200.00
*	3.05	138.22	194.40	11.10	.00	168.06	100.00
*	3.05	38.62	193.67	4.40	.00	139.01	100.00
*	3.05	35.11	193.60	4.13	.00	134.30	100.00
*	3.05	30.30	193.49	3.75	.00	127.11	100.00
*	3.05	24.17	193.32	3.25	.00	115.68	100.00
*	3.05	20.00	193.05	3.15	.00	96.85	100.00
*	3.35	138.22	194.44	135.82	.00	83.74	300.00
*	3.35	38.62	193.69	38.62	.00	42.06	300.00
*	3.35	35.11	193.62	35.10	.00	39.73	300.00
*	3.35	30.30	193.51	30.30	.00	36.13	300.00
*	3.35	24.17	193.33	24.17	.00	30.21	300.00
*	3.35	20.00	193.19	20.00	.00	25.63	300.00
	3.55	132.93	195.12	30.03	.00	67.78	200.00
	3.55	38.59	194.33	12.26	.00	43.95	200.00
	3.55	34.88	194.28	11.31	.00	42.81	200.00
	3.55	30.00	194.23	10.03	.00	41.08	200.00
*	3.55	24.09	194.16	8.32	.00	39.27	200.00
*	3.55	20.05	194.12	7.11	.00	37.84	200.00
*	3.75	132.93	195.69	15.12	.00	165.07	200.00
*	3.75	38.59	194.80	6.91	.00	98.72	200.00
*	3.75	34.88	194.74	6.51	.00	94.19	200.00
*	3.75	30.00	194.66	5.87	.00	88.92	200.00
	3.75	24.09	194.55	5.09	.00	81.17	200.00
	3.75	20.05	194.48	4.51	.00	75.19	200.00
*	3.80	132.93	196.14	31.28	.00	104.21	50.00
*	3.80	38.59	195.24	38.59	.00	6.10	50.00
*	3.80	34.88	195.14	34.88	.00	6.10	50.00
*	3.80	30.00	195.00	30.00	.00	6.10	50.00
*	3.80	24.09	194.81	24.09	.00	6.10	50.00
*	3.80	20.05	194.68	20.05	.00	6.10	50.00
*	3.81	132.93	197.41	19.44	73.51	163.01	10.00
*	3.81	38.59	195.61	38.59	.00	6.10	10.00
*	3.81	34.88	195.50	34.88	.00	6.10	10.00
*	3.81	30.00	195.36	30.00	.00	6.10	10.00
*	3.81	24.09	195.17	24.09	.00	6.10	10.00
*	3.81	20.05	195.04	20.05	.00	6.10	10.00
*	3.85	132.93	197.40	25.21	.00	135.14	40.00
*	3.85	38.59	196.65	9.72	.00	91.17	40.00
*	3.85	34.88	196.49	9.45	.00	81.08	40.00
*	3.85	30.00	196.25	9.07	.00	67.07	40.00
*	3.85	24.09	195.96	8.48	.00	50.86	40.00
*	3.85	20.05	195.74	7.67	.00	45.11	40.00
*	4.13	132.93	197.67	42.99	.00	194.86	280.00
*	4.13	38.59	196.76	21.97	.00	95.33	280.00
*	4.13	34.88	196.59	22.91	.00	76.33	280.00
*	4.13	30.00	196.55	20.56	.00	70.98	280.00
*	4.13	24.09	196.47	17.66	.00	62.62	280.00

*	4.13	20.05	196.41	15.52	.00	55.97	280.00
	4.41	66.71	198.08	7.20	.00	204.10	280.00
	4.41	18.34	197.45	3.24	.00	122.58	280.00
*	4.41	16.56	197.47	2.86	.00	125.74	280.00
*	4.41	14.26	197.42	2.60	.00	117.98	280.00
*	4.41	11.37	197.35	2.23	.00	108.01	280.00
*	4.41	9.39	197.29	1.96	.00	100.51	280.00
*	4.50	66.71	198.17	10.38	.00	82.40	90.00
*	4.50	18.34	197.60	4.91	.00	47.39	90.00
*	4.50	16.56	197.58	4.51	.00	46.48	90.00
*	4.50	14.26	197.53	4.10	.00	43.38	90.00
*	4.50	11.37	197.46	3.55	.00	38.99	90.00
*	4.50	9.39	197.40	3.20	.00	34.72	90.00
	4.65	66.71	199.07	21.70	.00	75.35	150.00
	4.65	18.34	198.64	9.16	.00	47.04	150.00
	4.65	16.56	198.59	8.71	.00	44.27	150.00
	4.65	14.26	198.55	7.85	.00	41.84	150.00
	4.65	11.37	198.50	6.72	.00	38.12	150.00
*	4.65	9.39	198.46	5.80	.00	35.97	150.00
*	4.48	66.71	199.69	8.59	.00	113.21	190.00
*	4.48	18.34	199.08	3.53	.00	71.58	190.00
*	4.48	16.56	199.05	3.29	.00	69.12	190.00
*	4.48	14.26	198.99	2.97	.00	65.19	190.00
*	4.48	11.37	198.92	2.54	.00	60.12	190.00
*	4.48	9.39	198.86	2.23	.00	55.87	190.00
*	4.97	66.71	199.91	13.08	.00	89.60	130.00
*	4.97	18.34	199.30	5.53	.00	52.38	130.00
*	4.97	16.56	199.26	5.16	.00	50.10	130.00
*	4.97	14.26	199.21	4.67	.00	46.90	130.00
*	4.97	11.37	199.13	4.00	.00	42.49	130.00
*	4.97	9.39	199.08	3.51	.00	39.07	130.00
	5.12	66.71	200.58	19.44	.00	58.24	150.00
	5.12	18.34	199.98	7.92	.00	32.70	150.00
	5.12	16.56	199.95	7.32	.00	31.54	150.00
	5.12	14.26	199.90	6.50	.00	30.02	150.00
	5.12	11.37	199.82	5.44	.00	27.83	150.00
	5.12	9.39	199.76	4.67	.00	26.11	150.00
*	5.30	66.71	201.33	14.23	.00	58.92	180.00
	5.30	18.34	200.60	5.79	.00	36.29	180.00
	5.30	16.56	200.56	5.38	.00	34.94	180.00
	5.30	14.26	200.50	4.85	.00	32.85	180.00
	5.30	11.37	200.40	4.13	.00	30.10	180.00
	5.30	9.39	200.33	3.60	.00	27.91	180.00
*	5.50	66.71	202.72	12.95	.00	48.09	200.00
*	5.50	18.34	202.11	6.19	.00	19.34	200.00
*	5.50	16.56	202.07	5.83	.00	17.47	200.00
*	5.50	14.26	201.99	5.42	.00	13.92	200.00
*	5.50	11.37	201.88	4.68	.00	12.46	200.00
*	5.50	9.39	201.81	4.07	.00	11.58	200.00
*	5.75	66.71	203.93	11.50	.00	83.68	250.00
*	5.75	18.34	203.26	4.77	.00	51.20	250.00
*	5.75	16.56	203.21	4.44	.00	49.33	250.00
*	5.75	14.26	203.17	3.99	.00	46.77	250.00
*	5.75	11.37	203.09	3.40	.00	42.95	250.00
*	5.75	9.39	203.02	2.98	.00	39.72	250.00
	5.85	66.71	204.12	8.94	.00	103.02	100.00
	5.85	18.34	203.48	4.12	.00	60.44	100.00
	5.85	16.56	203.43	3.89	.00	57.23	100.00
	5.85	14.26	203.39	3.52	.00	53.89	100.00
	5.85	11.37	203.31	3.04	.00	48.81	100.00
	5.85	9.39	203.25	2.68	.00	44.93	100.00
*	5.95	66.71	204.36	18.50	.00	75.74	100.00
*	5.95	18.34	203.83	7.75	.00	50.61	100.00
	5.95	16.56	203.80	7.16	.00	48.91	100.00
	5.95	14.26	203.76	6.39	.00	46.20	100.00
	5.95	11.37	203.69	5.37	.00	42.55	100.00
	5.95	9.39	203.65	4.62	.00	39.75	100.00
	6.18	66.71	205.41	11.13	.00	91.65	230.00
	6.18	18.34	204.88	4.61	.00	56.29	230.00
	6.18	16.56	204.84	4.31	.00	54.00	230.00
	6.18	14.26	204.79	3.89	.00	50.87	230.00
	6.18	11.37	204.73	3.33	.00	46.41	230.00

	6.18	9.39	204.67	2.92	.00	42.88	230.00
	6.35	66.71	206.08	10.65	.00	100.40	170.00
	6.35	18.34	205.56	4.60	.00	60.48	170.00
	6.35	16.56	205.53	4.30	.00	58.09	170.00
	6.35	14.26	205.48	3.87	.00	54.86	170.00
	6.35	11.37	205.42	3.30	.00	50.29	170.00
	6.35	9.39	205.38	2.88	.00	46.80	170.00
*	6.45	66.71	206.62	50.99	.00	67.92	100.00
*	6.45	18.34	206.14	18.03	.00	30.53	100.00
*	6.45	16.56	206.11	16.40	.00	28.44	100.00
*	6.45	14.26	206.08	14.25	.00	25.43	100.00
*	6.45	11.37	206.02	11.37	.00	21.63	100.00
*	6.45	9.39	205.98	9.39	.00	19.23	100.00
*	6.67	66.71	207.75	10.83	.00	97.64	220.00
*	6.67	18.34	207.17	4.45	.00	60.66	220.00
*	6.67	16.56	207.13	4.15	.00	58.35	220.00
*	6.67	14.26	207.08	3.73	.00	55.15	220.00
*	6.67	11.37	207.00	3.21	.00	50.19	220.00
*	6.67	9.39	206.94	2.79	.00	46.90	220.00
*	6.83	66.71	208.30	15.46	.00	80.40	160.00
*	6.83	18.34	207.73	6.92	.00	34.08	160.00
*	6.83	16.56	207.70	6.43	.00	32.72	160.00
*	6.83	14.26	207.65	5.78	.00	30.77	160.00
*	6.83	11.37	207.59	4.86	.00	28.43	160.00
*	6.83	9.39	207.53	4.25	.00	26.06	160.00
*	6.92	66.71	208.93	50.50	.00	43.75	90.00
	6.92	18.34	208.40	16.90	.00	26.21	90.00
	6.92	16.56	208.37	15.44	.00	25.08	90.00
	6.92	14.26	208.32	13.50	.00	23.50	90.00
	6.92	11.37	208.25	11.01	.00	21.07	90.00
	6.92	9.39	208.20	9.19	.00	19.59	90.00
*	7.04	66.71	209.78	12.73	.00	96.34	120.00
*	7.04	18.34	209.03	5.47	.00	55.28	120.00
*	7.04	16.56	208.99	5.10	.00	52.96	120.00
*	7.04	14.26	208.93	4.60	.00	49.71	120.00
*	7.04	11.37	208.84	3.91	.00	45.48	120.00
	7.04	9.39	208.78	3.46	.00	41.34	120.00
*	7.12	66.71	210.00	16.10	.00	72.10	80.00
*	7.12	18.34	209.36	6.86	.00	40.45	80.00
*	7.12	16.56	209.33	6.34	.00	39.08	80.00
*	7.12	14.26	209.28	5.72	.00	36.52	80.00
*	7.12	11.37	209.21	4.90	.00	32.78	80.00
*	7.12	9.39	209.18	4.21	.00	30.85	80.00
	7.20	66.71	210.44	65.58	.00	60.46	80.00
*	7.20	18.34	209.96	18.34	.00	45.02	80.00
*	7.20	16.56	209.93	16.56	.00	42.77	80.00
*	7.20	14.26	209.89	14.26	.00	40.56	80.00
*	7.20	11.37	209.83	11.37	.00	37.45	80.00
*	7.20	9.39	209.78	9.39	.00	34.61	80.00
*	7.28	66.71	210.89	19.04	.00	58.53	80.00
*	7.28	18.34	210.42	7.20	.00	37.67	80.00
*	7.28	16.56	210.41	6.60	.00	36.90	80.00
*	7.28	14.26	210.36	5.88	.00	35.06	80.00
*	7.28	11.37	210.30	4.97	.00	32.09	80.00
	7.28	9.39	210.26	4.28	.00	30.05	80.00
*	7.40	66.71	211.91	12.41	.00	99.25	120.00
*	7.40	18.34	211.28	5.27	.00	58.03	120.00
*	7.40	16.56	211.23	4.93	.00	55.45	120.00
*	7.40	14.26	211.18	4.46	.00	51.83	120.00
*	7.40	11.37	211.11	3.80	.00	47.42	120.00
*	7.40	9.39	211.05	3.32	.00	43.81	120.00
	7.52	66.71	212.36	65.75	.00	62.21	120.00
	7.52	18.34	211.91	18.34	.00	43.24	120.00
	7.52	16.56	211.88	16.56	.00	41.43	120.00
	7.52	14.26	211.84	14.26	.00	39.28	120.00
	7.52	11.37	211.79	11.37	.00	35.80	120.00
	7.52	9.39	211.75	9.39	.00	33.23	120.00
*	7.68	66.71	213.56	18.08	.00	62.62	160.00
	7.68	18.34	213.10	6.77	.00	41.19	160.00
	7.68	16.56	213.08	6.27	.00	39.78	160.00
	7.68	14.26	213.03	5.61	.00	37.55	160.00
	7.68	11.37	212.97	4.72	.00	34.70	160.00

	7.68	9.39	212.92	4.08	.00	32.35	160.00
*	7.78	66.71	214.72	57.37	.00	49.22	100.00
	7.78	18.34	214.03	18.34	.00	17.23	100.00
*	7.78	16.56	213.99	16.56	.00	15.95	100.00
*	7.78	14.26	213.95	14.26	.00	15.10	100.00
*	7.78	11.37	213.87	11.37	.00	13.82	100.00
*	7.78	9.39	213.81	9.39	.00	12.89	100.00
	7.76	66.71	215.53	34.66	.00	46.19	80.00
*	7.76	18.34	214.87	12.02	.00	28.33	80.00
*	7.76	16.56	214.82	11.10	.00	27.00	80.00
*	7.76	14.26	214.76	9.84	.00	25.31	80.00
*	7.76	11.37	214.67	8.19	.00	22.98	80.00
*	7.76	9.39	214.60	7.03	.00	21.04	80.00
*	8.03	66.71	216.85	54.92	.00	46.29	170.00
*	8.03	18.34	216.20	18.06	.00	22.15	170.00
*	8.03	16.56	216.17	16.38	.00	21.17	170.00
*	8.03	14.26	216.12	14.18	.00	19.48	170.00
*	8.03	11.37	216.06	11.37	.00	17.09	170.00
*	8.03	9.39	216.01	9.39	.00	15.39	170.00
*	8.22	66.71	218.89	50.19	.00	47.01	190.00
	8.22	18.34	218.30	17.41	.00	24.51	190.00
	8.22	16.56	218.26	15.92	.00	22.96	190.00
	8.22	14.26	218.22	13.88	.00	21.20	190.00
	8.22	11.37	218.15	11.24	.00	18.83	190.00
	8.22	9.39	218.09	9.35	.00	16.89	190.00
*	8.30	49.68	219.58	11.08	.00	67.27	80.00
	8.30	11.92	218.86	4.16	.00	37.84	80.00
	8.30	10.71	218.82	3.86	.00	36.26	80.00
	8.30	9.15	218.76	3.46	.00	33.85	80.00
	8.30	7.32	218.67	2.97	.00	30.51	80.00
	8.30	6.04	218.61	2.61	.00	27.94	80.00
*	8.42	49.68	220.11	49.62	.00	38.79	120.00
*	8.42	11.92	219.65	11.92	.00	22.24	120.00
*	8.42	10.71	219.62	10.71	.00	21.31	120.00
*	8.42	9.15	219.59	9.15	.00	20.01	120.00
*	8.42	7.32	219.54	7.31	.00	18.30	120.00
*	8.42	6.04	219.50	6.04	.00	16.95	120.00
*	8.55	49.68	221.40	12.42	.00	58.47	130.00
*	8.55	11.92	220.85	4.44	.00	34.57	130.00
*	8.55	10.71	220.82	4.11	.00	33.19	130.00
*	8.55	9.15	220.77	3.65	.00	31.37	130.00
*	8.55	7.32	220.72	3.09	.00	28.88	130.00
*	8.55	6.04	220.68	2.67	.00	26.90	130.00
*	8.58	49.68	222.32	11.59	.00	55.01	30.00
*	8.58	11.92	221.46	11.92	.00	3.70	30.00
*	8.58	10.71	221.39	10.71	.00	3.70	30.00
*	8.58	9.15	221.29	9.15	.00	3.70	30.00
*	8.58	7.32	221.17	7.31	.00	3.70	30.00
*	8.58	6.04	221.08	6.04	.00	3.70	30.00
*	8.59	49.68	223.51	6.85	19.01	97.91	10.00
*	8.59	11.92	221.98	11.92	.00	3.70	10.00
*	8.59	10.71	221.89	10.71	.00	3.70	10.00
*	8.59	9.15	221.75	9.15	.00	3.70	10.00
*	8.59	7.32	221.58	7.31	.00	3.70	10.00
*	8.59	6.04	221.45	6.04	.00	3.70	10.00
	8.64	49.68	223.51	46.95	.00	75.14	50.00
*	8.64	11.92	222.20	11.91	.00	51.52	50.00
*	8.64	10.71	222.08	10.71	.00	49.45	50.00
*	8.64	9.15	221.93	9.15	.00	45.27	50.00
*	8.64	7.32	221.74	7.31	.00	37.87	50.00
*	8.64	6.04	221.61	6.04	.00	32.42	50.00
*	8.73	49.68	223.40	16.59	.00	40.11	90.00
*	8.73	11.92	222.60	6.34	.00	19.95	90.00
*	8.73	10.71	222.56	5.84	.00	19.10	90.00
*	8.73	9.15	222.52	5.15	.00	18.03	90.00
*	8.73	7.32	222.46	4.32	.00	16.51	90.00
*	8.73	6.04	222.41	3.72	.00	15.28	90.00
*	8.89	49.68	224.75	38.43	.00	40.74	160.00
	8.89	11.92	224.20	11.59	.00	19.93	160.00
*	8.89	10.71	224.17	10.50	.00	18.71	160.00
*	8.89	9.15	224.12	9.06	.00	16.92	160.00
*	8.89	7.32	224.07	7.31	.00	14.68	160.00

*	8.89	6.04	224.02	6.04	.00	12.97	160.00
*	9.05	49.68	225.92	13.58	.00	62.17	160.00
	9.05	11.92	225.21	5.01	.00	34.14	160.00
	9.05	10.71	225.18	4.64	.00	32.59	160.00
	9.05	9.15	225.13	4.13	.00	30.54	160.00
	9.05	7.32	225.06	3.50	.00	27.87	160.00
	9.05	6.04	225.01	3.04	.00	25.66	160.00
*	9.21	49.68	227.01	17.21	.00	58.87	160.00
*	9.21	11.92	226.52	6.75	.00	32.32	160.00
*	9.21	10.71	226.49	6.28	.00	30.78	160.00
*	9.21	9.15	226.45	5.64	.00	28.61	160.00
*	9.21	7.32	226.40	4.84	.00	25.71	160.00
*	9.21	6.04	226.35	4.23	.00	23.32	160.00
*	9.38	49.68	227.88	9.62	.00	94.69	170.00
*	9.38	11.92	227.23	3.54	.00	55.61	170.00
*	9.38	10.71	227.19	3.27	.00	53.44	170.00
*	9.38	9.15	227.14	2.93	.00	50.32	170.00
*	9.38	7.32	227.07	2.49	.00	46.11	170.00
*	9.38	6.04	227.01	2.17	.00	42.77	170.00
*	9.55	49.68	228.31	10.78	.00	61.84	170.00
*	9.55	11.92	227.71	4.52	.00	39.66	170.00
*	9.55	10.71	227.68	4.22	.00	37.54	170.00
*	9.55	9.15	227.63	3.79	.00	34.82	170.00
*	9.55	7.32	227.58	3.24	.00	31.38	170.00
*	9.55	6.04	227.53	2.83	.00	28.77	170.00
	9.73	49.68	229.39	16.87	.00	46.42	180.00
	9.73	11.92	228.89	5.46	.00	29.82	180.00
*	9.73	10.71	228.85	5.00	.00	28.91	180.00
*	9.73	9.15	228.81	4.41	.00	27.49	180.00
*	9.73	7.32	228.75	3.68	.00	25.50	180.00
*	9.73	6.04	228.69	3.16	.00	23.92	180.00
*	9.90	49.68	230.91	29.36	.00	40.31	170.00
*	9.90	11.92	230.32	10.53	.00	19.52	170.00
*	9.90	10.71	230.29	9.68	.00	18.19	170.00
*	9.90	9.15	230.23	8.56	.00	16.11	170.00
*	9.90	7.32	230.15	7.11	.00	13.35	170.00
*	9.90	6.04	230.10	5.99	.00	11.48	170.00
*	10.03	49.68	231.62	11.66	.00	51.43	130.00
*	10.03	11.92	230.90	4.14	.00	31.34	130.00
*	10.03	10.71	230.86	3.82	.00	30.23	130.00
*	10.03	9.15	230.81	3.41	.00	28.54	130.00
*	10.03	7.32	230.73	2.88	.00	26.46	130.00
*	10.03	6.04	230.67	2.50	.00	24.60	130.00
*	10.09	49.68	232.18	24.69	.00	19.77	60.00
*	10.09	11.92	231.21	11.92	.00	3.25	60.00
*	10.09	10.71	231.13	10.71	.00	3.25	60.00
*	10.09	9.15	231.03	9.15	.00	3.25	60.00
*	10.09	7.32	230.90	7.31	.00	3.25	60.00
*	10.09	6.04	230.81	6.04	.00	3.25	60.00
*	10.10	49.68	233.21	15.50	24.26	53.34	8.00
	10.10	11.92	231.64	11.92	.00	3.25	8.00
	10.10	10.71	231.54	10.71	.00	3.25	8.00
	10.10	9.15	231.41	9.15	.00	3.25	8.00
	10.10	7.32	231.25	7.31	.00	3.25	8.00
	10.10	6.04	231.13	6.04	.00	3.25	8.00
*	10.13	49.68	233.27	45.10	.00	72.36	32.00
*	10.13	11.92	232.03	11.92	.00	38.70	32.00
*	10.13	10.71	231.90	10.71	.00	35.92	32.00
*	10.13	9.15	231.73	9.15	.00	32.59	32.00
*	10.13	7.32	231.52	7.31	.00	28.03	32.00
*	10.13	6.04	231.37	6.04	.00	24.78	32.00
	10.19	49.68	233.28	41.06	.00	76.89	60.00
*	10.19	11.92	232.03	11.92	.00	29.32	60.00
*	10.19	10.71	231.91	10.71	.00	26.53	60.00
*	10.19	9.15	231.75	9.15	.00	23.76	60.00
*	10.19	7.32	231.55	7.31	.00	20.38	60.00
*	10.19	6.04	231.40	6.04	.00	17.92	60.00
	-2.06	49.68	193.44	9.82	.00	171.25	.00
	-2.06	11.92	191.27	5.79	.00	149.93	.00
	-2.06	10.71	190.99	7.54	.00	147.41	.00
	-2.06	9.15	190.62	9.00	.00	48.41	.00
	-2.06	7.32	190.39	7.31	.00	15.86	.00

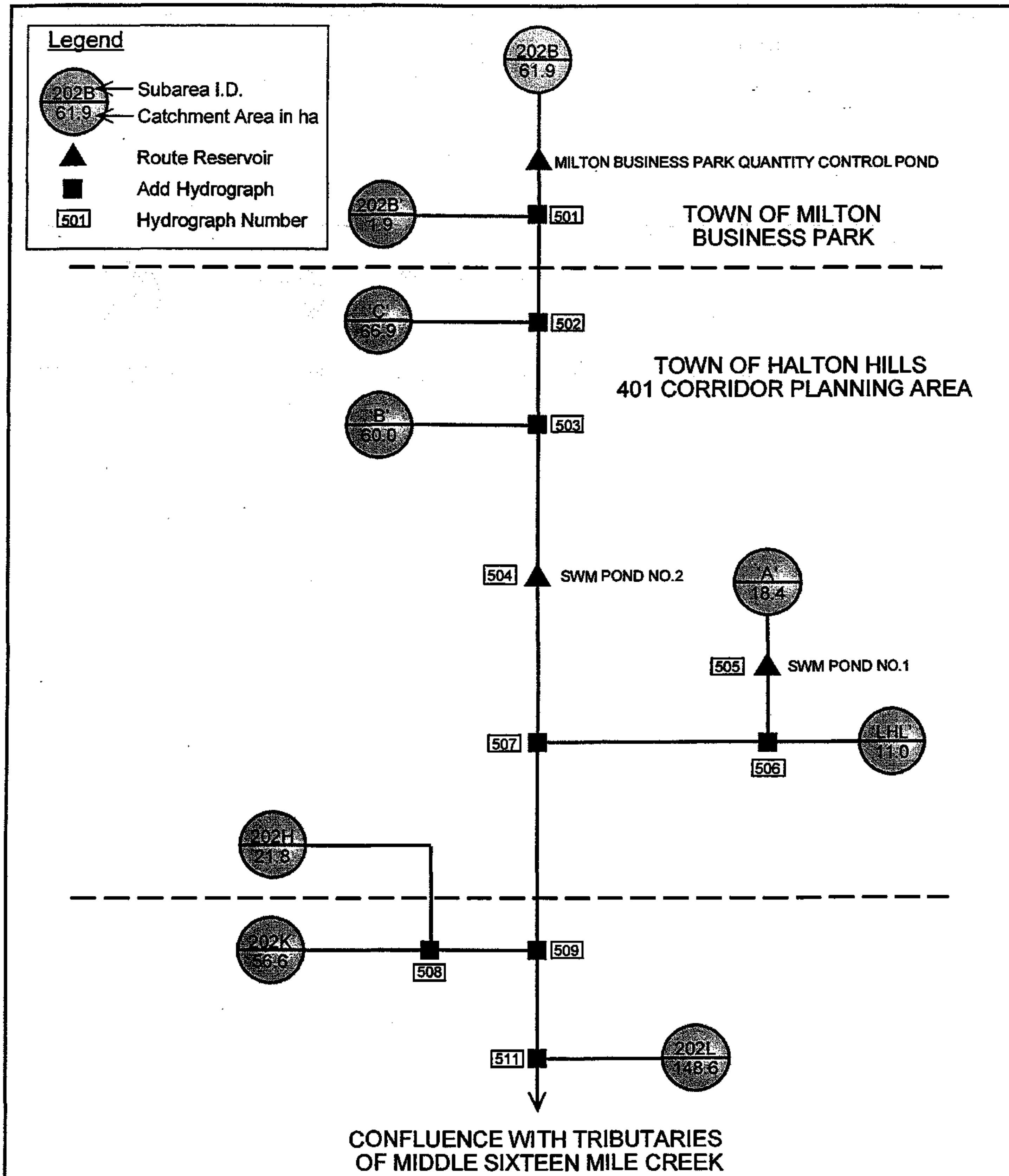
	-2.06	6.04	190.29	6.04	.00	14.83	.00
*	.08	262.16	193.38	71.02	.00	91.95	.00
*	.08	75.87	191.20	40.25	.00	77.08	.00
*	.08	67.96	191.19	36.44	.00	76.99	.00
*	.08	57.41	191.13	32.43	.00	76.54	.00
*	.08	44.98	191.02	28.38	.00	75.66	.00
*	.08	37.26	190.96	24.95	.00	65.94	.00
	.16	262.16	193.47	68.65	.00	123.96	80.00
*	.16	75.87	191.83	38.10	.00	101.99	80.00
*	.16	67.96	191.76	36.01	.00	97.67	80.00
*	.16	57.41	191.68	32.45	.00	92.80	80.00
*	.16	44.98	191.59	27.44	.00	87.57	80.00
*	.16	37.26	191.51	24.49	.00	82.88	80.00
*	.28	262.16	193.46	95.83	.00	102.89	92.00
*	.28	75.87	192.66	47.84	.00	73.89	92.00
*	.28	67.96	192.62	44.22	.00	71.43	92.00
*	.28	57.41	192.55	39.89	.00	66.47	92.00
*	.28	44.98	192.45	34.05	.00	60.23	92.00
*	.28	37.26	192.38	30.24	.00	55.28	92.00
	.40	262.16	193.87	68.24	.00	92.33	85.00
	.40	75.87	193.14	33.18	.00	90.35	85.00
	.40	67.96	193.08	31.65	.00	90.19	85.00
	.40	57.41	193.00	29.25	.00	88.73	85.00
	.40	44.98	192.88	25.84	.00	71.21	85.00
	.40	37.26	192.80	23.23	.00	59.18	85.00
	.50	262.16	194.21	37.92	.00	77.53	90.00
	.50	75.87	193.44	15.13	.00	65.68	90.00
	.50	67.96	193.38	14.04	.00	64.97	90.00
	.50	57.41	193.31	12.51	.00	63.99	90.00
	.50	44.98	193.20	10.72	.00	62.59	90.00
	.50	37.26	193.12	9.60	.00	61.53	90.00
*	.67	262.16	194.75	86.54	.00	62.63	125.00
*	.67	75.87	194.05	37.37	.00	57.38	125.00
*	.67	67.96	194.01	34.86	.00	57.04	125.00
*	.67	57.41	193.94	31.35	.00	56.14	125.00
*	.67	44.98	193.85	27.03	.00	54.85	125.00
*	.67	37.26	193.79	23.79	.00	54.11	125.00
*	.81	262.16	195.51	89.35	.00	69.77	80.00
	.81	75.87	194.57	36.97	.00	57.92	80.00
	.81	67.96	194.51	34.19	.00	56.84	80.00
	.81	57.41	194.43	30.23	.00	55.42	80.00
	.81	44.98	194.33	25.53	.00	53.34	80.00
	.81	37.26	194.25	22.62	.00	51.64	80.00
*	.94	262.16	196.06	96.89	.00	72.80	107.00
	.94	75.87	195.10	42.78	.00	44.06	107.00
	.94	67.96	195.04	39.80	.00	42.88	107.00
	.94	57.41	194.95	35.70	.00	40.35	107.00
	.94	44.98	194.84	29.83	.00	36.96	107.00
	.94	37.26	194.76	25.69	.00	35.01	107.00
*	1.04	262.16	196.85	48.83	.00	102.83	102.00
*	1.04	75.87	195.73	19.46	.00	88.86	102.00
*	1.04	67.96	195.66	18.09	.00	88.31	102.00
*	1.04	57.41	195.56	16.27	.00	87.52	102.00
*	1.04	44.98	195.43	14.21	.00	86.42	102.00
*	1.04	37.26	195.33	13.05	.00	85.61	102.00
	1.11	262.16	196.92	37.62	.00	148.21	65.00
	1.11	75.87	195.77	18.79	.00	120.48	65.00
	1.11	67.96	195.70	17.83	.00	116.45	65.00
	1.11	57.41	195.61	16.47	.00	110.90	65.00
	1.11	44.98	195.48	14.93	.00	103.54	65.00
	1.11	37.26	195.40	14.00	.00	98.52	65.00
	1.14	262.16	196.92	43.54	.00	148.44	28.00
*	1.14	75.87	196.40	15.20	.00	140.24	28.00
*	1.14	67.96	196.27	67.96	.00	7.70	28.00
*	1.14	57.41	196.08	57.41	.00	7.70	28.00
*	1.14	44.98	195.82	44.98	.00	7.70	28.00
*	1.14	37.26	195.63	37.26	.00	7.70	28.00
*	1.15	262.16	197.70	35.17	212.15	161.12	8.50
*	1.15	75.87	197.08	11.50	29.93	150.95	8.50
*	1.15	67.96	197.29	9.85	19.81	154.27	8.50
*	1.15	57.41	196.97	8.96	7.34	149.03	8.50
*	1.15	44.98	195.91	44.98	.00	7.70	8.50

*	1.15	37.26	195.73	37.26	.00	7.70	8.50
*	1.18	262.16	197.70	85.94	.00	116.56	33.00
*	1.18	75.87	197.08	31.24	.00	96.34	33.00
*	1.18	67.96	197.29	25.77	.00	113.30	33.00
*	1.18	57.41	196.97	24.89	.00	83.03	33.00
*	1.18	44.98	197.13	18.21	.00	102.26	33.00
*	1.18	37.26	196.81	17.48	.00	78.47	33.00
	1.30	262.16	197.95	62.69	.00	100.24	120.00
	1.30	75.87	197.20	26.47	.00	91.78	120.00
	1.30	67.96	197.34	21.52	.00	93.35	120.00
	1.30	57.41	197.07	22.33	.00	90.33	120.00
*	1.30	44.98	197.17	16.12	.00	91.41	120.00
*	1.30	37.26	196.89	16.93	.00	81.62	120.00
	1.50	262.16	198.33	79.67	.00	108.22	155.00
	1.50	75.87	197.49	29.02	.00	79.21	155.00
*	1.50	67.96	197.50	25.95	.00	79.51	155.00
*	1.50	57.41	197.36	22.79	.00	72.36	155.00
*	1.50	44.98	197.31	18.13	.00	69.65	155.00
*	1.50	37.26	197.17	15.63	.00	62.81	155.00
*	1.64	254.96	198.74	80.28	.00	86.37	140.00
*	1.64	73.30	198.02	29.00	.00	76.33	140.00
*	1.64	66.66	197.96	27.49	.00	72.48	140.00
*	1.64	57.65	197.91	24.31	.00	69.76	140.00
*	1.64	46.59	197.79	21.23	.00	61.37	140.00
*	1.64	38.96	197.77	18.13	.00	59.34	140.00
	1.73	254.96	199.34	72.28	.00	93.58	85.00
	1.73	73.30	198.61	34.21	.00	69.65	85.00
*	1.73	66.66	198.58	31.77	.00	69.09	85.00
	1.73	57.65	198.50	29.63	.00	67.19	85.00
*	1.73	46.59	198.43	26.16	.00	65.19	85.00
	1.73	38.96	198.35	24.39	.00	62.97	85.00
*	1.86	254.96	199.93	16.40	.00	978.95	100.00
*	1.86	73.30	199.37	19.34	.00	414.61	100.00
*	1.86	66.66	199.34	19.31	.00	390.26	100.00
*	1.86	57.65	199.32	18.14	.00	369.46	100.00
*	1.86	46.59	199.30	15.99	.00	348.20	100.00
*	1.86	38.96	199.27	15.32	.00	316.15	100.00
*	1.99	254.96	200.72	74.03	.00	107.74	90.00
*	1.99	73.30	200.06	33.48	.00	76.68	90.00
*	1.99	66.66	200.01	31.82	.00	74.65	90.00
*	1.99	57.65	199.92	29.67	.00	68.66	90.00
*	1.99	46.59	199.82	25.87	.00	62.28	90.00
*	1.99	38.96	199.75	23.01	.00	57.28	90.00
	2.11	64.73	201.65	27.48	.00	100.79	115.00
	2.11	19.98	200.75	14.56	.00	63.72	115.00
	2.11	18.15	200.71	13.61	.00	60.44	115.00
	2.11	15.72	200.65	12.25	.00	56.08	115.00
	2.11	12.82	200.54	10.66	.00	48.53	115.00
	2.11	10.78	200.45	9.41	.00	42.51	115.00
*	2.26	64.73	201.69	37.53	.00	61.62	140.00
*	2.26	19.98	200.89	16.22	.00	23.32	140.00
*	2.26	18.15	200.85	14.94	.00	22.52	140.00
*	2.26	15.72	200.79	13.19	.00	21.43	140.00
*	2.26	12.82	200.69	11.09	.00	19.70	140.00
*	2.26	10.78	200.61	9.55	.00	18.30	140.00
	2.32	64.73	201.89	35.45	.00	64.25	69.00
	2.32	19.98	201.09	15.44	.00	23.64	69.00
	2.32	18.15	201.04	14.27	.00	21.05	69.00
	2.32	15.72	200.97	12.62	.00	18.67	69.00
	2.32	12.82	200.87	10.53	.00	17.57	69.00
	2.32	10.78	200.79	9.02	.00	16.69	69.00
*	2.35	64.73	202.79	26.61	.00	105.14	37.00
*	2.35	19.98	201.37	19.98	.00	5.65	37.00
*	2.35	18.15	201.31	18.15	.00	5.65	37.00
*	2.35	15.72	201.21	15.72	.00	5.65	37.00
*	2.35	12.82	201.10	12.82	.00	5.65	37.00
*	2.35	10.78	201.01	10.78	.00	5.65	37.00
*	2.39	64.73	203.57	21.10	19.93	190.05	37.00
*	2.39	19.98	201.72	19.98	.00	5.65	37.00
*	2.39	18.15	201.63	18.15	.00	5.65	37.00
*	2.39	15.72	201.51	15.72	.00	5.65	37.00
*	2.39	12.82	201.36	12.82	.00	5.65	37.00

