CITY OF BELLEVILLE

DRAFT

PRELIMINARY DESIGN REPORT

STORMWATER MANAGEMENT
HERCHIMER AVENUE

AINLEY GRAHAM AND ASSOCIATES
CONSULTING ENGINEERS AND PLANNERS
COLLINGWOOD · BARRIE · BELLEVILLE · OTTAWA

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1.0 INTRODUCTION

1.1 Study Area

The study area consists of approximately 66.6 hectares of land in the east end of the City of Belleville, at the tip of the Bell Creek tributary which flows in a north-west to south-east direction. In general, the area is bounded by the CNR tracks north of Station Street, Victoria Avenue to the south, Golfdale Road to the west and Herchimer Avenue to the east.

The northern portion of the study area is mostly undeveloped and designated (under the City of Belleville official plan) as medium industrial, while the southerly portion consists of existing residential homes.

Figure 1 indicates the location of the study area.

1.2 Background

The City of Belleville intends to reconstruct Herchimer Avenue between Victoria Street and Station Street in 1997. This re-construction will include storm and sanitary works, as well as an urbanized road cross section. The purpose is to upgrade the deteriorated existing infrastructure to current standards and provide for future development. As part of this process, it is necessary to accommodate the stormwater discharge from the Herchimer Avenue and Station Street drainage area which flows easterly crossing Herchimer Avenue into Bell Creek through a series of ditches and culverts.

Any proposed facility(s) must be designed to deal with run-off quantity and quality to satisfy the Bay of Quinte Remedial Action Plan (RAP), established by the International Joint Commission (IJC) in 1985 and administered by the Moira River Conservation Authority (MRCA). The purpose of the RAP program is, in part, to restore and protect the Bay of Quinte ecosystem.

1.3 Previous Studies and Reports

The following studies and reports have been reviewed in order to establish the most feasible alternative for run-off control:

Bell Creek Water Management Study
Maclaren Plansearch Inc., 1984

The objective of this study was to examine potential flooding of Bell Creek, along with hydrological effects due to urbanization and also, to develop stormwater management options to reduce potential flood damage.

The study addressed a number of stormwater management and general flood damage issues including the following:

- pre and post development runoff for various return periods.
- techniques to achieve stream management objectives.
- rationale for selection of the stormwater management approaches.
- detailed rainfall analysis for the Belleville area, along with a regional analysis of flood flows on Bell Creek.
- detailed hydraulic modeling.
- structural works to reduce flooding potential.

A number of technical enclosures, in addition to floodline maps which outline flood and fill line areas, were also prepared as part of the study.

Storm Water Management Report
Stanley Park North Secondary Plan
G.M. Sernas, July 1987

The purpose of this report was to address stormwater management issues resulting from the development of the Stanley Park North Secondary Plan (located east of the subject study area). These issues included the following:

- determination of the 1:100 year storm post development floodlines within the Secondary Plan area.
- sizing of a culvert crossing at Bell Creek to accommodate the extension of Farley Avenue.
- design of a stormwater management pond west of Haig Road to attenuate peak flows.
- determination of locations and inverts of stormwater outfalls to the Bell Creek tributary with the Secondary Plan area to accommodate minor flows.
- recommendations for siltation control measures related to construction.

The report was prepared with consideration to the recommendations contained in the 1984 Maclaren Plansearch report summarized above.

Storm Water Management Plan
Stanley Park North Secondary Plan Area
G.M. Sernas, March 1993

This report was prepared at the request of the MRCA in order to update the information contained in the July 1987 report and also to achieve the following:

- reproduction, as nearly as possible, of the pre-development hydrologic response associated with the drainage area for post-development conditions.
- water quality treatment for post-development drainage.
- preservation of the natural features of wetlands within the study area.

The west limit of the study area was extended to consider lands west of Herchimer Avenue to Golfdale Road.

1.4 Existing Conditions

Based on information contained in the March 1993 G.M. Sernas report, the soils within the Stanley Park Secondary Plan area are predominantly Schomberg clay loams and marshy soils. These soils are underlain by bedrock at a very shallow depth. The average grades are less than 1%, with average run-off lengths of approximately 200 metres.

The undeveloped land within the study area consists primarily of open field with some wooded sections and areas of medium density vegetation. Most of this land is privately owned with no designated open space areas or provincially significant wetlands.

City owned land and rights-of-way are reflected in **Figure 2**. The area of property designated as Parcel 1 is approximately 2 hectares, while the rights-of-way shown within the future industrial and existing residential areas are all approximately 20 metres wide.

A physical inspection of the study area was conducted by Ainley Graham and Associates on September 13, 1996 in consideration of typical wet weather conditions at the outlet areas along Herchimer Avenue. Environment Canada records indicate that approximately 156mm of rainfall fell in the area over the preceding week, including 40mm on the inspection date. The average rainfall for the entire month of September is normally 74mm. The rainfall data, along with some selected photographs taken during the field inspection, are included as **Appendix A**.

2.0 REQUIRED LEVEL OF CONTROL

The Moira River Conservation Authority has indicated that quantity control is not required. Existing and future ponds downstream have been designed to over control flows in order to accommodate upstream contributions. Quality control for the 14mm storm event will be required however, as well as considerations for erosion mitigation.

City of Belleville criteria requires that conveyance systems be designed to accommodate a 5 year storm event.

3.0 METHODOLOGY

The following has been considered for preliminary design purposes:

- City of Belleville design standards including intensity-duration-frequency (IDF) curves based on rain gauge data from 1960 to 1983. This information, in conjunction with the computer model OTTHYMO, was utilized to establish a 12 hour design storm (as recommended in the 1984 Maclaren Plansearch report) for the five year return period. Parameters used in the computer model were based on a detailed review of previous reports and discussions with the MRCA and the City of Belleville.

- a 14mm design storm (provided by the MRCA) was used to establish flows for quality control.

- other supporting data and documentation available from the City of Belleville and the MRCA was reviewed, including the preliminary drawings associated with the reconstruction of Herchimer Avenue.

4.0 PRE AND POST DEVELOPMENT FLOWS

The pre and post development flows produced by the OTTHYMO model are summarized in Table 1, with the individual basins illustrated in **Figure 3**. Basin 100 is tributary to Point A, while Basins 101, 102 and 103 are tributary to Point B. The associated computer output files are included as **Appendix B.**

Table 1
Pre and Post Development Flows

Basin Number and Description	Area (ha)	Peak Flows (cms)			
		14mm Event		5 Year Event	
		Pre-dev.	Post-dev.	Pre-dev.	Post-dev.
100 - Future Industrial	12.8	0.02	0.10	0.14	0.66
101 - Future Industrial	14.6	0.02	0.11	0.16	0.75
102 - Ex. Low Density Residential	36.2	0.26	0.26	1.72	1.72
103 - Ex. Medium Density Residential	1.3	0.01	0.01	0.08	0.08
101, 102 & 103 Combined	52.1	0.29	0.38	1.91	2.48

These flows form the basis for the storm water controls recommended in this report.

5.0 ALTERNATIVE SOLUTIONS

The stormwater quality controls described below are based on an integrated approach to controlling pollution at source.

Lot Level Controls

The purpose of lot level controls is to treat stormwater on site before the runoff reaches the conveyance system. Traditional methods such as rooftop detention, catch-basin restrictors and oversized storm sewers are intended to control the quantity of stormwater. Quality control can be accomplished, to a certain extent, by implementing the following options:

Reduced Lot Grading - This technique is most appropriate in areas where the natural topography is relatively flat. It allows for pollutant removal by filtration through grass and infiltration through soil.

Ponding Areas - Roof leader discharge to temporary ponding areas created within rear yards or rear lot lines can serve to detain water until evaporation or infiltration takes place. The effectiveness of this method is a function of the soil conditions.

Conveyance Controls

Conveyance controls treat stormwater in transit through exfiltration from the conveyance system and infiltration to groundwater, and increased detention time allowing settling of particulate matter. These controls are classified as follows:

Pervious Pipe Systems - These systems consist of perforated pipe which allows exfiltration of water as it is conveyed downstream. They require soils with good infiltration potential and a deep groundwater table. Some form of pre-treatment is necessary to ensure longevity of the system. This can be best achieved through grassed boulevards.

Pervious Catch Basins - The design of these systems consist simply of a normal catch basin with a larger sump connected to an exfiltration storage media. Their function is to infiltrate road drainage which carries high levels of suspended sediment. As with pervious pipe systems, some form of pre-treatment is necessary. Catch basin sumps can be used for this purpose.

Enhanced Grassed Swales - This method utilizes check dams, reduced grades and wide depressions to increase temporary runoff storage and promote settling of pollutants. The expected removal efficiency is projected to be 70% for sediment, 30% for total phosphorus, 25% for soluble nutrients and 50% to 90% for various trace metals. Watershed characteristics such as slope, area and imperviousness are all considerations for design of these systems.

End of Pipe Facilities

End-of-pipe facilities receive and treat stormwater from a conveyance system and discharge the treated water to the receiving waters. The methods considered are as follows:

Extended Detention Wet Ponds - These type of facilities are normally designed to retain runoff for at least 24 hours, thereby allowing settling of suspended material and biodegradation. They incorporate a sediment forebay and a large permanent pool that has a controlled outflow. Sediment removal ranges from 50% to 90%. Total phosphorus removal ranges from 30% to 90%, while removal of soluble nutrients ranges from 40% to 80%. Moderate to high removal of trace metals can be expected. Design considerations include the size of the drainage area, planting strategy, inlet and outlet configurations, and maintenance among others.

Constructed Wetlands - The benefit of constructed (or artificial) wetlands is similar to wet ponds. They are shallow pools containing suitable conditions for the growth of marsh plants and are designed to maximize pollutant removal through wetland uptake, retention and settling. Design considerations include planting strategy, soil conditions and available space.

Oil/Grit Separators - The primary function of these units is to remove and contain sediment and hydrocarbon loads from surface runoff. They are often used in areas where wet ponds or wetlands are not feasible, such as small development situations, or in commercial/industrial areas to contain potential accidental spills. The overall sediment removal provided by oil/grit separators is expected to be in the order of 20% to 50%, depending on the separator size and contributing drainage area. The effectiveness of this system in the removal of silt, clay, nutrients, trace metals and organic matter is considered slight. Regular inspection and maintenance is required to ensure flow passages are not clogged and stored sediment, along with any trapped oil, is removed.

6.0 EVALUATION AND RECOMMENDATIONS

The study area contains two distinct sections, being the future industrial area and the existing residential area. These sections have been evaluated on an individual basis, since each area is comparatively unique in terms of viable options for stormwater quality control. There is, however, some overlap between these areas (as well as the individual drainage basins) which has been considered.

6.1 Future Industrial Area

The topography of the area is relatively flat, generally declining from west to east. Upon development, the City of Belleville will require that the individual property owners control five year post development runoff to five year pre-development levels (as recommended in the 1993 Sernas report). For events greater than this return period, on site detention will be required. This detention could be satisfied through roof top storage, parking lot storage, or any other acceptable means as approved by the City.

Currently, two culverts crossing Herchimer Avenue (Points A and B) serve as outlets to Bell Creek for Basins 100 and 101 respectively. Stormwater runoff from the north side of Station Street is conveyed by a 450mm CSP culvert to an existing ditch along the west side of Herchimer Avenue. This ditch, along with a number of CSP culverts located at entrances to existing buildings, provides conveyance for runoff to the outlets.

Comprehensive quality control on an individual basis through site plan control is an option. However, regular maintenance of each facility would be necessary to ensure that runoff treatment objectives are satisfied. Monitoring and enforcing this type of control may be difficult and quality control objectives may not be satisfied. This approach is more suited to infill situations where options are few. It is recommended that quality control on a site specific basis be limited to lot level controls, as specified below:

Lot Level Controls

Evaluation:

Reduced Lot Grading - The natural topography of the area provides opportunity to effectively utilize this type of control. Grading within 4 meters of any building should be at a minimum of 2% to avoid potential foundation drainage problems. Beyond this point, grades should be reduced to a minimum of 0.5%.

Ponding Areas - This approach should be taken to complement reduced lot grading. Roof leader discharge to these areas would further aid in stormwater treatment and reduce erosion potential downstream.

Recommendation:

Lot level control in the form of reduced lot grading and temporary ponding areas is recommended. This treatment can be readily implemented through site plan control.

Conveyance Controls

Evaluation:

Pervious Pipe Systems - These systems are experimental in nature and some problems have been experienced in the past by municipalities who have implemented them. Accordingly, this does not represent a viable alternative.

Pervious Catch Basins - The drainage characteristics of the soil and the relatively flat topography in the area, make this system undesirable.

Enhanced Grass Swales - As with reduced lot grading, the relatively flat topography in the area presents an opportunity to utilize this stormwater quality control. The existing Herchimer Avenue and Station Street road allowances, along with the future road allowances, provide ample space to construct this system.

Driveway spacing in the industrial area will be such that culverts could effectively be used as check dams with appropriate measures incorporated under the culverts to ensure that a permanent pool is not created in the swale. These swales could be designed in a manner to convey the 5 year storm event as required, which would negate the need for conventional storm sewers. In addition, the existing and future road allowances provide an opportunity for relatively long flow paths which would maximize infiltration and further reduce runoff at the Herchimer Avenue outlets.

Recommendation:

Enhanced grass swales are recommended for conveyance control. They provide a high level of treatment as a result of existing site conditions. There is no need for conventional storm sewer pipe with this system which results in a cost savings for the City. In addition, the swale construction can be limited to the Herchimer Avenue and Station Street road allowances until further development proceeds. This method of control should be stipulated for construction of the future road allowances.

End-of-pipe Facilities

Evaluation:

Extended Detention Wet Ponds - A central pond for the entire industrial area would require significant alteration to the existing topography. Accordingly, the most feasible solution would be individual ponds located at points A and B for Basins 100 and 101 respectively. Table 2 illustrates the total pond volume required for each basin. This was determined using the Stormwater Management Planning Practices and Design Manual (Table 4.1, assuming Level 1 receiving waters and 35% impervious). The extended detention storage indicated was compared to the values calculated using the OTTHYMO volumes from the 14mm event which resulted in totals of 493 m^3 for Basin 100 and 562 m^3 for Basin 101. The MOEE manual values were used to be conservative.

Table 2
Wet Pond Volume - Industrial Area

	Basin 100	Basin 101
Permanent Pool	1,280 m^3	1,460 m^3
Extended Detention Storage	512 m^3	584 m^3
Total Pond Volume	**1,792 m^3**	**2,044 m^3**

Based on the level of treatment provided by the recommended lot level and conveyance controls, as well as the contributing flows, the additional treatment that this type of facility would contribute appears insignificant. In addition, it is evident that the land required to support a facility of this size would be significant. The City owned land is located a substantial distance from the outfall points, with the general topography increasing in elevation toward that property. Furthermore, the March 1993 Sernas report identifies that the depth to bedrock is shallow which would significantly increase construction costs.

Constructed Wetlands - The total storage required to support constructed wetlands is 1024 m^3 and 1168 m^3 for Basins 100 and 101 respectively. Similarly this type of facility would not provide a significant level of treatment beyond the recommended lot level and conveyance controls and would require a large area of land.

Oil/Grit Separators - This method of control is a possibility considering the contributing flows. However, the level of treatment beyond the recommended lot level and conveyance controls would be negligible. In addition, conventional storm sewers would be necessary to effectively support this system.

Recommendation:

The most viable conveyance control system (i.e. grassed swales) is considered effective in providing a high level of treatment based on the relatively long flow paths possible and the relatively flat topography. The computer model indicates that runoff at the respective outlets is minimal. An additional check dam could be placed at each outlet to create an opportunity for further stormwater treatment. Accordingly, additional check dams are recommended for end-of-pipe control.

6.2 Existing Residential Area

Ninety-seven percent of the minor system runoff (i.e. Basin 102) generated from the existing residential area is conveyed to a storm sewer collector pipe located in the Herchimer Avenue road allowance and discharged into Bell Creek through an existing outlet at Point B. Roof top drainage discharges onto the lawns and is conveyed to the storm sewer collection system through sheet drainage or vegetative swales, thereby enhancing water quality by increasing evaporation and reducing surface runoff velocity.

The remaining three percent of the runoff (Basin 103) is similarly treated in terms of lot level control. The quality of the stormwater from this area is further enhanced through conveyance control provided by a vegetated swale which carries the runoff to Bell Creek, also at Point B.

Based on discussions with City of Belleville staff, the urbanized cross section to be established through the Herchimer Avenue re-construction will not increase runoff in the area, since the existing cross section collects street runoff in the same manner by way of asphalt ramps. Accordingly, any additional treatment provided by the City will improve the existing condition. In addition, the proposed reconstruction will not necessarily affect the use of the existing outlet. Consideration may be given to "doing nothing" in this regard and possibly utilizing the cost savings for other stormwater related projects where the benefits may be greater, or a City wide program to reduce pollutants in a broader fashion. Regardless, a complete assessment has been conducted as follows:

Lot Level Controls - Satisfied as described above.

Conveyance Controls

Evaluation:

Pervious Pipe Systems - As previously noted, these systems are experimental in nature and some problems have been experienced in the past by municipalities who have implemented them. In this consideration, along with the expense required beyond road reconstruction (i.e. excavation, material, labour), they do not represent a viable alternative.

Pervious Catch Basins - Under the road reconstruction, some existing catch basins may have to be relocated. This would create an opportunity to implement this alternative, provided site conditions such as utility locations, soils, groundwater table, etc., are favourable. However, this solution would only be viable for catch basins along Herchimer Avenue. To extend this treatment process along the local roads would be at a significant cost as it relates to the proposed road reconstruction work.

Enhanced Grass Swales - As with pervious pipe system, this alternative would generate significant costs beyond road reconstruction. They cannot be readily incorporated into the existing system and would necessitate significant disruption to the existing lot grading.

Recommendation:

To provide effective conveyance control would require a great deal of disruption to the homeowners in the area, at an expense well beyond the City's budget for this project. This limits treatment to runoff within the Herchimer Avenue road allowance itself, which accounts for a small portion of the contributing area. The existing catch basins will have to be relocated as part of the road reconstruction. Accordingly, there is opportunity to retrofit these catch basins to provide some conveyance control in the form of perforated catch basins. This method of control is recommended provided that the specific soil conditions are conducive and there are no utility conflicts. Otherwise, the treatment should be limited to end-of-pipe control.

End-of-pipe Facilities

Evaluation:

Extended Detention Wet Ponds - The most feasible location for a wet pond would be near the existing outlet of Basin 102 near Point B. Based on a contributing area of 37.5 hectares, the wet pond would have to accommodate a volume as indicated in Table 3 below.

Table 3
Wet Pond Volume - Residential Area

Permanent Pool	3,750 m^3
Extended Detention Storage	1,500 m^3
Total Pond Volume	**5,250 m^3**

The total pond volume was determined using the Stormwater Management Planning Practices and Design Manual (Table 4.1, assuming Level 1 receiving waters and 35% impervious). The extended detention storage using the OTTHYMO volume from the 14mm event was calculated at 1358 m^3. Accordingly, the MOEE manual value was used to be conservative.

As with the future industrial area, a substantial amount of land would be necessary to support the individual drainage basins based on the volumes indicated. This type of system would also require re-alignment of the existing storm sewer pipe within Herchimer Avenue or a diversion pipe to convey flow to the appropriate location.

Constructed Wetlands - The total storage required to support a constructed wetland is less than for a wet pond at 3000 m^3, but nevertheless considered significant.

Oil/Grit Separators - The road reconstruction presents an opportunity to utilize oil/grit separators. Based on contributing areas, these units can be placed appropriately at intersections to treat stormwater from Basin 102 with no additional impact on existing lots. Alternatively, a diversion pipe could be utilized near the outlet to direct the 14mm flows through a single unit prior to discharge into the creek. The additional runoff generated from Basin 103 does not warrant further treatment.

Recommendation:

The cost estimates provided illustrate that treatment in the form of wet ponds or constructed wetlands is very high in comparison to the cost associated with oil/grit separators. Although ponds provide a higher level of treatment than oil/grit separators, the City's budget for this project is a factor. There is also limited area to provide control in the form of a pond without acquiring additional lands at further expense. Accordingly, end-of-pipe control in the form of oil/grit separators is recommended.

7.0 COST ESTIMATES

Since cost is a factor in some of the recommendations provided, estimates for all of the alternatives considered have been included for illustration purposes. Table 4 below summarizes the estimated individual costs to the City of Belleville for each of these alternatives. A more detailed breakdown of these costs is included as **Appendix C**.