*	2.39	10.78	201.25	10.78	.00	5.65	37.00
*	2.42	64.73	203.58	30.46	.00	142.31	32.00
	2.42	19.98	202.15	13.88	.00	61.19	32.00
	2.42	18.15	202.03	13.41	.00	59.37	32.00
*	2.42	15.72	201.86	12.14	.00	40.69	32.00
*	2.42	12.82	201.54	10.74	.00	22.53	32.00
*	2.42	10.78	201.47	9.20	.00	20.58	32.00
*	2.55	64.73	203.61	58.80	.00	140.08	130.00
*	2.55	19.98	202.23	19.92	.00	78.51	130.00
*	2.55	18.15	202.14	18.13	.00	74.43	130.00
*	2.55	15.72	202.03	15.72	.00	69.19	130.00
*	2.55	12.82	201.90	12.82	.00	62.53	130.00
*	2.55	10.78	201.84	10.78	.00	58.56	130.00
*	2.75	41.12	203.62	7.13	.00	84.55	200.00
*	2.75	12.54	202.51	4.37	.00	29.95	200.00
*	2.75	11.39	202.48	4.03	.00	28.84	200.00
*	2.75	9.79	202.45	3.55	.00	27.25	200.00
*	2.75	7.94	202.41	2.96	.00	25.21	200.00
*	2.75	6.67	202.38	2.54	.00	23.66	200.00
*	2.86	41.12	204.14	10.08	.00	75.26	105.00
*	2.86	12.54	203.90	5.29	.00	52.39	105.00
*	2.86	11.39	203.88	5.00	.00	50.30	105.00
*	2.86	9.79	203.85	4.58	.00	47.15	105.00
*	2.86	7.94	203.82	4.02	.00	43.34	105.00
*	2.86	6.67	203.79	3.66	.00	39.58	105.00
*	2.90	41.12	204.41	7.80	.00	95.41	40.00
*	2.90	12.54	204.10	3.61	.00	72.02	40.00
*	2.90	11.39	204.07	3.42	.00	70.41	40.00
*	2.90	9.79	204.04	3.15	.00	67.97	40.00
*	2.90	7.94	204.01	2.75	.00	65.67	40.00
*	2.90	6.67	204.00	2.33	.00	65.33	40.00
*	2.90	41.12	204.65	6.36	32.22	113.65	3.00
*	2.90	12.54	204.30	2.64	4.48	87.99	3.00
*	2.90	11.39	204.27	2.49	3.45	85.72	3.00
*	2.90	9.79	204.22	2.27	2.16	82.19	3.00
*	2.90	7.94	204.16	2.02	.96	77.43	3.00
*	2.90	6.67	204.12	1.81	.49	74.46	3.00
*	2.93	41.12	204.57	35.00	.00	42.17	27.00
*	2.93	12.54	204.28	11.87	.00	30.18	27.00
*	2.93	11.39	204.25	10.88	.00	29.05	27.00
*	2.93	9.79	204.21	9.47	.00	27.27	27.00
*	2.93	7.94	204.15	7.80	.00	24.84	27.00
*	2.93	6.67	204.11	6.62	.00	23.37	27.00
	3.06	41.12	205.41	13.75	.00	48.96	124.00
*	3.06	12.54	204.93	6.87	.00	27.52	124.00
*	3.06	11.39	204.90	6.45	.00	26.35	124.00
*	3.06	9.79	204.86	5.83	.00	24.60	124.00
*	3.06	7.94	204.81	5.07	.00	22.32	124.00
	3.06	6.67	204.79	4.39	.00	21.27	124.00
	3.15	41.12	205.92	41.12	.00	50.05	81.00
	3.15	12.54	205.54	12.54	.00	31.34	81.00
	3.15	11.39	205.51	11.39	.00	30.01	81.00
	3.15	9.79	205.47	9.79	.00	28.00	81.00
	3.15	7.94	205.42	7.94	.00	25.38	81.00
	3.15	6.67	205.36	6.67	.00	22.89	81.00
*	3.32	41.12	207.16	25.10	.00	46.33	150.00
*	3.32	12.54	206.79	10.04	.00	26.17	150.00
*	3.32	11.39	206.76	9.33	.00	24.72	150.00
*	3.32	9.79	206.72	8.31	.00	22.44	150.00
*	3.32	7.94	206.66	7.09	.00	19.22	150.00
*	3.32	6.67	206.61	6.20	.00	16.36	150.00
*	3.50	41.12	208.10	14.86	.00	52.22	160.00
*	3.50	12.54	207.63	7.07	.00	33.27	160.00
*	3.50	11.39	207.60	6.63	.00	31.83	160.00
*	3.50	9.79	207.55	6.00	.00	29.66	160.00
*	3.50	7.94	207.49	5.21	.00	26.83	160.00
*	3.50	6.67	207.44	4.62	.00	24.64	160.00
	3.64	41.12	208.59	36.15	.00	43.72	140.00
*	3.64	12.54	208.19	12.24	.00	29.99	140.00
*	3.64	11.39	208.17	11.17	.00	29.06	140.00
*	3.64	9.79	208.14	9.66	.00	27.87	140.00
*	3.64	7.94	208.09	7.93	.00	26.37	140.00

*	3.64	6.67	208.06	6.66	.00	25.23	140.00
	3.79	41.12	209.17	23.02	.00	56.96	120.00
	3.79	12.54	208.75	9.54	.00	34.49	120.00
*	3.79	11.39	208.74	8.82	.00	33.28	120.00
*	3.79	9.79	208.70	7.78	.00	31.48	120.00
*	3.79	7.94	208.65	6.55	.00	28.94	120.00
*	3.79	6.67	208.61	5.67	.00	26.92	120.00
*	3.92	41.12	210.04	28.27	.00	70.91	127.00
*	3.92	12.54	209.75	11.00	.00	38.59	127.00
*	3.92	11.39	209.72	10.23	.00	35.53	127.00
*	3.92	9.79	209.69	9.01	.00	32.14	127.00
*	3.92	7.94	209.64	7.60	.00	26.12	127.00
*	3.92	6.67	209.59	6.55	.00	20.82	127.00

APPENDIX G
OTTHYMO89 FUTURE CONDITION INPUT AND OUTPUT SUMMARY

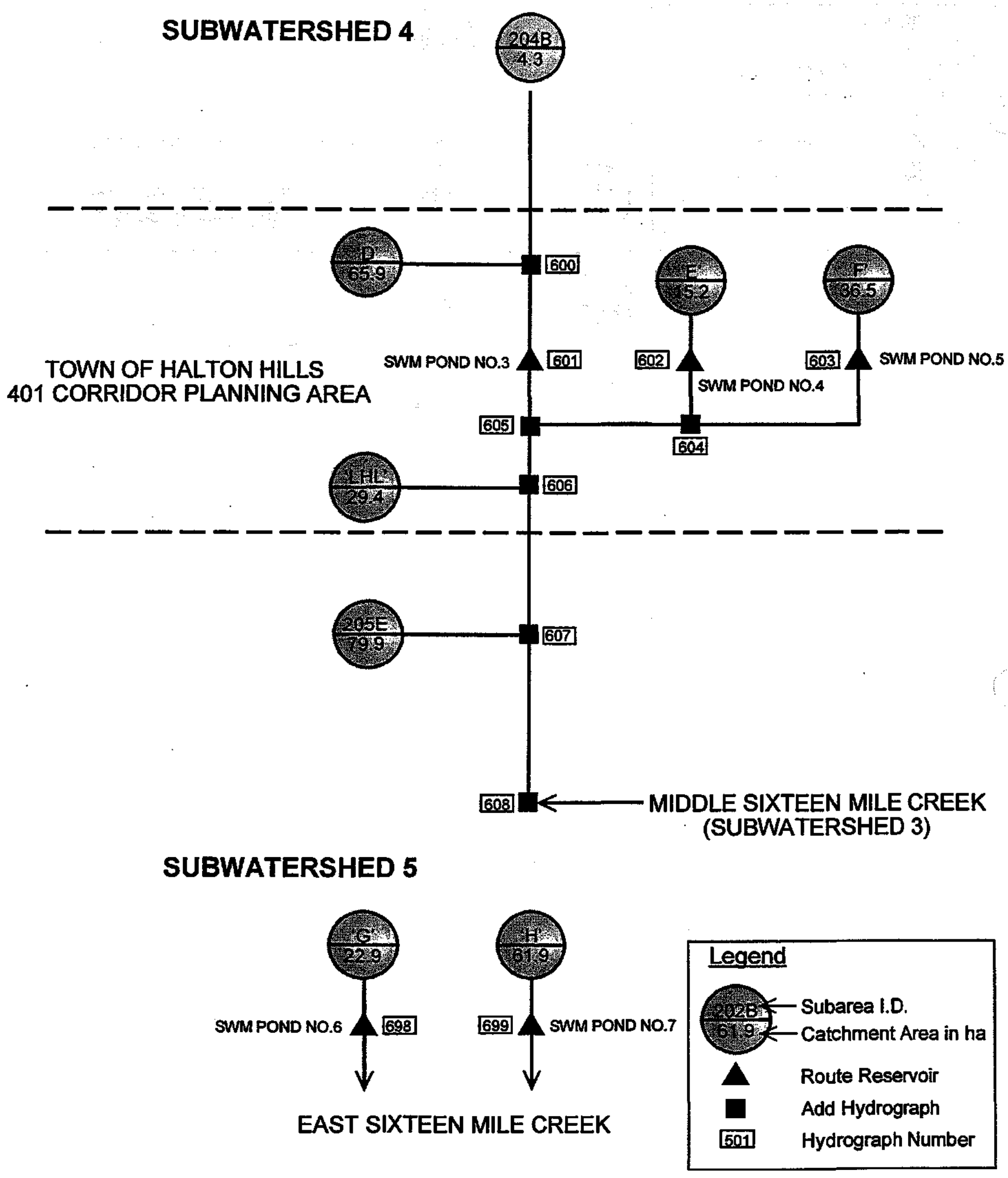


TOWN OF HALTON HILLS

DILLON CONSULTING

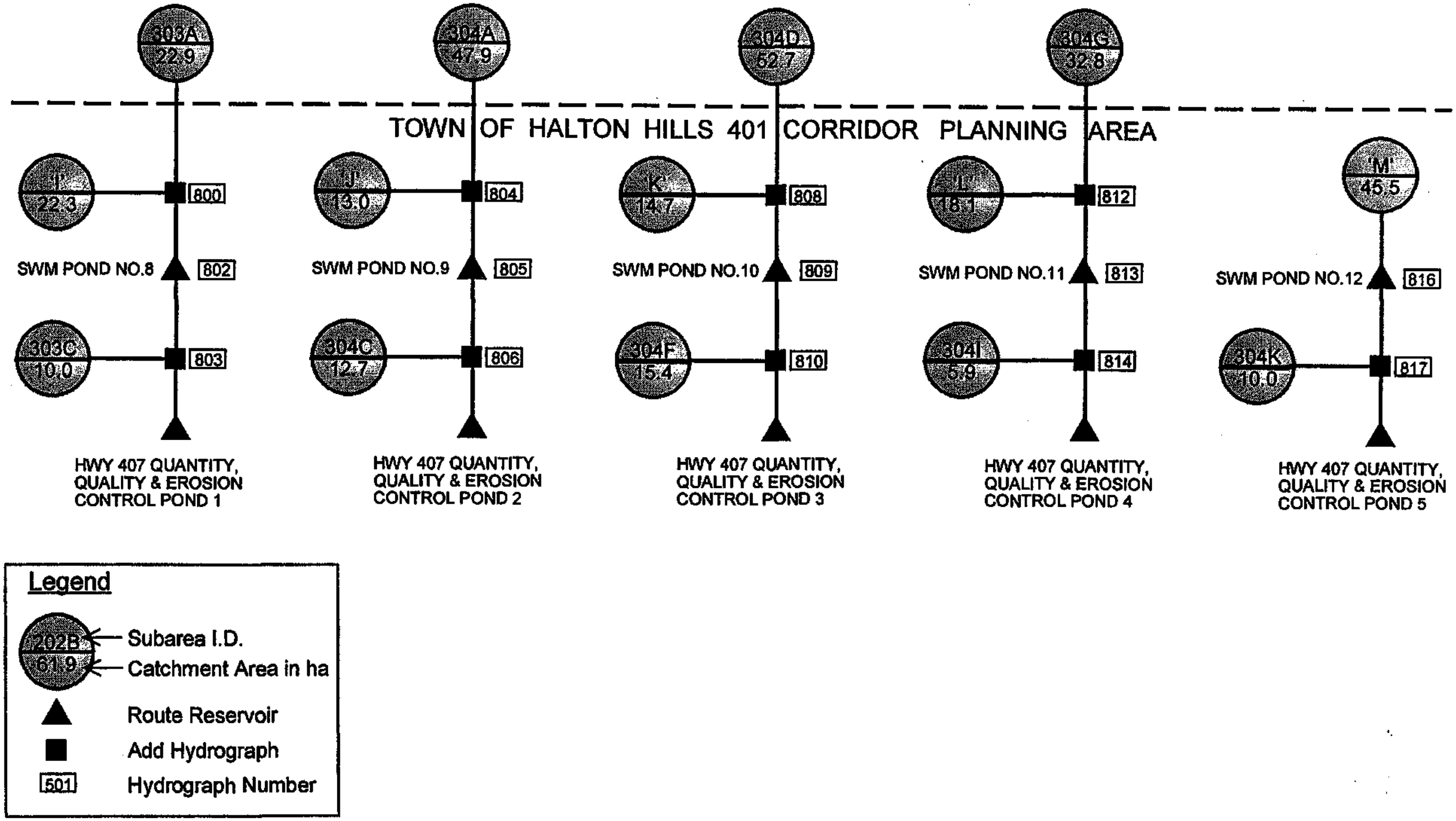
401 CORRIDOR INTEGRATED PLANNING PROJECT
SCOPED WATERSHED STUDIES

FUTURE OTTHYMO MODEL SCHEMATIC
SUBWATERSHED 3



401 CORRIDOR INTEGRATED PLANNING PROJECT
SCOPED WATERSHED STUDIES

FUTURE OTTHYMO MODEL SCHEMATIC
SUBWATERSHED 4 AND 5



TOWN OF HALTON HILLS

DILLON CONSULTING

401 CORRIDOR INTEGRATED PLANNING PROJECT
SCOPED SUBWATERSHED STUDIES

FUTURE OTTHYMO MODEL SCHEMATIC
SUBWATERSHED 6

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*****************************************************************************
*              OTTHYMO (version 89b - November 1989)
*              BY : DILLON CONSULTING LIMITED  DATE : MAY 28, 1999
*                   RJM
*
*             HWY 401 INTEGRATED PLANNING STUDY - TOWN OF HALTON HILLS
*
*             FILE : HH-FUT1.DAT - FUTURE CONDITIONS
*
*                   FUTURE CONDITIONS INCLUDING EXISTING
*                   SWM FACILITIES:
*                   MILTON BUSINESS PARK
*                   PROPOSED SWM PONDS NO.1-12
*                   HWY407/HWY401 INTERCHANGE PONDS 1 TO 5
*
*****************************************************************************
*
*       PRECIPITATION :  TOWN OF HALTON HILLS DESIGN STANDARDS
*                        COMPILATION OF TORONTO INT'L A., FERGUS SHAND DAM AND
*                        HEAT LAKE (WEIGHTED BY YEARS OF RECORD)
*                        CHICAGO RAINFALL DISTRIBUTION
*
*****************************************************************************
*
START               START= 0.0 HRS   METOUT=0  NSTORM=1  NRUN=1
                    25MM.STM
*
READ STORM          STORM.001
*
*****************************************************************************
*                        SIXTEEN MILE CREEK SUBWATERSHED 3                 *
*****************************************************************************
*
* MILTON BUSINESS PARKS INDUSTRIAL SUBDIVISION
* BASED ON OTTHYMO MODEL BY F.J. REINDERS (1988 SWM PLAN)
* URBHYD COMMAND CONVERTED TO CALIB STANDHYD
*
* SUBCATCHMENT 202B - CONTROLLED MILTON BUSINESS PARK AREA
*
CALIB STANDHYD      ID=1 NHYD=100  DT=5.0   DA= 62.27HA
                    XIMP=0.47  TIMP=0.87  DWF=0.0  LOSS=2    CN=80
                    DPSP=1.5   SLP=0.5%   LGP=80   MNP=0.25  SCP=0.0
                    DPSI=-1    SLI=0.5%   LGI=642  MNI=0.013 SCI=0.0
                    END=-1
*
ROUTE RESERVOIR     ID=2  NHYD=500  IDIN=1
                    DISCHG(CMS)     STORAGE(HA M)
                         0.000    0.000
                         0.146    0.615
                         0.179    1.473
                         0.206    2.414
                         0.790    3.377
                         1.601    3.868
                         2.152    4.114
                    -1
*
* SUBCATCHMENT 202B - UNCONTROLLED MILTON BUSINESS PARK AREA
*
CALIB STANDHYD      ID=1 NHYD=101  DT=5.0   DA= 1.91HA
                    XIMP=0.47  TIMP=0.87  DWF=0.0  LOSS=2    CN=80
                    DPSP=1.5   SLP=0.5%   LGP=80   MNP=0.25  SCP=0.0
                    DPSI=-1    SLI=0.5%   LGI=113  MNI=0.013 SCI=0.0
                    END=-1
*
ADD HYD             ID=3    NHYD=501    IDONE=1   IDTWO=2

* DRAINAGE AREA 'C' (FORMER 202F, 202G, & 202I)
*
CALIB STANDHYD      ID=1 NHYD=102  DT=5.0   DA= 66.89HA
                    XIMP=0.53  TIMP=0.67  DWF=0.0  LOSS=2   CN=82
                    DPSP=1.5   SLP=1.0%   LGP=80   MNP=0.25  SCP=0.0
                    DPSI=-1    SLI=0.5%   LGI=668  MNI=0.013 SCI=0.0
                    END=-1
*
ADD HYD             ID=2    NHYD=502    IDONE=1   IDTWO=3
*
* DRAINAGE AREA 'B' (FORMER 202E & 202D)
*
CALIB STANDHYD      ID=1 NHYD=103  DT=5.0   DA= 60.02HA
                    XIMP=0.54  TIMP=0.67  DWF=0.0  LOSS=2   CN=82
                    DPSP=1.5   SLP=1.0%   LGP=80   MNP=0.25  SCP=0.0
                    DPSI=-1    SLI=0.5%   LGI=633  MNI=0.013 SCI=0.0
                    END=-1
```

```
 *
 ADD HYD             ID=3    NHYD=503    IDONE=1   IDTWO=2
 *
 * Route Reservoir/Rating Curve
 *                       02-Jun-99
 *                     10:49:36 AM
 *                           0.364 m orifice     1.5 m depth
 *                           11.82 m weir       0.89 m depth
 *                           0.001 m weir offset above quality
 *
 *                                 Flow(cms)Storage (ha.m)    Comment
 ROUTE RESERVOIR     ID=1 NHYD=504 IDIN=3  DT=5min
                                    0.000    0.000
                                    0.156    0.845
                                    0.221    1.715
                                    0.270    2.610
                                    0.312    3.530
                                    0.349    4.476 Quality Level
                                    0.349    4.479 Weir Crest
                                    1.694    5.050
                                    4.135    5.628
                                    7.289    6.214
                                   11.021    6.808
                                   15.250    7.410 Max Weir Depth
                                     -1
 *
 * DRAINAGE AREA 'A' (FORMER 202C)
 *
 CALIB STANDHYD      ID=2 NHYD=104  DT=5.0   DA= 18.39HA
                     XIMP=0.56  TIMP=0.70  DWF=0.0  LOSS=2   CN=82
                     DPSP=1.5   SLP=1.0%   LGP=80   MNP=0.25  SCP=0.0
                     DPSI=-1    SLI=0.5%   LGI=350  MNI=0.013 SCI=0.0
                     END=-1
 *
 * Route Reservoir/Rating Curve
 *                       28-May-99
 *                     02:15:54 PM
 *                           0.156 m orifice       1 m depth
 *                            1.91 m weir       0.56 m depth
 *                           0.001 m weir offset above quality
 *
 *                                 Flow(cms)Storage (ha.m)    Comment
 *
 ROUTE RESERVOIR     ID=3 NHYD=505 IDIN=2  DT=5min
                                    0.000    0.000
                                    0.023    0.124
                                    0.033    0.254
                                    0.041    0.389
                                    0.047    0.530
                                    0.052    0.676 Quality Level
                                    0.052    0.676 Weir Crest
                                    0.162    0.760
                                    0.360    0.845
                                    0.616    0.932
                                    0.918    1.020
                                    1.260    1.110 Max Weir Depth
                                     -1
 *
 * LOCAL HAZARD LANDS (PARTS OF 202C, 202D, 202I, & 202J)
 *
 CALIB NASHYD        ID=2 NHYD=105  DT=5.0   DA=11.50 HA
                     DWF=0.0 CN=76  IA=5 N=3 TP=0.47HR END=-1
 *
 ADD HYD             ID=4    NHYD=506    IDONE=2   IDTWO=3
 *
 ADD HYD             ID=7    NHYD=507    IDONE=1   IDTWO=4
 *
 * SUBCATCHMENT 202H - STUDY AREA WITHIN JAMES SNOW PKWY INTERCHANGE
 *                     AND EXTERNAL AREA WEST OF INTERCHANGE
 *
 CALIB NASHYD        ID=1 NHYD=106  DT=5.0   DA= 21.75 HA
                     DWF=0.0 CN=82  IA=5 N=3 TP=0.80HR END=-1
 *
 * SUBCATCHMENT 202K - SOUTH OF STUDY AREA, WEST OF FIFTH LINE
 *
 CALIB NASHYD        ID=2 NHYD=107  DT=5.0   DA= 56.6 HA
                     DWF=0.0 CN=85  IA=5 N=3 TP=1.03HR END=-1
 *
 ADD HYD             ID=3    NHYD=508   IDONE=1   IDTWO=2
 *
 ADD HYD             ID=8    NHYD=509   IDONE=3   IDTWO=7
 *
 *  ROUTE SUBAREA 202L - FIFTH LINE TO OUTLET
 *
```

```
ROUTE CHANNEL        IDOUT=1        NHYD=510        IDIN=8       DT=5 MIN
                     CHLGTH=2400 M  CHSLOPE=0.25     FPSLOPE=0.25
                     VSN=1000       NSEG=3
                     N        DIST(M)
                     0.045    50
                     -0.035   57
                     0.045    107
                     DIST(M)  ELEV(M)
                     0        10.0
                     6        7.0
                     50       6.5
                     52       4.5
                     55       4.5
                     57       6.5
                     101      7.0
                     107      10.0
*
* SUBCATCHMENT 202L - SOUTH OF STUDY AREA, EAST OF FIFTH LINE
*
CALIB NASHYD         ID=2 NHYD=108  DT=5.0   DA= 148.6HA
                     DWF=0.0 CN=74  IA=5 N=3 TP=1.61HR END=-1
*
ADD HYD              ID=10   NHYD=511   IDONE=1   IDTWO=2
*
*
****************************************************************************
*                       SIXTEEN MILE CREEK SUBWATERSHED 4                  *
****************************************************************************
*
*
* WEST TRIBUTARY *
*
* SUBCATCHMENT 204B - STUDY AREA NORTH OF STEELES
*
CALIB NASHYD         ID=1 NHYD=200  DT=5.0   DA= 4.28 HA
                     DWF=0.0 CN=85  IA=5 N=3 TP=0.57HR END=-1
*
* DRAINAGE AREA 'D' - (FORMER AREAS 204C, 204D, & 202J)
*
CALIB STANDHYD       ID=2 NHYD=201  DT=5.0   DA= 65.90HA
                     XIMP=0.53  TIMP=0.66  DWF=0.0  LOSS=2   CN=82
                     DPSP=1.5   SLP=1.0%   LGP=80   MNP=0.25  SCP=0.0
                     DPSI=-1    SLI=0.5%   LGI=663  MNI=0.013 SCI=0.0
                     END=-1
*
ADD HYD              ID=3    NHYD=600   IDONE=1   IDTWO=2
*
* Route Reservoir/Rating Curve
*                         01-Jun-99
*                       08:42:06 AM
*                            0.287 m orifice        1 m depth
*                             5.70 m weir        0.61 m depth
*                            0.001 m weir offset above quality
*
*                                  Flow(cms)Storage (ha.m)    Comment
ROUTE RESERVOIR      ID=6 NHYD=601 IDIN=3  DT=5min
                                      0.000    0.000
                                      0.080    0.436
                                      0.113    0.882
                                      0.138    1.337
                                      0.159    1.803
                                      0.178    2.278 Quality Level
                                      0.178    2.280 Weir Crest
                                      0.551    2.574
                                      1.224    2.871
                                      2.092    3.171
                                      3.118    3.474
                                      4.280    3.780 Max Weir Depth
                                       -1
*
* DRAINAGE AREA 'E' - (FORMER AREAS 204E & 205C)
*
CALIB STANDHYD       ID=1 NHYD=202  DT=5.0   DA= 15.16HA
                     XIMP=0.45  TIMP=0.56  DWF=0.0  LOSS=2   CN=82
                     DPSP=1.5   SLP=1.0%   LGP=80   MNP=0.25  SCP=0.0
                     DPSI=-1    SLI=0.5%   LGI=318  MNI=0.013 SCI=0.0
                     END=-1
*
* Route Reservoir/Rating Curve
*                         01-Jun-99
*                       08:42:06 AM
*                            0.127 m orifice        1 m depth
*                             3.77 m weir        0.55 m depth
*                            0.001 m weir offset above quality
```

```
 *
 *                                Flow(cms)Storage (ha.m)    Comment
 ROUTE RESERVOIR      ID=2 NHYD=602 IDIN=1  DT=5min
                                   0.000    0.000
                                   0.016    0.081
                                   0.022    0.167
                                   0.027    0.256
                                   0.031    0.351
                                   0.035    0.449 Quality Level
                                   0.035    0.450 Weir Crest
                                   0.241    0.505
                                   0.617    0.562
                                   1.103    0.620
                                   1.678    0.680
                                   2.330    0.740 Max Weir Depth
                                    -1
 *
 * DRAINAGE AREA 'F' - (FORMER AREA 205D)
 *
 CALIB STANDHYD       ID=1 NHYD=203  DT=5.0   DA= 36.51HA
                      XIMP=0.58  TIMP=0.72  DWF=0.0  LOSS=2   CN=82
                      DPSP=1.5   SLP=1.0%   LGP=80   MNP=0.25  SCP=0.0
                      DPSI=-1    SLI=0.5%   LGI=493  MNI=0.013 SCI=0.0
                      END=-1
 *
 * Route Reservoir/Rating Curve
 *                        01-Jun-99
 *                      08:42:06 AM
 *                          0.224 m orifice       1 m depth
 *                           6.79 m weir       0.59 m depth
 *                          0.001 m weir offset above quality
 *
 *                                Flow(cms)Storage (ha.m)    Comment
 ROUTE RESERVOIR      ID=4 NHYD=603 IDIN=1  DT=5min
                                   0.000    0.000
                                   0.048    0.261
                                   0.068    0.530
                                   0.084    0.806
                                   0.096    1.091
                                   0.108    1.382 Quality Level
                                   0.108    1.384 Weir Crest
                                   0.530    1.560
                                   1.297    1.739
                                   2.289    1.920
                                   3.461    2.104
                                   4.790    2.290 Max Weir Depth
                                    -1
 *
 ADD HYD              ID=5    NHYD=604   IDONE=4   IDTWO=2
 *
 ADD HYD              ID=7    NHYD=605   IDONE=5   IDTWO=6
 *
 * LOCAL HAZARD LANDS - (PARTS OF FORMER AREAS 204C/D/E, & 205C)
 *
 CALIB NASHYD         ID=1 NHYD=204  DT=5.0   DA= 29.39HA
                      DWF=0.0 CN=72  IA=5 N=3 TP=0.74HR END=-1
 *
 ADD HYD              ID=2    NHYD=606   IDONE=1   IDTWO=7
 *
 * SUBCATCHMENT 205E - SOUTH OF STUDY AREA
 *
 CALIB NASHYD         ID=3 NHYD=205  DT=5.0   DA= 79.86 HA
                      DWF=0.0 CN=72  IA=5 N=3 TP=0.74HR END=-1
 *
 ADD HYD              ID=9    NHYD=607   IDONE=2   IDTWO=3
 *
 * ADD SUBWATERSHED 3 TO SUBWATERSHED 4 (STUDY AREA SUBCATCHMENTS ONLY)
 *
 ADD HYD              ID=1    NHYD=608   IDONE=9   IDTWO=10
 *
 ****************************************************************************
 *                        SIXTEEN MILE CREEK SUBWATERSHED 5                  *
 ****************************************************************************
 *
 * DRAINAGE AREA 'G' - (FORMER AREAS 205B & 300B)
 *
 CALIB STANDHYD       ID=2 NHYD=300  DT=5.0   DA=22.93HA
                      XIMP=0.54  TIMP=0.68  DWF=0.0  LOSS=2   CN=82
                      DPSP=1.5   SLP=1.0%   LGP=80   MNP=0.25  SCP=0.0
                      DPSI=-1    SLI=0.5%   LGI=391  MNI=0.013 SCI=0.0
                      END=-1
 *
 * Route Reservoir/Rating Curve
 *                        31-May-99
```

```
 *                      01:09:23 PM
 *                            0.171 m orifice       1 m depth
 *                             5.34 m weir        0.57 m depth
 *                            0.001 m weir offset above quality
 *
 *                                  Flow(cms)Storage (ha.m)     Comment
 ROUTE RESERVOIR      ID=3 NHYD=698 IDIN=2  DT=5min
                                       0.000     0.000
                                       0.028     0.151
                                       0.040     0.309
                                       0.049     0.472
                                       0.057     0.641
                                       0.063     0.816 Quality Level
                                       0.063     0.817 Weir Crest
                                       0.379     0.920
                                       0.953     1.025
                                       1.696     1.132
                                       2.574     1.240
                                       3.570     1.350 Max Weir Depth
                                        -1
 *
 * DRAIANGE AREA 'H' - (FORMER AREAS 300C & 300D)
 *
 CALIB STANDHYD       ID=4 NHYD=301  DT=5.0   DA= 61.89HA
                      XIMP=0.53  TIMP=0.66  DWF=0.0  LOSS=2   CN=82
                      DPSP=1.5   SLP=1.0%   LGP=80   MNP=0.25  SCP=0.0
                      DPSI=-1    SLI=0.5%   LGI=642  MNI=0.013 SCI=0.0
                      END=-1
 *
 * Route Reservoir/Rating Curve
 *                        31-May-99
 *                      01:09:23 PM
 *                            0.279 m orifice       1 m depth
 *                             7.85 m weir        0.61 m depth
 *                            0.001 m weir offset above quality
 *
 *                                  Flow(cms)Storage (ha.m)     Comment
 ROUTE RESERVOIR      ID=3 NHYD=699 IDIN=4  DT=5min
                                       0.000     0.000
                                       0.075     0.411
                                       0.106     0.831
                                       0.130     1.261
                                       0.150     1.700
                                       0.168     2.149 Quality Level
                                       0.168     2.152 Weir Crest
                                       0.678     2.429
                                       1.601     2.710
                                       2.793     2.993
                                       4.203     3.280
                                       5.800     3.570 Max Weir Depth
                                        -1
 *
 *
 *
*****************************************************************************
 *                      SIXTEEN MILE CREEK SUBWATERSHED 6                    *
*****************************************************************************
 *
 * TRIBUTARY 1
 *
 * SUBCATCHMENT 303A - UNDEVELOPED AREA NORTH OF STEELES
 *
 CALIB NASHYD         ID=1 NHYD=400  DT=5.0   DA= 22.91 HA
                      DWF=0.0 CN=82  IA=5 N=3 TP=0.72HR END=-1
 *
 * DRAINAGE AREA 'I' - (FORMER AREA 303B)
 *
 CALIB STANDHYD       ID=2 NHYD=401  DT=5.0   DA=22.33HA
                      XIMP=0.53  TIMP=0.67  DWF=0.0  LOSS=2   CN=79
                      DPSP=1.5   SLP=0.5%   LGP=10   MNP=0.25  SCP=0.0
                      DPSI=-1    SLI=0.5%   LGI=386  MNI=0.013 SCI=0.0
                      END=-1
 *
 ADD HYD              ID=3    NHYD=800    IDONE=1   IDTWO=2
 *
 * Route Reservoir/Rating Curve
 *                        31-May-99
 *                      01:09:23 PM
 *                            0.168 m orifice       1 m depth
 *                             7.22 m weir        0.57 m depth
 *                            0.001 m weir offset above quality
 *
 *                                  Flow(cms)Storage (ha.m)     Comment
 ROUTE RESERVOIR      ID=1 NHYD=801 IDIN=3  DT=5min
```

```
                                                  0.000    0.000
                                                  0.027    0.146
                                                  0.039    0.297
                                                  0.047    0.454
                                                  0.055    0.617
                                                  0.061    0.785 Quality Level
                                                  0.061    0.786 Weir Crest
                                                  0.487    0.885
                                                  1.263    0.986
                                                  2.266    1.089
                                                  3.454    1.194
                                                  4.800    1.300 Max Weir Depth
                                                   -1
*
* SUBCATCHMENT 303C - STUDY AREA - HIGHWAY 407/401 INTERCHANGE
*
CALIB STANDHYD      ID=2 NHYD=402  DT=5.0   DA= 9.99HA
                    XIMP=0.04  TIMP=0.37  DWF=0.0  LOSS=2   CN=79
                    DPSP=1.5   SLP=0.5%   LGP=10   MNP=0.25  SCP=0.0
                    DPSI=-1    SLI=0.5%   LGI=250  MNI=0.013 SCI=0.0
                    END=-1
*
ADD HYD             ID=3    NHYD=802    IDONE=1   IDTWO=2
*
*  EXISTING HIGHWAY 407/401 INTERCHANGE POND
*
ROUTE RESERVOIR     ID=1  NHYD=803  IDIN=3
                    DISCHG(CMS)     STORAGE(HA M)
                         0.000    0.000
                         0.022    0.077
                         0.031    0.153
                         0.038    0.230
                         0.044    0.307
                         0.049    0.383
                         0.053    0.460
                         0.059    0.590
                         1.170    0.783
                         3.000    1.033
                         5.100    1.283
                         8.670    1.531
                    -1
*
* TRIBUTARY 2
*
* SUBCATCHMENT 304A - UNDEVELOPED AREA NORTH OF STEELES
*
CALIB NASHYD        ID=1 NHYD=403  DT=5.0   DA= 47.88 HA
                    DWF=0.0 CN=81  IA=5 N=3 TP=0.75HR END=-1
*
* DRAINAGE AREA 'J' - (FORMER AREA 304B)
*
CALIB STANDHYD      ID=2 NHYD=404  DT=5.0   DA= 13.00HA
                    XIMP=0.53  TIMP=0.67  DWF=0.0  LOSS=2   CN=79.0
                    DPSP=1.5   SLP=0.5%   LGP=10   MNP=0.25  SCP=0.0
                    DPSI=-1    SLI=0.5%   LGI=294  MNI=0.013 SCI=0.0
                    END=-1
*
ADD HYD             ID=3    NHYD=804    IDONE=1   IDTWO=2
*
* Route Reservoir/Rating Curve
*                           31-May-99
*                         01:09:23 PM
*                               0.128 m orifice        1 m depth
*                                8.36 m weir        0.54 m depth
*                               0.001 m weir offset above quality
*
*                                     Flow(cms)Storage (ha.m)     Comment
ROUTE RESERVOIR     ID=1 NHYD=805 IDIN=3  DT=5min
                                          0.000    0.000
                                          0.016    0.083
                                          0.022    0.170
                                          0.027    0.262
                                          0.032    0.358
                                          0.035    0.459 Quality Level
                                          0.035    0.459 Weir Crest
                                          0.480    0.515
                                          1.290    0.572
                                          2.339    0.630
                                          3.581    0.690
                                          4.990    0.750 Max Weir Depth
                                           -1
*
* SUBCATCHMENT 304C - STUDY AREA - HIGHWAY 407/401 INTERCHANGE
*
```

```
 CALIB STANDHYD      ID=2 NHYD=405  DT=5.0   DA= 12.72HA
                     XIMP=0.03  TIMP=0.253  DWF=0.0  LOSS=2   CN=79.0
                     DPSP=1.5   SLP=0.5%   LGP=10   MNP=0.25  SCP=0.0
                     DPSI=-1    SLI=0.5%   LGI=220  MNI=0.013 SCI=0.0
                     END=-1
 *
 ADD HYD             ID=3    NHYD=806    IDONE=1   IDTWO=2
 *
 *  EXISTING HIGHWAY 407/401 INTERCHANGE POND
 *
 ROUTE RESERVOIR     ID=1  NHYD=807  IDIN=3
                     DISCHG(CMS)     STORAGE(HA M)
                          0.000    0.000
                          0.037    0.1125
                          0.053    0.2275
                          0.065    0.3450
                          0.075    0.4630
                          0.083    0.5800
                          1.900    0.7700
                          6.400    1.1000
                          9.200    1.2500
                     -1
 *
 * TRIBUTARY 3
 *
 * SUBCATCHMENT 304D - UNDEVELOPED AREA NORTH OF STEELES
 *
 CALIB NASHYD        ID=1 NHYD=406  DT=5.0   DA= 52.69 HA
                     DWF=0.0 CN=81  IA=5 N=3 TP=0.66HR END=-1
 *
 * DRAINAGE AREA 'K' - -(FORMER AREA 304E)
 *
 CALIB STANDHYD      ID=2 NHYD=407  DT=5.0   DA= 14.71HA
                     XIMP=0.52  TIMP=0.65  DWF=0.0  LOSS=2   CN=79.0
                     DPSP=1.5   SLP=0.5%   LGP=10   MNP=0.25  SCP=0.0
                     DPSI=-1    SLI=0.5%   LGI=313  MNI=0.013 SCI=0.0
                     END=-1
 *
 ADD HYD             ID=3    NHYD=808    IDONE=1   IDTWO=2
 *
 * Route Reservoir/Rating Curve
 *                        31-May-99
 *                      01:09:23 PM
 *                            0.135 m orifice       1 m depth
 *                             9.63 m weir       0.55 m depth
 *                            0.001 m weir offset above quality
 *
 *                                  Flow(cms)Storage (ha.m)    Comment
 ROUTE RESERVOIR     ID=1 NHYD=809 IDIN=3  DT=5min
                                       0.000    0.000
                                       0.018    0.093
                                       0.025    0.190
                                       0.031    0.292
                                       0.035    0.398
                                       0.039    0.510 Quality Level
                                       0.039    0.510 Weir Crest
                                       0.573    0.574
                                       1.547    0.638
                                       2.807    0.704
                                       4.298    0.771
                                       5.990    0.840 Max Weir Depth
                                        -1
 *
 * SUBCATCHMENT 304F - STUDY AREA - HIGHWAY 407/401 INTERCHANGE
 *
 CALIB STANDHYD      ID=2 NHYD=408  DT=5.0   DA= 15.41HA
                     XIMP=0.04  TIMP=0.442  DWF=0.0  LOSS=2   CN=79.0
                     DPSP=1.5   SLP=0.5%   LGP=10   MNP=0.25  SCP=0.0
                     DPSI=-1    SLI=0.5%   LGI=250  MNI=0.013 SCI=0.0
                     END=-1
 *
 ADD HYD             ID=3    NHYD=810    IDONE=1   IDTWO=2
 *
 *  EXISTING HIGHWAY 407/401 INTERCHANGE POND
 *
 ROUTE RESERVOIR     ID=1  NHYD=811  IDIN=3
                     DISCHG(CMS)     STORAGE(HA M)
                          0.000    0.000
                          0.045    0.075
                          0.063    0.162
                          0.089    0.246
                          0.100    0.393
                          0.118    0.560
                          0.133    0.720
```