Table 4
Individual Costs

Quality Control	Future Industrial Area		Existing Residential Area	
	Basin 100	**Basin 101**	**Basin 102**	**Basin 103**
Lot Level Controls				
Reduced Lot Grading	By Developer	By Developer	Satisfied	Satisfied
Ponding Areas	By Developer	By Developer	-	-
Conveyance Controls				
Pervious Pipe Systems	$ 101,000	$ 51,000	$315,000	-
Pervious Catch Basins	$ 77,000	$ 35,000	$ 81,000	-
Enhanced Grass Swales	$ 34,000	$ 9,000	$175,000	Satisfied
End-of-Pipe Facilities				N/A
Ext. Detention Wet Ponds	$ 81,000	$ 92,000	$236,000	-
Constructed Wetlands	$ 41,000	$ 47,000	$120,000	-
Oil/Grit Separators	$ 30,000	$ 30,000	$ 60,000	-

The costs stipulated for conveyance controls relate to works along Station Street and Herchimer Avenue within Basins 100 and 101, as well as Basin 102 in the existing residential area. It is assumed that the future road allowances in the industrial area will be constructed at the developer's expense, in accordance with City of Belleville requirements. The costs associated with end-of-pipe facilities consider contributions from the entire tributary areas, since it would not be feasible to retrofit each facility as development occurs. These estimates do not include any costs associated with land acquisition.

Based on the individual costs shown above, Table 5 illustrates the estimated cost to the City of Belleville for the combined alternatives. For example, if pervious pipe systems were utilized for conveyance control, along with extended detention wet ponds for end-of-pipe control, the cost to the City would be $182,000. Lot level controls have been satisfied, therefore no costs have been stipulated.

Table 5
Combined Costs

End-of-Pipe Facilities	*Conveyance Controls*								
	Future Industrial Area						**Existing Residential Area**		
	Basin 100			**Basin 101**			**Basin 102**		
	Pervious Pipe Systems	Pervious Catch Basins	Enhanced Grass Swales	Pervious Pipe Systems	Pervious Catch Basins	Enhanced Grass Swales	Pervious Pipe Systems	Pervious Catch Basins	Enhanced Grass Swales
Ext. Det. Wet Ponds	$182,000	$158,000	$115,000	$143,000	$127,000	$101,000	$551,000	$317,000	$411,000
Constr. Wetlands	$142,000	$118,000	$ 75,000	$ 98,000	$ 82,000	$ 56,000	$435,000	$201,000	$295,000
Oil/Grit Separators	$131,000	$107,000 *	$ 64,000 *	$ 81,000	$ 65,000 *	$ 39,000 *	$375,000	$141,000	$235,000

* Estimate does not include any necessary storm sewer pipe system.

8.0 SUMMARY OF COSTS AND RECOMMENDATIONS

Table 6 below is a summary of costs to the City of Belleville for the work necessary, based on the recommendations stipulated.

Table 6
Cost of Preferred Alternatives

Basin No.	**Level of Control and Cost to City of Belleville**						
	Lot Level	**Cost**	**Conveyance**	**Cost**	**End of Pipe**	**Cost**	**Total**
100	By Developer	-	Grass Swale	$ 34,000	Check Dam	$ 2,500	$ 36,500
101	By Developer	-	Grass Swale	$ 9,000	Check Dam	$ 2,500	$ 11,500
102	Satisfied	-	Pervious CB's	$ 21,000	Oil/Grit Sep.	$ 60,000	$ 81,000
103	Satisfied	-	Satisfied	-	N/A	-	Nil
Total	-	Nil	-	$ 64,000	-	$ 65,000	**$129,000**

Should runoff treatment be deferred in the existing residential area (i.e. Basin 102), the total estimated cost will be reduced from **$ 129,000** to **$ 48,000.**

Respectfully submitted,

AINLEY GRAHAM AND ASSOCIATES LIMITED

DRAFT

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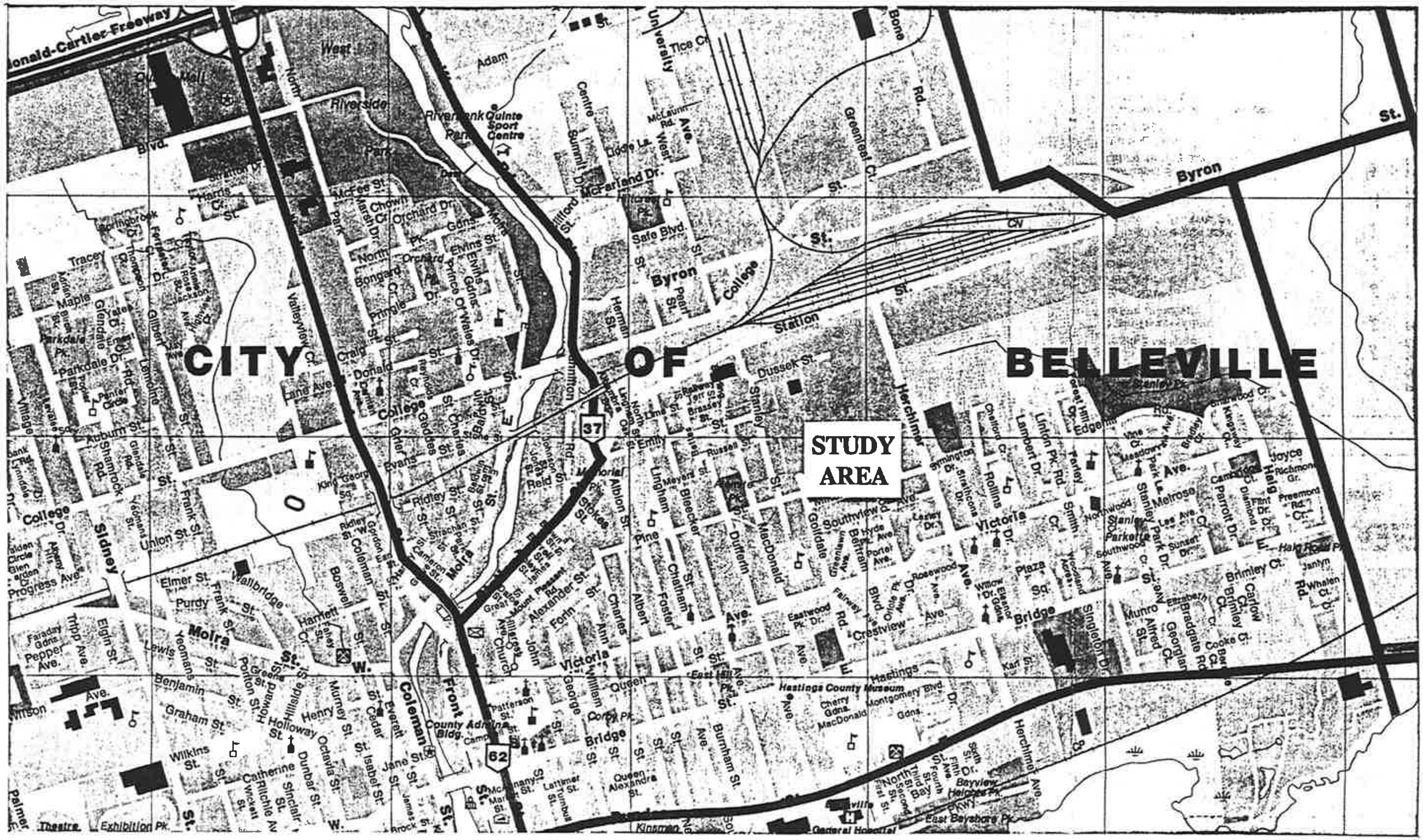


FIGURE 1: LOCATION PLAN (NTS)

STORMWATER MANAGEMENT
HERCHIMER AVENUE

Ainley Graham and Associates Limited
Consulting Engineers and Planners

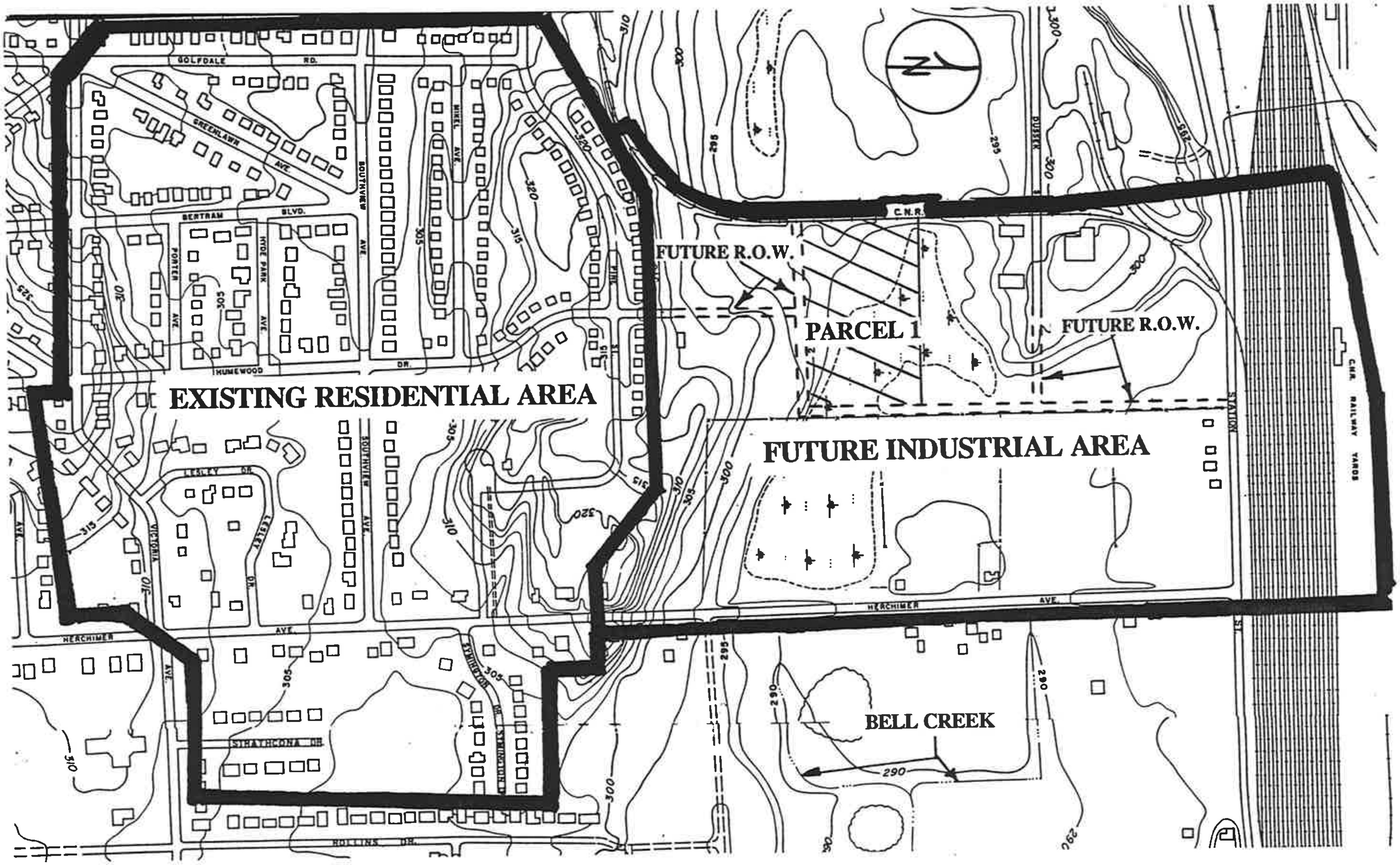


FIGURE 2: EXISTING CONDITIONS (NTS)