```
                      1.680     0.883
                      3.871     10.08
                      7.383     1.200
                      9.610     1.360
                      14.25     1.880
                 -1
 *
 * TRIBUTARY 4
 *
 * SUBCATCHMENT 304G - UNDEVELOPED AREA NORTH OF STEELES
 *
 CALIB NASHYD         ID=1 NHYD=409  DT=5.0   DA= 32.76 HA
                      DWF=0.0 CN=81  IA=5 N=3 TP=0.79HR END=-1
 *
 * DRAINAGE AREA 'L' - (FORMER AREA 304H)
 *
 CALIB STANDHYD       ID=2 NHYD=410  DT=5.0   DA= 18.11HA
                      XIMP=0.53  TIMP=0.67  DWF=0.0  LOSS=2   CN=79.0
                      DPSP=1.5   SLP=0.5%   LGP=10   MNP=0.25  SCP=0.0
                      DPSI=-1    SLI=0.5%   LGI=348  MNI=0.013 SCI=0.0
                      END=-1
 *
 ADD HYD              ID=3    NHYD=812    IDONE=1   IDTWO=2
 *
 * Route Reservoir/Rating Curve
 *                        31-May-99
 *                      01:09:23 PM
 *                             0.152 m orifice       1 m depth
 *                              6.45 m weir       0.56 m depth
 *                             0.001 m weir offset above quality
 *
 *                                   Flow(cms)Storage (ha.m)    Comment
 ROUTE RESERVOIR      ID=1 NHYD=813 IDIN=3  DT=5min
                                       0.000    0.000
                                       0.022    0.118
                                       0.031    0.240
                                       0.038    0.368
                                       0.044    0.501
                                       0.050    0.640 Quality Level
                                       0.050    0.640 Weir Crest
                                       0.411    0.719
                                       1.069    0.800
                                       1.920    0.882
                                       2.928    0.965
                                       4.070    1.050 Max Weir Depth
                                        -1
 *
 * SUBCATCHMENT 304I - STUDY AREA - HIGHWAY 407/401 INTERCHANGE
 *
 CALIB STANDHYD       ID=2 NHYD=411  DT=5.0   DA= 5.88HA
                      XIMP=0.05  TIMP=0.461 DWF=0.0  LOSS=2   CN=79.0
                      DPSP=1.5   SLP=0.5%   LGP=10   MNP=0.25  SCP=0.0
                      DPSI=-1    SLI=0.5%   LGI=250  MNI=0.013 SCI=0.0
                      END=-1
 *
 ADD HYD              ID=3    NHYD=814    IDONE=1   IDTWO=2
 *
 *  EXISTING HIGHWAY 407/401 INTERCHANGE POND
 *
 ROUTE RESERVOIR      ID=1  NHYD=815  IDIN=3
                      DISCHG(CMS)     STORAGE(HA M)
                           0.000    0.000
                           0.020    0.040
                           0.035    0.154
                           0.045    0.234
                           0.054    0.316
                           0.061    0.400
                           0.068    0.500
                           0.450    0.570
                           0.930    0.575
                           1.500    0.650
                           2.600    0.730
                           5.200    1.020
                           7.700    1.200
                      -1
 *
 * TRIBUTARY 5
 *
 * DRAINAGE AREA 'M' - (FORMER AREAS 304J & 310)
 *
 CALIB STANDHYD       ID=1 NHYD=412  DT=5.0   DA= 45.47HA
                      XIMP=0.53  TIMP=0.67  DWF=0.0  LOSS=2   CN=79.0
                      DPSP=1.5   SLP=0.5%   LGP=10   MNP=0.25  SCP=0.0
                      DPSI=-1    SLI=0.5%   LGI=551  MNI=0.013 SCI=0.0
```

```
                 END=-1
 *
 * Route Reservoir/Rating Curve
 *                      31-May-99
 *                     01:09:23 PM
 *                          0.240 m orifice      1 m depth
 *                           3.40 m weir      0.60 m depth
 *                          0.001 m weir offset above quality
 *
 *                                Flow(cms)Storage (ha.m)    Comment
 ROUTE RESERVOIR     ID=2 NHYD=816 IDIN=1  DT=5min
                                    0.000    0.000
                                    0.055    0.301
                                    0.078    0.611
                                    0.096    0.928
                                    0.111    1.254
                                    0.124    1.588 Quality Level
                                    0.124    1.589 Weir Crest
                                    0.342    1.792
                                    0.733    1.998
                                    1.238    2.206
                                    1.835    2.417
                                    2.510    2.630 Max Weir Depth
                                     -1
 *
 * SUBCATCHMENT 304K - STUDY AREA - HIGHWAY 407/401 INTERCHANGE
 *
 CALIB STANDHYD      ID=1 NHYD=413  DT=5.0   DA= 9.99HA
                     XIMP=0.02  TIMP=0.212 DWF=0.0  LOSS=2   CN=79.0
                     DPSP=1.5   SLP=0.5%   LGP=10   MNP=0.25  SCP=0.0
                     DPSI=-1    SLI=0.5%   LGI=400  MNI=0.013 SCI=0.0
                     END=-1
 *
 ADD HYD             ID=3    NHYD=817   IDONE=1   IDTWO=2
 *
 *  EXISTING HIGHWAY 407/401 INTERCHANGE POND
 *
 ROUTE RESERVOIR     ID=1  NHYD=818  IDIN=2
                     DISCHG(CMS)     STORAGE(HA M)
                         0.000     0.000
                         0.023     0.050
                         0.033     0.061
                         0.040     0.871
                         0.046     0.124
                         0.051     0.340
                         1.100     0.400
                         1.980     0.430
                         2.310     0.440
                         2.920     0.460
                         3.200     0.470
                         3.770     0.490
                         7.200     0.594
                     -1
 *
 ****************************************************************************
 *
 START               START= 0.0 HRS   METOUT=0  NSTORM=1  NRUN=2
                     HHILL2.STM
 *
 START               START= 0.0 HRS   METOUT=0  NSTORM=1  NRUN=3
                     HHILL5.STM
 *
 START               START= 0.0 HRS   METOUT=0  NSTORM=1  NRUN=4
                     HHILL10.STM
 *
 START               START= 0.0 HRS   METOUT=0  NSTORM=1  NRUN=5
                     HHILL25.STM
 *
 START               START= 0.0 HRS   METOUT=0  NSTORM=1  NRUN=6
                     HHILL50.STM
 *
 START               START= 0.0 HRS   METOUT=0  NSTORM=1  NRUN=7
                     HHILL100.STM
 *
 FINISH
```

```
***************************************************************************
*                OTTHYMO (version 89b - November 1989)
*                BY : DILLON CONSULTING LIMITED  DATE : APR 14, 1999
*                     RJM
*
*               HWY 401 INTEGRATED PLANNING STUDY - TOWN OF HALTON HILLS
*
*               FILE : BC-ONLY.DAT - EXISTING CONDITIONS
*                      (SUBCATCHMENTS B & C, FUTURE LAND USE AREAS)
*
*                      EXISTING CONDITIONS INCLUDING EXISTING
*                      SWM FACILITIES:
*                      CASHWAY DISTRIBUTION CENTRE
*
***************************************************************************
*
*       PRECIPITATION :  TOWN OF HALTON HILLS DESIGN STANDARDS
*                        COMPILATION OF TORONTO INT'L A., FERGUS SHAND DAM AND
*                        HEAT LAKE (WEIGHTED BY YEARS OF RECORD)
*                        CHICAGO RAINFALL DISTRIBUTION
*
***************************************************************************
*
START                 START= 0.0 HRS   METOUT=0  NSTORM=1  NRUN=1
                      25MM.STM
*
READ STORM            STORM.001
*
***************************************************************************
*                           SIXTEEN MILE CREEK SUBWATERSHED 3             *
***************************************************************************
*
* SUBCATCHMENT 202F - CASHWAY DISTRIBUTION CENTRE (DRAIN 1 AND 2)
*
CALIB STANDHYD        ID=1 NHYD=103  DT=5.0   DA= 38.58HA
                      XIMP=0.13  TIMP=0.261 DWF=0.0  LOSS=2    CN=80.0
                      DPSP=1.5   SLP=0.5%   LGP=80   MNP=0.25  SCP=0.0
                      DPSI=-1    SLI=0.5%   LGI=507  MNI=0.013 SCI=0.0
                      END=-1
*
* EXISTING WATER QUALITY MANAGEMENT POND
* BASED ON MIDUSS MODEL BY MTE (1997 SWM PLAN)
*
ROUTE RESERVOIR       ID=2 NHYD=504 IDIN=1  DT=5min
                      OUTFLOW (cms)      STORAGE (ha m)
                       0.0                   0.0
                       0.0585                0.3331
                       0.0906                0.7830
                       20.058                0.9960
                       21.660                1.0327
                       27.130                1.1828
                        -1
*
* SUBCATCHMENT 202G - STUDY AREA NORTH-EAST OF JAMES SNOW PKWY INTERCHANGE
*
CALIB NASHYD          ID=3 NHYD=104  DT=5.0   DA= 11.79 HA
                      DWF=0.0 CN=80  IA=5 N=3 TP=0.69HR END=-1
*
ADD HYD               ID=1     NHYD=505    IDONE=2    IDTWO=3
*
* SUBCATCHMENT 202I - STUDY AREA WEST OF FIFTH LINE
*
CALIB STANDHYD        ID=2 NHYD=105  DT=5.0   DA= 16.52HA
                      XIMP=0.01  TIMP=0.137 DWF=0.0  LOSS=2    CN=82.0
                      DPSP=1.5   SLP=0.5%   LGP=40   MNP=0.25  SCP=0.0
                      DPSI=-1    SLI=0.5%   LGI=408  MNI=0.013 SCI=0.0
                      END=-1
*
ADD HYD               ID=3     NHYD=777    IDONE=1    IDTWO=2
*
* SUBCATCHMENT 202E - STUDY AREA NORTH OF STEELES AVE ("DRAIN 2")
*
CALIB NASHYD          ID=1 NHYD=106  DT=5.0   DA= 23.59 HA
                      DWF=0.0 CN=80  IA=5 N=3 TP=0.59HR END=-1
*
* SUBCATCHMENT 202D - STUDY AREA NORTH OF STEELES
*
CALIB NASHYD          ID=2 NHYD=107  DT=5.0   DA= 46.9 HA
                      DWF=0.0 CN=80  IA=5 N=3 TP=0.56HR END=-1
*
ADD HYD               ID=4     NHYD=507    IDONE=1    IDTWO=2
*
ADD HYD               ID=5     NHYD=508    IDONE=3    IDTWO=4
```

```
*
* SUBCATCHMENT 202J - STUDY AREA EAST OF MIDDLE BRANCH
*
CALIB NASHYD         ID=1 NHYD=108  DT=5.0   DA= 12.49 HA
                     DWF=0.0 CN=85  IA=5 N=3 TP=0.46HR END=-1
*
ADD HYD              ID=2    NHYD=999    IDONE=1   IDTWO=5
*
*
*
START                START= 0.0 HRS   METOUT=0  NSTORM=1  NRUN=2
                     HHILL2.STM
*
START                START= 0.0 HRS   METOUT=0  NSTORM=1  NRUN=3
                     HHILL5.STM
*
START                START= 0.0 HRS   METOUT=0  NSTORM=1  NRUN=4
                     HHILL10.STM
*
START                START= 0.0 HRS   METOUT=0  NSTORM=1  NRUN=5
                     HHILL25.STM
*
START                START= 0.0 HRS   METOUT=0  NSTORM=1  NRUN=6
                     HHILL50.STM
*
START                START= 0.0 HRS   METOUT=0  NSTORM=1  NRUN=7
                     HHILL100.STM
*
FINISH
```

```
    CALIB NASHYD          0404  2  5.0    12.73     .18  2.25    5.15  .20     .000
    [CN=81.0          ]
    [ N= 3.0:Tp=  .29]
    ------------------
    ADD [0403 + 0404]     0803  3  5.0    60.61     .45  2.67    5.15  n/a     .000
    ------------------
  * CALIB STANDHYD        0405  1  5.0    12.72     .34  2.17    8.15  .32     .000
    [I%= 3.0:S%=  .50]
    ------------------
    ADD [0405 + 0803]     0804  2  5.0    73.33     .65  2.33    5.67  n/a     .000
    ------------------
    RESRVR [ 2 : 0804]    0805  3  5.0    73.33     .07  5.00    5.66  n/a     .000
    {ST=   .35 ha.m }
    ------------------
    CALIB NASHYD          0406  1  5.0    52.69     .43  2.75    5.16  .20     .000
    [CN=81.0          ]
    [ N= 3.0:Tp=  .66]
    ------------------
    CALIB NASHYD          0407  2  5.0    13.56     .22  2.25    5.41  .21     .000
    [CN=82.0          ]
    [ N= 3.0:Tp=  .26]
    ------------------
    ADD [0406 + 0407]     0806  3  5.0    66.25     .54  2.58    5.21  n/a     .000
    ------------------
  * CALIB STANDHYD        0408  1  5.0    15.41     .52  2.17    9.96  .39     .000
    [I%= 4.0:S%=  .50]
    ------------------
    ADD [0408 + 0806]     0807  2  5.0    81.66     .90  2.25    6.10  n/a     .000
    ------------------
    RESRVR [ 2 : 0807]    0808  3  5.0    81.66     .10  4.67    6.10  n/a     .000
    {ST=   .40 ha.m }
    ------------------
    CALIB NASHYD          0409  1  5.0    32.76     .23  2.92    5.15  .20     .000
    [CN=81.0          ]
    [ N= 3.0:Tp=  .79]
    ------------------
    CALIB NASHYD          0410  2  5.0    15.07     .17  2.50    5.15  .20     .000
    [CN=81.0          ]
    [ N= 3.0:Tp=  .43]
    ------------------
    ADD [0409 + 0410]     0809  3  5.0    47.83     .37  2.67    5.15  n/a     .000
    ------------------
  * CALIB STANDHYD        0411  1  5.0     5.88     .21  2.17   10.24  .40     .000
    [I%= 5.0:S%=  .50]
    ------------------
    ADD [0411 + 0809]     0810  2  5.0    53.71     .45  2.50    5.71  n/a     .000
    ------------------
    RESRVR [ 2 : 0810]    0811  3  5.0    53.71     .05  5.08    5.70  n/a     .000
    {ST=   .26 ha.m }
    ------------------
    CALIB NASHYD          0412  3  5.0    27.55     .22  2.75    4.91  .19     .000
    [CN=80.0          ]
    [ N= 3.0:Tp=  .62]
    ------------------
  * CALIB STANDHYD        0413  1  5.0     9.99     .22  2.25    7.73  .31     .000
    [I%= 2.0:S%=  .50]
    ------------------
    ADD [0413 + 0412]     0812  2  5.0    37.54     .37  2.42    5.66  n/a     .000
    ------------------
    RESRVR [ 2 : 0812]    0813  3  5.0    37.54     .05  4.67    5.65  n/a     .000
    {ST=   .17 ha.m }
    ------------------
    CALIB NASHYD          0414  1  5.0    21.71     .12  3.42    5.41  .21     .000
    [CN=82.0          ]
    [ N= 3.0:Tp= 1.13]
    ------------------
 ** END OF SIMULATION :   1

**********************************************************************************


 ****************************
 ** SIMULATION NUMBER:   2 **
 ****************************

 W/E COMMAND            HYD ID  DT     AREA    Qpeak Tpeak    R.V. R.C.     Qbase
                               min     ha      cms    hrs     mm            cms

    START @    .00 hrs
    ------------------
    READ STORM                10.0
```

```
[ Ptot= 55.87 mm ]
fname :HHILL2.STM
remark:24HR 2YR CHICAGO - HALTON HILL 88 STDS
------------------
* CALIB STANDHYD      0103  1  5.0   38.58    1.05  8.58  31.01  .56    .000
  [I%=13.0:S%=  .50]
  ------------------
  RESRVR [ 1 : 0103]  0504  2  5.0   38.58     .09 15.58  30.49  n/a    .000
  {ST=   .76 ha.m }
  ------------------
  CALIB NASHYD        0104  3  5.0   11.79     .22  8.83  22.61  .40    .000
  [CN=80.0         ]
  [ N= 3.0:Tp=  .69]
  ------------------
  ADD [0504 + 0104]   0505  1  5.0   50.37     .29  8.83  28.65  n/a    .000
  ------------------
* CALIB STANDHYD      0105  2  5.0   16.52     .61  8.42  29.11  .52    .000
  [I%= 1.0:S%=  .50]
  ------------------
  ADD [0505 + 0105]   0777  3  5.0   66.89     .83  8.42  28.76  n/a    .000
  ------------------
  CALIB NASHYD        0106  1  5.0   23.59     .50  8.67  22.62  .40    .000
  [CN=80.0         ]
  [ N= 3.0:Tp=  .59]
  ------------------
  CALIB NASHYD        0107  2  5.0   46.90    1.02  8.58  22.62  .40    .000
  [CN=80.0         ]
  [ N= 3.0:Tp=  .56]
  ------------------
  ADD [0106 + 0107]   0507  4  5.0   70.49    1.52  8.67  22.62  n/a    .000
  ------------------
  ADD [0777 + 0507]   0508  5  5.0  137.38    2.32  8.58  25.61  n/a    .000
  ------------------
  CALIB NASHYD        0108  1  5.0   12.49     .39  8.50  27.03  .48    .000
  [CN=85.0         ]
  [ N= 3.0:Tp=  .46]
  ------------------
  ADD [0108 + 0508]   0999  2  5.0  149.87    2.70  8.58  25.73  n/a    .000
  ------------------
  CALIB NASHYD        0200  1  5.0    4.28     .11  8.58  27.01  .48    .000
  [CN=85.0         ]
  [ N= 3.0:Tp=  .57]
  ------------------
  CALIB NASHYD        0201  2  5.0   53.85     .77  9.50  25.14  .45    .000
  [CN=83.0         ]
  [ N= 3.0:Tp= 1.24]
  ------------------
  ADD [0200 + 0201]   0600  3  5.0   58.13     .83  9.42  25.28  n/a    .000
  ------------------
  CALIB NASHYD        0202  1  5.0   10.45     .20  8.92  25.13  .45    .000
  [CN=83.0         ]
  [ N= 3.0:Tp=  .82]
  ------------------
  ADD [0202 + 0600]   0601  2  5.0   68.58    1.02  9.25  25.26  n/a    .000
  ------------------
  CALIB NASHYD        0203  1  5.0   15.59     .25  8.92  21.11  .38    .000
  [CN=78.0         ]
  [ N= 3.0:Tp=  .76]
  ------------------
  CALIB NASHYD        0208  6  5.0   12.18     .40  8.33  24.26  .43    .000
  [CN=82.0         ]
  [ N= 3.0:Tp=  .34]
  ------------------
  CALIB NASHYD        0204  3  5.0   11.89     .29  8.42  21.11  .38    .000
  [CN=78.0         ]
  [ N= 3.0:Tp=  .42]
  ------------------
  ADD [0203 + 0204]   0602  4  5.0   27.48     .50  8.58  21.11  n/a    .000
  ------------------
  ADD [0601 + 0602]   0603  1  5.0   96.06    1.41  9.00  24.07  n/a    .000
  ------------------
* CALIB STANDHYD      0205  2  5.0    4.45     .20  8.33  30.95  .55    .000
  [I%= 1.0:S%=  .50]
  ------------------
  CALIB NASHYD        0206  3  5.0   51.16    1.03  8.83  24.26  .43    .000
  [CN=82.0         ]
  [ N= 3.0:Tp=  .71]
  ------------------
  ADD [0205 + 0206]   0604  4  5.0   55.61    1.15  8.75  24.80  n/a    .000
  ------------------
  ADD [0603 + 0604]   0605  2  5.0  151.67    2.53  8.83  24.34  n/a    .000
  ------------------
  ADD [0605 + 0208]   0609  7  5.0  163.85    2.78  8.75  24.33  n/a    .000
  ------------------
```

	CALIB NASHYD [CN=72.0] [N= 3.0:Tp= .74]	0207	3	5.0	79.86	1.05	8.92	17.29	.31	.000
	ADD [0609 + 0207]	0606	9	5.0	243.71	3.82	8.83	22.02	n/a	.000
	ADD [0606 + 0000]	0607	1	5.0	243.71	3.82	8.83	22.02	n/a	.000
	CALIB NASHYD [CN=82.0] [N= 3.0:Tp= .45]	0300	1	5.0	30.20	.83	8.50	24.26	.43	.000
	CALIB NASHYD [CN=80.0] [N= 3.0:Tp= .65]	0301	2	5.0	40.29	.80	8.75	22.62	.40	.000
	CALIB NASHYD [CN=82.0] [N= 3.0:Tp= .72]	0302	3	5.0	25.98	.52	8.83	24.26	.43	.000
	ADD [0301 + 0302]	0700	4	5.0	66.27	1.31	8.75	23.26	n/a	.000
	ADD [0300 + 0700]	0701	2	5.0	96.47	2.07	8.67	23.58	n/a	.000
	CALIB NASHYD [CN=82.0] [N= 3.0:Tp= .72]	0400	1	5.0	22.91	.46	8.83	24.26	.43	.000
	CALIB NASHYD [CN=82.0] [N= 3.0:Tp= .55]	0401	2	5.0	27.66	.67	8.58	24.26	.43	.000
	ADD [0400 + 0401]	0800	3	5.0	50.57	1.11	8.67	24.26	n/a	.000
*	CALIB STANDHYD [I%= 4.0:S%= .50]	0402	1	5.0	9.99	.63	8.17	31.34	.56	.000
	ADD [0402 + 0800]	0801	2	5.0	60.56	1.36	8.50	25.43	n/a	.000
	RESRVR [2 : 0801] {ST= .67 ha.m }	0802	3	5.0	60.56	.51	10.08	25.32	n/a	.000
	CALIB NASHYD [CN=81.0] [N= 3.0:Tp= .75]	0403	1	5.0	47.88	.89	8.83	23.42	.42	.000
	CALIB NASHYD [CN=81.0] [N= 3.0:Tp= .29]	0404	2	5.0	12.73	.44	8.25	23.41	.42	.000
	ADD [0403 + 0404]	0803	3	5.0	60.61	1.13	8.67	23.42	n/a	.000
*	CALIB STANDHYD [I%= 3.0:S%= .50]	0405	1	5.0	12.72	.72	8.17	28.85	.52	.000
	ADD [0405 + 0803]	0804	2	5.0	73.33	1.54	8.33	24.36	n/a	.000
	RESRVR [2 : 0804] {ST= .65 ha.m }	0805	3	5.0	73.33	.79	9.67	24.34	n/a	.000
	CALIB NASHYD [CN=81.0] [N= 3.0:Tp= .66]	0406	1	5.0	52.69	1.07	8.75	23.42	.42	.000
	CALIB NASHYD [CN=82.0] [N= 3.0:Tp= .26]	0407	2	5.0	13.56	.53	8.25	24.25	.43	.000
	ADD [0406 + 0407]	0806	3	5.0	66.25	1.36	8.58	23.59	n/a	.000
*	CALIB STANDHYD [I%= 4.0:S%= .50]	0408	1	5.0	15.41	1.04	8.17	33.00	.59	.000
	ADD [0408 + 0806]	0807	2	5.0	81.66	2.05	8.17	25.37	n/a	.000
	RESRVR [2 : 0807] {ST= .80 ha.m }	0808	3	5.0	81.66	.87	9.67	25.36	n/a	.000
	CALIB NASHYD [CN=81.0] [N= 3.0:Tp= .79]	0409	1	5.0	32.76	.59	8.92	23.42	.42	.000
	CALIB NASHYD [CN=81.0]	0410	2	5.0	15.07	.41	8.42	23.42	.42	.000

```
     [ N= 3.0:Tp=  .43]
     ------------------
     ADD [0409 + 0410]  0809  3  5.0   47.83     .92  8.67  23.42  n/a    .000
     ------------------
  *  CALIB STANDHYD     0411  1  5.0    5.88     .41  8.17  33.54  .60    .000
     [I%= 5.0:S%=  .50]
     ------------------
     ADD [0411 + 0809]  0810  2  5.0   53.71    1.08  8.50  24.53  n/a    .000
     ------------------
     RESRVR [ 2 : 0810] 0811  3  5.0   53.71     .42 10.25  24.52  n/a    .000
     {ST=   .56 ha.m }
     ------------------
     CALIB NASHYD       0412  3  5.0   27.55     .56  8.67  22.62  .40    .000
     [CN=80.0         ]
     [ N= 3.0:Tp=  .62]
     ------------------
  *  CALIB STANDHYD     0413  1  5.0    9.99     .51  8.17  27.96  .50    .000
     [I%= 2.0:S%=  .50]
     ------------------
     ADD [0413 + 0412]  0812  2  5.0   37.54     .83  8.33  24.04  n/a    .000
     ------------------
     RESRVR [ 2 : 0812] 0813  3  5.0   37.54     .39  9.67  24.03  n/a    .000
     {ST=   .36 ha.m }
     ------------------
     CALIB NASHYD       0414  1  5.0   21.71     .32  9.33  24.26  .43    .000
     [CN=82.0         ]
     [ N= 3.0:Tp= 1.13]
     ------------------
  ** END OF SIMULATION :   2
*******************************************************************************


  ****************************
  ** SIMULATION NUMBER:   3 **
  ****************************

  W/E COMMAND            HYD ID   DT    AREA   Qpeak Tpeak   R.V. R.C.    Qbase
                                 min     ha     cms   hrs     mm           cms

     START @    .00 hrs
     ------------------
     READ STORM                 10.0
     [ Ptot= 71.72 mm ]
     fname :HHILL5.STM
     remark:24HR 5YR CHICAGO - HALTON HILL 88 STDS
     ------------------
  *  CALIB STANDHYD     0103  1  5.0   38.58    1.95  8.50  43.89  .61    .000
     [I%=13.0:S%=  .50]
     ------------------
     RESRVR [ 1 : 0103] 0504  2  5.0   38.58    1.14  9.25  43.34  n/a    .000
     {ST=   .80 ha.m }
     ------------------
     CALIB NASHYD       0104  3  5.0   11.79     .39  8.75  34.17  .48    .000
     [CN=80.0         ]
     [ N= 3.0:Tp=  .69]
     ------------------
     ADD [0504 + 0104]  0505  1  5.0   50.37    1.48  9.25  41.19  n/a    .000
     ------------------
  *  CALIB STANDHYD     0105  2  5.0   16.52    1.11  8.33  41.94  .58    .000
     [I%= 1.0:S%=  .50]
     ------------------
     ADD [0505 + 0105]  0777  3  5.0   66.89    1.84  9.25  41.38  n/a    .000
     ------------------
     CALIB NASHYD       0106  1  5.0   23.59     .88  8.67  34.18  .48    .000
     [CN=80.0         ]
     [ N= 3.0:Tp=  .59]
     ------------------
     CALIB NASHYD       0107  2  5.0   46.90    1.81  8.67  34.18  .48    .000
     [CN=80.0         ]
     [ N= 3.0:Tp=  .56]
     ------------------
     ADD [0106 + 0107]  0507  4  5.0   70.49    2.68  8.67  34.18  n/a    .000
     ------------------
     ADD [0777 + 0507]  0508  5  5.0  137.38    4.01  8.58  37.69  n/a    .000
     ------------------
     CALIB NASHYD       0108  1  5.0   12.49     .67  8.50  39.90  .56    .000
     [CN=85.0         ]
     [ N= 3.0:Tp=  .46]
     ------------------
     ADD [0108 + 0508]  0999  2  5.0  149.87    4.66  8.50  37.87  n/a    .000
```

	CALIB NASHYD [CN=85.0] [N= 3.0:Tp= .57]	0200	1	5.0	4.28	.20	8.67	39.87	.56	.000
	CALIB NASHYD [CN=83.0] [N= 3.0:Tp= 1.24]	0201	2	5.0	53.85	1.32	9.50	37.49	.52	.000
	ADD [0200 + 0201]	0600	3	5.0	58.13	1.43	9.33	37.66	n/a	.000
	CALIB NASHYD [CN=83.0] [N= 3.0:Tp= .82]	0202	1	5.0	10.45	.35	8.92	37.47	.52	.000
	ADD [0202 + 0600]	0601	2	5.0	68.58	1.75	9.25	37.63	n/a	.000
	CALIB NASHYD [CN=78.0] [N= 3.0:Tp= .76]	0203	1	5.0	15.59	.45	8.92	32.16	.45	.000
	CALIB NASHYD [CN=82.0] [N= 3.0:Tp= .34]	0208	6	5.0	12.18	.70	8.33	36.33	.51	.000
	CALIB NASHYD [CN=78.0] [N= 3.0:Tp= .42]	0204	3	5.0	11.89	.51	8.42	32.16	.45	.000
	ADD [0203 + 0204]	0602	4	5.0	27.48	.90	8.58	32.16	n/a	.000
	ADD [0601 + 0602]	0603	1	5.0	96.06	2.46	9.00	36.07	n/a	.000
*	CALIB STANDHYD [I%= 1.0:S%= .50]	0205	2	5.0	4.45	.36	8.25	44.24	.62	.000
	CALIB NASHYD [CN=82.0] [N= 3.0:Tp= .71]	0206	3	5.0	51.16	1.81	8.83	36.34	.51	.000
	ADD [0205 + 0206]	0604	4	5.0	55.61	1.98	8.75	36.98	n/a	.000
	ADD [0603 + 0604]	0605	2	5.0	151.67	4.39	8.83	36.40	n/a	.000
	ADD [0605 + 0208]	0609	7	5.0	163.85	4.82	8.75	36.40	n/a	.000
	CALIB NASHYD [CN=72.0] [N= 3.0:Tp= .74]	0207	3	5.0	79.86	1.92	8.83	26.90	.38	.000
	ADD [0609 + 0207]	0606	9	5.0	243.71	6.72	8.83	33.28	n/a	.000
	ADD [0606 + 0000]	0607	1	5.0	243.71	6.72	8.83	33.28	n/a	.000
	CALIB NASHYD [CN=82.0] [N= 3.0:Tp= .45]	0300	1	5.0	30.20	1.45	8.50	36.34	.51	.000
	CALIB NASHYD [CN=80.0] [N= 3.0:Tp= .65]	0301	2	5.0	40.29	1.41	8.75	34.18	.48	.000
	CALIB NASHYD [CN=82.0] [N= 3.0:Tp= .72]	0302	3	5.0	25.98	.91	8.83	36.34	.51	.000
	ADD [0301 + 0302]	0700	4	5.0	66.27	2.31	8.75	35.03	n/a	.000
	ADD [0300 + 0700]	0701	2	5.0	96.47	3.63	8.67	35.44	n/a	.000
	CALIB NASHYD [CN=82.0] [N= 3.0:Tp= .72]	0400	1	5.0	22.91	.80	8.83	36.34	.51	.000
	CALIB NASHYD [CN=82.0] [N= 3.0:Tp= .55]	0401	2	5.0	27.66	1.16	8.58	36.34	.51	.000
	ADD [0400 + 0401]	0800	3	5.0	50.57	1.94	8.67	36.34	n/a	.000
*	CALIB STANDHYD [I%= 4.0:S%= .50]	0402	1	5.0	9.99	1.04	8.17	44.57	.62	.000
	ADD [0402 + 0800]	0801	2	5.0	60.56	2.33	8.50	37.70	n/a	.000

```
   ------------------
   RESRVR [ 2 : 0801] 0802  3  5.0   60.56   1.40  9.42  37.59  n/a   .000
   {ST=   .82 ha.m }
   ------------------
   CALIB NASHYD       0403  1  5.0   47.88   1.57  8.83  35.24  .49   .000
   [CN=81.0          ]
   [ N= 3.0:Tp=  .75]
   ------------------
   CALIB NASHYD       0404  2  5.0   12.73    .77  8.25  35.23  .49   .000
   [CN=81.0          ]
   [ N= 3.0:Tp=  .29]
   ------------------
   ADD [0403 + 0404]  0803  3  5.0   60.61   1.99  8.67  35.24  n/a   .000
   ------------------
 * CALIB STANDHYD     0405  1  5.0   12.72   1.21  8.17  41.52  .58   .000
   [I%= 3.0:S%=  .50]
   ------------------
   ADD [0405 + 0803]  0804  2  5.0   73.33   2.66  8.33  36.33  n/a   .000
   ------------------
   RESRVR [ 2 : 0804] 0805  3  5.0   73.33   1.84  9.17  36.31  n/a   .000
   {ST=   .76 ha.m }
   ------------------
   CALIB NASHYD       0406  1  5.0   52.69   1.89  8.75  35.24  .49   .000
   [CN=81.0          ]
   [ N= 3.0:Tp=  .66]
   ------------------
   CALIB NASHYD       0407  2  5.0   13.56    .91  8.25  36.32  .51   .000
   [CN=82.0          ]
   [ N= 3.0:Tp=  .26]
   ------------------
   ADD [0406 + 0407]  0806  3  5.0   66.25   2.40  8.58  35.46  n/a   .000
   ------------------
 * CALIB STANDHYD     0408  1  5.0   15.41   1.81  8.08  46.59  .65   .000
   [I%= 4.0:S%=  .50]
   ------------------
   ADD [0408 + 0806]  0807  2  5.0   81.66   3.35  8.25  37.56  n/a   .000
   ------------------
   RESRVR [ 2 : 0807] 0808  3  5.0   81.66   2.32  9.00  37.56  n/a   .000
   {ST=   .92 ha.m }
   ------------------
   CALIB NASHYD       0409  1  5.0   32.76   1.03  8.92  35.24  .49   .000
   [CN=81.0          ]
   [ N= 3.0:Tp=  .79]
   ------------------
   CALIB NASHYD       0410  2  5.0   15.07    .72  8.50  35.24  .49   .000
   [CN=81.0          ]
   [ N= 3.0:Tp=  .43]
   ------------------
   ADD [0409 + 0410]  0809  3  5.0   47.83   1.62  8.67  35.24  n/a   .000
   ------------------
 * CALIB STANDHYD     0411  1  5.0    5.88    .70  8.08  47.22  .66   .000
   [I%= 5.0:S%=  .50]
   ------------------
   ADD [0411 + 0809]  0810  2  5.0   53.71   1.82  8.58  36.55  n/a   .000
   ------------------
   RESRVR [ 2 : 0810] 0811  3  5.0   53.71   1.29  9.33  36.54  n/a   .000
   {ST=   .62 ha.m }
   ------------------
   CALIB NASHYD       0412  3  5.0   27.55    .99  8.67  34.18  .48   .000
   [CN=80.0          ]
   [ N= 3.0:Tp=  .62]
   ------------------
 * CALIB STANDHYD     0413  1  5.0    9.99    .86  8.17  40.45  .56   .000
   [I%= 2.0:S%=  .50]
   ------------------
   ADD [0413 + 0412]  0812  2  5.0   37.54   1.44  8.33  35.85  n/a   .000
   ------------------
   RESRVR [ 2 : 0812] 0813  3  5.0   37.54   1.08  9.00  35.83  n/a   .000
   {ST=   .40 ha.m }
   ------------------
   CALIB NASHYD       0414  1  5.0   21.71    .55  9.33  36.34  .51   .000
   [CN=82.0          ]
   [ N= 3.0:Tp= 1.13]
   ------------------
 ** END OF SIMULATION :   3

*******************************************************************************


 ****************************
 ** SIMULATION NUMBER:   4 **
```

```
 ****************************
 W/E COMMAND              HYD ID   DT    AREA    Qpeak Tpeak   R.V. R.C.     Qbase
                                  min     ha      cms   hrs     mm            cms

        START @   .00 hrs
        ------------------
        READ STORM                10.0
        [ Ptot= 84.96 mm ]
        fname :HHILL10.STM
        remark:24HR 10YR CHICAGO - HALTON HILL 88 STDS
        ------------------
 *      CALIB STANDHYD     0103  1  5.0    38.58    2.76  8.42  55.17  .65     .000
        [I%=13.0:S%=  .50]
        ------------------
        RESRVR [ 1 : 0103] 0504  2  5.0    38.58    2.02  8.83  54.59  n/a     .000
        {ST=   .81 ha.m }
        ------------------
        CALIB NASHYD       0104  3  5.0    11.79     .53  8.75  44.55  .52     .000
        [CN=80.0         ]
        [ N= 3.0:Tp=  .69]
        ------------------
        ADD [0504 + 0104]  0505  1  5.0    50.37    2.55  8.83  52.24  n/a     .000
        ------------------
 *      CALIB STANDHYD     0105  2  5.0    16.52    1.54  8.25  53.21  .63     .000
        [I%= 1.0:S%=  .50]
        ------------------
        ADD [0505 + 0105]  0777  3  5.0    66.89    3.34  8.75  52.48  n/a     .000
        ------------------
        CALIB NASHYD       0106  1  5.0    23.59    1.19  8.67  44.56  .52     .000
        [CN=80.0         ]
        [ N= 3.0:Tp=  .59]
        ------------------
        CALIB NASHYD       0107  2  5.0    46.90    2.44  8.58  44.56  .52     .000
        [CN=80.0         ]
        [ N= 3.0:Tp=  .56]
        ------------------
        ADD [0106 + 0107]  0507  4  5.0    70.49    3.62  8.67  44.56  n/a     .000
        ------------------
        ADD [0777 + 0507]  0508  5  5.0   137.38    6.90  8.75  48.42  n/a     .000
        ------------------
        CALIB NASHYD       0108  1  5.0    12.49     .88  8.50  51.22  .60     .000
        [CN=85.0         ]
        [ N= 3.0:Tp=  .46]
        ------------------
        ADD [0108 + 0508]  0999  2  5.0   149.87    7.67  8.75  48.65  n/a     .000
        ------------------
        CALIB NASHYD       0200  1  5.0     4.28     .26  8.58  51.20  .60     .000
        [CN=85.0         ]
        [ N= 3.0:Tp=  .57]
        ------------------
        CALIB NASHYD       0201  2  5.0    53.85    1.76  9.42  48.43  .57     .000
        [CN=83.0         ]
        [ N= 3.0:Tp= 1.24]
        ------------------
        ADD [0200 + 0201]  0600  3  5.0    58.13    1.91  9.33  48.64  n/a     .000
        ------------------
        CALIB NASHYD       0202  1  5.0    10.45     .46  8.92  48.42  .57     .000
        [CN=83.0         ]
        [ N= 3.0:Tp=  .82]
        ------------------
        ADD [0202 + 0600]  0601  2  5.0    68.58    2.33  9.25  48.60  n/a     .000
        ------------------
        CALIB NASHYD       0203  1  5.0    15.59     .62  8.92  42.16  .50     .000
        [CN=78.0         ]
        [ N= 3.0:Tp=  .76]
        ------------------
        CALIB NASHYD       0208  6  5.0    12.18     .93  8.33  47.09  .55     .000
        [CN=82.0         ]
        [ N= 3.0:Tp=  .34]
        ------------------
        CALIB NASHYD       0204  3  5.0    11.89     .70  8.42  42.16  .50     .000
        [CN=78.0         ]
        [ N= 3.0:Tp=  .42]
        ------------------
        ADD [0203 + 0204]  0602  4  5.0    27.48    1.22  8.58  42.16  n/a     .000
        ------------------
        ADD [0601 + 0602]  0603  1  5.0    96.06    3.31  9.00  46.76  n/a     .000
        ------------------
 *      CALIB STANDHYD     0205  2  5.0     4.45     .48  8.25  55.83  .66     .000
        [I%= 1.0:S%=  .50]
        ------------------
        CALIB NASHYD       0206  3  5.0    51.16    2.42  8.83  47.10  .55     .000
        [CN=82.0         ]
```

	[N= 3.0:Tp= .71]									
	ADD [0205 + 0206]	0604	4	5.0	55.61	2.64	8.75	47.80	n/a	.000
	ADD [0603 + 0604]	0605	2	5.0	151.67	5.89	8.83	47.14	n/a	.000
	ADD [0605 + 0208]	0609	7	5.0	163.85	6.47	8.75	47.14	n/a	.000
	CALIB NASHYD [CN=72.0] [N= 3.0:Tp= .74]	0207	3	5.0	79.86	2.65	8.83	35.77	.42	.000
	ADD [0609 + 0207]	0606	9	5.0	243.71	9.08	8.83	43.41	n/a	.000
	ADD [0606 + 0000]	0607	1	5.0	243.71	9.08	8.83	43.41	n/a	.000
	CALIB NASHYD [CN=82.0] [N= 3.0:Tp= .45]	0300	1	5.0	30.20	1.94	8.50	47.10	.55	.000
	CALIB NASHYD [CN=80.0] [N= 3.0:Tp= .65]	0301	2	5.0	40.29	1.90	8.75	44.56	.52	.000
	CALIB NASHYD [CN=82.0] [N= 3.0:Tp= .72]	0302	3	5.0	25.98	1.22	8.83	47.10	.55	.000
	ADD [0301 + 0302]	0700	4	5.0	66.27	3.11	8.75	45.56	n/a	.000
	ADD [0300 + 0700]	0701	2	5.0	96.47	4.88	8.67	46.04	n/a	.000
	CALIB NASHYD [CN=82.0] [N= 3.0:Tp= .72]	0400	1	5.0	22.91	1.07	8.83	47.10	.55	.000
	CALIB NASHYD [CN=82.0] [N= 3.0:Tp= .55]	0401	2	5.0	27.66	1.56	8.58	47.10	.55	.000
	ADD [0400 + 0401]	0800	3	5.0	50.57	2.60	8.67	47.10	n/a	.000
*	CALIB STANDHYD [I%= 4.0:S%= .50]	0402	1	5.0	9.99	1.43	8.08	56.12	.66	.000
	ADD [0402 + 0800]	0801	2	5.0	60.56	3.02	8.58	48.59	n/a	.000
	RESRVR [2 : 0801] {ST= .92 ha.m }	0802	3	5.0	60.56	2.15	9.25	48.47	n/a	.000
	CALIB NASHYD [CN=81.0] [N= 3.0:Tp= .75]	0403	1	5.0	47.88	2.11	8.83	45.81	.54	.000
	CALIB NASHYD [CN=81.0] [N= 3.0:Tp= .29]	0404	2	5.0	12.73	1.03	8.25	45.79	.54	.000
	ADD [0403 + 0404]	0803	3	5.0	60.61	2.67	8.67	45.81	n/a	.000
*	CALIB STANDHYD [I%= 3.0:S%= .50]	0405	1	5.0	12.72	1.68	8.08	52.67	.62	.000
	ADD [0405 + 0803]	0804	2	5.0	73.33	3.39	8.25	47.00	n/a	.000
	RESRVR [2 : 0804] {ST= .83 ha.m }	0805	3	5.0	73.33	2.74	9.00	46.98	n/a	.000
	CALIB NASHYD [CN=81.0] [N= 3.0:Tp= .66]	0406	1	5.0	52.69	2.54	8.75	45.81	.54	.000
	CALIB NASHYD [CN=82.0] [N= 3.0:Tp= .26]	0407	2	5.0	13.56	1.21	8.25	47.07	.55	.000
	ADD [0406 + 0407]	0806	3	5.0	66.25	3.22	8.58	46.07	n/a	.000
*	CALIB STANDHYD [I%= 4.0:S%= .50]	0408	1	5.0	15.41	2.34	8.08	58.39	.69	.000
	ADD [0408 + 0806]	0807	2	5.0	81.66	4.43	8.25	48.39	n/a	.000
	RESRVR [2 : 0807]	0808	3	5.0	81.66	3.48	8.63	48.39	n/a	.000

```
   {ST=   .99 ha.m }
   -----------------
   CALIB NASHYD       0409  1  5.0   32.76    1.39  8.92  45.81  .54     .000
   [CN=81.0          ]
   [ N= 3.0:Tp=  .79]
   -----------------
   CALIB NASHYD       0410  2  5.0   15.07     .96  8.42  45.81  .54     .000
   [CN=81.0          ]
   [ N= 3.0:Tp=  .43]
   -----------------
   ADD [0409 + 0410]  0809  3  5.0   47.83    2.18  8.67  45.81  n/a     .000
   -----------------
 * CALIB STANDHYD     0411  1  5.0    5.88     .91  8.08  59.08  .70     .000
   [I%= 5.0:S%=  .50]
   -----------------
   ADD [0411 + 0809]  0810  2  5.0   53.71    2.44  8.58  47.26  n/a     .000
   -----------------
   RESRVR [ 2 : 0810] 0811  3  5.0   53.71    1.97  9.17  47.25  n/a     .000
   {ST=   .68 ha.m }
   -----------------
   CALIB NASHYD       0412  3  5.0   27.55    1.34  8.67  44.56  .52     .000
   [CN=80.0          ]
   [ N= 3.0:Tp=  .62]
   -----------------
 * CALIB STANDHYD     0413  1  5.0    9.99    1.15  8.17  51.47  .61     .000
   [I%= 2.0:S%=  .50]
   -----------------
   ADD [0413 + 0412]  0812  2  5.0   37.54    1.92  8.33  46.40  n/a     .000
   -----------------
   RESRVR [ 2 : 0812] 0813  3  5.0   37.54    1.67  8.83  46.38  n/a     .000
   {ST=   .42 ha.m }
   -----------------
   CALIB NASHYD       0414  1  5.0   21.71     .74  9.33  47.10  .55     .000
   [CN=82.0          ]
   [ N= 3.0:Tp= 1.13]
   -----------------
** END OF SIMULATION :   4

*******************************************************************************


****************************
** SIMULATION NUMBER:   5 **
****************************

W/E COMMAND               HYD ID   DT    AREA   Qpeak Tpeak   R.V. R.C.    Qbase
                                   min    ha     cms   hrs     mm           cms

   START @   .00 hrs
   -----------------
   READ STORM                      10.0
   [ Ptot=101.79 mm ]
   fname :HHILL25.STM
   remark:24HR 25YR CHICAGO - HALTON HILL 88 STDS
   -----------------
 * CALIB STANDHYD     0103  1  5.0   38.58    3.68  8.42  69.99  .69     .000
   [I%=13.0:S%=  .50]
   -----------------
   RESRVR [ 1 : 0103] 0504  2  5.0   38.58    3.53  8.58  69.39  n/a     .000
   {ST=   .82 ha.m }
   -----------------
   CALIB NASHYD       0104  3  5.0   11.79     .72  8.75  58.43  .57     .000
   [CN=80.0          ]
   [ N= 3.0:Tp=  .69]
   -----------------
   ADD [0504 + 0104]  0505  1  5.0   50.37    4.21  8.58  66.82  n/a     .000
   -----------------
 * CALIB STANDHYD     0105  2  5.0   16.52    2.07  8.25  68.05  .67     .000
   [I%= 1.0:S%=  .50]
   -----------------
   ADD [0505 + 0105]  0777  3  5.0   66.89    5.62  8.58  67.13  n/a     .000
   -----------------
   CALIB NASHYD       0106  1  5.0   23.59    1.59  8.67  58.44  .57     .000
   [CN=80.0          ]
   [ N= 3.0:Tp=  .59]
   -----------------
   CALIB NASHYD       0107  2  5.0   46.90    3.28  8.58  58.44  .57     .000
   [CN=80.0          ]
   [ N= 3.0:Tp=  .56]
   -----------------
   ADD [0106 + 0107]  0507  4  5.0   70.49    4.86  8.67  58.44  n/a     .000
```

ADD [0777 + 0507]	0508	5	5.0	137.38	10.48	8.58	62.67	n/a	.000
CALIB NASHYD [CN=85.0] [N= 3.0:Tp= .46]	0108	1	5.0	12.49	1.16	8.50	66.14	.65	.000
ADD [0108 + 0508]	0999	2	5.0	149.87	11.61	8.58	62.96	n/a	.000
CALIB NASHYD [CN=85.0] [N= 3.0:Tp= .57]	0200	1	5.0	4.28	.34	8.58	66.11	.65	.000
CALIB NASHYD [CN=83.0] [N= 3.0:Tp= 1.24]	0201	2	5.0	53.85	2.34	9.42	62.95	.62	.000
ADD [0200 + 0201]	0600	3	5.0	58.13	2.54	9.33	63.18	n/a	.000
CALIB NASHYD [CN=83.0] [N= 3.0:Tp= .82]	0202	1	5.0	10.45	.62	8.92	62.93	.62	.000
ADD [0202 + 0600]	0601	2	5.0	68.58	3.10	9.25	63.14	n/a	.000
CALIB NASHYD [CN=78.0] [N= 3.0:Tp= .76]	0203	1	5.0	15.59	.83	8.83	55.61	.55	.000
CALIB NASHYD [CN=82.0] [N= 3.0:Tp= .34]	0208	6	5.0	12.18	1.24	8.33	61.39	.60	.000
CALIB NASHYD [CN=78.0] [N= 3.0:Tp= .42]	0204	3	5.0	11.89	.94	8.42	55.60	.55	.000
ADD [0203 + 0204]	0602	4	5.0	27.48	1.65	8.58	55.61	n/a	.000
ADD [0601 + 0602]	0603	1	5.0	96.06	4.42	9.00	60.99	n/a	.000
* CALIB STANDHYD [I%= 1.0:S%= .50]	0205	2	5.0	4.45	.66	8.17	71.00	.70	.000
CALIB NASHYD [CN=82.0] [N= 3.0:Tp= .71]	0206	3	5.0	51.16	3.23	8.83	61.41	.60	.000
ADD [0205 + 0206]	0604	4	5.0	55.61	3.49	8.75	62.17	n/a	.000
ADD [0603 + 0604]	0605	2	5.0	151.67	7.84	8.83	61.42	n/a	.000
ADD [0605 + 0208]	0609	7	5.0	163.85	8.61	8.75	61.42	n/a	.000
CALIB NASHYD [CN=72.0] [N= 3.0:Tp= .74]	0207	3	5.0	79.86	3.64	8.83	47.90	.47	.000
ADD [0609 + 0207]	0606	9	5.0	243.71	12.21	8.75	56.99	n/a	.000
ADD [0606 + 0000]	0607	1	5.0	243.71	12.21	8.75	56.99	n/a	.000
CALIB NASHYD [CN=82.0] [N= 3.0:Tp= .45]	0300	1	5.0	30.20	2.59	8.50	61.40	.60	.000
CALIB NASHYD [CN=80.0] [N= 3.0:Tp= .65]	0301	2	5.0	40.29	2.55	8.75	58.44	.57	.000
CALIB NASHYD [CN=82.0] [N= 3.0:Tp= .72]	0302	3	5.0	25.98	1.63	8.83	61.40	.60	.000
ADD [0301 + 0302]	0700	4	5.0	66.27	4.17	8.75	59.60	n/a	.000
ADD [0300 + 0700]	0701	2	5.0	96.47	6.53	8.67	60.16	n/a	.000
CALIB NASHYD [CN=82.0] [N= 3.0:Tp= .72]	0400	1	5.0	22.91	1.43	8.83	61.40	.60	.000
CALIB NASHYD [CN=82.0]	0401	2	5.0	27.66	2.08	8.58	61.40	.60	.000

	[N= 3.0:Tp= .55]									
	ADD [0400 + 0401]	0800	3	5.0	50.57	3.47	8.67	61.40	n/a	.000
*	CALIB STANDHYD [I%= 4.0:S%= .50]	0402	1	5.0	9.99	1.87	8.08	71.24	.70	.000
	ADD [0402 + 0800]	0801	2	5.0	60.56	3.99	8.58	63.03	n/a	.000
	RESRVR [2 : 0801] {ST= 1.05 ha.m }	0802	3	5.0	60.56	3.11	9.08	62.91	n/a	.000
	CALIB NASHYD [CN=81.0] [N= 3.0:Tp= .75]	0403	1	5.0	47.88	2.83	8.83	59.90	.59	.000
	CALIB NASHYD [CN=81.0] [N= 3.0:Tp= .29]	0404	2	5.0	12.73	1.38	8.25	59.88	.59	.000
	ADD [0403 + 0404]	0803	3	5.0	60.61	3.59	8.58	59.90	n/a	.000
*	CALIB STANDHYD [I%= 3.0:S%= .50]	0405	1	5.0	12.72	2.23	8.08	67.38	.66	.000
	ADD [0405 + 0803]	0804	2	5.0	73.33	4.51	8.25	61.20	n/a	.000
	RESRVR [2 : 0804] {ST= .92 ha.m }	0805	3	5.0	73.33	3.88	8.83	61.17	n/a	.000
	CALIB NASHYD [CN=81.0] [N= 3.0:Tp= .66]	0406	1	5.0	52.69	3.40	8.75	59.90	.59	.000
	CALIB NASHYD [CN=82.0] [N= 3.0:Tp= .26]	0407	2	5.0	13.56	1.61	8.25	61.36	.60	.000
	ADD [0406 + 0407]	0806	3	5.0	66.25	4.31	8.50	60.20	n/a	.000
*	CALIB STANDHYD [I%= 4.0:S%= .50]	0408	1	5.0	15.41	3.05	8.08	73.78	.72	.000
	ADD [0408 + 0806]	0807	2	5.0	81.66	5.84	8.25	62.76	n/a	.000
	RESRVR [2 : 0807] {ST= 1.07 ha.m }	0808	3	5.0	81.66	4.94	8.67	62.76	n/a	.000
	CALIB NASHYD [CN=81.0] [N= 3.0:Tp= .79]	0409	1	5.0	32.76	1.86	8.92	59.90	.59	.000
	CALIB NASHYD [CN=81.0] [N= 3.0:Tp= .43]	0410	2	5.0	15.07	1.29	8.42	59.90	.59	.000
	ADD [0409 + 0410]	0809	3	5.0	47.83	2.93	8.67	59.90	n/a	.000
*	CALIB STANDHYD [I%= 5.0:S%= .50]	0411	1	5.0	5.88	1.18	8.08	74.53	.73	.000
	ADD [0411 + 0809]	0810	2	5.0	53.71	3.24	8.58	61.50	n/a	.000
	RESRVR [2 : 0810] {ST= .75 ha.m }	0811	3	5.0	53.71	2.80	9.00	61.49	n/a	.000
	CALIB NASHYD [CN=80.0] [N= 3.0:Tp= .62]	0412	3	5.0	27.55	1.80	8.67	58.44	.57	.000
*	CALIB STANDHYD [I%= 2.0:S%= .50]	0413	1	5.0	9.99	1.53	8.17	66.02	.65	.000
	ADD [0413 + 0412]	0812	2	5.0	37.54	2.56	8.33	60.46	n/a	.000
	RESRVR [2 : 0812] {ST= .44 ha.m }	0813	3	5.0	37.54	2.37	8.67	60.44	n/a	.000
	CALIB NASHYD [CN=82.0] [N= 3.0:Tp= 1.13]	0414	1	5.0	21.71	.98	9.33	61.40	.60	.000

** END OF SIMULATION : 5

```
***************************************************************************************

 ****************************
 ** SIMULATION NUMBER:   6 **
 ****************************

 W/E COMMAND              HYD ID   DT     AREA    Qpeak Tpeak   R.V.  R.C.    Qbase
                                   min     ha      cms   hrs     mm            cms

     START @   .00 hrs
     ------------------
     READ STORM                  10.0
     [ Ptot=114.35 mm ]
     fname :HHILL50.STM
     remark:24HR 50YR CHICAGO - HALTON HILL 88 STDS
     ------------------
  *  CALIB STANDHYD       0103  1  5.0    38.58    4.65  8.33  81.32  .71     .000
     [I%=13.0:S%=  .50]
     ------------------
  *  RESRVR [ 1 : 0103]  0504  2  5.0    38.58    4.99  8.42  80.71  n/a     .000
     {ST=   .84 ha.m }
     ------------------
     CALIB NASHYD         0104  3  5.0    11.79     .86  8.75  69.16  .60     .000
     [CN=80.0          ]
     [ N= 3.0:Tp=   .69]
     ------------------
     ADD [0504 + 0104]    0505  1  5.0    50.37    5.69  8.42  78.00  n/a     .000
     ------------------
  *  CALIB STANDHYD       0105  2  5.0    16.52    2.54  8.25  79.38  .69     .000
     [I%= 1.0:S%=  .50]
     ------------------
     ADD [0505 + 0105]    0777  3  5.0    66.89    7.84  8.42  78.34  n/a     .000
     ------------------
     CALIB NASHYD         0106  1  5.0    23.59    1.91  8.67  69.17  .60     .000
     [CN=80.0          ]
     [ N= 3.0:Tp=   .59]
     ------------------
     CALIB NASHYD         0107  2  5.0    46.90    3.92  8.58  69.17  .60     .000
     [CN=80.0          ]
     [ N= 3.0:Tp=   .56]
     ------------------
     ADD [0106 + 0107]    0507  4  5.0    70.49    5.82  8.67  69.17  n/a     .000
     ------------------
     ADD [0777 + 0507]    0508  5  5.0   137.38   13.18  8.42  73.64  n/a     .000
     ------------------
     CALIB NASHYD         0108  1  5.0    12.49    1.37  8.50  77.54  .68     .000
     [CN=85.0          ]
     [ N= 3.0:Tp=   .46]
     ------------------
     ADD [0108 + 0508]    0999  2  5.0   149.87   14.54  8.42  73.96  n/a     .000
     ------------------
     CALIB NASHYD         0200  1  5.0     4.28     .41  8.58  77.52  .68     .000
     [CN=85.0          ]
     [ N= 3.0:Tp=   .57]
     ------------------
     CALIB NASHYD         0201  2  5.0    53.85    2.78  9.42  74.09  .65     .000
     [CN=83.0          ]
     [ N= 3.0:Tp= 1.24]
     ------------------
     ADD [0200 + 0201]    0600  3  5.0    58.13    3.02  9.33  74.34  n/a     .000
     ------------------
     CALIB NASHYD         0202  1  5.0    10.45     .73  8.92  74.07  .65     .000
     [CN=83.0          ]
     [ N= 3.0:Tp=   .82]
     ------------------
     ADD [0202 + 0600]    0601  2  5.0    68.58    3.69  9.25  74.30  n/a     .000
     ------------------
     CALIB NASHYD         0203  1  5.0    15.59    1.00  8.83  66.05  .58     .000
     [CN=78.0          ]
     [ N= 3.0:Tp=   .76]
     ------------------
     CALIB NASHYD         0208  6  5.0    12.18    1.48  8.33  72.40  .63     .000
     [CN=82.0          ]
     [ N= 3.0:Tp=   .34]
     ------------------
     CALIB NASHYD         0204  3  5.0    11.89    1.13  8.42  66.05  .58     .000
     [CN=78.0          ]
     [ N= 3.0:Tp=   .42]
     ------------------
     ADD [0203 + 0204]    0602  4  5.0    27.48    1.99  8.58  66.05  n/a     .000
```

ADD [0601 + 0602]	0603	1	5.0	96.06	5.28	8.92	71.94	n/a	.000
* CALIB STANDHYD [I%= 1.0:S%= .50]	0205	2	5.0	4.45	.81	8.17	82.56	.72	.000
CALIB NASHYD [CN=82.0] [N= 3.0:Tp= .71]	0206	3	5.0	51.16	3.85	8.83	72.41	.63	.000
ADD [0205 + 0206]	0604	4	5.0	55.61	4.14	8.75	73.23	n/a	.000
ADD [0603 + 0604]	0605	2	5.0	151.67	9.34	8.83	72.41	n/a	.000
ADD [0605 + 0208]	0609	7	5.0	163.85	10.26	8.75	72.41	n/a	.000
CALIB NASHYD [CN=72.0] [N= 3.0:Tp= .74]	0207	3	5.0	79.86	4.42	8.83	57.45	.50	.000
ADD [0609 + 0207]	0606	9	5.0	243.71	14.63	8.75	67.51	n/a	.000
ADD [0606 + 0000]	0607	1	5.0	243.71	14.63	8.75	67.51	n/a	.000
CALIB NASHYD [CN=82.0] [N= 3.0:Tp= .45]	0300	1	5.0	30.20	3.08	8.50	72.41	.63	.000
CALIB NASHYD [CN=80.0] [N= 3.0:Tp= .65]	0301	2	5.0	40.29	3.05	8.75	69.17	.60	.000
CALIB NASHYD [CN=82.0] [N= 3.0:Tp= .72]	0302	3	5.0	25.98	1.94	8.83	72.41	.63	.000
ADD [0301 + 0302]	0700	4	5.0	66.27	4.98	8.75	70.44	n/a	.000
ADD [0300 + 0700]	0701	2	5.0	96.47	7.79	8.67	71.06	n/a	.000
CALIB NASHYD [CN=82.0] [N= 3.0:Tp= .72]	0400	1	5.0	22.91	1.71	8.83	72.41	.63	.000
CALIB NASHYD [CN=82.0] [N= 3.0:Tp= .55]	0401	2	5.0	27.66	2.48	8.58	72.41	.63	.000
ADD [0400 + 0401]	0800	3	5.0	50.57	4.13	8.67	72.41	n/a	.000
* CALIB STANDHYD [I%= 4.0:S%= .50]	0402	1	5.0	9.99	2.21	8.08	82.77	.72	.000
ADD [0402 + 0800]	0801	2	5.0	60.56	4.74	8.58	74.12	n/a	.000
RESRVR [2 : 0801] {ST= 1.14 ha.m }	0802	3	5.0	60.56	3.85	9.08	74.00	n/a	.000
CALIB NASHYD [CN=81.0] [N= 3.0:Tp= .75]	0403	1	5.0	47.88	3.38	8.83	70.77	.62	.000
CALIB NASHYD [CN=81.0] [N= 3.0:Tp= .29]	0404	2	5.0	12.73	1.64	8.25	70.74	.62	.000
ADD [0403 + 0404]	0803	3	5.0	60.61	4.29	8.58	70.77	n/a	.000
* CALIB STANDHYD [I%= 3.0:S%= .50]	0405	1	5.0	12.72	2.65	8.08	78.63	.69	.000
ADD [0405 + 0803]	0804	2	5.0	73.33	5.37	8.25	72.13	n/a	.000
RESRVR [2 : 0804] {ST= .98 ha.m }	0805	3	5.0	73.33	4.72	8.83	72.11	n/a	.000
CALIB NASHYD [CN=81.0] [N= 3.0:Tp= .66]	0406	1	5.0	52.69	4.06	8.75	70.78	.62	.000
CALIB NASHYD [CN=82.0] [N= 3.0:Tp= .28]	0407	2	5.0	13.56	1.91	8.25	72.37	.63	.000

```
      ADD [0406 + 0407]  0806  3  5.0    66.25     5.15  8.50  71.10  n/a     .000
      -----------------
   *  CALIB STANDHYD     0408  1  5.0    15.41     3.58  8.08  85.47  .75     .000
      [I%= 4.0:S%=  .50]
      -----------------
      ADD [0408 + 0806]  0807  2  5.0    81.66     6.91  8.25  73.81  n/a     .000
      -----------------
      RESRVR [ 2 : 0807] 0808  3  5.0    81.66     6.02  8.67  73.81  n/a     .000
      {ST=  1.13 ha.m }
      -----------------
      CALIB NASHYD       0409  1  5.0    32.76     2.23  8.92  70.77  .62     .000
      [CN=81.0         ]
      [ N= 3.0:Tp=  .79]
      -----------------
      CALIB NASHYD       0410  2  5.0    15.07     1.54  8.42  70.77  .62     .000
      [CN=81.0         ]
      [ N= 3.0:Tp=  .43]
      -----------------
      ADD [0409 + 0410]  0809  3  5.0    47.83     3.50  8.67  70.77  n/a     .000
      -----------------
   *  CALIB STANDHYD     0411  1  5.0     5.88     1.38  8.08  86.26  .75     .000
      [I%= 5.0:S%=  .50]
      -----------------
      ADD [0411 + 0809]  0810  2  5.0    53.71     3.86  8.58  72.47  n/a     .000
      -----------------
      RESRVR [ 2 : 0810] 0811  3  5.0    53.71     3.36  9.00  72.46  n/a     .000
      {ST=   .82 ha.m }
      -----------------
      CALIB NASHYD       0412  3  5.0    27.55     2.15  8.67  69.17  .60     .000
      [CN=80.0         ]
      [ N= 3.0:Tp=  .62]
      -----------------
   *  CALIB STANDHYD     0413  1  5.0     9.99     1.82  8.17  77.18  .67     .000
      [I%= 2.0:S%=  .50]
      -----------------
      ADD [0413 + 0412]  0812  2  5.0    37.54     3.05  8.33  71.30  n/a     .000
      -----------------
      RESRVR [ 2 : 0812] 0813  3  5.0    37.54     2.88  8.58  71.29  n/a     .000
      {ST=   .46 ha.m }
      -----------------
      CALIB NASHYD       0414  1  5.0    21.71     1.17  9.33  72.41  .63     .000
      [CN=82.0         ]
      [ N= 3.0:Tp= 1.13]
      -----------------
   ** END OF SIMULATION :   6

***************************************************************************************


   ****************************
   ** SIMULATION NUMBER:   7 **
   ****************************

   W/E COMMAND              HYD ID   DT    AREA   Qpeak Tpeak   R.V. R.C.    Qbase
                                     min    ha     cms   hrs     mm           cms

      START @  .00 hrs
      -----------------
      READ STORM                    10.0
      [ Ptot=124.95 mm ]
      fname :HHILL100.STM
      remark:24HR 100YR CHICAGO - HALTON HILL 88 STDS
      -----------------
   *  CALIB STANDHYD     0103  1  5.0    38.58     5.43  8.33  91.02  .73     .000
      [I%=13.0:S%=  .50]
      -----------------
   *  RESRVR [ 1 : 0103] 0504  2  5.0    38.58     6.16  8.33  90.41  n/a     .000
      {ST=   .86 ha.m }
      -----------------
      CALIB NASHYD       0104  3  5.0    11.79     1.00  8.75  78.42  .63     .000
      [CN=80.0         ]
      [ N= 3.0:Tp=  .69]
      -----------------
      ADD [0504 + 0104]  0505  1  5.0    50.37     6.87  8.33  87.60  n/a     .000
      -----------------
   *  CALIB STANDHYD     0105  2  5.0    16.52     2.96  8.25  89.10  .71     .000
      [I%= 1.0:S%=  .50]
      -----------------
      ADD [0505 + 0105]  0777  3  5.0    66.89     9.62  8.33  87.97  n/a     .000
      -----------------
      CALIB NASHYD       0106  1  5.0    23.59     2.22  8.67  78.42  .63     .000
```

[CN=80.0] [N= 3.0:Tp= .59]									
CALIB NASHYD [CN=80.0] [N= 3.0:Tp= .56]	0107	2	5.0	46.90	4.57	8.58	78.43	.63	.000
ADD [0106 + 0107]	0507	4	5.0	70.49	6.78	8.67	78.43	n/a	.000
ADD [0777 + 0507]	0508	5	5.0	137.38	15.25	8.33	83.07	n/a	.000
CALIB NASHYD [CN=85.0] [N= 3.0:Tp= .46]	0108	1	5.0	12.49	1.58	8.50	87.31	.70	.000
ADD [0108 + 0508]	0999	2	5.0	149.87	16.74	8.33	83.43	n/a	.000
CALIB NASHYD [CN=85.0] [N= 3.0:Tp= .57]	0200	1	5.0	4.28	.47	8.58	87.29	.70	.000
CALIB NASHYD [CN=83.0] [N= 3.0:Tp= 1.24]	0201	2	5.0	53.85	3.23	9.42	83.66	.67	.000
ADD [0200 + 0201]	0600	3	5.0	58.13	3.50	9.33	83.93	n/a	.000
CALIB NASHYD [CN=83.0] [N= 3.0:Tp= .82]	0202	1	5.0	10.45	.85	8.92	83.65	.67	.000
ADD [0202 + 0600]	0601	2	5.0	68.58	4.28	9.25	83.88	n/a	.000
CALIB NASHYD [CN=78.0] [N= 3.0:Tp= .76]	0203	1	5.0	15.59	1.17	8.83	75.09	.60	.000
CALIB NASHYD [CN=82.0] [N= 3.0:Tp= .34]	0208	6	5.0	12.18	1.71	8.33	81.86	.66	.000
CALIB NASHYD [CN=78.0] [N= 3.0:Tp= .42]	0204	3	5.0	11.89	1.32	8.42	75.08	.60	.000
ADD [0203 + 0204]	0602	4	5.0	27.48	2.33	8.58	75.09	n/a	.000
ADD [0601 + 0602]	0603	1	5.0	96.06	6.14	8.92	81.37	n/a	.000
* CALIB STANDHYD [I%= 1.0:S%= .50]	0205	2	5.0	4.45	.93	8.17	92.44	.74	.000
CALIB NASHYD [CN=82.0] [N= 3.0:Tp= .71]	0206	3	5.0	51.16	4.47	8.83	81.88	.66	.000
ADD [0205 + 0206]	0604	4	5.0	55.61	4.79	8.75	82.73	n/a	.000
ADD [0603 + 0604]	0605	2	5.0	151.67	10.85	8.83	81.87	n/a	.000
ADD [0605 + 0208]	0609	7	5.0	163.85	11.91	8.75	81.87	n/a	.000
CALIB NASHYD [CN=72.0] [N= 3.0:Tp= .74]	0207	3	5.0	79.86	5.22	8.83	65.78	.53	.000
ADD [0609 + 0207]	0606	9	5.0	243.71	17.07	8.75	76.59	n/a	.000
ADD [0606 + 0000]	0607	1	5.0	243.71	17.07	8.75	76.59	n/a	.000
CALIB NASHYD [CN=82.0] [N= 3.0:Tp= .45]	0300	1	5.0	30.20	3.57	8.50	81.88	.66	.000
CALIB NASHYD [CN=80.0] [N= 3.0:Tp= .65]	0301	2	5.0	40.29	3.55	8.75	78.43	.63	.000
CALIB NASHYD [CN=82.0] [N= 3.0:Tp= .72]	0302	3	5.0	25.98	2.25	8.83	81.88	.66	.000
ADD [0301 + 0302]	0700	4	5.0	66.27	5.80	8.75	79.78	n/a	.000

	ADD [0300 + 0700]	0701	2	5.0	96.47	9.05	8.67	80.44	n/a	.000
	CALIB NASHYD [CN=82.0] [N= 3.0:Tp= .72]	0400	1	5.0	22.91	1.98	8.83	81.88	.66	.000
	CALIB NASHYD [CN=82.0] [N= 3.0:Tp= .55]	0401	2	5.0	27.66	2.88	8.58	81.88	.66	.000
	ADD [0400 + 0401]	0800	3	5.0	50.57	4.80	8.67	81.88	n/a	.000
*	CALIB STANDHYD [I%= 4.0:S%= .50]	0402	1	5.0	9.99	2.54	8.08	92.62	.74	.000
	ADD [0402 + 0800]	0801	2	5.0	60.56	5.48	8.58	83.65	n/a	.000
	RESRVR [2 : 0801] {ST= 1.22 ha.m }	0802	3	5.0	60.56	4.57	9.00	83.54	n/a	.000
	CALIB NASHYD [CN=81.0] [N= 3.0:Tp= .75]	0403	1	5.0	47.88	3.93	8.83	80.14	.64	.000
	CALIB NASHYD [CN=81.0] [N= 3.0:Tp= .29]	0404	2	5.0	12.73	1.90	8.25	80.10	.64	.000
	ADD [0403 + 0404]	0803	3	5.0	60.61	4.99	8.58	80.13	n/a	.000
*	CALIB STANDHYD [I%= 3.0:S%= .50]	0405	1	5.0	12.72	3.06	8.08	88.27	.71	.000
	ADD [0405 + 0803]	0804	2	5.0	73.33	6.21	8.25	81.54	n/a	.000
	RESRVR [2 : 0804] {ST= 1.04 ha.m }	0805	3	5.0	73.33	5.56	8.75	81.52	n/a	.000
	CALIB NASHYD [CN=81.0] [N= 3.0:Tp= .66]	0406	1	5.0	52.69	4.72	8.75	80.14	.64	.000
	CALIB NASHYD [CN=82.0] [N= 3.0:Tp= .26]	0407	2	5.0	13.56	2.21	8.25	81.83	.65	.000
	ADD [0406 + 0407]	0806	3	5.0	66.25	5.99	8.50	80.49	n/a	.000
*	CALIB STANDHYD [I%= 4.0:S%= .50]	0408	1	5.0	15.41	4.09	8.08	95.45	.76	.000
	ADD [0408 + 0806]	0807	2	5.0	81.66	7.97	8.25	83.31	n/a	.000
	RESRVR [2 : 0807] {ST= 1.19 ha.m }	0808	3	5.0	81.66	7.11	8.58	83.30	n/a	.000
	CALIB NASHYD [CN=81.0] [N= 3.0:Tp= .79]	0409	1	5.0	32.76	2.59	8.92	80.14	.64	.000
	CALIB NASHYD [CN=81.0] [N= 3.0:Tp= .43]	0410	2	5.0	15.07	1.78	8.42	80.13	.64	.000
	ADD [0409 + 0410]	0809	3	5.0	47.83	4.07	8.67	80.14	n/a	.000
*	CALIB STANDHYD [I%= 5.0:S%= .50]	0411	1	5.0	5.88	1.57	8.08	96.27	.77	.000
	ADD [0411 + 0809]	0810	2	5.0	53.71	4.48	8.58	81.90	n/a	.000
	RESRVR [2 : 0810] {ST= .88 ha.m }	0811	3	5.0	53.71	3.93	9.00	81.89	n/a	.000
	CALIB NASHYD [CN=80.0] [N= 3.0:Tp= .62]	0412	3	5.0	27.55	2.51	8.67	78.43	.63	.000
*	CALIB STANDHYD [I%= 2.0:S%= .50]	0413	1	5.0	9.99	2.20	8.08	86.76	.69	.000
	ADD [0413 + 0412]	0812	2	5.0	37.54	3.35	8.25	80.64	n/a	.000
	RESRVR [2 : 0812]	0813	3	5.0	37.54	3.25	8.58	80.63	n/a	.000

```
    {ST=   .47 ha.m }
    ------------------
    CALIB NASHYD        0414  1  5.0    21.71     1.36  9.33  81.88  .66     .000
    [CN=82.0         ]
    [ N= 3.0:Tp= 1.13]
    ------------------
 FINISH
==========================================================================================
```

```
 OOO    TTTTT  TTTTT  H   H  Y   Y  M   M   OOO    I N T E R H Y M O
O   O     T      T    H   H   Y Y   MM MM  O   O   * * * 1989b * * *
O   O     T      T    HHHHH    Y    M M M  O   O
O   O     T      T    H   H    Y    M   M  O   O
 OOO      T      T    H   H    Y    M   M   OOO    □□□□□□□□□□00025
```


***** S U M M A R Y   O U T P U T *****

Input filename: hh-fut1.dat
Output filename: hh-fut1.out
Summary filename: hh-fut1.sum

DATE: 01-20-1999 TIME: 14:52:50

USER: ________________________

COMMENTS: ________________________

****
** SIMULATION NUMBER: 1 **
****

W/E	COMMAND	HYD	ID	DT min	AREA ha	Qpeak cms	Tpeak hrs	R.V. mm	R.C.	Qbase cms
	START @ .00 hrs									
	READ STORM [Ptot= 25.30 mm] fname :25MM.STM remark: 25MM STOR			10.0						
	CALIB STANDHYD [I%=47.0:S%= .50]	0100	1	5.0	62.27	3.16	2.17	19.51	.77	.000
	RESRVR [1 : 0100] {ST= 1.06 ha.m }	0500	2	5.0	62.27	.16	4.42	19.49	n/a	.000
*	CALIB STANDHYD [I%=47.0:S%= .50]	0101	1	5.0	1.91	.15	2.00	19.46	.77	.000
	ADD [0101 + 0500]	0501	3	5.0	64.18	.20	2.42	19.49	n/a	.000
	CALIB STANDHYD [I%=53.0:S%= 1.00]	0102	1	5.0	66.89	3.11	2.17	17.19	.68	.000
	ADD [0102 + 0501]	0502	2	5.0	131.07	3.27	2.17	18.32	n/a	.000
	CALIB STANDHYD [I%=54.0:S%= 1.00]	0103	1	5.0	60.02	2.86	2.17	17.28	.68	.000
	ADD [0103 + 0502]	0503	3	5.0	191.09	6.13	2.17	17.99	n/a	.000
	RESRVR [3 : 0503] {ST= 2.12 ha.m }	0504	1	5.0	191.09	.24	5.25	17.76	n/a	.000
	CALIB STANDHYD [I%=56.0:S%= 1.00]	0104	2	5.0	18.39	1.12	2.08	17.72	.70	.000
	RESRVR [2 : 0104] {ST= .29 ha.m }	0505	3	5.0	18.39	.04	4.33	17.61	n/a	.000
	CALIB NASHYD [CN=76.0] [N= 3.0:Tp= .47]	0105	2	5.0	11.50	.09	2.50	4.09	.16	.000
	ADD [0105 + 0505]	0506	4	5.0	29.89	.12	2.58	12.41	n/a	.000
	ADD [0504 + 0506]	0507	7	5.0	220.98	.32	2.75	17.03	n/a	.000
	CALIB NASHYD [CN=82.0] [N= 3.0:Tp= .80]	0106	1	5.0	21.75	.16	2.92	5.41	.21	.000

CALIB NASHYD [CN=85.0] [N= 3.0:Tp= 1.03]	0107	2	5.0	56.60	.41	3.25	6.32	.25	.000
ADD [0106 + 0107]	0508	3	5.0	78.35	.56	3.17	6.07	n/a	.000
ADD [0508 + 0507]	0509	8	5.0	299.33	.88	3.08	14.16	n/a	.000
CHANNEL[8 : 0509]	0510	1	5.0	299.33	.65	4.17	14.15	n/a	.000
CALIB NASHYD [CN=74.0] [N= 3.0:Tp= 1.61]	0108	2	5.0	148.60	.45	4.00	3.76	.15	.000
ADD [0510 + 0108]	0511	10	5.0	447.93	1.10	4.17	10.70	n/a	.000
CALIB NASHYD [CN=85.0] [N= 3.0:Tp= .57]	0200	1	5.0	4.28	.05	2.67	6.30	.25	.000
CALIB STANDHYD [I%=53.0:S%= 1.00]	0201	2	5.0	65.90	3.06	2.17	17.10	.68	.000
ADD [0200 + 0201]	0600	3	5.0	70.18	3.08	2.17	16.44	n/a	.000
RESRVR [3 : 0600] {ST= 1.02 ha.m }	0601	6	5.0	70.18	.12	4.67	16.34	n/a	.000
CALIB STANDHYD [I%=45.0:S%= 1.00]	0202	1	5.0	15.16	.76	2.08	15.54	.61	.000
RESRVR [1 : 0202] {ST= .21 ha.m }	0602	2	5.0	15.16	.02	4.58	15.45	n/a	.000
CALIB STANDHYD [I%=58.0:S%= 1.00]	0203	1	5.0	36.51	2.07	2.08	18.08	.71	.000
RESRVR [1 : 0203] {ST= .59 ha.m }	0603	4	5.0	36.51	.07	4.42	17.97	n/a	.000
ADD [0603 + 0602]	0604	5	5.0	51.67	.10	4.42	17.23	n/a	.000
ADD [0604 + 0601]	0605	7	5.0	121.85	.22	4.58	16.71	n/a	.000
CALIB NASHYD [CN=72.0] [N= 3.0:Tp= .74]	0204	1	5.0	29.39	.15	2.92	3.45	.14	.000
ADD [0204 + 0605]	0606	2	5.0	151.24	.34	3.00	14.14	n/a	.000
CALIB NASHYD [CN=72.0] [N= 3.0:Tp= .74]	0205	3	5.0	79.86	.40	2.92	3.46	.14	.000
ADD [0606 + 0205]	0607	9	5.0	231.10	.74	2.92	10.45	n/a	.000
ADD [0607 + 0511]	0608	1	5.0	679.03	1.63	3.67	10.62	n/a	.000
CALIB STANDHYD [I%=54.0:S%= 1.00]	0300	2	5.0	22.93	1.32	2.08	17.36	.69	.000
RESRVR [2 : 0300] {ST= .35 ha.m }	0698	3	5.0	22.93	.04	4.42	17.26	n/a	.000
CALIB STANDHYD [I%=53.0:S%= 1.00]	0301	4	5.0	61.89	2.89	2.17	17.10	.68	.000
RESRVR [4 : 0301] {ST= .94 ha.m }	0699	3	5.0	61.89	.11	4.58	16.99	n/a	.000
CALIB NASHYD [CN=82.0] [N= 3.0:Tp= .72]	0400	1	5.0	22.91	.18	2.83	5.41	.21	.000
CALIB STANDHYD [I%=53.0:S%= .50]	0401	2	5.0	22.33	1.47	2.08	16.69	.66	.000
ADD [0400 + 0401]	0800	3	5.0	45.24	1.51	2.08	10.98	n/a	.000
RESRVR [3 : 0800] {ST= .44 ha.m }	0801	1	5.0	45.24	.05	4.67	10.90	n/a	.000
* CALIB STANDHYD [I%= 4.0:S%= .50]	0402	2	5.0	9.99	.31	2.17	9.23	.36	.000