STORMWATER MANAGEMENT
HERCHIMER AVENUE

Ainley Graham and Associates Limited
Consulting Engineers and Planners

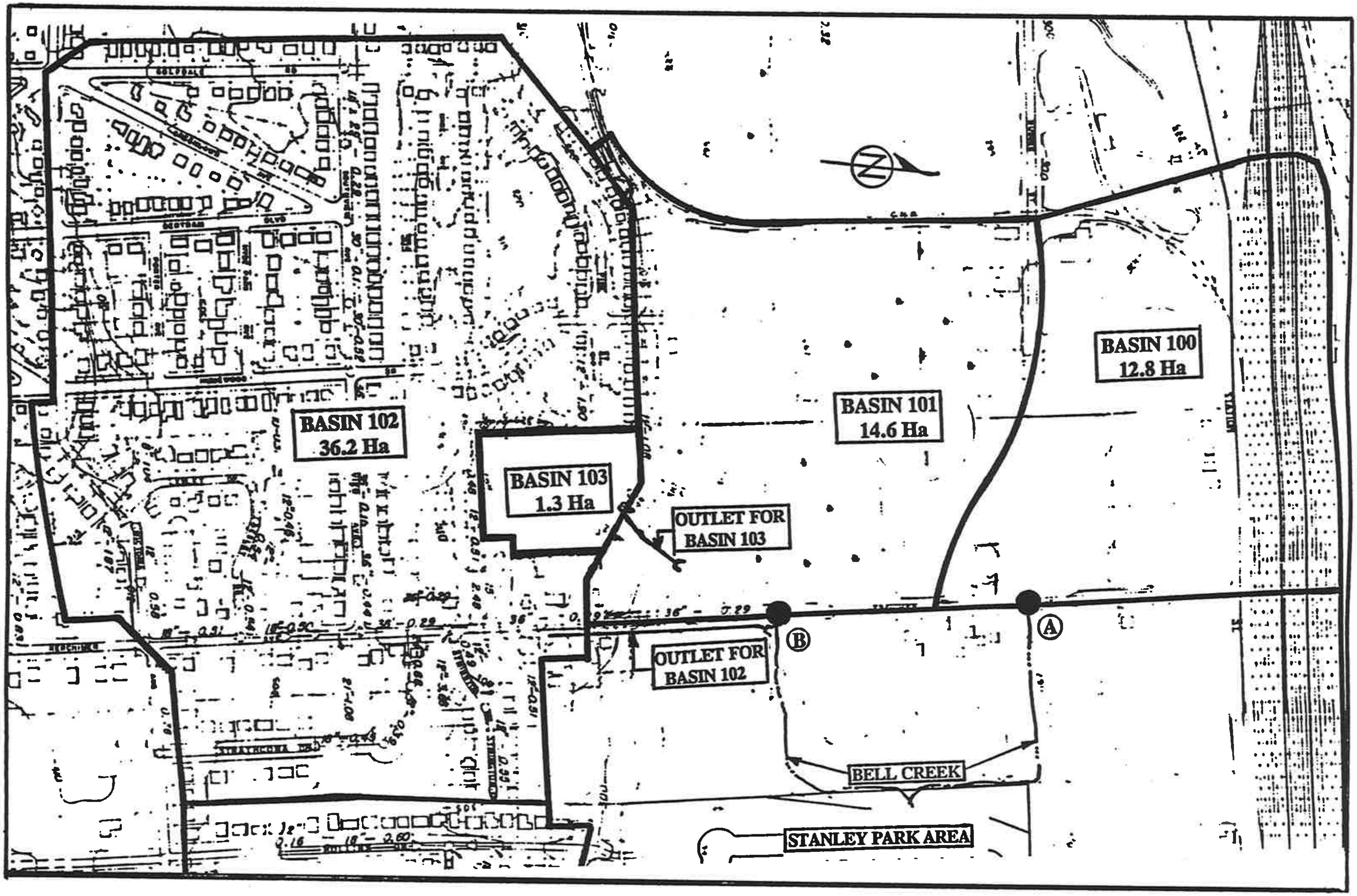


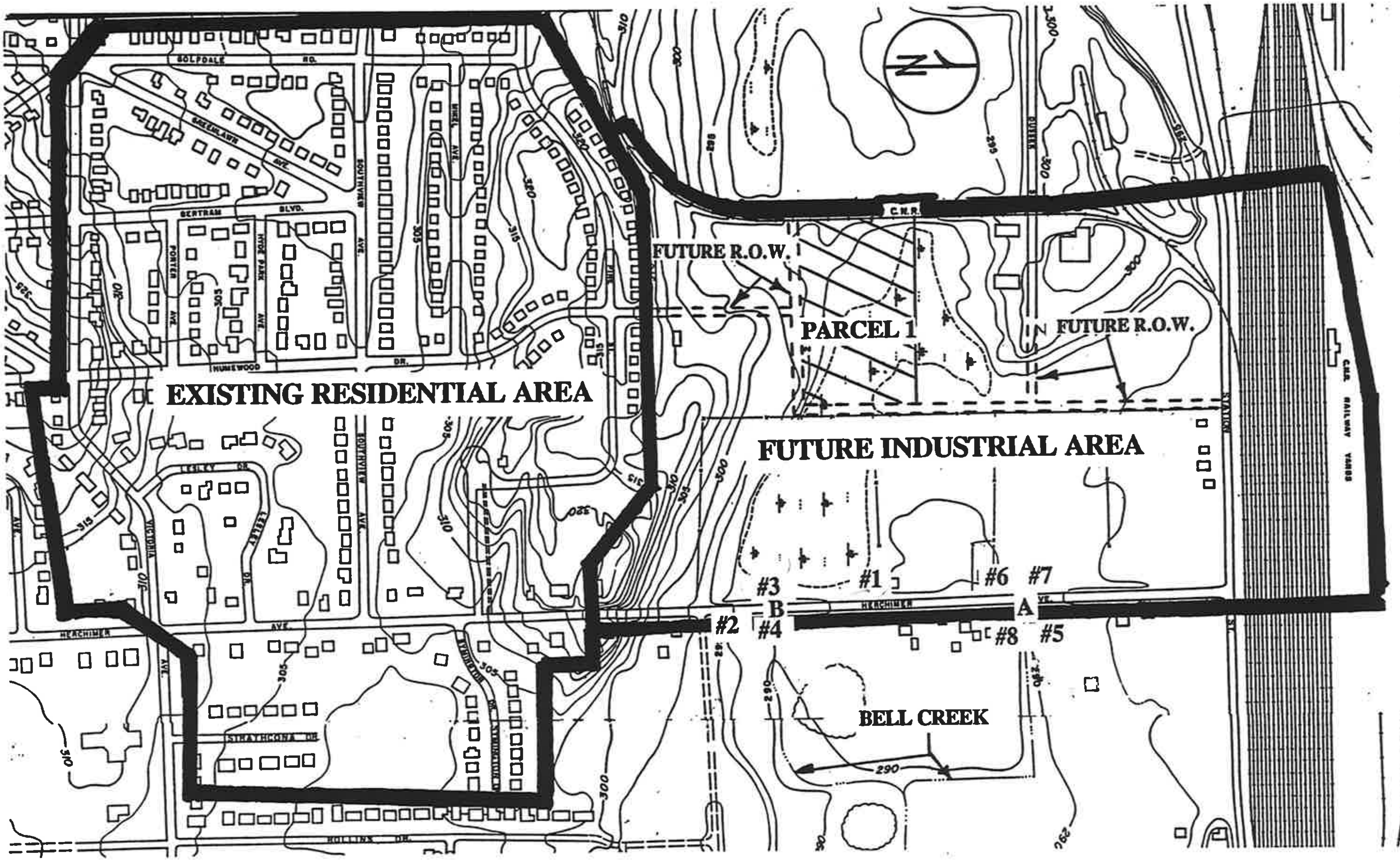
FIGURE 3: DRAINAGE BASINS (SCALE = 1:4800)