```
    ------------------
    ADD [0801 + 0402]  0802  3  5.0    55.23     .34  2.17  10.60  n/a     .000
    ------------------
    RESRVR [ 3 : 0802] 0803  1  5.0    55.23     .03 21.25  10.47  n/a     .000
    {ST=    .17 ha.m }
    ------------------
    CALIB NASHYD       0403  1  5.0    47.88     .35  2.92   5.15  .20     .000
    [CN=81.0          ]
    [ N= 3.0:Tp=  .75]
    ------------------
    CALIB STANDHYD     0404  2  5.0    13.00     .90  2.08  16.69  .66     .000
    [I%=53.0:S%=  .50]
    ------------------
    ADD [0403 + 0404]  0804  3  5.0    60.88     .96  2.08   7.62  n/a     .000
    ------------------
    RESRVR [ 3 : 0804] 0805  1  5.0    60.88     .03  5.42   7.53  n/a     .000
    {ST=    .42 ha.m }
    ------------------
  * CALIB STANDHYD     0405  2  5.0    12.72     .34  2.17   8.15  .32     .000
    [I%= 3.0:S%=  .50]
    ------------------
    ADD [0805 + 0405]  0806  3  5.0    73.60     .36  2.17   7.64  n/a     .000
    ------------------
    RESRVR [ 3 : 0806] 0807  1  5.0    73.60     .03  4.92   7.54  n/a     .000
    {ST=    .11 ha.m }
    ------------------
    CALIB NASHYD       0406  1  5.0    52.69     .43  2.75   5.16  .20     .000
    [CN=81.0          ]
    [ N= 3.0:Tp=  .66]
    ------------------
    CALIB STANDHYD     0407  2  5.0    14.71     .93  2.08  16.42  .65     .000
    [I%=52.0:S%=  .50]
    ------------------
    ADD [0406 + 0407]  0808  3  5.0    67.40    1.03  2.08   7.61  n/a     .000
    ------------------
    RESRVR [ 3 : 0808] 0809  1  5.0    67.40     .04  5.17   7.53  n/a     .000
    {ST=    .47 ha.m }
    ------------------
  * CALIB STANDHYD     0408  2  5.0    15.41     .52  2.17   9.96  .39     .000
    [I%= 4.0:S%=  .50]
    ------------------
    ADD [0809 + 0408]  0810  3  5.0    82.81     .54  2.17   7.98  n/a     .000
    ------------------
 ** RESRVR [ 3 : 0810] 0811  1  5.0    82.81     .06  4.25   7.95  n/a     .000
    {ST=    .14 ha.m }
    ------------------
    CALIB NASHYD       0409  1  5.0    32.76     .23  2.92   5.15  .20     .000
    [CN=81.0          ]
    [ N= 3.0:Tp=  .79]
    ------------------
    CALIB STANDHYD     0410  2  5.0    18.11    1.21  2.08  16.69  .66     .000
    [I%=53.0:S%=  .50]
    ------------------
    ADD [0409 + 0410]  0812  3  5.0    50.87    1.26  2.08   9.26  n/a     .000
    ------------------
    RESRVR [ 3 : 0812] 0813  1  5.0    50.87     .04  5.08   9.18  n/a     .000
    {ST=    .42 ha.m }
    ------------------
  * CALIB STANDHYD     0411  2  5.0     5.88     .21  2.17  10.24  .40     .000
    [I%= 5.0:S%=  .50]
    ------------------
    ADD [0813 + 0411]  0814  3  5.0    56.75     .23  2.17   9.29  n/a     .000
    ------------------
    RESRVR [ 3 : 0814] 0815  1  5.0    56.75     .03 20.83   9.25  n/a     .000
    {ST=    .12 ha.m }
    ------------------
    CALIB STANDHYD     0412  1  5.0    45.47    2.55  2.08  16.69  .66     .000
    [I%=53.0:S%=  .50]
    ------------------
    RESRVR [ 1 : 0412] 0816  2  5.0    45.47     .08  4.25  16.58  n/a     .000
    {ST=    .69 ha.m }
    ------------------
  * CALIB STANDHYD     0413  1  5.0     9.99     .22  2.25   7.73  .31     .000
    [I%= 2.0:S%=  .50]
    ------------------
    ADD [0413 + 0816]  0817  3  5.0    55.46     .29  2.25  14.99  n/a     .000
    ------------------
 ** RESRVR [ 2 : 0816] 0818  1  5.0    45.47     .03 27.17  16.50  n/a     .000
    {ST=    .28 ha.m }
    ------------------
 ** END OF SIMULATION :    1

*****************************************************************************
```

```
****************************
** SIMULATION NUMBER:   2 **
****************************

W/E COMMAND                HYD ID   DT     AREA    Qpeak Tpeak    R.V.  R.C.     Qbase
                                    min    ha      cms    hrs      mm             cms

     START @    .00 hrs
     -----------------
     READ STORM                    10.0
     [ Ptot= 55.87 mm ]
     fname :HHILL2.STM
     remark:24HR 2YR CHICAGO - HALTON HILL 88 STDS
     -----------------
     CALIB STANDHYD      0100  1   5.0    62.27    4.92  8.08   48.72  .87      .000
     [I%=47.0:S%=  .50]
     -----------------
     RESRVR [ 1 : 0100]  0500  2   5.0    62.27     .20 14.58   48.35  n/a      .000
     {ST=  2.06 ha.m }
     -----------------
*    CALIB STANDHYD      0101  1   5.0     1.91     .22  8.00   48.67  .87      .000
     [I%=47.0:S%=  .50]
     -----------------
     ADD [0101 + 0500]   0501  3   5.0    64.18     .34  8.00   48.36  n/a      .000
     -----------------
     CALIB STANDHYD      0102  1   5.0    66.89    4.86  8.08   44.06  .79      .000
     [I%=53.0:S%= 1.00]
     -----------------
     ADD [0102 + 0501]   0502  2   5.0   131.07    5.16  8.08   46.17  n/a      .000
     -----------------
     CALIB STANDHYD      0103  1   5.0    60.02    4.48  8.08   44.15  .79      .000
     [I%=54.0:S%= 1.00]
     -----------------
     ADD [0103 + 0502]   0503  3   5.0   191.09    9.63  8.08   45.53  n/a      .000
     -----------------
     RESRVR [ 3 : 0503]  0504  1   5.0   191.09     .48 17.42   41.69  n/a      .000
     {ST=  4.53 ha.m }
     -----------------
     CALIB STANDHYD      0104  2   5.0    18.39    1.82  8.00   44.92  .80      .000
     [I%=56.0:S%= 1.00]
     -----------------
     RESRVR [ 2 : 0104]  0505  3   5.0    18.39     .05 15.50   43.78  n/a      .000
     {ST=   .58 ha.m }
     -----------------
     CALIB NASHYD        0105  2   5.0    11.50     .24  8.50   19.73  .35      .000
     [CN=76.0         ]
     [ N= 3.0:Tp=  .47]
     -----------------
     ADD [0105 + 0505]   0506  4   5.0    29.89     .28  8.50   34.53  n/a      .000
     -----------------
     ADD [0504 + 0506]   0507  7   5.0   220.98     .55 17.42   40.72  n/a      .000
     -----------------
     CALIB NASHYD        0106  1   5.0    21.75     .40  8.92   24.26  .43      .000
     [CN=82.0         ]
     [ N= 3.0:Tp=  .80]
     -----------------
     CALIB NASHYD        0107  2   5.0    56.60    1.01  9.25   27.04  .48      .000
     [CN=85.0         ]
     [ N= 3.0:Tp= 1.03]
     -----------------
     ADD [0106 + 0107]   0508  3   5.0    78.35    1.39  9.17   26.27  n/a      .000
     -----------------
     ADD [0508 + 0507]   0509  8   5.0   299.33    1.89  9.08   36.94  n/a      .000
     -----------------
     CHANNEL[ 8 : 0509]  0510  1   5.0   299.33    1.54  9.75   36.72  n/a      .000
     -----------------
     CALIB NASHYD        0108  2   5.0   148.60    1.23 10.00   18.47  .33      .000
     [CN=74.0         ]
     [ N= 3.0:Tp= 1.61]
     -----------------
     ADD [0510 + 0108]   0511 10   5.0   447.93    2.75  9.83   30.67  n/a      .000
     -----------------
     CALIB NASHYD        0200  1   5.0     4.28     .11  8.58   27.01  .48      .000
     [CN=85.0         ]
     [ N= 3.0:Tp=  .57]
     -----------------
     CALIB STANDHYD      0201  2   5.0    65.90    4.79  8.08   43.86  .79      .000
     [I%=53.0:S%= 1.00]
     -----------------
     ADD [0200 + 0201]   0600  3   5.0    70.18    4.83  8.08   42.84  n/a      .000
```

	RESRVR [3 : 0600] {ST= 2.10 ha.m }	0601	6	5.0	70.18	.17	16.25	41.56	n/a	.000
	CALIB STANDHYD [I%=45.0:S%= 1.00]	0202	1	5.0	15.16	1.26	8.00	41.20	.74	.000
	RESRVR [1 : 0202] {ST= .44 ha.m }	0602	2	5.0	15.16	.03	16.67	40.03	n/a	.000
	CALIB STANDHYD [I%=58.0:S%= 1.00]	0203	1	5.0	36.51	3.22	8.08	45.51	.81	.000
	RESRVR [1 : 0203] {ST= 1.16 ha.m }	0603	4	5.0	36.51	.10	15.42	44.36	n/a	.000
	ADD [0603 + 0602]	0604	5	5.0	51.67	.13	15.75	43.09	n/a	.000
	ADD [0604 + 0601]	0605	7	5.0	121.85	.30	16.00	42.21	n/a	.000
	CALIB NASHYD [CN=72.0] [N= 3.0:Tp= .74]	0204	1	5.0	29.39	.39	8.92	17.29	.31	.000
	ADD [0204 + 0605]	0606	2	5.0	151.24	.65	8.92	37.36	n/a	.000
	CALIB NASHYD [CN=72.0] [N= 3.0:Tp= .74]	0205	3	5.0	79.86	1.05	8.92	17.29	.31	.000
	ADD [0606 + 0205]	0607	9	5.0	231.10	1.70	8.92	30.43	n/a	.000
	ADD [0607 + 0511]	0608	1	5.0	679.03	4.06	9.50	30.59	n/a	.000
	CALIB STANDHYD [I%=54.0:S%= 1.00]	0300	2	5.0	22.93	1.99	8.08	44.35	.79	.000
	RESRVR [2 : 0300] {ST= .71 ha.m }	0698	3	5.0	22.93	.06	15.75	43.18	n/a	.000
	CALIB STANDHYD [I%=53.0:S%= 1.00]	0301	4	5.0	61.89	4.53	8.08	43.86	.79	.000
	RESRVR [4 : 0301] {ST= 1.89 ha.m }	0699	3	5.0	61.89	.16	15.92	42.63	n/a	.000
	CALIB NASHYD [CN=82.0] [N= 3.0:Tp= .72]	0400	1	5.0	22.91	.46	8.83	24.26	.43	.000
	CALIB STANDHYD [I%=53.0:S%= .50]	0401	2	5.0	22.33	2.26	8.08	42.85	.77	.000
	ADD [0400 + 0401]	0800	3	5.0	45.24	2.39	8.08	33.44	n/a	.000
	RESRVR [3 : 0800] {ST= .84 ha.m }	0801	1	5.0	45.24	.31	10.50	32.51	n/a	.000
*	CALIB STANDHYD [I%= 4.0:S%= .50]	0402	2	5.0	9.99	.63	8.17	31.34	.56	.000
	ADD [0801 + 0402]	0802	3	5.0	55.23	.67	8.17	32.30	n/a	.000
	RESRVR [3 : 0802] {ST= .60 ha.m }	0803	1	5.0	55.23	.12	16.58	28.31	n/a	.000
	CALIB NASHYD [CN=81.0] [N= 3.0:Tp= .75]	0403	1	5.0	47.88	.89	8.83	23.42	.42	.000
	CALIB STANDHYD [I%=53.0:S%= .50]	0404	2	5.0	13.00	1.41	8.00	42.85	.77	.000
	ADD [0403 + 0404]	0804	3	5.0	60.88	1.56	8.00	27.57	n/a	.000
	RESRVR [3 : 0804] {ST= .55 ha.m }	0805	1	5.0	60.88	.92	9.33	27.15	n/a	.000
*	CALIB STANDHYD [I%= 3.0:S%= .50]	0405	2	5.0	12.72	.72	8.17	28.85	.52	.000
	ADD [0805 + 0405]	0806	3	5.0	73.60	1.03	9.25	27.45	n/a	.000
	RESRVR [3 : 0806]	0807	1	5.0	73.60	.48	10.83	27.00	n/a	.000

```
      {ST=   .62 ha.m }
      ------------------
      CALIB NASHYD        0406  1  5.0   52.69    1.07  8.75  23.42  .42    .000
      [CN=81.0          ]
      [ N= 3.0:Tp=  .66]
      ------------------
      CALIB STANDHYD      0407  2  5.0   14.71    1.55  8.00  42.33  .76    .000
      [I%=52.0:S%=  .50]
      ------------------
      ADD [0406 + 0407]   0808  3  5.0   67.40    1.76  8.00  27.55  n/a    .000
      ------------------
      RESRVR [ 3 : 0808]  0809  1  5.0   67.40    1.09  9.17  27.15  n/a    .000
      {ST=   .61 ha.m }
      ------------------
 *    CALIB STANDHYD      0408  2  5.0   15.41    1.04  8.17  33.00  .59    .000
      [I%= 4.0:S%=  .50]
      ------------------
      ADD [0809 + 0408]   0810  3  5.0   82.81    1.26  9.17  28.24  n/a    .000
      ------------------
 **   RESRVR [ 3 : 0810]  0811  1  5.0   82.81     .51 10.92  28.09  n/a    .000
      {ST=   .76 ha.m }
      ------------------
      CALIB NASHYD        0409  1  5.0   32.76     .59  8.92  23.42  .42    .000
      [CN=81.0          ]
      [ N= 3.0:Tp=  .79]
      ------------------
      CALIB STANDHYD      0410  2  5.0   18.11    1.90  8.00  42.85  .77    .000
      [I%=53.0:S%=  .50]
      ------------------
      ADD [0409 + 0410]   0812  3  5.0   50.87    1.99  8.00  30.34  n/a    .000
      ------------------
      RESRVR [ 3 : 0812]  0813  1  5.0   50.87     .48 10.00  29.63  n/a    .000
      {ST=   .73 ha.m }
      ------------------
 *    CALIB STANDHYD      0411  2  5.0    5.88     .41  8.17  33.54  .60    .000
      [I%= 5.0:S%=  .50]
      ------------------
      ADD [0813 + 0411]   0814  3  5.0   56.75     .52 10.00  30.04  n/a    .000
      ------------------
      RESRVR [ 3 : 0814]  0815  1  5.0   56.75     .19 13.50  28.72  n/a    .000
      {ST=   .52 ha.m }
      ------------------
      CALIB STANDHYD      0412  1  5.0   45.47    4.28  8.08  42.85  .77    .000
      [I%=53.0:S%=  .50]
      ------------------
      RESRVR [ 1 : 0412]  0816  2  5.0   45.47     .11 15.50  41.72  n/a    .000
      {ST=  1.36 ha.m }
      ------------------
 *    CALIB STANDHYD      0413  1  5.0    9.99     .51  8.17  27.96  .50    .000
      [I%= 2.0:S%=  .50]
      ------------------
      ADD [0413 + 0816]   0817  3  5.0   55.46     .59  8.17  39.24  n/a    .000
      ------------------
 **   RESRVR [ 2 : 0816]  0818  1  5.0   45.47   10.95 43.58  29.51  n/a    .000
      {ST=  1.01 ha.m }
      ------------------
 ** END OF SIMULATION :    2

*******************************************************************************


 ****************************
 ** SIMULATION NUMBER:    3 **
 ****************************

 W/E COMMAND               HYD ID   DT    AREA   Qpeak Tpeak   R.V. R.C.    Qbase
                                    min    ha     cms   hrs     mm           cms

      START @   .00 hrs
      ------------------
      READ STORM                   10.0
      [ Ptot= 71.72 mm ]
      fname :HHILL5.STM
      remark:24HR 5YR CHICAGO - HALTON HILL 88 STDS
      ------------------
      CALIB STANDHYD      0100  1  5.0   62.27    8.03  8.08  64.24  .90    .000
      [I%=47.0:S%=  .50]
      ------------------
      RESRVR [ 1 : 0100]  0500  2  5.0   62.27     .40 11.33  63.63  n/a    .000
      {ST=  2.74 ha.m }
      ------------------
```

CALIB NASHYD [CN=76.0] [N= 3.0:Tp= .47]	0105	2	5.0	11.50	.59	8.50	39.90	.47	.000
ADD [0105 + 0505]	0506	4	5.0	29.89	.69	8.67	58.79	n/a	.000
ADD [0504 + 0506]	0507	7	5.0	220.98	4.11	9.33	66.71	n/a	.000
CALIB NASHYD [CN=82.0] [N= 3.0:Tp= .80]	0106	1	5.0	21.75	.95	8.92	47.10	.55	.000
CALIB NASHYD [CN=85.0] [N= 3.0:Tp= 1.03]	0107	2	5.0	56.60	2.27	9.17	51.23	.60	.000
ADD [0106 + 0107]	0508	3	5.0	78.35	3.18	9.08	50.08	n/a	.000
ADD [0508 + 0507]	0509	8	5.0	299.33	7.24	9.25	62.36	n/a	.000
CHANNEL[8 : 0509]	0510	1	5.0	299.33	6.26	9.75	62.10	n/a	.000
CALIB NASHYD [CN=74.0] [N= 3.0:Tp= 1.61]	0108	2	5.0	148.60	2.99	9.92	37.78	.44	.000
ADD [0510 + 0108]	0511	10	5.0	447.93	9.22	9.83	54.03	n/a	.000
CALIB NASHYD [CN=85.0] [N= 3.0:Tp= .57]	0200	1	5.0	4.28	.26	8.58	51.20	.60	.000
CALIB STANDHYD [I%=53.0:S%= 1.00]	0201	2	5.0	65.90	9.33	8.08	71.07	.84	.000
ADD [0200 + 0201]	0600	3	5.0	70.18	9.43	8.08	69.86	n/a	.000
RESRVR [3 : 0600] {ST= 2.91 ha.m }	0601	6	5.0	70.18	1.34	9.58	68.20	n/a	.000
CALIB STANDHYD [I%=45.0:S%= 1.00]	0202	1	5.0	15.16	2.21	8.00	67.79	.80	.000
RESRVR [1 : 0202] {ST= .54 ha.m }	0602	2	5.0	15.16	.49	9.00	66.45	n/a	.000
CALIB STANDHYD [I%=58.0:S%= 1.00]	0203	1	5.0	36.51	5.80	8.08	73.09	.86	.000
RESRVR [1 : 0203] {ST= 1.61 ha.m }	0603	4	5.0	36.51	.76	9.42	71.28	n/a	.000
ADD [0603 + 0602]	0604	5	5.0	51.67	1.20	9.25	69.86	n/a	.000
ADD [0604 + 0601]	0605	7	5.0	121.85	2.49	9.42	68.91	n/a	.000
CALIB NASHYD [CN=72.0] [N= 3.0:Tp= .74]	0204	1	5.0	29.39	.97	8.83	35.76	.42	.000
ADD [0204 + 0605]	0606	2	5.0	151.24	3.31	9.33	62.47	n/a	.000
CALIB NASHYD [CN=72.0] [N= 3.0:Tp= .74]	0205	3	5.0	79.86	2.65	8.83	35.77	.42	.000
ADD [0606 + 0205]	0607	9	5.0	231.10	5.74	9.08	53.24	n/a	.000
ADD [0607 + 0511]	0608	1	5.0	679.03	14.19	9.50	53.76	n/a	.000
CALIB STANDHYD [I%=54.0:S%= 1.00]	0300	2	5.0	22.93	3.76	8.00	71.69	.84	.000
RESRVR [2 : 0300] {ST= .96 ha.m }	0698	3	5.0	22.93	.57	9.25	69.97	n/a	.000
CALIB STANDHYD [I%=53.0:S%= 1.00]	0301	4	5.0	61.89	8.81	8.08	71.07	.84	.000
RESRVR [4 : 0301] {ST= 2.61 ha.m }	0699	3	5.0	61.89	1.28	9.50	69.33	n/a	.000
CALIB NASHYD [CN=82.0]	0400	1	5.0	22.91	1.07	8.83	47.10	.55	.000

```
    [ N= 3.0:Tp=  .79]
    ------------------
    CALIB STANDHYD      0410  2  5.0    18.11     2.74  8.00  57.31  .80     .000
    [I%=53.0:S%=  .50]
    ------------------
    ADD [0409 + 0410]   0812  3  5.0    50.87     2.90  8.00  43.10  n/a     .000
    ------------------
    RESRVR [ 3 : 0812]  0813  1  5.0    50.87     1.22  9.25  42.39  n/a     .000
    {ST=   .81 ha.m }
    ------------------
 *  CALIB STANDHYD      0411  2  5.0     5.88      .70  8.08  47.22  .66     .000
    [I%= 5.0:S%=  .50]
    ------------------
    ADD [0813 + 0411]   0814  3  5.0    56.75     1.31  9.25  42.89  n/a     .000
    ------------------
    RESRVR [ 3 : 0814]  0815  1  5.0    56.75     1.00 10.00  41.56  n/a     .000
    {ST=   .58 ha.m }
    ------------------
    CALIB STANDHYD      0412  1  5.0    45.47     6.35  8.08  57.32  .80     .000
    [I%=53.0:S%=  .50]
    ------------------
    RESRVR [ 1 : 0412]  0816  2  5.0    45.47      .30 10.92  55.65  n/a     .000
    {ST=  1.76 ha.m }
    ------------------
 *  CALIB STANDHYD      0413  1  5.0     9.99      .86  8.17  40.45  .56     .000
    [I%= 2.0:S%=  .50]
    ------------------
    ADD [0413 + 0816]   0817  3  5.0    55.46      .95  8.17  52.91  n/a     .000
    ------------------
 ** RESRVR [ 2 : 0816]  0818  1  5.0    45.47    10.98 24.08  44.33  n/a     .000
    {ST=  1.57 ha.m }
    ------------------
 ** END OF SIMULATION :   3

*******************************************************************************


 ****************************
 ** SIMULATION NUMBER:   4 **
 ****************************

 W/E COMMAND             HYD ID   DT    AREA    Qpeak Tpeak   R.V. R.C.    Qbase
                                 min     ha      cms   hrs     mm           cms

    START @   .00 hrs
    ------------------
    READ STORM                  10.0
    [ Ptot= 84.96 mm ]
    fname :HHILL10.STM
    remark:24HR 10YR CHICAGO - HALTON HILL 88 STDS
    ------------------
    CALIB STANDHYD      0100  1  5.0    62.27     9.85  8.08  77.28  .91     .000
    [I%=47.0:S%=  .50]
    ------------------
    RESRVR [ 1 : 0100]  0500  2  5.0    62.27      .67 10.42  76.60  n/a     .000
    {ST=  3.18 ha.m }
    ------------------
 *  CALIB STANDHYD      0101  1  5.0     1.91      .40  8.00  77.24  .91     .000
    [I%=47.0:S%=  .50]
    ------------------
    ADD [0101 + 0500]   0501  3  5.0    64.18      .69 10.33  76.62  n/a     .000
    ------------------
    CALIB STANDHYD      0102  1  5.0    66.89     9.49  8.08  71.34  .84     .000
    [I%=53.0:S%= 1.00]
    ------------------
    ADD [0102 + 0501]   0502  2  5.0   131.07     9.96  8.08  73.93  n/a     .000
    ------------------
    CALIB STANDHYD      0103  1  5.0    60.02     8.68  8.08  71.42  .84     .000
    [I%=54.0:S%= 1.00]
    ------------------
    ADD [0103 + 0502]   0503  3  5.0   191.09    18.64  8.08  73.14  n/a     .000
    ------------------
    RESRVR [ 3 : 0503]  0504  1  5.0   191.09     3.52  9.33  67.94  n/a     .000
    {ST=  5.48 ha.m }
    ------------------
    CALIB STANDHYD      0104  2  5.0    18.39     3.24  8.00  72.38  .85     .000
    [I%=56.0:S%= 1.00]
    ------------------
    RESRVR [ 2 : 0104]  0505  3  5.0    18.39      .31  9.58  70.61  n/a     .000
    {ST=   .82 ha.m }
    ------------------
```

ADD [0204 + 0605]	0606	2	5.0	151.24	1.47	9.92	50.75	n/a	.000
CALIB NASHYD [CN=72.0] [N= 3.0:Tp= .74]	0205	3	5.0	79.86	1.92	8.83	26.90	.38	.000
ADD [0606 + 0205]	0607	9	5.0	231.10	3.04	9.17	42.51	n/a	.000
ADD [0607 + 0511]	0608	1	5.0	679.03	8.20	9.75	42.80	n/a	.000
CALIB STANDHYD [I%=54.0:S%= 1.00]	0300	2	5.0	22.93	3.11	8.00	59.13	.82	.000
RESRVR [2 : 0300] {ST= .87 ha.m }	0698	3	5.0	22.93	.24	10.08	57.50	n/a	.000
CALIB STANDHYD [I%=53.0:S%= 1.00]	0301	4	5.0	61.89	6.99	8.08	58.57	.82	.000
RESRVR [4 : 0301] {ST= 2.36 ha.m }	0699	3	5.0	61.89	.56	10.42	56.91	n/a	.000
CALIB NASHYD [CN=82.0] [N= 3.0:Tp= .72]	0400	1	5.0	22.91	.80	8.83	36.34	.51	.000
CALIB STANDHYD [I%=53.0:S%= .50]	0401	2	5.0	22.33	3.31	8.00	57.31	.80	.000
ADD [0400 + 0401]	0800	3	5.0	45.24	3.45	8.00	46.69	n/a	.000
RESRVR [3 : 0800] {ST= .95 ha.m }	0801	1	5.0	45.24	1.01	9.25	45.76	n/a	.000
* CALIB STANDHYD [I%= 4.0:S%= .50]	0402	2	5.0	9.99	1.04	8.17	44.57	.62	.000
ADD [0801 + 0402]	0802	3	5.0	55.23	1.15	9.25	45.54	n/a	.000
RESRVR [3 : 0802] {ST= .69 ha.m }	0803	1	5.0	55.23	.66	10.42	41.55	n/a	.000
CALIB NASHYD [CN=81.0] [N= 3.0:Tp= .75]	0403	1	5.0	47.88	1.57	8.83	35.24	.49	.000
CALIB STANDHYD [I%=53.0:S%= .50]	0404	2	5.0	13.00	2.20	8.00	57.31	.80	.000
ADD [0403 + 0404]	0804	3	5.0	60.88	2.45	8.00	39.96	n/a	.000
RESRVR [3 : 0804] {ST= .60 ha.m }	0805	1	5.0	60.88	1.80	9.00	39.54	n/a	.000
* CALIB STANDHYD [I%= 3.0:S%= .50]	0405	2	5.0	12.72	1.21	8.17	41.52	.58	.000
ADD [0805 + 0405]	0806	3	5.0	73.60	2.06	8.83	39.88	n/a	.000
RESRVR [3 : 0806] {ST= .73 ha.m }	0807	1	5.0	73.60	1.54	9.58	39.43	n/a	.000
CALIB NASHYD [CN=81.0] [N= 3.0:Tp= .66]	0406	1	5.0	52.69	1.89	8.75	35.24	.49	.000
CALIB STANDHYD [I%=52.0:S%= .50]	0407	2	5.0	14.71	2.23	8.00	56.71	.79	.000
ADD [0406 + 0407]	0808	3	5.0	67.40	2.59	8.00	39.93	n/a	.000
RESRVR [3 : 0808] {ST= .67 ha.m }	0809	1	5.0	67.40	2.20	8.83	39.53	n/a	.000
* CALIB STANDHYD [I%= 4.0:S%= .50]	0408	2	5.0	15.41	1.81	8.08	46.59	.65	.000
ADD [0809 + 0408]	0810	3	5.0	82.81	2.57	8.75	40.84	n/a	.000
** RESRVR [3 : 0810] {ST= .90 ha.m }	0811	1	5.0	82.81	1.69	9.58	40.69	n/a	.000
CALIB NASHYD [CN=81.0]	0409	1	5.0	32.76	1.03	8.92	35.24	.49	.000

* CALIB STANDHYD [I%=47.0:S%= .50]	0101	1	5.0	1.91	.33	8.00	64.20	.90	.000
ADD [0101 + 0500]	0501	3	5.0	64.18	.48	8.00	63.64	n/a	.000
CALIB STANDHYD [I%=53.0:S%= 1.00]	0102	1	5.0	66.89	7.74	8.08	58.81	.82	.000
ADD [0102 + 0501]	0502	2	5.0	131.07	8.15	8.08	61.18	n/a	.000
CALIB STANDHYD [I%=54.0:S%= 1.00]	0103	1	5.0	60.02	6.89	8.08	58.89	.82	.000
ADD [0103 + 0502]	0503	3	5.0	191.09	15.04	8.08	60.46	n/a	.000
RESRVR [3 : 0503] {ST= 5.02 ha.m }	0504	1	5.0	191.09	1.63	10.33	55.52	n/a	.000
CALIB STANDHYD [I%=56.0:S%= 1.00]	0104	2	5.0	18.39	2.62	8.00	59.78	.83	.000
RESRVR [2 : 0104] {ST= .74 ha.m }	0505	3	5.0	18.39	.14	10.75	58.09	n/a	.000
CALIB NASHYD [CN=76.0] [N= 3.0:Tp= .47]	0105	2	5.0	11.50	.43	8.50	30.29	.42	.000
ADD [0105 + 0505]	0506	4	5.0	29.89	.48	8.50	47.39	n/a	.000
ADD [0504 + 0506]	0507	7	5.0	220.98	1.85	10.25	54.42	n/a	.000
CALIB NASHYD [CN=82.0] [N= 3.0:Tp= .80]	0106	1	5.0	21.75	.71	8.92	36.34	.51	.000
CALIB NASHYD [CN=85.0] [N= 3.0:Tp= 1.03]	0107	2	5.0	56.60	1.71	9.17	39.91	.56	.000
ADD [0106 + 0107]	0508	3	5.0	78.35	2.39	9.08	38.92	n/a	.000
ADD [0508 + 0507]	0509	8	5.0	299.33	3.82	9.50	50.36	n/a	.000
CHANNEL[8 : 0509]	0510	1	5.0	299.33	3.44	10.08	50.11	n/a	.000
CALIB NASHYD [CN=74.0] [N= 3.0:Tp= 1.61]	0108	2	5.0	148.60	2.18	10.00	28.54	.40	.000
ADD [0510 + 0108]	0511	10	5.0	447.93	5.62	10.00	42.96	n/a	.000
CALIB NASHYD [CN=85.0] [N= 3.0:Tp= .57]	0200	1	5.0	4.28	.20	8.67	39.87	.56	.000
CALIB STANDHYD [I%=53.0:S%= 1.00]	0201	2	5.0	65.90	7.39	8.08	58.57	.82	.000
ADD [0200 + 0201]	0600	3	5.0	70.18	7.47	8.08	57.43	n/a	.000
RESRVR [3 : 0600] {ST= 2.61 ha.m }	0601	6	5.0	70.18	.63	10.50	55.84	n/a	.000
CALIB STANDHYD [I%=45.0:S%= 1.00]	0202	1	5.0	15.16	1.82	8.00	55.54	.77	.000
RESRVR [1 : 0202] {ST= .50 ha.m }	0602	2	5.0	15.16	.22	9.58	54.26	n/a	.000
CALIB STANDHYD [I%=58.0:S%= 1.00]	0203	1	5.0	36.51	4.77	8.08	60.44	.84	.000
RESRVR [1 : 0203] {ST= 1.47 ha.m }	0603	4	5.0	36.51	.32	10.50	58.72	n/a	.000
ADD [0603 + 0602]	0604	5	5.0	51.67	.51	10.08	57.41	n/a	.000
ADD [0604 + 0601]	0605	7	5.0	121.85	1.13	10.33	56.51	n/a	.000
CALIB NASHYD [CN=72.0] [N= 3.0:Tp= .74]	0204	1	5.0	29.39	.71	8.83	26.89	.37	.000

	ADD [0403 + 0404]	0804	3	5.0	60.88	3.85	8.00	65.38	n/a	.000
	RESRVR [3 : 0804] {ST= .68 ha.m }	0805	1	5.0	60.88	3.27	8.83	64.96	n/a	.000
*	CALIB STANDHYD [I%= 3.0:S%= .50]	0405	2	5.0	12.72	2.23	8.08	67.38	.66	.000
	ADD [0805 + 0405]	0806	3	5.0	73.60	3.84	8.42	65.38	n/a	.000
	RESRVR [3 : 0806] {ST= .88 ha.m }	0807	1	5.0	73.60	3.47	9.08	64.92	n/a	.000
	CALIB NASHYD [CN=81.0] [N= 3.0:Tp= .66]	0406	1	5.0	52.69	3.40	8.75	59.90	.59	.000
	CALIB STANDHYD [I%=52.0:S%= .50]	0407	2	5.0	14.71	3.67	8.00	84.82	.83	.000
	ADD [0406 + 0407]	0808	3	5.0	67.40	4.41	8.00	65.34	n/a	.000
	RESRVR [3 : 0808] {ST= .76 ha.m }	0809	1	5.0	67.40	4.01	8.75	64.94	n/a	.000
*	CALIB STANDHYD [I%= 4.0:S%= .50]	0408	2	5.0	15.41	3.05	8.08	73.78	.72	.000
	ADD [0809 + 0408]	0810	3	5.0	82.81	4.98	8.42	66.58	n/a	.000
**	RESRVR [3 : 0810] {ST= 1.85 ha.m }	0811	1	5.0	82.81	1.91	10.08	66.43	n/a	.000
	CALIB NASHYD [CN=81.0] [N= 3.0:Tp= .79]	0409	1	5.0	32.76	1.86	8.92	59.90	.59	.000
	CALIB STANDHYD [I%=53.0:S%= .50]	0410	2	5.0	18.11	4.50	8.00	85.56	.84	.000
	ADD [0409 + 0410]	0812	3	5.0	50.87	4.83	8.00	69.04	n/a	.000
	RESRVR [3 : 0812] {ST= .93 ha.m }	0813	1	5.0	50.87	2.49	8.83	68.31	n/a	.000
*	CALIB STANDHYD [I%= 5.0:S%= .50]	0411	2	5.0	5.88	1.18	8.08	74.53	.73	.000
	ADD [0813 + 0411]	0814	3	5.0	56.75	2.72	8.75	68.96	n/a	.000
	RESRVR [3 : 0814] {ST= .72 ha.m }	0815	1	5.0	56.75	2.42	9.25	67.59	n/a	.000
	CALIB STANDHYD [I%=53.0:S%= .50]	0412	1	5.0	45.47	9.76	8.08	85.57	.84	.000
	RESRVR [1 : 0412] {ST= 2.24 ha.m }	0816	2	5.0	45.47	1.34	9.08	83.73	n/a	.000
*	CALIB STANDHYD [I%= 2.0:S%= .50]	0413	1	5.0	9.99	1.53	8.17	66.02	.65	.000
	ADD [0413 + 0816]	0817	3	5.0	55.46	1.68	8.83	80.54	n/a	.000
**	RESRVR [2 : 0816] {ST= 2.76 ha.m }	0818	1	5.0	45.47	11.32	10.50	66.97	n/a	.000

** END OF SIMULATION : 5

****

****
** SIMULATION NUMBER: 6 **
****

W/E COMMAND	HYD	ID	DT min	AREA ha	Qpeak cms	Tpeak hrs	R.V. mm	R.C.	Qbase cms
START @ .00 hrs									

[N= 3.0:Tp= 1.61]									
ADD [0510 + 0108]	0511	10	5.0	447.93	14.03	9.58	68.63	n/a	.000
CALIB NASHYD [CN=85.0] [N= 3.0:Tp= .57]	0200	1	5.0	4.28	.34	8.58	66.11	.65	.000
CALIB STANDHYD [I%=53.0:S%= 1.00]	0201	2	5.0	65.90	11.55	8.08	87.17	.86	.000
ADD [0200 + 0201]	0600	3	5.0	70.18	11.69	8.08	85.88	n/a	.000
RESRVR [3 : 0600] {ST= 3.28 ha.m }	0601	6	5.0	70.18	2.45	9.17	84.16	n/a	.000
CALIB STANDHYD [I%=45.0:S%= 1.00]	0202	1	5.0	15.16	2.81	8.00	83.64	.82	.000
RESRVR [1 : 0202] {ST= .60 ha.m }	0602	2	5.0	15.16	.89	8.75	82.24	n/a	.000
CALIB STANDHYD [I%=58.0:S%= 1.00]	0203	1	5.0	36.51	7.62	8.00	89.33	.88	.000
RESRVR [1 : 0203] {ST= 1.78 ha.m }	0603	4	5.0	36.51	1.52	8.92	87.43	n/a	.000
ADD [0603 + 0602]	0604	5	5.0	51.67	2.37	8.83	85.91	n/a	.000
ADD [0604 + 0601]	0605	7	5.0	121.85	4.67	9.00	84.90	n/a	.000
CALIB NASHYD [CN=72.0] [N= 3.0:Tp= .74]	0204	1	5.0	29.39	1.34	8.83	47.89	.47	.000
ADD [0204 + 0605]	0606	2	5.0	151.24	5.99	9.00	77.71	n/a	.000
CALIB NASHYD [CN=72.0] [N= 3.0:Tp= .74]	0205	3	5.0	79.86	3.64	8.83	47.90	.47	.000
ADD [0606 + 0205]	0607	9	5.0	231.10	9.59	8.92	67.41	n/a	.000
ADD [0607 + 0511]	0608	1	5.0	679.03	22.29	9.33	68.22	n/a	.000
CALIB STANDHYD [I%=54.0:S%= 1.00]	0300	2	5.0	22.93	4.73	8.00	87.84	.86	.000
RESRVR [2 : 0300] {ST= 1.05 ha.m }	0698	3	5.0	22.93	1.12	8.83	86.03	n/a	.000
CALIB STANDHYD [I%=53.0:S%= 1.00]	0301	4	5.0	61.89	10.90	8.08	87.17	.86	.000
RESRVR [4 : 0301] {ST= 2.91 ha.m }	0699	3	5.0	61.89	2.45	9.08	85.34	n/a	.000
CALIB NASHYD [CN=82.0] [N= 3.0:Tp= .72]	0400	1	5.0	22.91	1.43	8.83	61.40	.60	.000
CALIB STANDHYD [I%=53.0:S%= .50]	0401	2	5.0	22.33	5.45	8.00	85.56	.84	.000
ADD [0400 + 0401]	0800	3	5.0	45.24	5.74	8.00	73.33	n/a	.000
RESRVR [3 : 0800] {ST= 1.10 ha.m }	0801	1	5.0	45.24	2.37	8.75	72.37	n/a	.000
* CALIB STANDHYD [I%= 4.0:S%= .50]	0402	2	5.0	9.99	1.87	8.08	71.24	.70	.000
ADD [0801 + 0402]	0802	3	5.0	55.23	2.85	8.58	72.17	n/a	.000
RESRVR [3 : 0802] {ST= .91 ha.m }	0803	1	5.0	55.23	2.08	9.33	68.11	n/a	.000
CALIB NASHYD [CN=81.0] [N= 3.0:Tp= .75]	0403	1	5.0	47.88	2.83	8.83	59.90	.59	.000
CALIB STANDHYD [I%=53.0:S%= .50]	0404	2	5.0	13.00	3.32	8.00	85.56	.84	.000