STORMWATER MANAGEMENT
HERCHIMER AVENUE

Ainley Graham and Associates Limited
Consulting Engineers and Planners

APPENDIX A

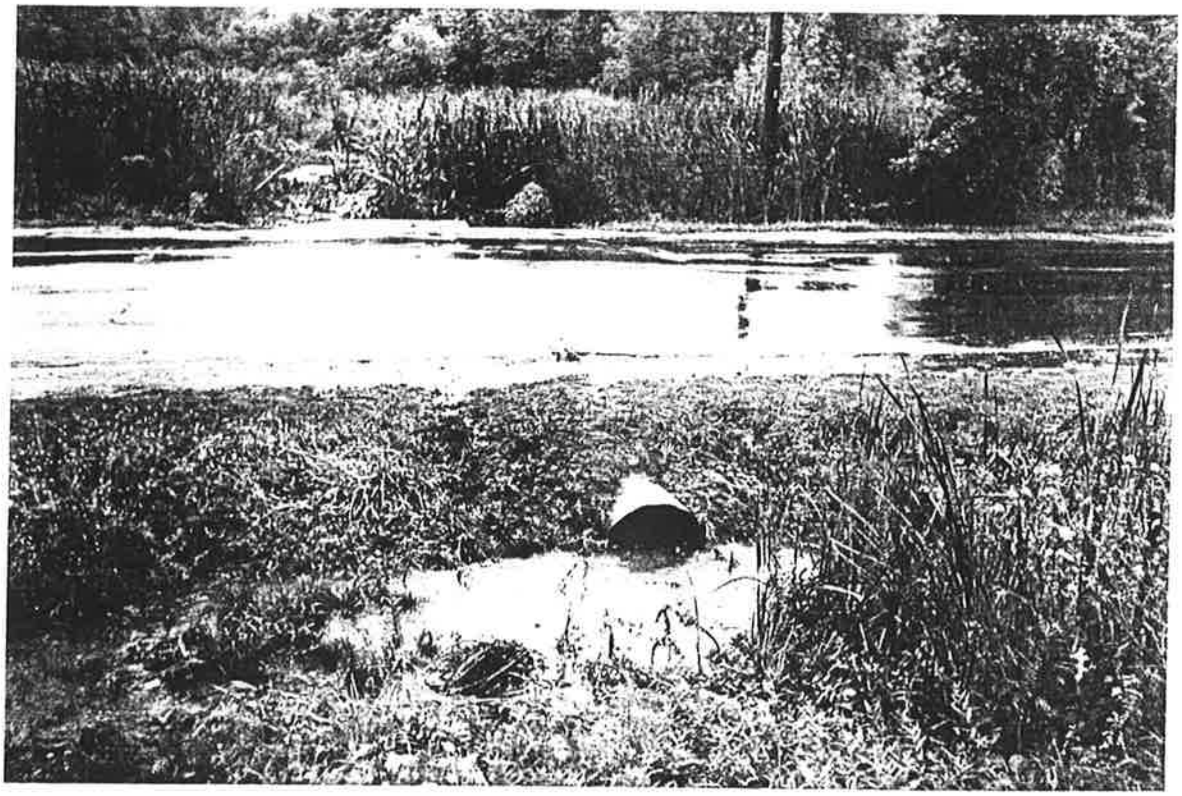
Field Photographs



REFERENCE PLAN SHOWING ID NUMBER AND LOCATION OF EACH PHOTOGRAPH

#1 - WEST SIDE LOOKING SOUTH

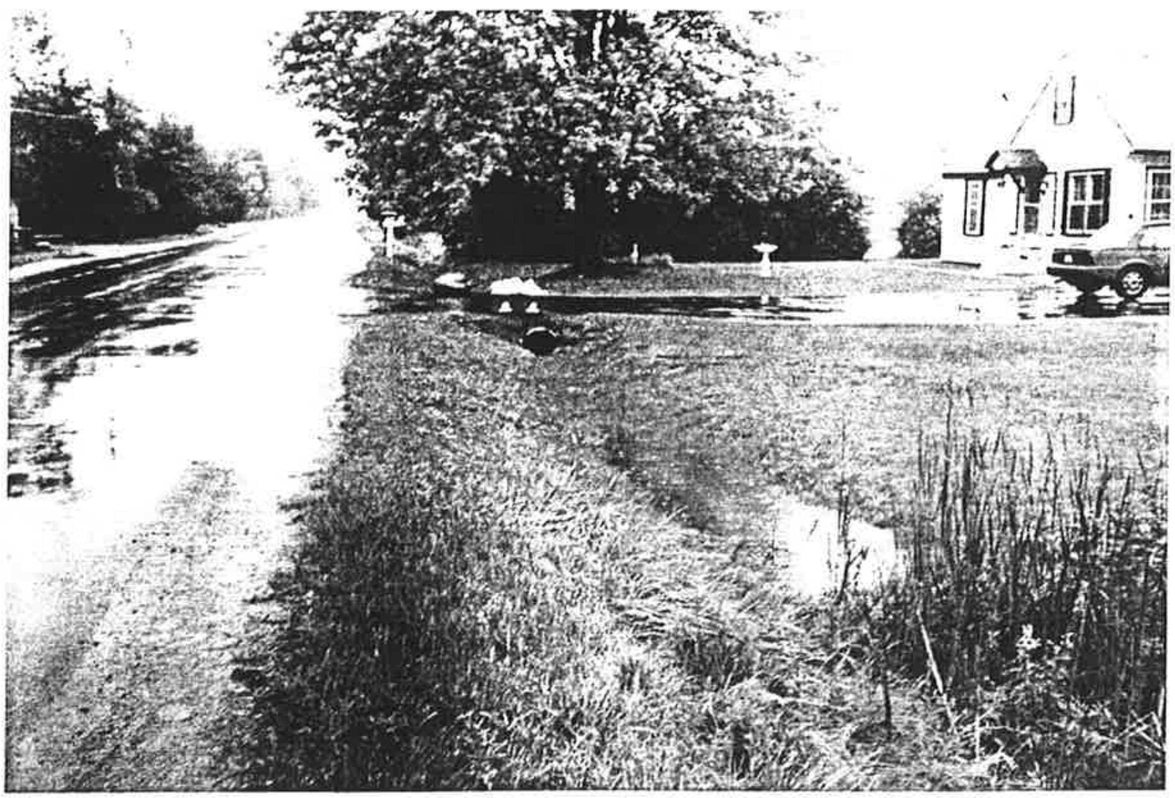
#2 - EAST SIDE LOOKING NORTH



#3 - AT POINT B LOOKING EAST

#4 - AT POINT B ON EAST SIDE

#5 - AT POINT A LOOKING NORTH ON EAST SIDE



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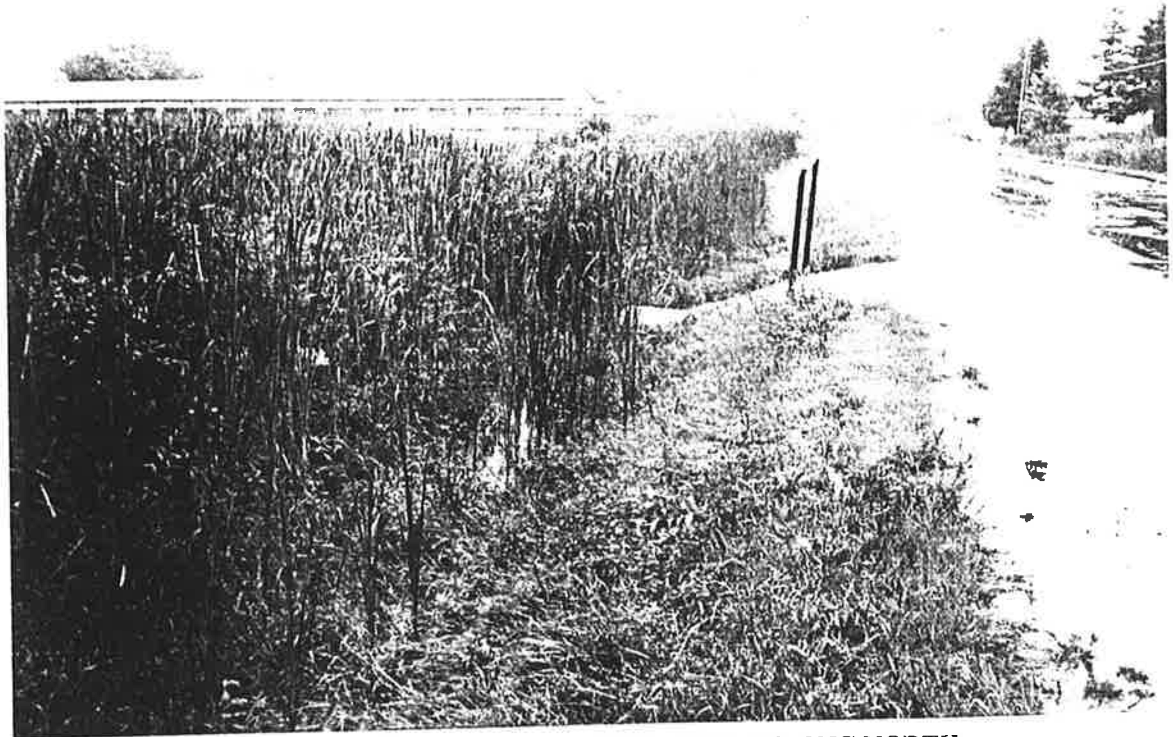

#7 - AT POINT A ON WEST SIDE LOOKING NORTH

#8 - AT POINT A ON EAST SIDE LOOKING EAST

MONTHLY METEOROLOGICAL SUMMARY

SOMMAIRE METEOROLOGIQUE MENSUEL

STATION NAME : Trenton (YTR)

Environment Canada

Ontario Region

August, 1996.

LAT: 44'07N ELEVATION/ALTITUDE: 86. Metres (ASL) / Metres (NNM)
LONG: 77'32W STANDARD TIME USED / HEURE NORMALE UTILISEE:

DATE	Temperature / Température: Maximum Max.	Minimum Min.	Mean Moyenne	Degree-Days / Degrés-Jours: Heating De Chauffe	Growing De Croissance	Cooling De Refrigeration	Rel Humidity / Humidite Rel: Max.	Min.	Precipitation / Precipitations: Rain-fall Pluie Hauteur	Snow-fall Neige Hauteur	Total Precip Precip. Totale	Snow on Ground / Neige au Sol
	C	C	C	base 18	base 5	base 10	%	%	mm	cm	mm	cm
01	23.5	15.5	19.5	0	14.5	1.5	94	64	0	0	8.1	
02	24.3	13.0	18.7	0	13.7	0.7	97	62	0	0	0.0	
03	26.0	13.0	19.5	0	14.5	1.5	71	55	0	0	0.0	
04	26.9	13.1	20.0	0	15.0	2.0	97	38	0	0	0.0	
05	28.5	12.8	20.7	0	15.7	2.7	97	50	0	0	0.0	
06	29.9	15.6	22.8	0	17.8	4.8	98	49	0	0	0.0	
07	27.5	17.4	22.5	0	17.5	4.5	98	67	0	0	0.4	
08	27.0	17.6	22.3	0	17.3	4.3	95	72	0	0	2.0	
09	27.1	15.7	21.4	0	16.4	3.4	96	42	0	0	0.0	
10	22.8	11.0	16.9	1.1	11.9	0	88	33	0	0	0.0	
11	23.3	8.4	15.9	2.1	10.9	0	89	42	0	0	0	-9999
12	24.8	11.8	18.3	0	13.3	0.3	95	49	0	0	0.0	
13	24.5	15.0	19.8	0	14.8	1.8	86	67	0	0	0.0	
14	27.7	14.4	21.1	0	16.1	3.1	93	43	0	0	0.0	
15	29.3	14.2	21.8	0	16.9	3.8	94	52	0	0	0.8	
16	24.5	17.5	21.0	0	16.0	3.0	97	44	0	0	TR	
17	25.0	15.0	20.0	0	15.0	2.0	99	56	0	0	0.0	
18	28.6	13.4	21.0	0	16.0	3.0	96	49	0	0	TR	
19	28.7	14.9	21.8	0	16.8	3.8	96	37	0	0	0.0	
20	26.7	14.8	20.8	0	15.8	2.8	96	64	0	0	0.2	
21	26.8	15.0	20.9	0	15.9	2.9	98	59	0	0	0.0	
22	27.4	14.3	20.9	0	15.9	2.9	99	50	0	0	0.0	
23	28.5	18.4	23.5	0	18.5	5.5	95	55	0	0	3.4	
24	27.1	14.3	20.7	0	15.7	2.7	90	41	0	0	0.0	
25	28.6	14.2	21.4	0	16.4	3.4	85	39	0	0	0.0	
26	25.1	15.9	20.5	0	15.5	2.5	98	52	0	0	6.0	
27	23.1	13.2	18.2	0	13.2	0.2	94	54	0	0	1.0	
28	24.8	11.5	18.2	0	13.2	0.2	94	55	0	0	0.0	
29	25.5	12.1	18.8	0	13.8	0.8	99	43	0	0	0.0	
30	22.1	9.3	15.7	2.3	10.7	0	93	44	0	0	0.0	
31	24.9	10.5	17.7	0.3	12.7	0	94	52	0	0	0.0	
TOTL	810.4	432.6		5.8	467.1	70.1			0.0	0.0	24.9	
MEAN	26.1	14.0	20.0				93	51				
NORM	24.0	13.7	19.3	22.2	444.3	63.5			74.0	0.0	74.0	

NOTE/AVIS
1. Climatological Day: 01 01 LST - 01 00 LST
2. Normal 1961 - 1990
3. TR = Trace
4. No entry = Missing

1. Journee Climatologique: 01 01 LST - 01 00 LST
2. Normale 1961 - 1990
3. TR = Trace
4. Pas de Valeur = Manquant

NOTE: This data has been only partially Quality Controlled.

For additional climate data, please contact:

Ontario Climate Centre
Environment Canada - Ontario Region
4905 Dufferin St,
Downsview, Ontario
M3H 5T4
phone 1-900-565-1111, FAX 416-739-4521

APPENDIX B

OTTHYMO Output Files

```
==========================================================================

   OOO    TTTTT  TTTTT  H   H  Y   Y  M   M   OOO
  O   O     T      T    H   H   Y Y   MM MM  O   O    * * *1989-94* * *
  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     95A905L1X2L5-01
```

EXCUSIVE USE TO: Ainley Graham and Associates Ltd

Input filename: 96567-1\PRE14MM.DAT
Output filename: 96567-1\PRE14MM.OUT
Summary filename: 96567-1\PRE14MM.SUM

DATE: TIME:

COMMENTS: ____

---

*
* OCTOBER 1996
* FILE: 96567-1
* HERCHIMER AVENUE SWM - PRE DEVELOPMENT FLOWS - FOR 14mm 4hr STORM
*

****
** SIMULATION NUMBER: 1 **
****

*

READ STORM Ptotal= 14.25 mm

Filename: 14MM4HSC.STM
Comments: Fourteen mm Four Hour Storm - Belleville

TIME hrs	RAIN mm/hr	TIME hrs	RAIN mm/hr	TIME hrs	RAIN mm/hr	TIME hrs	RAIN mm/hr
.17	1.50	1.17	4.30	2.17	3.10	3.17	1.50
.33	1.80	1.33	11.10	2.33	2.60	3.33	1.80
.50	2.10	1.50	11.70	2.50	2.60	3.50	1.80
.67	2.10	1.67	11.70	2.67	2.20	3.67	1.50
.83	2.80	1.83	4.10	2.83	2.00	3.83	1.40
1.00	4.30	2.00	4.10	3.00	2.00	4.00	1.40

```
*
* PROPOSED NORTH INDUSTRIAL AREA - AREA 100
*
--------------------
| CALIB              |
| STANDHYD  (0100)   |   Area     (ha)=  12.80
|ID= 1 DT= 3.0 min   |   Total Imp(%)=    5.00   Dir. Conn.(%)=    5.00
--------------------
                                 IMPERVIOUS     PERVIOUS (i)
     Surface Area      (ha)=         .64          12.16
     Dep. Storage      (mm)=        1.58           2.50
     Average Slope      (%)=        2.00           2.00
     Length             (m)=      292.00         292.00
     Mannings n           =         .013           .250

         NOTE:  RAINFALL WAS TRANSFORMED TO   3.0 MIN. TIME STEP.

                                 IMPERVIOUS     PERVIOUS (i)
     Max.eff.Inten.(mm/hr)=        11.70            .39
                over (min)          9.00         225.00
     Storage Coeff.  (min)=         9.31 (ii)    222.78 (ii)
     Unit Hyd. Tpeak (min)=         9.00         225.00
     Unit Hyd. peak  (cms)=          .12            .01
                                                                *TOTALS*
     PEAK FLOW       (cms)=          .02            .00            .02 (iii)
     TIME TO PEAK    (hrs)=         1.65           6.00           1.65
     RUNOFF VOLUME    (mm)=        12.68            .76           1.35
     TOTAL RAINFALL   (mm)=        14.25          14.25          14.25
     RUNOFF COEFFICIENT   =          .89            .05            .09

***** WARNING:FOR AREAS WITH IMPERVIOUS RATIOS BELOW 20%
              YOU SHOULD CONSIDER SPLITTING THE AREA.

       (i) CN PROCEDURE SELECTED FOR PERVIOUS LOSSES:
           CN*  =  60.0    Ia = Dep. Storage  (Above)
      (ii) TIME STEP (DT) SHOULD BE SMALLER OR EQUAL
           THAN THE STORAGE COEFFICIENT.
     (iii) PEAK FLOW DOES NOT INCLUDE BASEFLOW IF ANY.

------------------------------------------------------------------------------
*
* PROPOSED SOUTH INDUSTRIAL AREA - AREA 101
*
--------------------
| CALIB              |
| STANDHYD  (0101)   |   Area     (ha)=  14.60
|ID= 2 DT= 3.0 min   |   Total Imp(%)=    5.00   Dir. Conn.(%)=    5.00
--------------------
                                 IMPERVIOUS     PERVIOUS (i)
     Surface Area      (ha)=         .73          13.87
     Dep. Storage      (mm)=        1.58           2.50
```

```
     Average Slope      (%)=       2.00         2.00
     Length             (m)=     312.00       312.00
     Mannings n            =       .013         .250

     Max.eff.Inten.(mm/hr)=       11.70          .39
               over (min)          9.00       234.00
     Storage Coeff.  (min)=        9.69 (ii)  231.81 (ii)
     Unit Hyd. Tpeak (min)=        9.00       234.00
     Unit Hyd. peak  (cms)=         .12          .00
                                                              *TOTALS*
     PEAK FLOW       (cms)=         .02          .00             .02 (iii)
     TIME TO PEAK    (hrs)=        1.65         6.15            1.65
     RUNOFF VOLUME    (mm)=       12.68          .76            1.35
     TOTAL RAINFALL   (mm)=       14.25        14.25           14.25
     RUNOFF COEFFICIENT   =         .89          .05             .09

***** WARNING:FOR AREAS WITH IMPERVIOUS RATIOS BELOW 20%
              YOU SHOULD CONSIDER SPLITTING THE AREA.

       (i) CN PROCEDURE SELECTED FOR PERVIOUS LOSSES:
           CN*  =  60.0    Ia = Dep. Storage  (Above)
      (ii) TIME STEP (DT) SHOULD BE SMALLER OR EQUAL
           THAN THE STORAGE COEFFICIENT.
     (iii) PEAK FLOW DOES NOT INCLUDE BASEFLOW IF ANY.

-------------------------------------------------------------------------------
*
* EXISTING LOW DENSITY RESIDENTIAL AREA - AREA 102
*
--------------------
| CALIB              |
| STANDHYD   (0102)  |   Area     (ha)=  36.20
|ID= 3 DT= 3.0 min   |   Total Imp(%)=  35.00   Dir. Conn.(%)=  25.00
--------------------
                                IMPERVIOUS    PERVIOUS (i)
     Surface Area       (ha)=      12.67        23.53
     Dep. Storage       (mm)=       1.58         2.50
     Average Slope      (%)=        2.00         2.00
     Length             (m)=      491.00       491.00
     Mannings n            =        .013         .250

     Max.eff.Inten.(mm/hr)=        11.70          .55
               over (min)          12.00       270.00
     Storage Coeff.  (min)=        12.72 (ii)  267.29 (ii)
     Unit Hyd. Tpeak (min)=        12.00       270.00
     Unit Hyd. peak  (cms)=          .09          .00
                                                              *TOTALS*
     PEAK FLOW       (cms)=          .26          .01             .26 (iii)
     TIME TO PEAK    (hrs)=         1.70         6.65            1.70
     RUNOFF VOLUME    (mm)=        12.67          .92            3.85
     TOTAL RAINFALL   (mm)=        14.25        14.25           14.25
```

```
    RUNOFF COEFFICIENT   =        .89          .06            .27

      (i) CN PROCEDURE SELECTED FOR PERVIOUS LOSSES:
          CN*  =  60.0    Ia = Dep. Storage  (Above)
     (ii) TIME STEP (DT) SHOULD BE SMALLER OR EQUAL
          THAN THE STORAGE COEFFICIENT.
    (iii) PEAK FLOW DOES NOT INCLUDE BASEFLOW IF ANY.

--------------------------------------------------------------------------------
*
* EXISTING MEDIUM DENSITY RESIDENTIAL AREA - AREA 103
*
--------------------
| CALIB              |
| STANDHYD  (0103)   |   Area     (ha)=   1.30
|ID= 4 DT= 3.0 min   |   Total Imp(%)=  35.00   Dir. Conn.(%)=  25.00
--------------------
                               IMPERVIOUS    PERVIOUS (i)
    Surface Area      (ha)=        .46           .84
    Dep. Storage      (mm)=       1.58          2.50
    Average Slope      (%)=       2.00          2.00
    Length             (m)=      93.00         93.00
    Mannings n            =       .013          .250

    Max.eff.Inten.(mm/hr)=      11.70           .55
               over (min)        6.00         99.00
    Storage Coeff.  (min)=       4.69 (ii)    98.50 (ii)
    Unit Hyd. Tpeak (min)=       6.00         99.00
    Unit Hyd. peak  (cms)=        .22           .01
                                                             *TOTALS*
    PEAK FLOW       (cms)=        .01           .00            .01 (iii)
    TIME TO PEAK    (hrs)=       1.65          4.05           1.65
    RUNOFF VOLUME    (mm)=      12.68           .92           3.82
    TOTAL RAINFALL   (mm)=      14.25         14.25          14.25
    RUNOFF COEFFICIENT   =        .89           .06            .27

      (i) CN PROCEDURE SELECTED FOR PERVIOUS LOSSES:
          CN*  =  60.0    Ia = Dep. Storage  (Above)
     (ii) TIME STEP (DT) SHOULD BE SMALLER OR EQUAL
          THAN THE STORAGE COEFFICIENT.
    (iii) PEAK FLOW DOES NOT INCLUDE BASEFLOW IF ANY.

--------------------------------------------------------------------------------
*

--------------------
| ADD HYD   (0104)  |
|  3 +  4 =  5      |         AREA     QPEAK    TPEAK     R.V.
--------------------          (ha)     (cms)    (hrs)     (mm)
```

```
          ID1= 3 (0102):     36.20         .26      1.70       3.85
        + ID2= 4 (0103):      1.30         .01      1.65       3.82
          =====================================================
          ID = 5 (0104):     37.50         .27      1.70       3.85

     NOTE:  PEAK FLOWS DO NOT INCLUDE BASEFLOWS IF ANY.

--------------------------------------------------------------------------------
*

 --------------------
 | ADD HYD   (0105) |
 |  5 +  2 =   6    |          AREA     QPEAK     TPEAK        R.V.
 --------------------          (ha)     (cms)     (hrs)        (mm)
          ID1= 5 (0104):     37.50         .27      1.70       3.85
        + ID2= 2 (0101):     14.60         .02      1.65       1.35
          =====================================================
          ID = 6 (0105):     52.10         .29      1.70       3.15

     NOTE:  PEAK FLOWS DO NOT INCLUDE BASEFLOWS IF ANY.

--------------------------------------------------------------------------------
*

 FINISH
================================================================================
```

```
==========================================================================

     OOO   TTTTT  TTTTT  H   H  Y   Y  M   M   OOO
    O   O    T      T    H   H   Y Y   MM MM  O   O    * * *1989-94* * *
    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     95A905L1X2L5-01

  EXCUSIVE USE TO: Ainley Graham and Associates Ltd

  Input   filename: 96567-1\post14mm.dat
  Output  filename: 96567-1\post14mm.out
  Summary filename: 96567-1\post14mm.sum


DATE:                                 TIME:


COMMENTS: ____________________________________________________

--------------------------------------------------------------------------
*
* OCTOBER 1996
* FILE:  96567-1
* HERCHIMER AVENUE SWM - POST DEVELOPMENT FLOWS - FOR 14mm 4hr STORM
*
  ****************************
  ** SIMULATION NUMBER:   1 **
  ****************************

*

--------------------
|    READ STORM    |      Filename: 14MM4HSC.STM
| Ptotal= 14.25 mm |      Comments: Fourteen mm Four Hour Storm - Belleville
--------------------
```