```
*    CALIB STANDHYD     0413  1  5.0     9.99    1.15  8.17  51.47  .61    .000
     [I%= 2.0:S%=  .50]
     ------------------
     ADD [0413 + 0816]  0817  3  5.0    55.46    1.25  8.17  64.93  n/a    .000
     ------------------
**   RESRVR [ 2 : 0816] 0818  1  5.0    45.47   11.01 18.42  52.01  n/a    .000
     {ST=  2.10 ha.m }
     ------------------
** END OF SIMULATION :    4

*************************************************************************************



     ****************************
     ** SIMULATION NUMBER:    5 **
     ****************************

W/E COMMAND               HYD ID   DT     AREA   Qpeak Tpeak   R.V. R.C.    Qbase
                                   min    ha     cms   hrs     mm            cms

     START @   .00 hrs
     ------------------
     READ STORM                   10.0
     [ Ptot=101.79 mm ]
     fname :HHILL25.STM
     remark:24HR 25YR CHICAGO - HALTON HILL 88 STDS
     ------------------
     CALIB STANDHYD     0100  1  5.0    62.27   12.17  8.08  93.93  .92    .000
     [I%=47.0:S%=  .50]
     ------------------
     RESRVR [ 1 : 0100] 0500  2  5.0    62.27    1.28  9.67  93.19  n/a    .000
     {ST=  3.67 ha.m }
     ------------------
*    CALIB STANDHYD     0101  1  5.0     1.91     .48  8.00  93.90  .92    .000
     [I%=47.0:S%=  .50]
     ------------------
     ADD [0101 + 0500]  0501  3  5.0    64.18    1.31  9.67  93.21  n/a    .000
     ------------------
     CALIB STANDHYD     0102  1  5.0    66.89   11.75  8.08  87.47  .86    .000
     [I%=53.0:S%= 1.00]
     ------------------
     ADD [0102 + 0501]  0502  2  5.0   131.07   12.30  8.08  90.28  n/a    .000
     ------------------
     CALIB STANDHYD     0103  1  5.0    60.02   10.73  8.08  87.54  .86    .000
     [I%=54.0:S%= 1.00]
     ------------------
     ADD [0103 + 0502]  0503  3  5.0   191.09   23.03  8.08  89.42  n/a    .000
     ------------------
     RESRVR [ 3 : 0503] 0504  1  5.0   191.09    6.50  9.00  84.02  n/a    .000
     {ST=  6.07 ha.m }
     ------------------
     CALIB STANDHYD     0104  2  5.0    18.39    3.97  8.00  88.58  .87    .000
     [I%=56.0:S%= 1.00]
     ------------------
     RESRVR [ 2 : 0104] 0505  3  5.0    18.39     .60  9.08  86.72  n/a    .000
     {ST=   .93 ha.m }
     ------------------
     CALIB NASHYD       0105  2  5.0    11.50     .80  8.50  52.91  .52    .000
     [CN=76.0         ]
     [ N= 3.0:Tp=  .47]
     ------------------
     ADD [0105 + 0505]  0506  4  5.0    29.89    1.25  8.75  73.71  n/a    .000
     ------------------
     ADD [0504 + 0506]  0507  7  5.0   220.98    7.67  9.00  82.63  n/a    .000
     ------------------
     CALIB NASHYD       0106  1  5.0    21.75    1.26  8.92  61.40  .60    .000
     [CN=82.0         ]
     [ N= 3.0:Tp=  .80]
     ------------------
     CALIB NASHYD       0107  2  5.0    56.60    3.00  9.17  66.15  .65    .000
     [CN=85.0         ]
     [ N= 3.0:Tp= 1.03]
     ------------------
     ADD [0106 + 0107]  0508  3  5.0    78.35    4.22  9.08  64.83  n/a    .000
     ------------------
     ADD [0508 + 0507]  0509  8  5.0   299.33   11.86  9.00  77.97  n/a    .000
     ------------------
     CHANNEL[ 8 : 0509] 0510  1  5.0   299.33   10.14  9.50  77.71  n/a    .000
     ------------------
     CALIB NASHYD       0108  2  5.0   148.60    4.08  9.92  50.35  .49    .000
     [CN=74.0         ]
```

	[N= 3.0:Tp= .72]										
	CALIB STANDHYD [I%=53.0:S%= .50]	0401	2	5.0	22.33	4.04	8.00	69.65	.82	.000
	ADD [0400 + 0401]	0800	3	5.0	45.24	4.24	8.00	58.23	n/a	.000
	RESRVR [3 : 0800] {ST= 1.02 ha.m }	0801	1	5.0	45.24	1.60	9.00	57.28	n/a	.000
*	CALIB STANDHYD [I%= 4.0:S%= .50]	0402	2	5.0	9.99	1.43	8.08	56.12	.66	.000
	ADD [0801 + 0402]	0802	3	5.0	55.23	1.85	8.92	57.07	n/a	.000
	RESRVR [3 : 0802] {ST= .79 ha.m }	0803	1	5.0	55.23	1.25	9.83	53.05	n/a	.000
	CALIB NASHYD [CN=81.0] [N= 3.0:Tp= .75]	0403	1	5.0	47.88	2.11	8.83	45.81	.54	.000
	CALIB STANDHYD [I%=53.0:S%= .50]	0404	2	5.0	13.00	2.69	8.00	69.65	.82	.000
	ADD [0403 + 0404]	0804	3	5.0	60.88	3.05	8.00	50.90	n/a	.000
	RESRVR [3 : 0804] {ST= .64 ha.m }	0805	1	5.0	60.88	2.45	8.92	50.48	n/a	.000
*	CALIB STANDHYD [I%= 3.0:S%= .50]	0405	2	5.0	12.72	1.68	8.08	52.67	.62	.000
	ADD [0805 + 0405]	0806	3	5.0	73.60	2.80	8.75	50.86	n/a	.000
	RESRVR [3 : 0806] {ST= .81 ha.m }	0807	1	5.0	73.60	2.40	9.33	50.41	n/a	.000
	CALIB NASHYD [CN=81.0] [N= 3.0:Tp= .66]	0406	1	5.0	52.69	2.54	8.75	45.81	.54	.000
	CALIB STANDHYD [I%=52.0:S%= .50]	0407	2	5.0	14.71	2.96	8.00	68.98	.81	.000
	ADD [0406 + 0407]	0808	3	5.0	67.40	3.48	8.00	50.87	n/a	.000
	RESRVR [3 : 0808] {ST= .71 ha.m }	0809	1	5.0	67.40	3.00	8.75	50.46	n/a	.000
*	CALIB STANDHYD [I%= 4.0:S%= .50]	0408	2	5.0	15.41	2.34	8.08	58.39	.69	.000
	ADD [0809 + 0408]	0810	3	5.0	82.81	3.56	8.67	51.94	n/a	.000
**	RESRVR [3 : 0810] {ST= 1.25 ha.m }	0811	1	5.0	82.81	1.77	9.83	51.78	n/a	.000
	CALIB NASHYD [CN=81.0] [N= 3.0:Tp= .79]	0409	1	5.0	32.76	1.39	8.92	45.81	.54	.000
	CALIB STANDHYD [I%=53.0:S%= .50]	0410	2	5.0	18.11	3.63	8.00	69.65	.82	.000
	ADD [0409 + 0410]	0812	3	5.0	50.87	3.86	8.00	54.30	n/a	.000
	RESRVR [3 : 0812] {ST= .87 ha.m }	0813	1	5.0	50.87	1.77	9.00	53.58	n/a	.000
*	CALIB STANDHYD [I%= 5.0:S%= .50]	0411	2	5.0	5.88	.91	8.08	59.08	.70	.000
	ADD [0813 + 0411]	0814	3	5.0	56.75	1.91	9.00	54.15	n/a	.000
	RESRVR [3 : 0814] {ST= .65 ha.m }	0815	1	5.0	56.75	1.55	9.67	52.80	n/a	.000
	CALIB STANDHYD [I%=53.0:S%= .50]	0412	1	5.0	45.47	7.83	8.08	69.65	.82	.000
	RESRVR [1 : 0412] {ST= 1.97 ha.m }	0816	2	5.0	45.47	.68	9.58	67.89	n/a	.000

RESRVR [1 : 0203] {ST= 1.90 ha.m }	0603	4	5.0	36.51	2.18	8.75	99.58	n/a	.000
ADD [0603 + 0602]	0604	5	5.0	51.67	3.34	8.67	98.00	n/a	.000
ADD [0604 + 0601]	0605	7	5.0	121.85	6.49	8.83	96.96	n/a	.000
CALIB NASHYD [CN=72.0] [N= 3.0:Tp= .74]	0204	1	5.0	29.39	1.63	8.83	57.44	.50	.000
ADD [0204 + 0605]	0606	2	5.0	151.24	8.12	8.83	89.28	n/a	.000
CALIB NASHYD [CN=72.0] [N= 3.0:Tp= .74]	0205	3	5.0	79.86	4.42	8.83	57.45	.50	.000
ADD [0606 + 0205]	0607	9	5.0	231.10	12.54	8.83	78.28	n/a	.000
ADD [0607 + 0511]	0608	1	5.0	679.03	28.81	9.17	79.29	n/a	.000
CALIB STANDHYD [I%=54.0:S%= 1.00]	0300	2	5.0	22.93	5.40	8.00	99.99	.87	.000
RESRVR [2 : 0300] {ST= 1.12 ha.m }	0698	3	5.0	22.93	1.58	8.67	98.14	n/a	.000
CALIB STANDHYD [I%=53.0:S%= 1.00]	0301	4	5.0	61.89	13.03	8.08	99.28	.87	.000
RESRVR [4 : 0301] {ST= 3.13 ha.m }	0699	3	5.0	61.89	3.45	8.92	97.42	n/a	.000
CALIB NASHYD [CN=82.0] [N= 3.0:Tp= .72]	0400	1	5.0	22.91	1.71	8.83	72.41	.63	.000
CALIB STANDHYD [I%=53.0:S%= .50]	0401	2	5.0	22.33	6.26	8.00	97.57	.85	.000
ADD [0400 + 0401]	0800	3	5.0	45.24	6.61	8.00	84.83	n/a	.000
RESRVR [3 : 0800] {ST= 1.15 ha.m }	0801	1	5.0	45.24	3.01	8.58	83.86	n/a	.000
* CALIB STANDHYD [I%= 4.0:S%= .50]	0402	2	5.0	9.99	2.21	8.08	82.77	.72	.000
ADD [0801 + 0402]	0802	3	5.0	55.23	3.79	8.42	83.67	n/a	.000
RESRVR [3 : 0802] {ST= .99 ha.m }	0803	1	5.0	55.23	2.70	9.17	79.58	n/a	.000
CALIB NASHYD [CN=81.0] [N= 3.0:Tp= .75]	0403	1	5.0	47.88	3.38	8.83	70.77	.62	.000
CALIB STANDHYD [I%=53.0:S%= .50]	0404	2	5.0	13.00	3.80	8.00	97.56	.85	.000
ADD [0403 + 0404]	0804	3	5.0	60.88	4.46	8.00	76.50	n/a	.000
RESRVR [3 : 0804] {ST= .70 ha.m }	0805	1	5.0	60.88	3.90	8.83	76.07	n/a	.000
* CALIB STANDHYD [I%= 3.0:S%= .50]	0405	2	5.0	12.72	2.65	8.08	78.63	.69	.000
ADD [0805 + 0405]	0806	3	5.0	73.60	4.77	8.25	76.51	n/a	.000
RESRVR [3 : 0806] {ST= .94 ha.m }	0807	1	5.0	73.60	4.23	9.00	76.05	n/a	.000
CALIB NASHYD [CN=81.0] [N= 3.0:Tp= .66]	0406	1	5.0	52.69	4.06	8.75	70.78	.62	.000
CALIB STANDHYD [I%=52.0:S%= .50]	0407	2	5.0	14.71	4.21	8.00	96.78	.85	.000
ADD [0406 + 0407]	0808	3	5.0	67.40	5.12	8.00	76.45	n/a	.000
RESRVR [3 : 0808]	0809	1	5.0	67.40	4.78	8.67	76.04	n/a	.000

```
------------------
READ STORM                    10.0
[ Ptot=114.35 mm ]
fname :HHILL50.STM
remark:24HR 50YR CHICAGO - HALTON HILL 88 STDS
------------------
CALIB STANDHYD       0100  1  5.0    62.27    13.91  8.08 106.38  .93     .000
[I%=47.0:S%=  .50]
------------------
RESRVR [ 1 : 0100] 0500  2  5.0    62.27     1.88  9.33 105.62  n/a     .000
{ST=  3.99 ha.m }
------------------
* CALIB STANDHYD     0101  1  5.0     1.91      .54  8.00 106.35  .93     .000
[I%=47.0:S%=  .50]
------------------
ADD [0101 + 0500]  0501  3  5.0    64.18     1.93  9.33 105.64  n/a     .000
------------------
CALIB STANDHYD       0102  1  5.0    66.89    14.05  8.08  99.60  .87     .000
[I%=53.0:S%= 1.00]
------------------
ADD [0102 + 0501]  0502  2  5.0   131.07    14.67  8.08 102.56  n/a     .000
------------------
CALIB STANDHYD       0103  1  5.0    60.02    12.80  8.08  99.67  .87     .000
[I%=54.0:S%= 1.00]
------------------
ADD [0103 + 0502]  0503  3  5.0   191.09    27.47  8.08 101.65  n/a     .000
------------------
RESRVR [ 3 : 0503] 0504  1  5.0   191.09     9.12  8.83  96.14  n/a     .000
{ST=  6.51 ha.m }
------------------
CALIB STANDHYD       0104  2  5.0    18.39     4.52  8.00 100.76  .88     .000
[I%=56.0:S%= 1.00]
------------------
RESRVR [ 2 : 0104] 0505  3  5.0    18.39      .85  8.92  98.85  n/a     .000
{ST=  1.00 ha.m }
------------------
CALIB NASHYD         0105  2  5.0    11.50      .96  8.50  63.06  .55     .000
[CN=76.0          ]
[ N= 3.0:Tp=  .47]
------------------
ADD [0105 + 0505]  0506  4  5.0    29.89     1.70  8.67  85.08  n/a     .000
------------------
ADD [0504 + 0506]  0507  7  5.0   220.98    10.77  8.83  94.64  n/a     .000
------------------
CALIB NASHYD         0106  1  5.0    21.75     1.51  8.92  72.41  .63     .000
[CN=82.0          ]
[ N= 3.0:Tp=  .80]
------------------
CALIB NASHYD         0107  2  5.0    56.60     3.55  9.17  77.55  .68     .000
[CN=85.0          ]
[ N= 3.0:Tp= 1.03]
------------------
ADD [0106 + 0107]  0508  3  5.0    78.35     5.01  9.08  76.12  n/a     .000
------------------
ADD [0508 + 0507]  0509  8  5.0   299.33    15.56  8.92  89.80  n/a     .000
------------------
CHANNEL[ 8 : 0509] 0510  1  5.0   299.33    13.30  9.33  89.53  n/a     .000
------------------
CALIB NASHYD         0108  2  5.0   148.60     4.94  9.92  60.20  .53     .000
[CN=74.0          ]
[ N= 3.0:Tp= 1.61]
------------------
ADD [0510 + 0108]  0511 10  5.0   447.93    17.81  9.42  79.80  n/a     .000
------------------
CALIB NASHYD         0200  1  5.0     4.28      .41  8.58  77.52  .68     .000
[CN=85.0          ]
[ N= 3.0:Tp=  .57]
------------------
CALIB STANDHYD       0201  2  5.0    65.90    13.22  8.08  99.28  .87     .000
[I%=53.0:S%= 1.00]
------------------
ADD [0200 + 0201]  0600  3  5.0    70.18    13.40  8.08  97.95  n/a     .000
------------------
RESRVR [ 3 : 0600] 0601  6  5.0    70.18     3.38  9.00  96.20  n/a     .000
{ST=  3.55 ha.m }
------------------
CALIB STANDHYD       0202  1  5.0    15.16     3.21  8.00  95.60  .84     .000
[I%=45.0:S%= 1.00]
------------------
RESRVR [ 1 : 0202] 0602  2  5.0    15.16     1.23  8.58  94.19  n/a     .000
{ST=   .63 ha.m }
------------------
CALIB STANDHYD       0203  1  5.0    36.51     8.69  8.00 101.54  .89     .000
[I%=58.0:S%= 1.00]
```

```
    {ST=   .79 ha.m }
    ------------------
 *  CALIB STANDHYD      0408  2  5.0    15.41     3.58  8.08  85.47  .75     .000
    [I%= 4.0:S%=  .50]
    ------------------
    ADD [0809 + 0408]   0810  3  5.0    82.81     6.20  8.25  77.80  n/a     .000
    ------------------
 ** RESRVR [ 3 : 0810]  0811  1  5.0    82.81     2.03 10.17  77.64  n/a     .000
    {ST=  2.36 ha.m }
    ------------------
    CALIB NASHYD        0409  1  5.0    32.76     2.23  8.92  70.77  .62     .000
    [CN=81.0          ]
    [ N= 3.0:Tp=  .79]
    ------------------
    CALIB STANDHYD      0410  2  5.0    18.11     5.16  8.00  97.57  .85     .000
    [I%=53.0:S%=  .50]
    ------------------
    ADD [0409 + 0410]   0812  3  5.0    50.87     5.57  8.00  80.31  n/a     .000
    ------------------
    RESRVR [ 3 : 0812]  0813  1  5.0    50.87     3.02  8.75  79.58  n/a     .000
    {ST=   .97 ha.m }
    ------------------
 *  CALIB STANDHYD      0411  2  5.0     5.88     1.38  8.08  86.26  .75     .000
    [I%= 5.0:S%=  .50]
    ------------------
    ADD [0813 + 0411]   0814  3  5.0    56.75     3.37  8.58  80.27  n/a     .000
    ------------------
    RESRVR [ 3 : 0814]  0815  1  5.0    56.75     2.95  9.17  78.89  n/a     .000
    {ST=   .77 ha.m }
    ------------------
    CALIB STANDHYD      0412  1  5.0    45.47    10.89  8.00  97.57  .85     .000
    [I%=53.0:S%=  .50]
    ------------------
    RESRVR [ 1 : 0412]  0816  2  5.0    45.47     1.91  8.92  95.69  n/a     .000
    {ST=  2.44 ha.m }
    ------------------
 *  CALIB STANDHYD      0413  1  5.0     9.99     1.82  8.17  77.18  .67     .000
    [I%= 2.0:S%=  .50]
    ------------------
    ADD [0413 + 0816]   0817  3  5.0    55.46     2.46  8.58  92.35  n/a     .000
    ------------------
 ** RESRVR [ 2 : 0816]  0818  1  5.0    45.47    11.25 10.42  81.41  n/a     .000
    {ST=  3.24 ha.m }
    ------------------
 ** END OF SIMULATION :   6

*********************************************************************************


 ****************************
 ** SIMULATION NUMBER:   7 **
 ****************************

 W/E COMMAND               HYD ID   DT     AREA    Qpeak Tpeak   R.V. R.C.    Qbase
                                   min      ha      cms   hrs     mm           cms

    START @   .00 hrs
    ------------------
    READ STORM                     10.0
    [ Ptot=124.95 mm ]
    fname :HHILL100.STM
    remark:24HR 100YR CHICAGO - HALTON HILL 88 STDS
    ------------------
    CALIB STANDHYD      0100  1  5.0    62.27    15.61  8.08 116.91  .94     .000
    [I%=47.0:S%=  .50]
    ------------------
 *  RESRVR [ 1 : 0100]  0500  2  5.0    62.27     2.55  9.17 116.14  n/a     .000
    {ST=  4.29 ha.m }
    ------------------
 *  CALIB STANDHYD      0101  1  5.0     1.91      .60  8.00 116.88  .94     .000
    [I%=47.0:S%=  .50]
    ------------------
    ADD [0101 + 0500]   0501  3  5.0    64.18     2.61  9.17 116.16  n/a     .000
    ------------------
    CALIB STANDHYD      0102  1  5.0    66.89    15.81  8.08 109.90  .88     .000
    [I%=53.0:S%= 1.00]
    ------------------
    ADD [0102 + 0501]   0502  2  5.0   131.07    16.48  8.08 112.97  n/a     .000
    ------------------
    CALIB STANDHYD      0103  1  5.0    60.02    14.39  8.08 109.96  .88     .000
    [I%=54.0:S%= 1.00]
```

ADD [0103 + 0502]	0503	3	5.0	191.09	30.88	8.08	112.02	n/a	.000
RESRVR [3 : 0503] {ST= 6.93 ha.m }	0504	1	5.0	191.09	11.86	8.75	106.47	n/a	.000
CALIB STANDHYD [I%=56.0:S%= 1.00]	0104	2	5.0	18.39	5.03	8.00	111.09	.89	.000
RESRVR [2 : 0104] {ST= 1.07 ha.m }	0505	3	5.0	18.39	1.12	8.83	109.17	n/a	.000
CALIB NASHYD [CN=76.0] [N= 3.0:Tp= .47]	0105	2	5.0	11.50	1.13	8.50	71.87	.58	.000
ADD [0105 + 0505]	0506	4	5.0	29.89	2.16	8.67	94.82	n/a	.000
ADD [0504 + 0506]	0507	7	5.0	220.98	13.99	8.75	104.90	n/a	.000
CALIB NASHYD [CN=82.0] [N= 3.0:Tp= .80]	0106	1	5.0	21.75	1.75	8.92	81.88	.66	.000
CALIB NASHYD [CN=85.0] [N= 3.0:Tp= 1.03]	0107	2	5.0	56.60	4.10	9.17	87.32	.70	.000
ADD [0106 + 0107]	0508	3	5.0	78.35	5.79	9.08	85.81	n/a	.000
ADD [0508 + 0507]	0509	8	5.0	299.33	19.37	8.83	99.90	n/a	.000
CHANNEL[8 : 0509]	0510	1	5.0	299.33	16.68	9.42	99.64	n/a	.000
CALIB NASHYD [CN=74.0] [N= 3.0:Tp= 1.61]	0108	2	5.0	148.60	5.80	9.92	68.78	.55	.000
ADD [0510 + 0108]	0511	10	5.0	447.93	22.07	9.42	89.40	n/a	.000
CALIB NASHYD [CN=85.0] [N= 3.0:Tp= .57]	0200	1	5.0	4.28	.47	8.58	87.29	.70	.000
CALIB STANDHYD [I%=53.0:S%= 1.00]	0201	2	5.0	65.90	15.54	8.08	109.57	.88	.000
ADD [0200 + 0201]	0600	3	5.0	70.18	15.74	8.08	108.21	n/a	.000
* RESRVR [3 : 0600] {ST= 3.80 ha.m }	0601	6	5.0	70.18	4.36	8.92	106.45	n/a	.000
CALIB STANDHYD [I%=45.0:S%= 1.00]	0202	1	5.0	15.16	3.59	8.00	105.76	.85	.000
RESRVR [1 : 0202] {ST= .67 ha.m }	0602	2	5.0	15.16	1.56	8.50	104.35	n/a	.000
CALIB STANDHYD [I%=58.0:S%= 1.00]	0203	1	5.0	36.51	9.71	8.00	111.89	.90	.000
RESRVR [1 : 0203] {ST= 2.01 ha.m }	0603	4	5.0	36.51	2.88	8.67	109.92	n/a	.000
ADD [0603 + 0602]	0604	5	5.0	51.67	4.38	8.67	108.29	n/a	.000
ADD [0604 + 0601]	0605	7	5.0	121.85	8.51	8.75	107.23	n/a	.000
CALIB NASHYD [CN=72.0] [N= 3.0:Tp= .74]	0204	1	5.0	29.39	1.92	8.83	65.78	.53	.000
ADD [0204 + 0605]	0606	2	5.0	151.24	10.41	8.75	99.17	n/a	.000
CALIB NASHYD [CN=72.0] [N= 3.0:Tp= .74]	0205	3	5.0	79.86	5.22	8.83	65.78	.53	.000
ADD [0606 + 0205]	0607	9	5.0	231.10	15.56	8.83	87.63	n/a	.000
ADD [0607 + 0511]	0608	1	5.0	679.03	34.98	9.17	88.80	n/a	.000
CALIB STANDHYD [I%=54.0:S%= 1.00]	0300	2	5.0	22.93	6.02	8.00	110.29	.88	.000

	RESRVR [2 : 0300] {ST= 1.18 ha.m }	0698	3	5.0	22.93	2.07	8.58	108.43	n/a	.000
	CALIB STANDHYD [I%=53.0:S%= 1.00]	0301	4	5.0	61.89	14.66	8.08	109.57	.88	.000
	RESRVR [4 : 0301] {ST= 3.34 ha.m }	0699	3	5.0	61.89	4.51	8.75	107.69	n/a	.000
	CALIB NASHYD [CN=82.0] [N= 3.0:Tp= .72]	0400	1	5.0	22.91	1.98	8.83	81.88	.66	.000
	CALIB STANDHYD [I%=53.0:S%= .50]	0401	2	5.0	22.33	7.02	8.00	107.77	.86	.000
	ADD [0400 + 0401]	0800	3	5.0	45.24	7.43	8.00	94.66	n/a	.000
	RESRVR [3 : 0800] {ST= 1.21 ha.m }	0801	1	5.0	45.24	3.67	8.50	93.69	n/a	.000
*	CALIB STANDHYD [I%= 4.0:S%= .50]	0402	2	5.0	9.99	2.54	8.08	92.62	.74	.000
	ADD [0801 + 0402]	0802	3	5.0	55.23	4.73	8.33	93.50	n/a	.000
	RESRVR [3 : 0802] {ST= 1.07 ha.m }	0803	1	5.0	55.23	3.34	9.08	89.41	n/a	.000
	CALIB NASHYD [CN=81.0] [N= 3.0:Tp= .75]	0403	1	5.0	47.88	3.93	8.83	80.14	.64	.000
*	CALIB STANDHYD [I%=53.0:S%= .50]	0404	2	5.0	13.00	4.26	8.00	107.77	.86	.000
	ADD [0403 + 0404]	0804	3	5.0	60.88	5.03	8.00	86.04	n/a	.000
	RESRVR [3 : 0804] {ST= .73 ha.m }	0805	1	5.0	60.88	4.52	8.83	85.61	n/a	.000
*	CALIB STANDHYD [I%= 3.0:S%= .50]	0405	2	5.0	12.72	3.06	8.08	88.27	.71	.000
	ADD [0805 + 0405]	0806	3	5.0	73.60	5.82	8.25	86.07	n/a	.000
	RESRVR [3 : 0806] {ST= 1.00 ha.m }	0807	1	5.0	73.60	4.98	8.92	85.61	n/a	.000
	CALIB NASHYD [CN=81.0] [N= 3.0:Tp= .66]	0406	1	5.0	52.69	4.72	8.75	80.14	.64	.000
	CALIB STANDHYD [I%=52.0:S%= .50]	0407	2	5.0	14.71	4.71	8.00	106.95	.86	.000
	ADD [0406 + 0407]	0808	3	5.0	67.40	5.79	8.00	85.99	n/a	.000
	RESRVR [3 : 0808] {ST= .82 ha.m }	0809	1	5.0	67.40	5.54	8.67	85.58	n/a	.000
*	CALIB STANDHYD [I%= 4.0:S%= .50]	0408	2	5.0	15.41	4.09	8.08	95.45	.76	.000
	ADD [0809 + 0408]	0810	3	5.0	82.81	7.47	8.25	87.42	n/a	.000
**	RESRVR [3 : 0810] {ST= 2.88 ha.m }	0811	1	5.0	82.81	2.16	10.25	87.26	n/a	.000
	CALIB NASHYD [CN=81.0] [N= 3.0:Tp= .79]	0409	1	5.0	32.76	2.59	8.92	80.14	.64	.000
	CALIB STANDHYD [I%=53.0:S%= .50]	0410	2	5.0	18.11	5.78	8.00	107.76	.86	.000
	ADD [0409 + 0410]	0812	3	5.0	50.87	6.27	8.00	89.97	n/a	.000
	RESRVR [3 : 0812] {ST= 1.01 ha.m }	0813	1	5.0	50.87	3.57	8.58	89.24	n/a	.000
*	CALIB STANDHYD [I%= 5.0:S%= .50]	0411	2	5.0	5.88	1.57	8.08	96.27	.77	.000

	ADD [0813 + 0411]	0814	3	5.0	56.75	4.11	8.42	89.97	n/a	.000
	RESRVR [3 : 0814] {ST= .83 ha.m }	0815	1	5.0	56.75	3.48	9.08	88.58	n/a	.000
	CALIB STANDHYD [I%=53.0:S%= .50]	0412	1	5.0	45.47	12.22	8.00	107.77	.86	.000
*	RESRVR [1 : 0412] {ST= 2.64 ha.m }	0816	2	5.0	45.47	2.52	8.75	105.88	n/a	.000
*	CALIB STANDHYD [I%= 2.0:S%= .50]	0413	1	5.0	9.99	2.20	8.08	86.76	.69	.000
	ADD [0413 + 0816]	0817	3	5.0	55.46	3.17	8.58	102.43	n/a	.000
**	RESRVR [2 : 0816] {ST= 3.61 ha.m }	0818	1	5.0	45.47	11.49	10.42	89.34	n/a	.000

FINISH

```
===========================================================================

     OOO   TTTTT  TTTTT  H   H  Y   Y  M   M   OOO    I N T E R H Y M O
    O   O    T      T    H   H   Y Y   MM MM  O   O   * * * 1989b * * *
    O   O    T      T    HHHHH    Y    M M M  O   O
    O   O    T      T    H   H    Y    M   M  O   O
     OOO     T      T    H   H    Y    M   M   OOO    □□□□□□□□□□00025
```


***** S U M M A R Y   O U T P U T *****

Input filename: bc-only.dat
Output filename: bc-only.out
Summary filename: bc-only.sum

DATE: 01-20-1999   TIME: 14:52:50

USER: ____________________

COMMENTS: ____________________

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****************************
** SIMULATION NUMBER:  1 **
****************************
```

W/E	COMMAND	HYD	ID	DT min	AREA ha	Qpeak cms	Tpeak hrs	R.V. mm	R.C.	Qbase cms
	START @ .00 hrs									
	READ STORM [Ptot= 25.30 mm] fname :25MM.STM remark: 25MM STOR			10.0						
*	CALIB STANDHYD [I%=13.0:S%= .50]	0103	1	5.0	38.58	.56	2.08	9.58	.38	.000
	RESRVR [1 : 0103] {ST= .30 ha.m }	0504	2	5.0	38.58	.05	5.42	9.52	n/a	.000
	CALIB NASHYD [CN=80.0] [N= 3.0:Tp= .69]	0104	3	5.0	11.79	.09	2.83	4.90	.19	.000
	ADD [0504 + 0104]	0505	1	5.0	50.37	.12	2.92	8.44	n/a	.000
*	CALIB STANDHYD [I%= 1.0:S%= .50]	0105	2	5.0	16.52	.26	2.50	8.08	.32	.000
	ADD [0505 + 0105]	0777	3	5.0	66.89	.35	2.58	8.35	n/a	.000
	CALIB NASHYD [CN=80.0] [N= 3.0:Tp= .59]	0106	1	5.0	23.59	.20	2.67	4.91	.19	.000
	CALIB NASHYD [CN=80.0] [N= 3.0:Tp= .56]	0107	2	5.0	46.90	.41	2.67	4.91	.19	.000
	ADD [0106 + 0107]	0507	4	5.0	70.49	.60	2.67	4.91	n/a	.000
	ADD [0777 + 0507]	0508	5	5.0	137.38	.95	2.67	6.59	n/a	.000
	CALIB NASHYD [CN=85.0] [N= 3.0:Tp= .46]	0108	1	5.0	12.49	.16	2.50	6.32	.25	.000
	ADD [0108 + 0508]	0999	2	5.0	149.87	1.11	2.58	6.57	n/a	.000
	CALIB NASHYD [CN=85.0] [N= 3.0:Tp= .57]	0200	1	5.0	4.28	.05	2.67	6.30	.25	.000
	CALIB NASHYD [CN=83.0] [N= 3.0:Tp= 1.24]	0201	2	5.0	53.85	.30	3.50	5.69	.22	.000

ADD [0200 + 0201]	0600	3	5.0	58.13	.33	3.42	5.74	n/a	.000
CALIB NASHYD [CN=83.0] [N= 3.0:Tp= .82]	0202	1	5.0	10.45	.08	3.00	5.68	.22	.000
ADD [0202 + 0600]	0601	2	5.0	68.58	.40	3.33	5.73	n/a	.000
CALIB NASHYD [CN=78.0] [N= 3.0:Tp= .76]	0203	1	5.0	15.59	.10	2.92	4.47	.18	.000
CALIB NASHYD [CN=82.0] [N= 3.0:Tp= .34]	0208	6	5.0	12.18	.17	2.33	5.41	.21	.000
CALIB NASHYD [CN=78.0] [N= 3.0:Tp= .42]	0204	3	5.0	11.89	.11	2.50	4.47	.18	.000
ADD [0203 + 0204]	0602	4	5.0	27.48	.20	2.58	4.47	n/a	.000
ADD [0601 + 0602]	0603	1	5.0	96.06	.56	3.00	5.37	n/a	.000
* CALIB STANDHYD [I%= 1.0:S%= .50]	0205	2	5.0	4.45	.08	2.42	8.81	.35	.000
CALIB NASHYD [CN=82.0] [N= 3.0:Tp= .71]	0206	3	5.0	51.16	.41	2.83	5.41	.21	.000
ADD [0205 + 0206]	0604	4	5.0	55.61	.47	2.75	5.69	n/a	.000
ADD [0603 + 0604]	0605	2	5.0	151.67	1.02	2.92	5.48	n/a	.000
ADD [0605 + 0208]	0609	7	5.0	163.85	1.11	2.75	5.48	n/a	.000
CALIB NASHYD [CN=72.0] [N= 3.0:Tp= .74]	0207	3	5.0	79.86	.40	2.92	3.46	.14	.000
ADD [0609 + 0207]	0606	9	5.0	243.71	1.51	2.83	4.82	n/a	.000
ADD [0606 + 0000]	0607	1	5.0	243.71	1.51	2.83	4.82	n/a	.000
CALIB NASHYD [CN=82.0] [N= 3.0:Tp= .45]	0300	1	5.0	30.20	.34	2.50	5.41	.21	.000
CALIB NASHYD [CN=80.0] [N= 3.0:Tp= .65]	0301	2	5.0	40.29	.31	2.75	4.91	.19	.000
CALIB NASHYD [CN=82.0] [N= 3.0:Tp= .72]	0302	3	5.0	25.98	.21	2.83	5.41	.21	.000
ADD [0301 + 0302]	0700	4	5.0	66.27	.52	2.83	5.11	n/a	.000
ADD [0300 + 0700]	0701	2	5.0	96.47	.83	2.67	5.20	n/a	.000
CALIB NASHYD [CN=82.0] [N= 3.0:Tp= .72]	0400	1	5.0	22.91	.18	2.83	5.41	.21	.000
CALIB NASHYD [CN=82.0] [N= 3.0:Tp= .55]	0401	2	5.0	27.66	.27	2.67	5.41	.21	.000
ADD [0400 + 0401]	0800	3	5.0	50.57	.44	2.67	5.41	n/a	.000
* CALIB STANDHYD [I%= 4.0:S%= .50]	0402	1	5.0	9.99	.31	2.17	9.23	.36	.000
ADD [0402 + 0800]	0801	2	5.0	60.56	.58	2.50	6.04	n/a	.000
RESRVR [2 : 0801] {ST= .32 ha.m }	0802	3	5.0	60.56	.04	5.00	6.03	n/a	.000
CALIB NASHYD [CN=81.0] [N= 3.0:Tp= .75]	0403	1	5.0	47.88	.35	2.92	5.15	.20	.000

APPENDIX H
QUALHYMO EXISTING CONDITION MODEL PARAMETERS

Halton Hills - 401 Corridor Integrated Planning Project
QUALHYMO Model Catchment Data

Existing Conditions

								Tp Calc										
Catch. No.	Series No.	Description	(2) Area (ha)	Frac. Imp.	CN	SMAX	SMIN	Hmax (m)	Hmin (m)	L (m)	S	Overland Vel (m/s)	Channel L (m)	Vel (m/s)	To (hrs)	Tp (perv.) (hrs)	Tp (imp.) (hrs)	Comments (3)
200	200	u/s Scotch Block (1)	1327	-	70.2	551	45	-	-	-	-	-	-	-	-	3.64	2.44	
201	201	u/s Scotch Block (1)	2000	-	62.6	767	63	-	-	-	-	-	-	-	-	5.76	3.86	
201B	202	Scotch Block (1)	566	0.03	62.6	767	63	-	-	-	-	-	-	-	-	3.64	2.44	
202A	210	u/s of Study Area (1)	1195.1	0.03	73.2	493	39	-	-	-	-	-	-	-	-	3.54	2.37	Tp from pro-rated area
202B	215	Study Aea (202B,A,B,C)	209.48	0.03	73.2	493	39	220	205	700	0.0214	0.24	2500	1.00	1.50	1.01	0.68	
202C	220	d/s of Study Area + Hazard(1)	238.45	0.03	73.2	493	39	210	205	900	0.0056	0.13	3000	1.00	2.83	1.90	1.27	
	333	**Sub-Watershed 3 Totals**	**5536.03**	**(SMCWP = 5422 ha)**														
203	203	u/s External Area (1)	2136.7	0.03	77.4	403	30	-	-	-	-	-	-	-	-	4.46	2.99	
204A	204	u/s External Area (1)	901.06	0.03	74.5	463	36	-	-	-	-	-	-	-	-	3.07	2.11	
204B	225	Study Area (D,E)	85.39	0.03	74.5	463	36	200	195	1100	0.0045	0.12	-	-	2.53	1.69	1.13	
205A	205	u/s External Area (1)	934.08	0.03	77.7	397	29	-	-	-	-	-	-	-	-	2.91	1.95	Tp from pro-rated area
205B	240	Study Area (F)	36.51	0.03	77.7	397	29	208	195	800	0.0163	0.23			0.97	0.65	0.44	
205C	245	d/s of Study Area + Hazard(1)	109.25	0.03	77.7	397	29	200	190	500	0.0200	0.24	1500	1.00	1.00	0.67	0.45	
	444	**Sub-Watershed 4 Totals**	**4202.99**	**(SMCWP = 4175 ha)**														
300	551	u/s External Area (1)	1902.3	0.03	75.6	441	33	-	-	-	-	-	-	-	-	3.17	2.12	
301A	552	Study Area (G,H)	84.82	0.03	71.5	533	42	215	205	1000	0.0100	0.17	700	1.00	1.79	1.20	0.80	
301B	301	d/s of Study Area + Hazard(1)	882.43	0.03	71.5	533	42	-	-	-	-	-	-	-	-	1.92	1.29	Tp from pro-rated area
	555	**Sub-Watershed 5 Totals**	**2869.55**	**(SMCWP = 2886 ha)**														
303A	661	u/s External Area (1)	22.91	0.03	78.1	390	28	218	215	500	0.0060	0.13	-	-	1.10	0.74	0.49	
303B	662	Study Area (I)	22.33	0.03	78.1	390	28	215	210	600	0.0083	0.17			0.99	0.66	0.45	
303C	303	d/s of Study Area (1)	589.82	0.03	78.1	390	28	-	-	-	-	-	-	-	-	2.88	1.93	Tp from pro-rated area
304A	671	u/s External Area (1)	133.33	0.03	78.1	390	28	222	213	1000	0.0090	0.17	-	-	1.63	1.09	0.73	
304B	672	Study Area (J,K,L,M)	91.29	0.03	78.1	390	28	220	215	300	0.0167	0.23			0.36	0.24	0.16	
304C	674	403 Interchange	56.88	0.03	78.1	390	28	215	212.5	200	0.0125	0.20	-	-	0.28	0.19	0.12	
304D	304	d/s of Study Area (1)	825.41	0.16	78.1	390	28	-	-	-	-	-	-	-	-	3.07	2.06	Tp from pro-rated area
302	302	d/s of Study Area (1)	713.5	0.03	72.9	500	39	-	-	-	-	-	-	-	-	3.48	2.33	
305	305	d/s of Study Area (1)	906.56	0.03	77.3	407	30	-	-	-	-	-	-	-	-	5.66	3.79	
	666	**Sub-Watershed 6 Totals**	**3362.03**	**(SMCWP = 3309 ha)**														
206	375	Sub-catchment 206	710	0.03	75.9	434	33	-	-	-	-	-	-	-	-	3.34	2.24	From Watershed Plan
207A	380	Sub-catchment 207A	781	0.03	73.9	478	37	-	-	-	-	-	-	-	-	3.19	2.14	From Watershed Plan
207B	385	Sub-catchment 207B	442	0.03	73.9	478	37	-	-	-	-	-	-	-	-	2.85	1.91	From Watershed Plan
306	390	Sub-catchment 306	643	0.03	76.2	427	32	-	-	-	-	-	-	-	-	3.90	2.61	From Watershed Plan
307	395	Sub-catchment 307	508	0.03	76.3	425	32	-	-	-	-	-	-	-	-	3.64	2.44	From Watershed Plan
308	400	Sub-catchment 308	594	0.03	76.3	425	32	-	-	-	-	-	-	-	-	3.49	2.34	From Watershed Plan
309	405	Sub-catchment 309	525	0.03	78.1	389	28	-	-	-	-	-	-	-	-	2.58	1.73	From Watershed Plan
	777	**Sub-Watershed 7 Totals**	**4203**	**(SMCWP = 4203 ha)**														

7/1/99

Notes :

1. Based on Watershed Plan model parameters.
2. Areas from 401 Corridor Study except for Subwatershed 7
3. Where ther are discrepancies, data are derived from QUALHYMO watershed model, not reports.