TIME hrs	RAIN mm/hr	TIME hrs	RAIN mm/hr	TIME hrs	RAIN mm/hr	TIME hrs	RAIN mm/hr
.17	1.50	1.17	4.30	2.17	3.10	3.17	1.50
.33	1.80	1.33	11.10	2.33	2.60	3.33	1.80
.50	2.10	1.50	11.70	2.50	2.60	3.50	1.80
.67	2.10	1.67	11.70	2.67	2.20	3.67	1.50
.83	2.80	1.83	4.10	2.83	2.00	3.83	1.40
1.00	4.30	2.00	4.10	3.00	2.00	4.00	1.40

```
--------------------------------------------------------------------------
```

```
*
* PROPOSED NORTH INDUSTRIAL AREA - AREA 100
*
--------------------
| CALIB              |
| STANDHYD   (0100)  |   Area     (ha)=  12.80
|ID= 1 DT= 3.0 min   |   Total  Imp(%)=  35.00   Dir. Conn.(%)=  25.00
--------------------
                              IMPERVIOUS    PERVIOUS (i)
    Surface Area      (ha)=      4.48          8.32
    Dep. Storage      (mm)=      1.58          2.50
    Average Slope      (%)=      2.00          2.00
    Length             (m)=    292.00        292.00
    Mannings n            =      .013          .250

        NOTE:  RAINFALL WAS TRANSFORMED TO   3.0 MIN. TIME STEP.

                              IMPERVIOUS    PERVIOUS (i)
    Max.eff.Inten.(mm/hr)=      11.70           .55
              over (min)        9.00        198.00
    Storage Coeff.  (min)=       9.31 (ii)   195.69 (ii)
    Unit Hyd. Tpeak (min)=      9.00        198.00
    Unit Hyd. peak  (cms)=       .12           .01
                                                          *TOTALS*
    PEAK FLOW       (cms)=       .10           .00            .10 (iii)
    TIME TO PEAK    (hrs)=      1.65          5.50           1.65
    RUNOFF VOLUME    (mm)=     12.67           .92           3.85
    TOTAL RAINFALL   (mm)=     14.25         14.25          14.25
    RUNOFF COEFFICIENT   =       .89           .06            .27

      (i) CN PROCEDURE SELECTED FOR PERVIOUS LOSSES:
           CN*  =  60.0     Ia = Dep. Storage  (Above)
     (ii) TIME STEP (DT) SHOULD BE SMALLER OR EQUAL
          THAN THE STORAGE COEFFICIENT.
    (iii) PEAK FLOW DOES NOT INCLUDE BASEFLOW IF ANY.

--------------------------------------------------------------------------------
*
* PROPOSED SOUTH INDUSTRIAL AREA - AREA 101
*
--------------------
| CALIB              |
| STANDHYD   (0101)  |   Area     (ha)=  14.60
|ID= 2 DT= 3.0 min   |   Total  Imp(%)=  35.00   Dir. Conn.(%)=  25.00
--------------------
                              IMPERVIOUS    PERVIOUS (i)
    Surface Area      (ha)=      5.11          9.49
    Dep. Storage      (mm)=      1.58          2.50
    Average Slope      (%)=      2.00          2.00
    Length             (m)=    312.00        312.00
```

```
    Mannings n              =         .013          .250

    Max.eff.Inten.(mm/hr)=           11.70           .55
               over (min)             9.00        204.00
    Storage Coeff.  (min)=            9.69 (ii)   203.62 (ii)
    Unit Hyd. Tpeak (min)=            9.00        204.00
    Unit Hyd. peak  (cms)=             .12           .01
                                                                 *TOTALS*
    PEAK FLOW       (cms)=             .11           .00            .11 (iii)
    TIME TO PEAK    (hrs)=            1.65          5.60           1.65
    RUNOFF VOLUME    (mm)=           12.67           .92           3.85
    TOTAL RAINFALL   (mm)=           14.25         14.25          14.25
    RUNOFF COEFFICIENT   =             .89           .06            .27

      (i) CN PROCEDURE SELECTED FOR PERVIOUS LOSSES:
           CN*  =  60.0    Ia = Dep. Storage  (Above)
     (ii) TIME STEP (DT) SHOULD BE SMALLER OR EQUAL
          THAN THE STORAGE COEFFICIENT.
    (iii) PEAK FLOW DOES NOT INCLUDE BASEFLOW IF ANY.

-------------------------------------------------------------------------------
*
* EXISTING LOW DENSITY RESIDENTIAL AREA - AREA 102
*
--------------------
| CALIB              |
| STANDHYD  (0102)   |   Area    (ha)=  36.20
|ID= 3 DT= 3.0 min   |   Total Imp(%)=  35.00   Dir. Conn.(%)=  25.00
--------------------
                               IMPERVIOUS    PERVIOUS (i)
    Surface Area      (ha)=      12.67         23.53
    Dep. Storage      (mm)=       1.58          2.50
    Average Slope      (%)=       2.00          2.00
    Length             (m)=     491.00        491.00
    Mannings n            =       .013          .250

    Max.eff.Inten.(mm/hr)=       11.70           .55
               over (min)        12.00        270.00
    Storage Coeff.  (min)=       12.72 (ii)   267.29 (ii)
    Unit Hyd. Tpeak (min)=       12.00        270.00
    Unit Hyd. peak  (cms)=         .09           .00
                                                                *TOTALS*
    PEAK FLOW       (cms)=         .26           .01               .26 (iii)
    TIME TO PEAK    (hrs)=        1.70          6.65              1.70
    RUNOFF VOLUME    (mm)=       12.67           .92              3.85
    TOTAL RAINFALL   (mm)=       14.25         14.25             14.25
    RUNOFF COEFFICIENT   =         .89           .06               .27

      (i) CN PROCEDURE SELECTED FOR PERVIOUS LOSSES:
```

```
         CN*   =  60.0     Ia = Dep. Storage  (Above)
    (ii) TIME STEP (DT) SHOULD BE SMALLER OR EQUAL
         THAN THE STORAGE COEFFICIENT.
   (iii) PEAK FLOW DOES NOT INCLUDE BASEFLOW IF ANY.

-----------------------------------------------------------------------------
*
* EXISTING MEDIUM DENSITY RESIDENTIAL AREA - AREA 103
*
--------------------
| CALIB              |
| STANDHYD  (0103)   |   Area     (ha)=   1.30
|ID= 4 DT= 3.0 min   |   Total Imp(%)=  35.00   Dir. Conn.(%)=  25.00
--------------------
                              IMPERVIOUS    PERVIOUS (i)
    Surface Area       (ha)=       .46          .84
    Dep. Storage       (mm)=      1.58         2.50
    Average Slope       (%)=      2.00         2.00
    Length              (m)=     93.00        93.00
    Mannings n            =       .013         .250

    Max.eff.Inten.(mm/hr)=       11.70          .55
               over (min)         6.00        99.00
    Storage Coeff.  (min)=        4.69 (ii)   98.50 (ii)
    Unit Hyd. Tpeak (min)=        6.00        99.00
    Unit Hyd. peak  (cms)=         .22          .01
                                                            *TOTALS*
    PEAK FLOW       (cms)=         .01          .00            .01 (iii)
    TIME TO PEAK    (hrs)=        1.65         4.05           1.65
    RUNOFF VOLUME    (mm)=       12.68          .92           3.82
    TOTAL RAINFALL   (mm)=       14.25        14.25          14.25
    RUNOFF COEFFICIENT   =         .89          .06            .27

     (i) CN PROCEDURE SELECTED FOR PERVIOUS LOSSES:
         CN*   =  60.0     Ia = Dep. Storage  (Above)
    (ii) TIME STEP (DT) SHOULD BE SMALLER OR EQUAL
         THAN THE STORAGE COEFFICIENT.
   (iii) PEAK FLOW DOES NOT INCLUDE BASEFLOW IF ANY.

-----------------------------------------------------------------------------
*

--------------------
| ADD HYD    (0104) |
|  3 +  4 =  5      |         AREA     QPEAK     TPEAK      R.V.
--------------------          (ha)     (cms)     (hrs)      (mm)
         ID1= 3 (0102):      36.20       .26      1.70      3.85
       + ID2= 4 (0103):       1.30       .01      1.65      3.82
         ==================================================
         ID = 5 (0104):      37.50       .27      1.70      3.85
```

NOTE: PEAK FLOWS DO NOT INCLUDE BASEFLOWS IF ANY.

---

*

```
 --------------------
| ADD HYD   (0105) |
|   5 +  2 =  6    |              AREA     QPEAK     TPEAK      R.V.
 --------------------             (ha)     (cms)     (hrs)      (mm)
          ID1= 5 (0104):        37.50       .27      1.70      3.85
        + ID2= 2 (0101):        14.60       .11      1.65      3.85
          ==================================================
          ID = 6 (0105):        52.10       .38      1.65      3.85
```

NOTE: PEAK FLOWS DO NOT INCLUDE BASEFLOWS IF ANY.