File : 98.12/Halton/Tables.xls

APPENDIX I
PROPOSED STORMWATER FACILITY STAGE - STORAGE - DISCHARGE RELATIONSHIPS

PRELIMINARY POND DESIGN - RATING CURVE FOR SUB-AREA A

Spreadsheet Information

- Water Quality and Streambank Erosion
  Drawdown Time and Orifice Sizing
- Water Quantity (100-Year) Wier Sizing
- Pond Geometry
- Filename: PONDPS-1.WK4 15-Jun-99
- *Version 1.4 (MAR 1,1997)*

Requirements:

Hydrologic Data (Input parameters)

- Storm Water Management Pond No.:	1.0	(Figure)
- QUALHYMO Sub-Area :		(Figure)
- Contributing Drainage Area to Pond:		ha (Proposed Development Area)
- Recommended Protection Level:		
- Recommended End-of Pipe SWMP :		
- Percent Imperviousness:		%
- Unit Water Quality Storage (Total):		m3/ha + (Table 3.1)
- Unit Water Quality Storage (Ex. Det):		m3/ha (Table 3.1)
- Water Quality Storage (Ex. Detention):	736	m3
- Streambank Erosion (25 mm 4 hr Chicago)	6654	m3 (from QUALHYMO)
- Permanent Pool Volume	[illegible]	m3 *
100 year volume:	1.11	ha.m

WATER QUALITY AND STREAMBANK EROSION

Pond Geometry (input parameters)

Active Storage (extended detention)

SB ErosionL:W Ratio	3	:1
SB Erosion Side Slopes H:V	4	:1
SB Erosion Volume	6654	(cu.m)
SB Erosion Depth	1.00	(m)
Water Quality Volume	736	m3
Water Quality Depth	0.1	m
Permanent Pool		
Permanent Pool Depth	1	m

Pond Geometry (calculated parameters)

Average SB Erosion Area	6654.0	sq.m	
Average SB Erosion Width	47.1	m	
Average SB Erosion Lengt	141.3	m	
Bottom SB Erosion Width	43.1	m	
Bottom SB Erosion Length	137.3	m	
Top SB Erosion Width	51.1	m	
Top SB Erosion Length	145.3	m	
C2 (dA/dH) SWMP Eqn.	1507.1	sq.m / m	
C3 (Ap) SWMP Eqn.	5916.5	sq.m	
Permanent Pool Max H	5.4	m (assuming Quality SS)	
Bottom Perm. Pool Width	35.1	m	
Bottom Perm. Pool Length	129.3	m	
Average Perm. Pool Area	5227	sq.m	
Perm. Pool Volume	5227	cu.m *	okay
Total Volume	11881	cu.m	
Total Volume / Area	ERR	cu.m/ha +	

Orifice Design (input parameters)

Orifice Diameter	0.156	m
Discharge Coeff.(typ 0.62)	0.62	-

Orifice Performance (SB Erosion)

100% Drawdown	68.0	hrs
Last 10% Drawdown	20.0	hrs
First 90% Drawdown	48.0	hrs
okay		

Orifice Performance (Quality Check)

100% Drawdown	21.0	hrs
Last 10% Drawdown	6.6	hrs
First 90% Drawdown	14.4	hrs
okay		

[SWMP Manual t = (0.66 * C2 * h^1.5 + 2 * C3 * h ^0.5) / (Ao C (2g)^0.5)]
Detention Time Check OK, t 90% > 24 hrs

Weir Design (input parameters)

Weir Offset Above Quality	0.001	m
Weir Length	1.91	m
Quantity Side Slopes H:V	3	: 1
Weir Depth (above offset)	0.56	m
Discharge Coeff.(typ 1.5)	1.5	-

Weir Performance

Top Quantity Width	54.5	m
Top Quantity Length	148.6	m
Top Area	8094.5	sq.m
Max. Quantity Volume	4343.8	cu.m
Weir Flow at Max. Vol.	1.195	cms

Existing Condition Flows

2-Year:	0.25	m3/s
10-Year:	0.72	m3/s
100-Year:	1.50	m3/s

* **Route Reservoir/Rating Curve**
* 15-Jun-99
* 08:51:15 AM
* 0.156 m orifice 1 m depth
* 1.91 m weir 0.56 m depth
* 0.001 m weir offset above quality
*
*
*

Flow(cms)	Storage (ha.m)	Comment	Depth	Elevation	Area	Orifice Q	Weir Q
0.000	0.000		0	0.00	6088.9	0.000	
0.023	0.124		0.200	0.20	6355.8	0.023	
0.033	0.254		0.400	0.40	6622.7	0.033	
0.041	0.389		0.600	0.60	6889.7	0.041	
0.047	0.530		0.800	0.80	7156.6	0.047	
0.052	0.676	Quality Level	1.000	1.00	7423.5	0.052	
0.052	0.676	Weir Crest	1.001	1.00	7424.7	0.052	
0.162	0.760		1.113	1.11	7558.7	0.055	0.107
0.360	0.845		1.225	1.22	7692.6	0.058	0.302
0.616	0.932		1.336	1.34	7826.6	0.061	0.555
0.918	1.020		1.448	1.45	7960.5	0.063	0.855
1.260	1.110	Max Weir Depth	1.560	1.56	8094.5	0.065	1.195

PRELIMINARY POND DESIGN - RATING CURVE FOR SUB-AREAS B & C

Spreadsheet Information

- Water Quality and Streambank Erosion
  Drawdown Time and Orifice Sizing
- Water Quantity (100-Year) Wier Sizing
- Pond Geometry
- Filename: PONDPS-1.WK4 15-Jun-99
- *Version 1.4 (MAR 1,1997)*

Requirements:

Hydrologic Data (input parameters)

- Storm Water Management Pond No.:	2.0	(Figure)
- QUALHYMO Sub-Area :		(Figure)
- Contributing Drainage Area to Pond:		ha (Proposed Development Area)
- Recommended Protection Level:		
- Recommended End-of Pipe SWMP :		
- Percent Imperviousness:		%
- Unit Water Quality Storage (Total):		m3/ha + (Table 3.1)
- Unit Water Quality Storage (Ex. Det):		m3/ha (Table 3.1)
- Water Quality Storage (Ex. Detention):	5076	m3
- Streambank Erosion (25 mm 4 hr Chicago)	44285	m3 (from QUALHYMO)
- Permanent Pool Volume	122440	m3 *
100 year volume:	7.41	ha.m

WATER QUALITY AND STREAMBANK EROSION

Pond Geometry (input parameters)

Active Storage (extended detention)		
SB ErosionL:W Ratio	3	:1
SB Erosion Side Slopes H:V	4	:1
SB Erosion Volume	44285	(cu.m)
SB Erosion Depth	1.50	(m)
Water Quality Volume	5076	m3
Water Quality Depth	0.1	m
Permanent Pool		
Permanent Pool Depth	1.5	m

Pond Geometry (calculated parameters)

Average SB Erosion Area	29523.3	sq.m	
Average SB Erosion Width	99.2	m	
Average SB Erosion Lengt	297.6	m	
Bottom SB Erosion Width	93.2	m	
Bottom SB Erosion Length	291.6	m	
Top SB Erosion Width	105.2	m	
Top SB Erosion Length	303.6	m	
C2 (dA/dH) SWMP Eqn.	3174.5	sq.m / m	
C3 (Ap) SWMP Eqn.	27178.5	sq.m	
Permanent Pool Max H	11.7	m (assuming Quality SS)	
Bottom Perm. Pool Width	81.2	m	
Bottom Perm. Pool Length	279.6	m	
Average Perm. Pool Area	24942	sq.m	
Perm. Pool Volume	37412	cu.m *	okay
Total Volume	81697	cu.m	
Total Volume / Area	ERR	cu.m/ha +	

Orifice Design (input parameters)

Orifice Diameter	0.364	m
Discharge Coeff.(typ 0.62)	0.62	-

Orifice Performance (SB Erosion)

100% Drawdown	68.6	hrs
Last 10% Drawdown	20.6	hrs
First 90% Drawdown	48.0	hrs
	okay	

Orifice Performance (Quality Check)

100% Drawdown	17.6	hrs
Last 10% Drawdown	5.6	hrs
First 90% Drawdown	12.1	hrs
	okay	

[SWMP Manual t = (0.66 * C2 * h^1.5 + 2 * C3 * h ^0.5) / (Ao C (2g)^0.5)]
Detention Time Check **OK, t 90% > 24 hrs**

Weir Design (input parameters)

Weir Offset Above Quality	0.001	m
Weir Length	11.82	m
Quantity Side Slopes H:V	3	: 1
Weir Depth (above offset)	0.89	m
Discharge Coeff.(typ 1.5)	1.5	-

Weir Performance

Top Quantity Width	110.5	m
Top Quantity Length	308.9	m
Top Area	34146.6	sq.m
Max. Quantity Volume	29341.6	cu.m
Weir Flow at Max. Vol.	14.810	cms

Existing Condition Flows

2-Year:	0.25	m3/s
10-Year:	0.72	m3/s
100-Year:	1.50	m3/s

* **Route Reservoir/Rating Curve**
* 15-Jun-99
* 08:58:58 AM
* 0.364 m orifice 1.5 m depth
* 11.82 m weir 0.89 m depth
* 0.001 m weir offset above quality
*
*
*

Flow(cms)	Storage (ha.m)	Comment	Depth	Elevation	Area	Orifice Q	Weir Q
0.000	0.000		0	0.00	27737.7	0.000	
0.156	0.845		0.300	0.30	28578.2	0.156	
0.221	1.715		0.600	0.60	29418.7	0.221	
0.270	2.610		0.900	0.90	30259.2	0.270	
0.312	3.530		1.200	1.20	31099.7	0.312	
0.349	4.476	Quality Level	1.500	1.50	31940.2	0.349	
0.349	4.479	Weir Crest	1.501	1.50	31942.6	0.349	
1.694	5.050		1.678	1.68	32383.4	0.369	1.325
4.135	5.628		1.856	1.86	32824.2	0.388	3.747
7.289	6.214		2.033	2.03	33265.0	0.406	6.883
11.021	6.808		2.211	2.21	33705.8	0.424	10.597
15.250	7.410	Max Weir Depth	2.388	2.39	34146.6	0.440	14.810

PRELIMINARY POND DESIGN - RATING CURVE FOR SUB-AREA D

Spreadsheet Information

- Water Quality and Streambank Erosion Drawdown Time and Orifice Sizing
- Water Quantity (100-Year) Wier Sizing
- Pond Geometry
- Filename: PONDPS-1.WK4 — 15-Jun-99
- *Version 1.4 (MAR 1,1997)*

Requirements:

Hydrologic Data (input parameters)

- Storm Water Management Pond No.:	3.0	(Figure)
- QUALHYMO Sub-Area :		(Figure)
- Contributing Drainage Area to Pond:		ha (Proposed Development Area)
- Recommended Protection Level:		
- Recommended End-of Pipe SWMP :		
- Percent Imperviousness:		%
- Unit Water Quality Storage (Total):		m3/ha + (Table 3.1)
- Unit Water Quality Storage (Ex. Det):		m3/ha (Table 3.1)
- Water Quality Storage (Ex. Detention):	2636	m3
- Streambank Erosion (25 mm 4 hr Chicago)	22597	m3 (from QUALHYMO)
- Permanent Pool Volume	11820	m3 *
100 year volume:	3.78	ha.m

WATER QUALITY AND STREAMBANK EROSION

Pond Geometry (input parameters)

Active Storage (extended detention)

SB ErosionL:W Ratio		:1
SB Erosion Side Slopes H:V		:1
SB Erosion Volume	22597	(cu.m)
SB Erosion Depth	1.00	(m)
Water Quality Volume	2636	m3
Water Quality Depth	0.1	m

Permanent Pool

Permanent Pool Depth		m

Pond Geometry (calculated parameters)

Average SB Erosion Area	22597.0	sq.m
Average SB Erosion Widt	86.8	m
Average SB Erosion Leng	260.4	m
Bottom SB Erosion Width	82.8	m
Bottom SB Erosion Lengt	256.4	m
Top SB Erosion Width	90.8	m
Top SB Erosion Length	264.4	m
C2 (dA/dH) SWMP Eqn.	2777.2	sq.m / m
C3 (Ap) SWMP Eqn.	21224.4	sq.m
Permanent Pool Max H	10.3	m (assuming Quality SS)
Bottom Perm. Pool Width	74.8	m
Bottom Perm. Pool Lengt	248.4	m
Average Perm. Pool Area	19900	sq.m
Perm. Pool Volume	19900	cu.m * okay
Total Volume	42497	cu.m
Total Volume / Area	ERR	cu.m/ha +

Orifice Design (input parameters)

Orifice Diameter	0.287	m
Discharge Coeff.(typ 0.62)	0.62	-

Orifice Performance (SB Erosion)

100% Drawdown	69.0	hrs
Last 10% Drawdown	21.0	hrs
First 90% Drawdown	48.0	hrs

okay

Orifice Performance (Quality Check)

100% Drawdown	22.0	hrs
Last 10% Drawdown	6.9	hrs
First 90% Drawdown	15.1	hrs

okay

[SWMP Manual t = (0.66 * C2 * h^1.5 + 2 * C3 * h ^0.5) / (Ao C (2g)^0.5)]
Detention Time Check — OK, t 90% > 24 hrs

Weir Design (input parameters)

Weir Offset Above Quality	0.001	m
Weir Length	5.70	m
Quantity Side Slopes H:V		: 1
Weir Depth (above offset)	0.61	m
Discharge Coeff.(typ 1.5)	1.5	-

Weir Performance

Top Quantity Width	94.4	m
Top Quantity Length	268.0	m
Top Area	25313.2	sq.m
Max. Quantity Volume	15021.4	cu.m
Weir Flow at Max. Vol.	4.054	cms

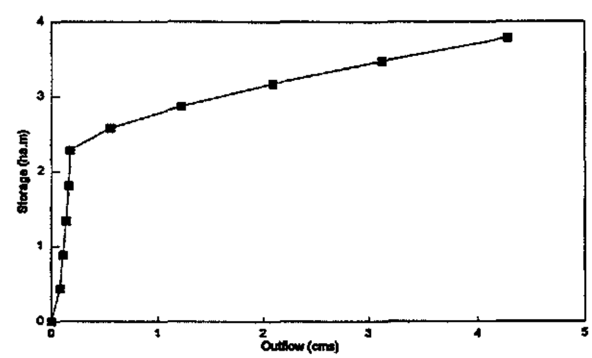
Existing Condition Flows

2-Year:	0.25	m3/s
10-Year:	0.72	m3/s
100-Year:	1.50	m3/s

Route Reservoir/Rating Curve

15-Jun-99
08:51:15 AM
0.287 m orifice — 1 m depth
5.70 m weir — 0.61 m depth
0.001 m weir offset above quality

Flow(cms)	Storage (ha.m)	Comment	Depth	Elevation	Area	Orifice Q	Weir Q
0.000	0.000		0	0.00	21555.5	0.000	
0.080	0.436		0.200	0.20	22044.8	0.080	
0.113	0.882		0.400	0.40	22534.0	0.113	
0.138	1.337		0.600	0.60	23023.2	0.138	
0.159	1.803		0.800	0.80	23512.4	0.159	
0.178	2.278	Quality Level	1.000	1.00	24001.6	0.178	
0.178	2.280	Weir Crest	1.001	1.00	24003.8	0.178	
0.551	2.574		1.123	1.12	24265.6	0.189	0.363
1.224	2.871		1.244	1.24	24527.5	0.199	1.026
2.092	3.171		1.366	1.37	24789.4	0.208	1.884
3.118	3.474		1.488	1.49	25051.3	0.217	2.901
4.280	3.780	Max Weir Depth	1.609	1.61	25313.2	0.226	4.054



PRELIMINARY POND DESIGN - RATING CURVE FOR SUB-AREA E

Spreadsheet Information

- Water Quality and Streambank Erosion
  Drawdown Time and Orifice Sizing
- Water Quantity (100-Year) Wier Sizing
- Pond Geometry
- Filename: PONDPS-1.WK4 15-Jun-99
- *Version 1.4 (MAR 1,1997)*

Requirements:

Hydrologic Data (input parameters)

- Storm Water Management Pond No.:	4.0	(Figure)
- QUALHYMO Sub-Area :	[illegible]	(Figure)
- Contributing Drainage Area to Pond:	[illegible]	ha (Proposed Development Area)
- Recommended Protection Level:	[illegible]	
- Recommended End-of Pipe SWMP :	[illegible]	
- Percent Imperviousness:	[illegible]	%
- Unit Water Quality Storage (Total):	[illegible]	m3/ha + (Table 3.1)
- Unit Water Quality Storage (Ex. Det):	[illegible]	m3/ha (Table 3.1)
- Water Quality Storage (Ex. Detention):	606	m3
- Streambank Erosion (25 mm 4 hr Chicago)	4408	m3 (from QUALHYMO)
- Permanent Pool Volume	2253	m3 *
100 year volume:	0.74	ha.m

WATER QUALITY AND STREAMBANK EROSION

Pond Geometry (input parameters)

Active Storage (extended detention)		
SB ErosionL:W Ratio	[illegible]	:1
SB Erosion Side Slopes H:V	[illegible]	:1
SB Erosion Volume	4408	(cu.m)
SB Erosion Depth	1.00	(m)
Water Quality Volume	606	m3
Water Quality Depth	0.1	m
Permanent Pool		
Permanent Pool Depth	[illegible]	m

Pond Geometry (calculated parameters)

Average SB Erosion Area	4408.0	sq.m
Average SB Erosion Widt	38.3	m
Average SB Erosion Leng	115.0	m
Bottom SB Erosion Width	34.3	m
Bottom SB Erosion Lengt	111.0	m
Top SB Erosion Width	42.3	m
Top SB Erosion Length	119.0	m
C2 (dA/dH) SWMP Eqn.	1226.6	sq.m / m
C3 (Ap) SWMP Eqn.	3810.7	sq.m
Permanent Pool Max H	4.3	m (assuming Quality SS)
Bottom Perm. Pool Width	26.3	m
Bottom Perm. Pool Lengt	103.0	m
Average Perm. Pool Area	3261	sq.m
Perm. Pool Volume	3261	cu.m * okay
Total Volume	7669	cu.m
Total Volume / Area	ERR	cu.m/ha +

Orifice Design (input parameters)

Orifice Diameter	0.127	m
Discharge Coeff.(typ 0.62)	0.62	-

Orifice Performance (SB Erosion)

100% Drawdown	67.5	hrs
Last 10% Drawdown	19.5	hrs
First 90% Drawdown	48.0	hrs
okay		

Orifice Performance (Quality Check)

100% Drawdown	20.5	hrs
Last 10% Drawdown	6.4	hrs
First 90% Drawdown	14.1	hrs
okay		

[SWMP Manual t = (0.66 * C2 * h^1.5 + 2 * C3 * h ^0.5) / (Ao C (2g)^0.5)]
Detention Time Check OK, t 90% > 24 hrs

Weir Design (input parameters)

Weir Offset Above Quality	0.001	m
Weir Length	3.77	m
Quantity Side Slopes H:V	[illegible]	: 1
Weir Depth (above offset)	0.55	m
Discharge Coeff.(typ 1.5)	1.5	-

Weir Performance

Top Quantity Width	45.6	m
Top Quantity Length	122.3	m
Top Area	5578.3	sq.m
Max. Quantity Volume	2907.3	cu.m
Weir Flow at Max. Vol.	2.287	cms

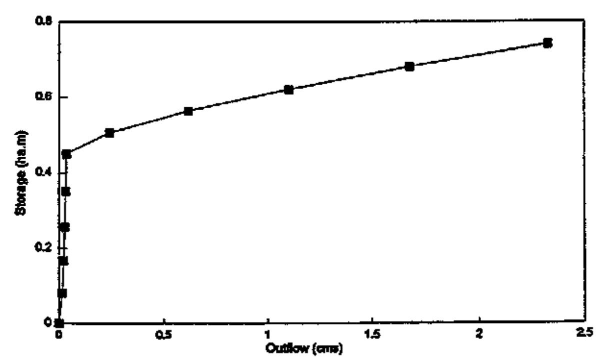
Existing Condition Flows

2-Year:	0.25	m3/s
10-Year:	0.72	m3/s
100-Year:	1.50	m3/s

Route Reservoir/Rating Curve

15-Jun-99
08:53:25 AM
0.127 m orifice 1 m depth
3.77 m weir 0.55 m depth
0.001 m weir offset above quality

Flow(cms)	Storage (ha.m)	Comment	Depth	Elevation	Area	Orifice Q	Weir Q
0.000	0.000		0	0.00	3948.0	0.000	
0.016	0.081		0.200	0.20	4165.9	0.016	
0.022	0.167		0.400	0.40	4383.7	0.022	
0.027	0.256		0.600	0.60	4601.6	0.027	
0.031	0.351		0.800	0.80	4819.5	0.031	
0.035	0.449	Quality Level	1.000	1.00	5037.3	0.035	
0.035	0.450	Weir Crest	1.001	1.00	5038.3	0.035	
0.241	0.505		1.110	1.11	5146.3	0.037	0.205
0.617	0.562		1.220	1.22	5254.3	0.038	0.579
1.103	0.620		1.329	1.33	5362.3	0.040	1.063
1.678	0.680		1.438	1.44	5470.3	0.042	1.636
2.330	0.740	Max Weir Depth	1.548	1.55	5578.3	0.043	2.287



PRELIMINARY POND DESIGN - RATING CURVE FOR SUB-AREA F

Spreadsheet Information

- Water Quality and Streambank Erosion Drawdown Time and Orifice Sizing
- Water Quantity (100-Year) Wier Sizing
- Pond Geometry
- Filename: PONDPS-1.WK4 15-Jun-99
- *Version 1.4 (MAR 1,1997)*

Requirements:

Hydrologic Data (input parameters)

- Storm Water Management Pond No.:	5.0	(Figure)
- QUALHYMO Sub-Area :		(Figure)
- Contributing Drainage Area to Pond:		ha (Proposed Development Area)
- Recommended Protection Level:		
- Recommended End-of Pipe SWMP :		
- Percent Imperviousness:		%
- Unit Water Quality Storage (Total):		m3/ha + (Table 3.1)
- Unit Water Quality Storage (Ex. Det):		m3/ha (Table 3.1)
- Water Quality Storage (Ex. Detention):	1460	m3
- Streambank Erosion (25 mm 4 hr Chicago)	13679	m3 (from QUALHYMO)
- Permanent Pool Volume	6949	m3 *
100 year volume:	2.29	ha.m

WATER QUALITY AND STREAMBANK EROSION

Pond Geometry (input parameters)

Active Storage (extended detention)

SB ErosionL:W Ratio		:1
SB Erosion Side Slopes H:V		:1
SB Erosion Volume	13679	(cu.m)
SB Erosion Depth	1.00	(m)
Water Quality Volume	1460	m3
Water Quality Depth	0.1	m
Permanent Pool		
Permanent Pool Depth	1	m

Pond Geometry (calculated parameters)

Average SB Erosion Area	13679.0	sq.m	
Average SB Erosion Widt	67.5	m	
Average SB Erosion Leng	202.6	m	
Bottom SB Erosion Width	63.5	m	
Bottom SB Erosion Lengt	198.6	m	
Top SB Erosion Width	71.5	m	
Top SB Erosion Length	206.6	m	
C2 (dA/dH) SWMP Eqn.	2160.8	sq.m / m	
C3 (Ap) SWMP Eqn.	12614.6	sq.m	
Permanent Pool Max H	7.9	m (assuming Quality SS)	
Bottom Perm. Pool Width	55.5	m	
Bottom Perm. Pool Lengt	190.6	m	
Average Perm. Pool Area	11598	sq.m	
Perm. Pool Volume	11598	cu.m *	okay
Total Volume	25277	cu.m	
Total Volume / Area	ERR	cu.m/ha +	

Orifice Design (input parameters)

Orifice Diameter	0.224	m
Discharge Coeff.(typ 0.62)	0.62	-

Orifice Performance (SB Erosion)

100% Drawdown	68.7	hrs
Last 10% Drawdown	20.7	hrs
First 90% Drawdown	48.0	hrs
	okay	

Orifice Performance (Quality Check)

100% Drawdown	21.7	hrs
Last 10% Drawdown	6.8	hrs
First 90% Drawdown	14.9	hrs
	okay	

[SWMP Manual t = (0.66 * C2 * h^1.5 + 2 * C3 * h ^0.5) / (Ao C (2g)^0.5)]

Detention Time Check **OK, t 90% > 24 hrs**

Weir Design (input parameters)

Weir Offset Above Quality	0.001	m
Weir Length	6.79	m
Quantity Side Slopes H:V		:1
Weir Depth (above offset)	0.59	m
Discharge Coeff.(typ 1.5)	1.5	-

Weir Performance

Top Quantity Width	75.1	m
Top Quantity Length	210.1	m
Top Area	15779.6	sq.m
Max. Quantity Volume	9077.9	cu.m
Weir Flow at Max. Vol.	4.654	cms

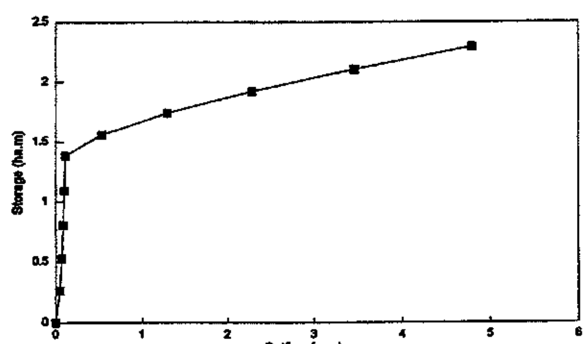
Existing Condition Flows

2-Year:	0.25	m3/s
10-Year:	0.72	m3/s
100-Year:	1.50	m3/s

Route Reservoir/Rating Curve

15-Jun-99
08:53:47 AM
0.224 m orifice 1 m depth
6.79 m weir 0.59 m depth
0.001 m weir offset above quality

Flow(cms)	Storage (ha.m)	Comment	Depth	Elevation	Area	Orifice Q	Weir Q
0.000	0.000		0	0.00	12868.7	0.000	
0.048	0.261		0.200	0.20	13250.0	0.048	
0.068	0.530		0.400	0.40	13631.4	0.068	
0.084	0.806		0.600	0.60	14012.7	0.084	
0.096	1.091		0.800	0.80	14394.1	0.096	
0.108	1.382	Quality Level	1.000	1.00	14775.4	0.108	
0.108	1.384	Weir Crest	1.001	1.00	14777.1	0.108	
0.530	1.560		1.120	1.12	14977.6	0.114	0.416
1.297	1.739		1.238	1.24	15178.1	0.120	1.177
2.289	1.920		1.357	1.36	15378.6	0.126	2.163
3.461	2.104		1.476	1.48	15579.1	0.131	3.330
4.790	2.290	Max Weir Depth	1.594	1.59	15779.6	0.136	4.654



PRELIMINARY POND DESIGN - RATING CURVE FOR SUB-AREA G

Spreadsheet Information

- Water Quality and Streambank Erosion Drawdown Time and Orifice Sizing
- Water Quantity (100-Year) Wier Sizing
- Pond Geometry
- Filename: PONDPS-1.WK4 — 15-Jun-99
- *Version 1.4 (MAR 1,1997)*

Requirements:

Hydrologic Data (input parameters)

- *Storm Water Management Pond No.:* [illegible] Figure).
- *QUALHYMO Sub-Area :* [illegible] Figure)
- *Contributing Drainage Area to Pond:* [illegible] ha (Proposed Development Area)
- *Recommended Protection Level:* [illegible]
- *Recommended End-of Pipe SWMP :* [illegible]
- *Percent Imperviousness:* [illegible]
- *Unit Water Quality Storage (Total):* [illegible] + (Table 3.1)
- *Unit Water Quality Storage (Ex. Det):* [illegible] (Table 3.1)
- *Water Quality Storage (Ex. Detention):* [illegible] m3
- *Streambank Erosion (25 mm 4 hr Chicago)* [illegible] m3 (from QUALHYMO)
- *Permanent Pool Volume* [illegible] m3 *

100 year volume: [illegible] ha.m

WATER QUALITY AND STREAMBANK EROSION

Pond Geometry (input parameters)

Active Storage (extended detention)

SB ErosionL:W Ratio	[illegible]	:1
SB Erosion Side Slopes H:V	[illegible]	:1
SB Erosion Volume	8049	(cu.m)
SB Erosion Depth	[illegible]	(m)
Water Quality Volume	917	m3
Water Quality Depth	0.1	m

Permanent Pool

Permanent Pool Depth	[illegible]	m

Pond Geometry (calculated parameters)

Average SB Erosion Area	8049.0	sq.m
Average SB Erosion Widt	51.8	m
Average SB Erosion Leng	155.4	m
Bottom SB Erosion Width	47.8	m
Bottom SB Erosion Lengt	151.4	m
Top SB Erosion Width	55.8	m
Top SB Erosion Length	159.4	m
C2 (dA/dH) SWMP Eqn.	1657.5	sq.m / m
C3 (Ap) SWMP Eqn.	7236.2	sq.m
Permanent Pool Max H	6.0	m (assuming Quality SS)
Bottom Perm. Pool Width	39.8	m
Bottom Perm. Pool Lengt	143.4	m
Average Perm. Pool Area	6471	sq.m
Perm. Pool Volume	6471	cu.m * okay
Total Volume	14520	cu.m
Total Volume / Area	ERR	cu.m/ha +

Orifice Design (input parameters)

Orifice Diameter	[illegible]	m
Discharge Coeff.(typ 0.62)	[illegible]	-

Orifice Performance (SB Erosion)

100% Drawdown	68.2	hrs
Last 10% Drawdown	20.2	hrs
First 90% Drawdown	48.0	hrs
	okay	

Orifice Performance (Quality Check)

100% Drawdown	21.2	hrs
Last 10% Drawdown	6.7	hrs
First 90% Drawdown	14.5	hrs
	okay	

[SWMP Manual t = (0.66 * C2 * h^1.5 + 2 * C3 * h ^0.5) / (Ao C (2g)^0.5)]

Detention Time Check — **OK, t 90% > 24 hrs**

Weir Design (input parameters)

Weir Offset Above Quality	[illegible]	m
Weir Length	[illegible]	m
Quantity Side Slopes H:V	[illegible]	: 1
Weir Depth (above offset)	[illegible]	m
Discharge Coeff.(typ 1.5)	[illegible]	-

Weir Performance

Top Quantity Width	59.3	m
Top Quantity Length	162.8	m
Top Area	9649.3	sq.m
Max. Quantity Volume	5339.4	cu.m
Weir Flow at Max. Vol.	3.490	cms

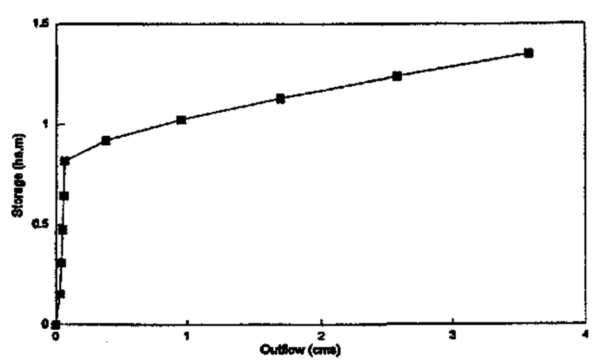
Existing Condition Flows

2-Year:	0.25 m3/s
10-Year:	0.72 m3/s
100-Year:	1.50 m3/s

Route Reservoir/Rating Curve

15-Jun-99
06:54:04 AM
0.171 m orifice — 1 m depth
5.34 m weir — 0.57 m depth
0.001 m weir offset above quality

Flow(cms)	Storage (ha.m)	Comment	Depth	Elevation	Area	Orifice Q	Weir Q
0.000	0.000		0	0.00	7427.4	0.000	
0.028	0.151		0.200	0.20	7720.7	0.028	
0.040	0.309		0.400	0.40	8014.0	0.040	
0.049	0.472		0.600	0.60	8307.2	0.049	
0.057	0.641		0.800	0.80	8600.5	0.057	
0.063	0.816	Quality Level	1.000	1.00	8893.8	0.063	
0.063	0.817	Weir Crest	1.001	1.00	8895.1	0.063	
0.379	0.920		1.116	1.12	9045.9	0.067	0.312
0.953	1.025		1.231	1.23	9196.7	0.070	0.883
1.696	1.132		1.346	1.35	9347.6	0.074	1.622
2.574	1.240		1.461	1.46	9498.4	0.077	2.498
3.570	1.350	Max Weir Depth	1.576	1.58	9649.3	0.080	3.490



PRELIMINARY POND DESIGN - RATING CURVE FOR SUB-AREA H

Spreadsheet Information

- Water Quality and Streambank Erosion
  Drawdown Time and Orifice Sizing
- Water Quantity (100-Year) Wier Sizing
- Pond Geometry
- Filename: PONDPS-1.WK4 15-Jun-99
- *Version 1.4 (MAR 1,1997)*

Requirements:

Hydrologic Data (input parameters)

- Storm Water Management Pond No.:	7.0	(Figure)
- QUALHYMO Sub-Area :		(Figure)
- Contributing Drainage Area to Pond:		ha (Proposed Development Area)
- Recommended Protection Level:		
- Recommended End-of Pipe SWMP :		
- Percent Imperviousness:		%
- Unit Water Quality Storage (Total):		m3/ha + (Table 3.1)
- Unit Water Quality Storage (Ex. Det):		m3/ha (Table 3.1)
- Water Quality Storage (Ex. Detention):	2476	m3
- Streambank Erosion (25 mm 4 hr Chicago)	21317	m3 (from QUALHYMO)
- Permanent Pool Volume	5196	m3 *
100 year volume:	3.57	ha.m

WATER QUALITY AND STREAMBANK EROSION

Pond Geometry (input parameters)

Active Storage (extended detention)		
SB ErosionL:W Ratio	[illegible]	:1
SB Erosion Side Slopes H:V	[illegible]	:1
SB Erosion Volume	21317	(cu.m)
SB Erosion Depth	1.00	(m)
Water Quality Volume	2476	m3
Water Quality Depth	0.1	m
Permanent Pool		
Permanent Pool Depth	[illegible]	m

Pond Geometry (calculated parameters)

Average SB Erosion Area	21317.0	sq.m	
Average SB Erosion Widt	84.3	m	
Average SB Erosion Leng	252.9	m	
Bottom SB Erosion Width	80.3	m	
Bottom SB Erosion Lengt	248.9	m	
Top SB Erosion Width	88.3	m	
Top SB Erosion Length	256.9	m	
C2 (dA/dH) SWMP Eqn.	2697.4	sq.m / m	
C3 (Ao) SWMP Eqn.	19984.3	sq.m	
Permanent Pool Max H	10.0	m (assuming Quality SS)	
Bottom Perm. Pool Width	72.3	m	
Bottom Perm. Pool Lengt	240.9	m	
Average Perm. Pool Area	18700	sq.m	
Perm. Pool Volume	18700	cu.m *	okay
Total Volume	40017	cu.m	
Total Volume / Area	ERR	cu.m/ha +	

Orifice Design (input parameters)

Orifice Diameter	0.279	m
Discharge Coeff.(typ 0.62)	0.62	-

Orifice Performance (SB Erosion)

100% Drawdown	69.0	hrs
Last 10% Drawdown	21.0	hrs
First 90% Drawdown	48.0	hrs
	okay	

Orifice Performance (Quality Check)

100% Drawdown	22.0	hrs
Last 10% Drawdown	6.9	hrs
First 90% Drawdown	15.1	hrs
	okay	

[SWMP Manual t = (0.66 * C2 * h^1.5 + 2 * C3 * h ^0.5) / (Ao C (2g)^0.5)]
Detention Time Check OK, t 90% > 24 hrs

Weir Design (input parameters)

Weir Offset Above Quality	0.001	m
Weir Length	7.65	m
Quantity Side Slopes H:V	[illegible]	:1
Weir Depth (above offset)	0.61	m
Discharge Coeff.(typ 1.5)	1.5	-

Weir Performance

Top Quantity Width	92.0	m
Top Quantity Length	260.5	m
Top Area	23956.8	sq.m
Max. Quantity Volume	14206.4	cu.m
Weir Flow at Max. Vol.	5.587	cms

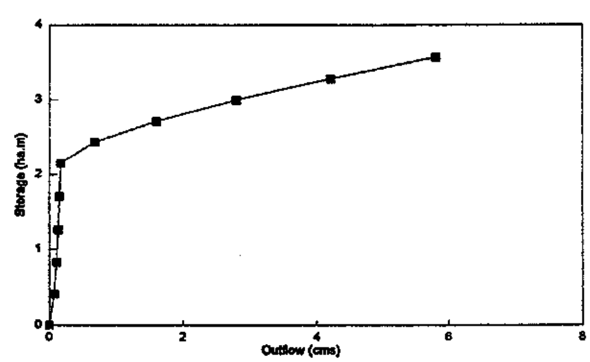
Existing Condition Flows

2-Year:	0.25	m3/s
10-Year:	0.72	m3/s
100-Year:	1.50	m3/s

Route Reservoir/Rating Curve

15-Jun-99
08:54:19 AM
0.279 m orifice 1 m depth
7.65 m weir 0.61 m depth
0.001 m weir offset above quality

Flow(cms)	Storage (ha.m)	Comment	Depth	Elevation	Area	Orifice Q	Weir Q
0.000	0.000		0	0.00	20305.5	0.000	
0.075	0.411		0.200	0.20	20780.7	0.075	
0.106	0.831		0.400	0.40	21256.0	0.106	
0.130	1.261		0.600	0.60	21731.2	0.130	
0.150	1.700		0.800	0.80	22206.5	0.150	
0.168	2.149	Quality Level	1.000	1.00	22681.7	0.168	
0.168	2.152	Weir Crest	1.001	1.00	22683.8	0.168	
0.678	2.429		1.123	1.12	22938.4	0.178	0.500
1.601	2.710		1.244	1.24	23193.0	0.188	1.413
2.793	2.993		1.366	1.37	23447.6	0.197	2.596
4.203	3.280		1.488	1.49	23702.2	0.205	3.998
5.800	3.570	Max Weir Depth	1.609	1.61	23956.8	0.213	5.587



PRELIMINARY POND DESIGN - RATING CURVE FOR SUB-AREA I

Spreadsheet Information

- Water Quality and Streambank Erosion
  Drawdown Time and Orifice Sizing
- Water Quantity (100-Year) Wier Sizing
- Pond Geometry
- Filename: PONDPS-1.WK4 15-Jun-99
- *Version 1.4 (MAR 1,1997)*

Requirements:

Hydrologic Data (input parameters)

- Storm Water Management Pond No.:	[illegible]	(Figure ·)
- QUALHYMO Sub-Area :	[illegible]	(Figure)
- Contributing Drainage Area to Pond:	[illegible]	ha (Proposed Development Area)
- Recommended Protection Level:	[illegible]	
- Recommended End-of Pipe SWMP :	[illegible]	
- Percent Imperviousness:	[illegible]	%
- Unit Water Quality Storage (Total):	[illegible]	m3/ha + (Table 3.1)
- Unit Water Quality Storage (Ex. Det):	[illegible]	m3/ha (Table 3.1)
- Water Quality Storage (Ex. Detention):	[illegible]	m3
- Streambank Erosion (25 mm 4 hr Chicago)	[illegible]	m3 (from QUALHYMO)
- Permanent Pool Volume	[illegible]	m3 *
100 year volume:	[illegible]	ha.m

WATER QUALITY AND STREAMBANK EROSION

Pond Geometry (input parameters)

Active Storage (extended detention)

SB ErosionL:W Ratio	[illegible]	:1
SB Erosion Side Slopes H:V	[illegible]	:1
SB Erosion Volume	7741	(cu.m)
SB Erosion Depth	[illegible]	(m)
Water Quality Volume	893	m3
Water Quality Depth	0.1	m
Permanent Pool		
Permanent Pool Depth	[illegible]	m

Pond Geometry (calculated parameters)

Average SB Erosion Area	7741.0	sq.m	
Average SB Erosion Widt	50.8	m	
Average SB Erosion Leng	152.4	m	
Bottom SB Erosion Width	46.8	m	
Bottom SB Erosion Lengt	148.4	m	
Top SB Erosion Width	54.8	m	
Top SB Erosion Length	156.4	m	
C2 (dA/dH) SWMP Eqn.	1625.5	sq.m / m	
C3 (Ap) SWMP Eqn.	6944.2	sq.m	
Permanent Pool Max H	5.8	m (assuming Quality SS)	
Bottom Perm. Pool Width	38.8	m	
Bottom Perm. Pool Lengt	140.4	m	
Average Perm. Pool Area	6195	sq.m	
Perm. Pool Volume	6195	cu.m *	okay
Total Volume	13936	cu.m	
Total Volume / Area	ERR	cu.m/ha +	

Orifice Design (input parameters)

Orifice Diameter	0.168	m
Discharge Coeff.(typ 0.62)	0.62	-

Orifice Performance (SB Erosion)

100% Drawdown	68.2	hrs
Last 10% Drawdown	20.2	hrs
First 90% Drawdown	48.0	hrs

okay

Orifice Performance (Quality Check)

100% Drawdown	21.2	hrs
Last 10% Drawdown	6.6	hrs
First 90% Drawdown	14.5	hrs

okay

[SWMP Manual t = (0.66 * C2 * h^1.5 + 2 * C3 * h ^0.5) / (Ao C (2g)^0.5)]

Detention Time Check OK, t 90% > 24 hrs

Weir Design (input parameters)

Weir Offset Above Quality	0.001	m
Weir Length	7.22	m
Quantity Side Slopes H:V	[illegible]	: 1
Weir Depth (above offset)	0.57	m
Discharge Coeff.(typ 1.5)	1.5	-

Weir Performance

Top Quantity Width	58.3	m
Top Quantity Length	159.8	m
Top Area	9311.5	sq.m
Max. Quantity Volume	5149.4	cu.m
Weir Flow at Max. Vol.	4.723	cms

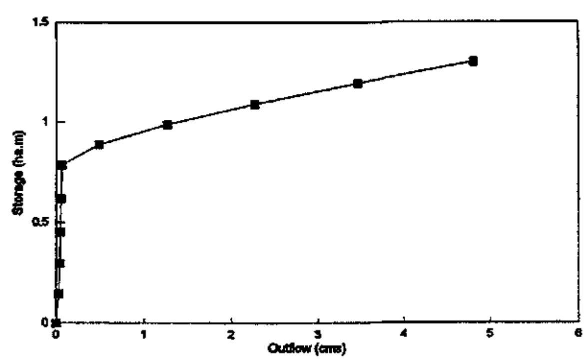
Existing Condition Flows

2-Year:	0.25	m3/s
10-Year:	0.72	m3/s
100-Year:	1.50	m3/s

Route Reservoir/Rating Curve

15-Jun-99
08:54:47 AM
0.168 m orifice 1 m depth
7.22 m weir 0.57 m depth
0.001 m weir offset above quality

Flow(cms)	Storage (ha.m)	Comment	Depth	Elevation	Area	Orifice Q	Weir Q
0.000	0.000		0	[illegible]	7131.4	0.000	
0.027	0.146		0.200	0.20	7419.1	0.027	
0.039	0.297		0.400	0.40	7706.8	0.039	
0.047	0.454		0.600	0.60	7994.4	0.047	
0.055	0.617		0.800	0.80	8282.1	0.055	
0.061	0.785	Quality Level	1.000	1.00	8569.8	0.061	
0.061	0.786	Weir Crest	1.001	1.00	8571.0	0.061	
0.487	0.885		1.116	1.12	8719.1	0.064	0.422
1.263	0.986		1.231	1.23	8867.2	0.068	1.195
2.266	1.089		1.346	1.35	9015.3	0.071	2.195
3.454	1.194		1.461	1.46	9163.4	0.074	3.380
4.800	1.300	Max Weir Depth	1.576	1.58	9311.5	0.077	4.723



PRELIMINARY POND DESIGN - RATING CURVE FOR SUB-AREA J

Spreadsheet Information

- Water Quality and Streambank Erosion
  Drawdown Time and Orifice Sizing
- Water Quantity (100-Year) Wier Sizing
- Pond Geometry
- Filename: PONDPS-1.WK4 — 15-Jun-99
- *Version 1.4 (MAR 1,1997)*

Requirements:

Hydrologic Data (input parameters)

- Storm Water Management Pond No.:	9.0	(Figure)
- QUALHYMO Sub-Area :		(Figure)
- Contributing Drainage Area to Pond:		ha (Proposed Development Area)
- Recommended Protection Level:		
- Recommended End-of Pipe SWMP :		
- Percent Imperviousness:		%
- Unit Water Quality Storage (Total):		m3/ha + (Table 3.1)
- Unit Water Quality Storage (Ex. Det):		m3/ha (Table 3.1)
- Water Quality Storage (Ex. Detention):	520	m3
- Streambank Erosion (25 mm 4 hr Chicago)	4501	m3 (from QUALHYMO)
- Permanent Pool Volume	[illegible]	m3 *
100 year volume:	0.75	ha.m

WATER QUALITY AND STREAMBANK EROSION

Pond Geometry (input parameters)

Active Storage (extended detention)

SB ErosionL:W Ratio	[illegible]	:1
SB Erosion Side Slopes H:V	4	:1
SB Erosion Volume	4501	(cu.m)
SB Erosion Depth	1.00	(m)
Water Quality Volume	520	m3
Water Quality Depth	0.1	m

Permanent Pool

Permanent Pool Depth	[illegible]	m

Pond Geometry (calculated parameters)

Average SB Erosion Area	4501.0	sq.m	
Average SB Erosion Widt	38.7	m	
Average SB Erosion Leng	116.2	m	
Bottom SB Erosion Width	34.7	m	
Bottom SB Erosion Lengt	112.2	m	
Top SB Erosion Width	42.7	m	
Top SB Erosion Length	120.2	m	
C2 (dA/dH) SWMP Eqn.	1239.5	sq.m / m	
C3 (Ap) SWMP Eqn.	3897.3	sq.m	
Permanent Pool Max H	4.3	m (assuming Quality SS)	
Bottom Perm. Pool Width	26.7	m	
Bottom Perm. Pool Lengt	104.2	m	
Average Perm. Pool Area	3342	sq.m	
Perm. Pool Volume	3342	cu.m *	okay
Total Volume	7843	cu.m	
Total Volume / Area	ERR	cu.m/ha +	

Orifice Design (input parameters)

Orifice Diameter	0.128	m
Discharge Coeff.(typ 0.62)	0.62	-

Orifice Performance (SB Erosion)

100% Drawdown	67.5	hrs
Last 10% Drawdown	19.5	hrs
First 90% Drawdown	48.0	hrs
	okay	

Orifice Performance (Quality Check)

100% Drawdown	20.5	hrs
Last 10% Drawdown	6.4	hrs
First 90% Drawdown	14.1	hrs
	okay	

[SWMP Manual t = (0.66 * C2 * h^1.5 + 2 * C3 * h ^0.5) / (Ao C (2g)^0.5)]
Detention Time Check — OK, t 90% > 24 hrs

Weir Design (input parameters)

Weir Offset Above Quality	0.001	m
Weir Length	8.36	m
Quantity Side Slopes H:V	[illegible]	: 1
Weir Depth (above offset)	0.54	m
Discharge Coeff.(typ 1.5)	1.5	-

Weir Performance

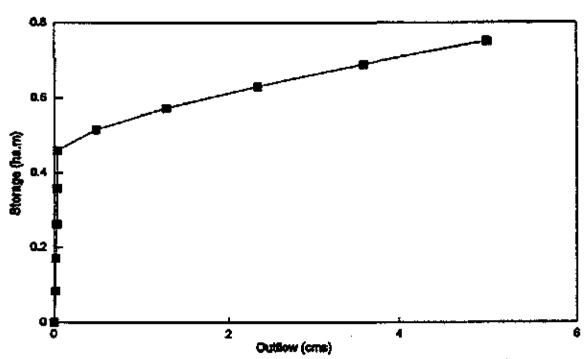
Top Quantity Width	46.0	m
Top Quantity Length	123.4	m
Top Area	5674.1	sq.m
Max. Quantity Volume	2913.5	cu.m
Weir Flow at Max. Vol.	4.946	cms

Existing Condition Flows

2-Year:	0.25 m3/s
10-Year:	0.72 m3/s
100-Year:	1.50 m3/s

* **Route Reservoir/Rating Curve**
* 15-Jun-99
* 08:55:04 AM
* 0.128 m orifice — 1 m depth
* 8.36 m weir — 0.54 m depth
* 0.001 m weir offset above quality

Flow(cms)	Storage (ha.m)	Comment	Depth	Elevation	Area	Orifice Q	Weir Q
0.000	0.000		0	0.00	4036.2	0.000	
0.016	0.083		0.200	0.20	4256.3	0.016	
0.022	0.170		0.400	0.40	4476.4	0.022	
0.027	0.262		0.600	0.60	4696.5	0.027	
0.032	0.358		0.800	0.80	4916.6	0.032	
0.035	0.459	Quality Level	1.000	1.00	5136.7	0.035	
0.035	0.459	Weir Crest	1.001	1.00	5137.7	0.035	
0.480	0.515		1.109	1.11	5245.0	0.037	0.442
1.290	0.572		1.216	1.22	5352.3	0.039	1.251
2.339	0.630		1.324	1.32	5459.6	0.041	2.299
3.581	0.690		1.431	1.43	5566.9	0.042	3.539
4.990	0.750	Max Weir Depth	1.539	1.54	5674.1	0.044	4.946



PRELIMINARY POND DESIGN - RATING CURVE FOR SUB-AREA K

Spreadsheet Information

- Water Quality and Streambank Erosion Drawdown Time and Orifice Sizing
- Water Quantity (100-Year) Wier Sizing
- Pond Geometry
- Filename: PONDPS-1.WK4 15-Jun-99
- *Version 1.4 (MAR 1,1997)*

Requirements:

Hydrologic Data (input parameters)

- *Storm Water Management Pond No.:* [redacted] (Figure)
- *QUALHYMO Sub-Area :* [redacted] (Figure)
- *Contributing Drainage Area to Pond:* [redacted] ha (Proposed Development Area)
- *Recommended Protection Level:* [redacted]
- *Recommended End-of Pipe SWMP :* [redacted]
- *Percent Imperviousness:* [redacted] %
- *Unit Water Quality Storage (Total):* [redacted] m3/ha + (Table 3.1)
- *Unit Water Quality Storage (Ex. Det):* [redacted] m3/ha (Table 3.1)
- *Water Quality Storage (Ex. Detention):* [redacted] m3
- *Streambank Erosion (25 mm 4 hr Chicago)* [redacted] m3 (from QUALHYMO)
- *Permanent Pool Volume* [redacted] m3 *

100 year volume: [redacted] ha.m

WATER QUALITY AND STREAMBANK EROSION

Pond Geometry (input parameters)

Active Storage (extended detention)

SB ErosionL:W Ratio	[redacted]	:1
SB Erosion Side Slopes H:V	[redacted]	:1
SB Erosion Volume	[redacted]	(cu.m)
SB Erosion Depth	[redacted]	(m)
Water Quality Volume	598	m3
Water Quality Depth	0.1	m

Permanent Pool

Permanent Pool Depth	[redacted]	m

Pond Geometry (calculated parameters)

Average SB Erosion Area	5006.0	sq.m
Average SB Erosion Widt	40.8	m
Average SB Erosion Leng	122.5	m
Bottom SB Erosion Width	36.8	m
Bottom SB Erosion Lengt	118.5	m
Top SB Erosion Width	44.8	m
Top SB Erosion Length	126.5	m
C2 (dA/dH) SWMP Eqn.	1307.2	sq.m / m
C3 (Ap) SWMP Eqn.	4369.4	sq.m
Permanent Pool Max H	4.6	m (assuming Quality SS)
Bottom Perm. Pool Width	28.8	m
Bottom Perm. Pool Lengt	110.5	m
Average Perm. Pool Area	3779	sq.m
Perm. Pool Volume	3779	cu.m * okay
Total Volume	8785	cu.m
Total Volume / Area	ERR	cu.m/ha +

Orifice Design (input parameters)

Orifice Diameter	[redacted]	m
Discharge Coeff.(typ 0.62)	[redacted]	-

Orifice Performance (SB Erosion)

100% Drawdown	67.7	hrs
Last 10% Drawdown	19.7	hrs
First 90% Drawdown	48.0	hrs
	okay	

Orifice Performance (Quality Check)

100% Drawdown	20.6	hrs
Last 10% Drawdown	6.5	hrs
First 90% Drawdown	14.2	hrs
	okay	

[SWMP Manual t = (0.66 * C2 * h^1.5 + 2 * C3 * h ^0.5) / (Ao C (2g)^0.5)]

Detention Time Check OK, t 90% > 24 hrs

Weir Design (input parameters)

Weir Offset Above Quality	[redacted]	m
Weir Length	[redacted]	m
Quantity Side Slopes H:V	[redacted]	: 1
Weir Depth (above offset)	[redacted]	m
Discharge Coeff.(typ 1.5)	[redacted]	-

Weir Performance

Top Quantity Width	48.2	m
Top Quantity Length	129.9	m
Top Area	6256.2	sq.m
Max. Quantity Volume	3304.3	cu.m
Weir Flow at Max. Vol.	5.941	cms

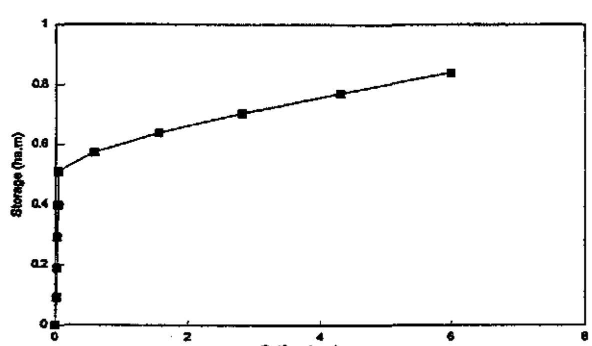
Existing Condition Flows

2-Year:	0.25 m3/s
10-Year:	0.72 m3/s
100-Year:	1.50 m3/s

Route Reservoir/Rating Curve

15-Jun-99
08:55:22 AM
0.135 m orifice 1 m depth
9.63 m weir 0.55 m depth
0.001 m weir offset above quality

Flow(cms)	Storage (ha.m)	Comment	Depth	Elevation	Area	Orifice Q	Weir Q
0.000	0.000		0	[redacted]	4515.8	0.000	
0.018	0.093		0.200	0.20	4747.8	0.018	
0.025	0.190		0.400	0.40	4979.7	0.025	
0.031	0.292		0.600	0.60	5211.7	0.031	
0.035	0.398		0.800	0.80	5443.6	0.035	
0.039	0.510	Quality Level	1.000	1.00	5675.6	0.039	
0.039	0.510	Weir Crest	1.001	1.00	5676.6	0.039	
0.573	0.574		1.112	1.11	5792.5	0.042	0.531
1.547	0.638		1.222	1.22	5908.5	0.044	1.503
2.807	0.704		1.333	1.33	6024.4	0.045	2.761
4.298	0.771		1.443	1.44	6140.3	0.047	4.251
5.990	0.840	Max Weir Depth	1.554	1.55	6256.2	0.049	5.941



PRELIMINARY POND DESIGN - RATING CURVE FOR SUB-AREA L

Spreadsheet Information

- Water Quality and Streambank Erosion Drawdown Time and Orifice Sizing
- Water Quantity (100-Year) Wier Sizing
- Pond Geometry
- Filename: PONDPS-1.WK4 15-Jun-99
- *Version 1.4 (MAR 1,1997)*

Requirements:

Hydrologic Data (input parameters)

- Storm Water Management Pond No.:	11.0	(Figure)
- QUALHYMO Sub-Area :		(Figure)
- Contributing Drainage Area to Pond:		ha (Proposed Development Area)
- Recommended Protection Level:		
- Recommended End-of Pipe SWMP :		
- Percent Imperviousness:		%
- Unit Water Quality Storage (Total):		m3/ha + (Table 3.1)
- Unit Water Quality Storage (Ex. Det):		m3/ha (Table 3.1)
- Water Quality Storage (Ex. Detention):	724	m3
- Streambank Erosion (25 mm 4 hr Chicago)	6296	m3 (from QUALHYMO)
- Permanent Pool Volume	775	m3 *
100 year volume:	1.05	ha.m

WATER QUALITY AND STREAMBANK EROSION

Pond Geometry (input parameters)

Active Storage (extended detention)

SB ErosionL:W Ratio		:1
SB Erosion Side Slopes H:V		:1
SB Erosion Volume	6296	(cu.m)
SB Erosion Depth	1.00	(m)
Water Quality Volume	724	m3
Water Quality Depth	0.1	m

Permanent Pool

Permanent Pool Depth		m

Pond Geometry (calculated parameters)

Average SB Erosion Area	6296.0	sq.m	
Average SB Erosion Widt	45.8	m	
Average SB Erosion Leng	137.4	m	
Bottom SB Erosion Width	41.8	m	
Bottom SB Erosion Lengt	133.4	m	
Top SB Erosion Width	49.8	m	
Top SB Erosion Length	141.4	m	
C2 (dA/dH) SWMP Eqn.	1466.0	sq.m / m	
C3 (Ap) SWMP Eqn.	5579.0	sq.m	
Permanent Pool Max H	5.2	m (assuming Quality SS)	
Bottom Perm. Pool Width	33.8	m	
Bottom Perm. Pool Lengt	125.4	m	
Average Perm. Pool Area	4910	sq.m	
Perm. Pool Volume	4910	cu.m *	okay
Total Volume	11206	cu.m	
Total Volume / Area	ERR	cu.m/ha +	

Orifice Design (input parameters)

Orifice Diameter	0.152	m
Discharge Coeff.(typ 0.62)	0.62	-

Orifice Performance (SB Erosion)

100% Drawdown	67.9	hrs
Last 10% Drawdown	19.9	hrs
First 90% Drawdown	48.0	hrs
okay		

Orifice Performance (Quality Check)

100% Drawdown	20.9	hrs
Last 10% Drawdown	6.6	hrs
First 90% Drawdown	14.4	hrs
okay		

[SWMP Manual t = (0.66 * C2 * h^1.5 + 2 * C3 * h ^0.5) / (Ao C (2g)^0.5)]

Detention Time Check **OK, t 90% > 24 hrs**

Weir Design (input parameters)

Weir Offset Above Quality	0.001	m
Weir Length	6.45	m
Quantity Side Slopes H:V		: 1
Weir Depth (above offset)	0.56	m
Discharge Coeff.(typ 1.5)	1.5	-

Weir Performance

Top Quantity Width	53.2	m
Top Quantity Length	144.8	m
Top Area	7695.2	sq.m
Max. Quantity Volume	4104.4	cu.m
Weir Flow at Max. Vol.	4.008	cms

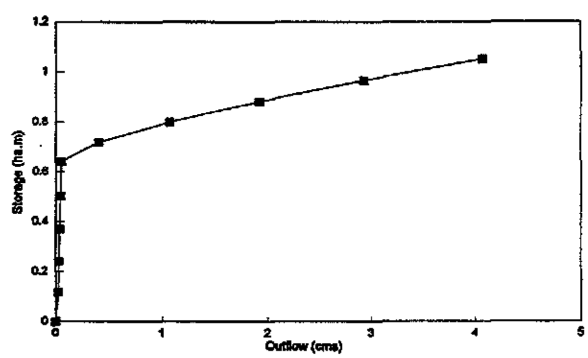
Existing Condition Flows

2-Year:	0.25	m3/s
10-Year:	0.72	m3/s
100-Year:	1.50	m3/s

Route Reservoir/Rating Curve

15-Jun-99
08:55:41 AM
0.152 m orifice 1 m depth
6.45 m weir 0.56 m depth
0.001 m weir offset above quality

Flow(cms)	Storage (ha.m)	Comment	Depth	Elevation	Area	Orifice Q	Weir Q
0.000	0.000		0	0.00	5746.3	0.000	
0.022	0.118		0.200	0.20	6006.0	0.022	
0.031	0.240		0.400	0.40	6265.8	0.031	
0.038	0.368		0.600	0.60	6525.5	0.038	
0.044	0.501		0.800	0.80	6785.2	0.044	
0.050	0.640	Quality Level	1.000	1.00	7045.0	0.050	
0.050	0.640	Weir Crest	1.001	1.00	7046.1	0.050	
0.411	0.719		1.112	1.11	7175.9	0.052	0.358
1.069	0.800		1.223	1.22	7305.7	0.055	1.014
1.920	0.882		1.335	1.33	7435.6	0.057	1.863
2.928	0.965		1.446	1.45	7565.4	0.060	2.868
4.070	1.050	Max Weir Depth	1.557	1.56	7695.2	0.062	4.008



PRELIMINARY POND DESIGN - RATING CURVE FOR SUB-AREA M

Spreadsheet Information

- Water Quality and Streambank Erosion Drawdown Time and Orifice Sizing
- Water Quantity (100-Year) Wier Sizing
- Pond Geometry
- Filename: PONDPS-1.WK4 15-Jun-99
- *Version 1.4 (MAR 1,1997)*

Requirements:

Hydrologic Data (input parameters)

- Storm Water Management Pond No.:	12.0	(Figure).
- QUALHYMO Sub-Area :		(Figure)
- Contributing Drainage Area to Pond:		ha (Proposed Development Area)
- Recommended Protection Level:		
- Recommended End-of Pipe SWMP :		
- Percent Imperviousness:		%
- Unit Water Quality Storage (Total):		m3/ha + (Table 3.1)
- Unit Water Quality Storage (Ex. Det):		m3/ha (Table 3.1)
- Water Quality Storage (Ex. Detention):	1819	m3
- Streambank Erosion (25 mm 4 hr Chicago)	15724	m3 (from QUALHYMO)
- Permanent Pool Volume	1949	m3 *
100 year volume:	2.63	ha.m

WATER QUALITY AND STREAMBANK EROSION

Pond Geometry (input parameters)

Active Storage (extended detention)

SB ErosionL:W Ratio	[illegible]	:1
SB Erosion Side Slopes H:V	[illegible]	:1
SB Erosion Volume	15724	(cu.m)
SB Erosion Depth	1.00	(m)
Water Quality Volume	1819	m3
Water Quality Depth	0.1	m
Permanent Pool		
Permanent Pool Depth	[illegible]	m

Pond Geometry (calculated parameters)

Average SB Erosion Area	15724.0	sq.m	
Average SB Erosion Widt	72.4	m	
Average SB Erosion Leng	217.2	m	
Bottom SB Erosion Width	68.4	m	
Bottom SB Erosion Lengt	213.2	m	
Top SB Erosion Width	76.4	m	
Top SB Erosion Length	221.2	m	
C2 (dA/dH) SWMP Eqn.	2316.7	sq.m / m	
C3 (Ap) SWMP Eqn.	14581.6	sq.m	
Permanent Pool Max H	8.5	m (assuming Quality SS)	
Bottom Perm. Pool Width	60.4	m	
Bottom Perm. Pool Lengt	205.2	m	
Average Perm. Pool Area	13487	sq.m	
Perm. Pool Volume	13487	cu.m *	okay
Total Volume	29211	cu.m	
Total Volume / Area	ERR	cu.m/ha +	

Orifice Design (input parameters)

Orifice Diameter	0.240	m
Discharge Coeff.(typ 0.62)	0.62	-

Orifice Performance (SB Erosion)

100% Drawdown	68.8	hrs
Last 10% Drawdown	20.8	hrs
First 90% Drawdown	48.0	hrs
okay		

Orifice Performance (Quality Check)

100% Drawdown	21.8	hrs
Last 10% Drawdown	6.9	hrs
First 90% Drawdown	14.9	hrs
okay		

[SWMP Manual t = (0.66 * C2 * h^1.5 + 2 * C3 * h ^0.5) / (Ao C (2g)^0.5)]

Detention Time Check OK, t 90% > 24 hrs

Weir Design (input parameters)

Weir Offset Above Quality	0.001	m
Weir Length	3.40	m
Quantity Side Slopes H:V	[illegible]	: 1
Weir Depth (above offset)	0.60	m
Discharge Coeff.(typ 1.5)	1.5	-

Weir Performance

Top Quantity Width	80.0	m
Top Quantity Length	224.8	m
Top Area	17978.5	sq.m
Max. Quantity Volume	10423.2	cu.m
Weir Flow at Max. Vol.	2.353	cms

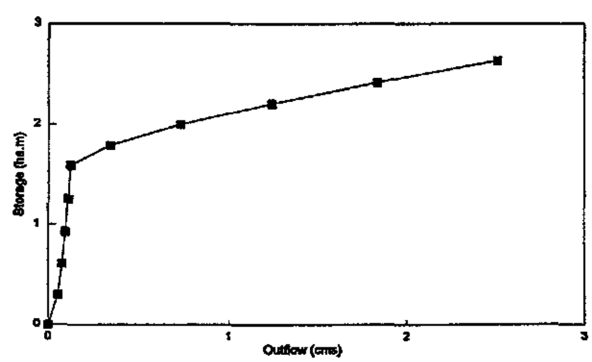
Existing Condition Flows

2-Year:	0.25	m3/s
10-Year:	0.72	m3/s
100-Year:	1.50	m3/s

- **Route Reservoir/Rating Curve**

15-Jun-99
08:55:58 AM
0.240 m orifice 1 m depth
3.40 m weir 0.60 m depth
0.001 m weir offset above quality

Flow(cms)	Storage (ha.m)	Comment	Depth	Elevation	Area	Orifice Q	Weir Q
0.000	0.000		0	0.00	14855.2	0.000	
0.055	0.301		0.200	0.20	15263.9	0.055	
0.078	0.611		0.400	0.40	15672.5	0.078	
0.096	0.928		0.600	0.60	16081.1	0.096	
0.111	1.254		0.800	0.80	16489.7	0.111	
0.124	1.588	Quality Level	1.000	1.00	16898.4	0.124	
0.124	1.589	Weir Crest	1.001	1.00	16900.1	0.124	
0.342	1.792		1.120	1.12	17115.8	0.131	0.210
0.733	1.998		1.240	1.24	17331.5	0.138	0.595
1.238	2.206		1.359	1.36	17547.1	0.145	1.094
1.835	2.417		1.478	1.48	17762.8	0.151	1.684
2.510	2.630	Max Weir Depth	1.598	1.60	17978.5	0.157	2.353



								Erosion Control 46mm/46hr		52mm/48hr		Quality Control		Permanent Pool		Active Storage			100 year
Pond ID	Subcatchment	Area (ha)	Future Impervious TIMP for OTTHYMO (%)	Impervious Area (ha)	LGI for OTTHYMO (A/1.5)^0.5	XIMP for OTTHYMO (0.8*TIMP)	Watershed Release Rate(1) (L/s)	Volume (m3)	Release Rate(2) (L/s)	Volume (m3)	Release Rate(3) (L/s)	Unit Volume Required (m3/ha)	Volume Required (m3)	Unit Volume Required (m3/ha)	Volume Required (m3)	Unit Volume Required (m3/ha)	Volume Required (m3)	24 hour avg Release Rate (L/s)	Volume Required(4) (ha.m)
1	A - INDUSTRIAL	18.01	70	12.61								225	4052	185	3332				
	A - ROW	0.38	50	0.19								178	68	138	52				
Total		18.39	70	12.80	350.14	0.56	1.89	5887	35.55	6654	38.51		4119.89		3384	40	736	8.51	1.11
2	B - INDUSTRIAL	52.33	70	36.63								225	11774	185	9681				
	B - ROW	7.69	50	3.85								178	1369	138	1061				
	C - INDUSTRIAL	25.95	70	18.17								225	5839	185	4801				
	C - GATEWAY	27.89	80	22.31								242	6749	202	5634				
	C - PARKWAY	4.63	0	0.00								0	0	0	0				
	C - ROW	8.42	50	4.21								190	1600	150	1263				
Total		126.91	67	85.16	919.82	0.54	13.07	39175	236.56	44285	256.28		27331		22440	40	5076	58.75	7.41
3	D - INDUSTRIAL	56.68	70	39.68								225	12753	185	10486				
	D - HAZARD	1.66	0	0.00								0	0	0	0				
	D - ROW	7.56	50	3.78								178	1346	138	1043				
Total		65.90	66	43.46	662.82	0.53	6.79	19990	120.71	22597	130.77		1345.68		11529	40	2636	30.51	3.78
4	E - INDUSTRIAL	10.51	70	7.36								225	2365	185	1944				
	E - OPEN SPACE	2.41	0	0.00								0	0	0	0				
	E - ROW	2.24	50	1.12								178	399	138	309				
Total		15.16	56	8.48	317.91	0.45	1.56	3899	23.55	4408	25.51		2763.47		2253	40	606	7.02	0.74
5	F - INDUSTRIAL	21.52	70	15.06								225	4842	185	3981				
	F - GATEWAY	12.49	80	9.99								242	3023	202	2523				
	F - ROW	2.5	50	1.25								178	445	138	345				
Total		36.51	72	26.31	493.36	0.58	3.76	12101	73.07	13679	79.16		8309.58		6849	40	1460	16.90	2.29
6	G - INDUSTRIAL	20.07	70	14.05								130	2609	90	1806				
	G - ROW	2.86	50	1.43								105	300	65	186				
Total		22.93	68	15.48	390.98	0.54	2.36	7120	43.00	8049	46.58		2909.4		1992	40	917	10.62	1.35
7	H - INDUSTRIAL	51.56	70	36.09								130	6703	90	4640				
	H - INSTITUTION	1.75	35	0.61								90	158	0	0				
	H - ROW	8.58	50	4.29								105	901	65	558				
Total		61.89	66	40.99	642.34	0.53	6.37	18857	113.87	21317	123.36		7761.2		5198	40	2476	28.65	3.57
8	I - INDUSTRIAL	18.61	70	13.03								85	1582	45	837				
	I- ROW	3.72	50	1.86								71	264	31	115				
Total		22.33	67	14.89	385.83	0.53	2.30	6848	41.35	7741	44.80		1845.97		953	40	893	10.34	1.30
9	J - INDUSTRIAL	10.78	70	7.55								85	916	45	485				
	J - ROW	2.22	50	1.11								71	158	31	69				
Total		13	67	8.66	294.39	0.53	1.34	3982	24.04	4501	26.05		1073.92		554	40	520	6.02	0.75
10	K - INDUSTRIAL	11.36	70	7.95								85	966	45	511				
	K - ROW	3.35	50	1.68								71	238	31	104				
Total		14.71	65	9.63	313.16	0.52	1.52	4428	26.74	5006	28.97		1203.45		615	40	588	6.81	0.84
11	L - INDUSTRIAL	15.26	70	10.68								85	1297	45	687				
	L - ROW	2.85	50	1.43								71	202	31	88				
Total		18.11	67	12.11	347.47	0.53	1.87	5569	33.63	6296	36.43		1499.45		775	40	724	8.38	1.05
12	M - INDUSTRIAL	16.71	70	11.70								85	1420	45	752				
	M - GATEWAY	19.62	80	15.70								92	1805	52	1020				
	M - OPEN SPACE	3.45	0	0.00								0	0	0	0				
	M - ROW	5.69	50	2.85								71	404	31	176				
Total		45.47	67	30.24	550.58	0.53	4.68	13909	83.99	15724	90.99		3629.38		1949	40	1819	21.05	2.63

1 critical threshold unit release rate for erosion control (SMCWP):	0.103	L/s.ha
2 erosion control depth for impervious hectares:	46.00	mm
3 erosion control depth for impervious hectares:	52.00	mm
4 100 year control depth for impervious hectares:	87.00	mm

quality control = permanent pool + active storage

TOWN OF HALTON HILLS

Working Together Working for You!

DILLON CONSULTING

LEGEND

SUBWATERSHED BOUNDARY	STORMWATER MANAGEMENT POND
SUBCATCHMENT BOUNDARY	202A SUBCATCHMENT NUMBER
401 CORRIDOR PLANNING AREA	3 SUB-WATERSHED NUMBER
WATERCOURSE	

SCALE 1:10,000

401 CORRIDOR INTEGRATED PLANNING PROJECT
SCOPED SUBWATERSHED STUDIES

LOCAL SUBCATCHMENT BOUNDARIES

DRAWING NO.1

LEGEND

WATERCOURSE	SUBWATERSHED BOUNDARY	EXISTING SWM POND
EXISTING ROADS	3 SUBWATERSHED NUMBER	UNCONTROLLED FILLING
HYDRO LINE	STUDY AREA BOUNDARY	ILLICIT DUMPING
CPR RAIL LINE	REGULATORY FILL LINE	WOODLOT ID

FISHERIES SETBACK
MEANDER BELT SETBACK
SLOPE STABILITY SETBACK
WOODLOT

TOWN OF HALTON HILLS
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401 CORRIDOR INTEGRATED PLANNING PROJECT
SCOPED SUBWATERSHED STUDIES

HAZARD LANDS AND NATURAL HERITAGE/ ENVIRONMENTAL PROTECTION LANDS

DRAWING NO. 2
SCALE 1:7,500

TOWN OF HALTON HILLS
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LEGEND

	WATERCOURSE		SUBWATERSHED BOUNDARY
	EXISTING ROADS	3	SUBWATERSHED NUMBER
	HYDRO LINE		STUDY AREA BOUNDARY
	CPR RAIL LINE		EXISTING SWM POND

401 CORRIDOR INTEGRATED PLANNING PROJECT
SCOPED SUBWATERSHED STUDIES

RESTORATION AND PRESERVATION STRATEGY

DRAWING NO. 3
SCALE 1:7,500

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LEGEND

- WATERCOURSE
- EXISTING ROADS
- PROPOSED RIGHT-OF-WAY
- HYDRO LINE
- CPR RAIL LINE
- SUBWATERSHED BOUNDARY
- SUBCATCHMENT BOUNDARY
- 3 SUBWATERSHED NUMBER
- 202K SUBCATCHMENT NUMBER
- A PROPOSED DEVELOPMENT AREA ID
- STUDY AREA BOUNDARY
- EXISTING SWM POND
- PROPOSED SWM POND (WATER QUALITY, EROSION & FLOOD CONTROL)
- FLOW DIRECTION
- 70% impervious
- PRESTIGE INDUSTRIAL
- 80% impervious.
- GATEWAY COMMERCIAL
- From Table 5-1 Page 5-4 Scoped Subwatershed
- PARKWAY BELT
- HAZARD LANDS
- OPEN SPACE

401 CORRIDOR INTEGRATED PLANNING PROJECT
SCOPED SUBWATERSHED STUDIES

URBAN STORMWATER MANAGEMENT PLAN

DRAWING NO. 4
SCALE 1:7,500