---

*

FINISH

===

```
=====================================================================================

      OOO    TTTTT  TTTTT  H   H  Y   Y  M   M   OOO
     O   O     T      T    H   H   Y Y   MM MM  O   O    * * *1989-94* * *
     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     95A905L1X2L5-01
```

EXCUSIVE USE TO: Ainley Graham and Associates Ltd

Input filename: 96567-1\PRE5YR.DAT
Output filename: 96567-1\PRE5YR.OUT
Summary filename: 96567-1\PRE5YR.SUM

DATE: TIME:

COMMENTS: ____

```
------------------------------------------------------------------------------------
*
* OCTOBER 1996
* FILE:  96567-1
*
* HERCHIMER AVENUE SWM - PRE DEVELOPMENT FLOWS - FOR 12HR 5YR CHIC STORM
*
  *****************************
  ** SIMULATION NUMBER:   1 **
  *****************************

*
--------------------
| CHICAGO STORM    |    IDF curve parameters: A= 630.224
| Ptotal= 49.42 mm |                          B=   3.776
--------------------                          C=    .764
                        used in:   INTENSITY =  A / (t + B)^C

                        Duration of storm  = 12.00 hrs
                        Storm time step    = 10.00 min
                        Time to peak ratio =   .49
```

TIME hrs	RAIN mm/hr	TIME hrs	RAIN mm/hr	TIME hrs	RAIN mm/hr	TIME hrs	RAIN mm/hr
.17	1.01	3.17	1.83	6.17	10.98	9.17	1.59
.33	1.04	3.33	1.93	6.33	7.60	9.33	1.53
.50	1.06	3.50	2.04	6.50	5.91	9.50	1.48

.67	1.09	3.67	2.16	6.67	4.89	9.67	1.43
.83	1.12	3.83	2.30	6.83	4.20	9.83	1.38
1.00	1.15	4.00	2.47	7.00	3.70	10.00	1.34
1.17	1.18	4.17	2.67	7.17	3.31	10.17	1.30
1.33	1.21	4.33	2.90	7.33	3.01	10.33	1.26
1.50	1.25	4.50	3.19	7.50	2.76	10.50	1.22
1.67	1.29	4.67	3.56	7.67	2.56	10.67	1.19
1.83	1.33	4.83	4.05	7.83	2.39	10.83	1.16
2.00	1.38	5.00	4.72	8.00	2.24	11.00	1.13
2.17	1.42	5.17	5.71	8.17	2.11	11.17	1.10
2.33	1.48	5.33	7.34	8.33	2.00	11.33	1.08
2.50	1.54	5.50	10.63	8.50	1.90	11.50	1.05
2.67	1.60	5.67	21.56	8.67	1.81	11.67	1.03
2.83	1.67	5.83	84.96	8.83	1.73	11.83	1.01
3.00	1.75	6.00	21.94	9.00	1.66	12.00	.99

```
-----------------------------------------------------------------------------
*
* PROPOSED NORTH INDUSTRIAL AREA - AREA 100
*
--------------------
| CALIB              |
| STANDHYD  (0100)   |  Area    (ha)=  12.80
|ID= 1 DT= 3.0 min   |  Total Imp(%)=   5.00   Dir. Conn.(%)=   5.00
--------------------
                              IMPERVIOUS    PERVIOUS (i)
    Surface Area      (ha)=        .64        12.16
    Dep. Storage      (mm)=       1.58         2.50
    Average Slope      (%)=       2.00         2.00
    Length             (m)=     292.00       292.00
    Mannings n            =       .013         .250

        NOTE:  RAINFALL WAS TRANSFORMED TO   3.0 MIN. TIME STEP.

                              IMPERVIOUS    PERVIOUS (i)
    Max.eff.Inten.(mm/hr)=      84.96         5.80
               over (min)       6.00        78.00
    Storage Coeff.  (min)=       4.21 (ii)   76.87 (ii)
    Unit Hyd. Tpeak (min)=       6.00        78.00
    Unit Hyd. peak  (cms)=        .23          .01
                                                         *TOTALS*
    PEAK FLOW       (cms)=        .13          .10          .14 (iii)
    TIME TO PEAK    (hrs)=       5.85         7.10         5.85
    RUNOFF VOLUME    (mm)=      47.85        10.18        12.06
    TOTAL RAINFALL   (mm)=      49.42        49.42        49.42
    RUNOFF COEFFICIENT   =        .97          .21          .24

***** WARNING:FOR AREAS WITH IMPERVIOUS RATIOS BELOW 20%
              YOU SHOULD CONSIDER SPLITTING THE AREA.
```

```
       (i) CN PROCEDURE SELECTED FOR PERVIOUS LOSSES:
           CN*  =  60.0    Ia = Dep. Storage  (Above)
      (ii) TIME STEP (DT) SHOULD BE SMALLER OR EQUAL
           THAN THE STORAGE COEFFICIENT.
     (iii) PEAK FLOW DOES NOT INCLUDE BASEFLOW IF ANY.

--------------------------------------------------------------------------------
*
* PROPOSED SOUTH INDUSTRIAL AREA - AREA 101
*
--------------------
| CALIB            |
| STANDHYD  (0101) |  Area      (ha)=  14.60
|ID= 2 DT= 3.0 min |  Total Imp(%)=    5.00   Dir. Conn.(%)=   5.00
--------------------
                              IMPERVIOUS    PERVIOUS (i)
     Surface Area      (ha)=       .73        13.87
     Dep. Storage      (mm)=      1.58         2.50
     Average Slope      (%)=      2.00         2.00
     Length             (m)=    312.00       312.00
     Mannings n            =      .013         .250

     Max.eff.Inten.(mm/hr)=      84.96         5.80
                over (min)        6.00        81.00
     Storage Coeff.  (min)=       4.38 (ii)   79.99 (ii)
     Unit Hyd. Tpeak (min)=       6.00        81.00
     Unit Hyd. peak  (cms)=        .22          .01
                                                           *TOTALS*
     PEAK FLOW       (cms)=        .15          .11            .16 (iii)
     TIME TO PEAK    (hrs)=       5.85         7.15           5.85
     RUNOFF VOLUME    (mm)=      47.85        10.18          12.06
     TOTAL RAINFALL   (mm)=      49.42        49.42          49.42
     RUNOFF COEFFICIENT   =        .97          .21            .24

***** WARNING:FOR AREAS WITH IMPERVIOUS RATIOS BELOW 20%
              YOU SHOULD CONSIDER SPLITTING THE AREA.

       (i) CN PROCEDURE SELECTED FOR PERVIOUS LOSSES:
           CN*  =  60.0    Ia = Dep. Storage  (Above)
      (ii) TIME STEP (DT) SHOULD BE SMALLER OR EQUAL
           THAN THE STORAGE COEFFICIENT.
     (iii) PEAK FLOW DOES NOT INCLUDE BASEFLOW IF ANY.

--------------------------------------------------------------------------------
*
* EXISTING LOW DENSITY RESIDENTIAL AREA - AREA 102
*
--------------------
| CALIB            |
| STANDHYD  (0102) |  Area      (ha)=  36.20
|ID= 3 DT= 3.0 min |  Total Imp(%)=  35.00   Dir. Conn.(%)=  25.00
```

```
-------------------
                                IMPERVIOUS    PERVIOUS (i)
     Surface Area       (ha)=      12.67         23.53
     Dep. Storage       (mm)=       1.58          2.50
     Average Slope       (%)=       2.00          2.00
     Length              (m)=     491.00        491.00
     Mannings n             =       .013          .250

     Max.eff.Inten.(mm/hr)=        84.96          7.59
                over (min)          6.00         96.00
     Storage Coeff.  (min)=         5.75 (ii)    94.89 (ii)
     Unit Hyd. Tpeak (min)=         6.00         96.00
     Unit Hyd. peak  (cms)=          .19           .01
                                                               *TOTALS*
     PEAK FLOW       (cms)=         1.70           .22           1.72 (iii)
     TIME TO PEAK    (hrs)=         5.85          7.40           5.85
     RUNOFF VOLUME    (mm)=        47.85         11.51          20.59
     TOTAL RAINFALL   (mm)=        49.42         49.42          49.42
     RUNOFF COEFFICIENT   =          .97           .23            .42


       (i) CN PROCEDURE SELECTED FOR PERVIOUS LOSSES:
            CN*  =  60.0    Ia = Dep. Storage  (Above)
      (ii) TIME STEP (DT) SHOULD BE SMALLER OR EQUAL
           THAN THE STORAGE COEFFICIENT.
     (iii) PEAK FLOW DOES NOT INCLUDE BASEFLOW IF ANY.

--------------------------------------------------------------------------------
*
* EXISTING MEDIUM DENSITY RESIDENTIAL AREA - AREA 103
*
-------------------
| CALIB            |
| STANDHYD  (0103) |   Area     (ha)=    1.30
|ID= 4 DT= 2.0 min |   Total Imp(%)=   35.00   Dir. Conn.(%)=  25.00
-------------------
                                IMPERVIOUS    PERVIOUS (i)
     Surface Area       (ha)=        .46           .84
     Dep. Storage       (mm)=       1.58          2.50
     Average Slope       (%)=       2.00          2.00
     Length              (m)=      93.00         93.00
     Mannings n             =       .013          .250

         NOTE:  RAINFALL WAS TRANSFORMED TO   2.0 MIN. TIME STEP.

                                IMPERVIOUS    PERVIOUS (i)
     Max.eff.Inten.(mm/hr)=        84.96         12.58
                over (min)          5.00         30.00
     Storage Coeff.  (min)=         2.12 (ii)    28.95 (ii)
     Unit Hyd. Tpeak (min)=         4.00         30.00
     Unit Hyd. peak  (cms)=          .40           .04
```

```
================================================================================

     OOO    TTTTT   TTTTT  H   H  Y   Y  M   M   OOO
    O   O     T       T    H   H   Y Y   MM MM  O   O   * * *1989-94* * *
    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    95A905L1X2L5-01
```

EXCUSIVE USE TO: Ainley Graham and Associates Ltd

Input   filename: 96567-1\POST5YR.DAT
Output filename: 96567-1\POST5YR.OUT
Summary filename: 96567-1\POST5YR.SUM

DATE: TIME:

COMMENTS: ____

```
*
* OCTOBER 1996
* FILE:  96567-1
*
* HERCHIMER AVENUE SWM - POST DEVELOPMENT FLOWS - FOR 12HR 5YR CHIC STORM
*
  ****************************
  ** SIMULATION NUMBER:   1 **
  ****************************

*
--------------------
| CHICAGO STORM    |   IDF curve parameters: A= 630.224
| Ptotal= 49.42 mm |                         B=   3.776
--------------------                         C=    .764
                       used in:   INTENSITY =  A / (t + B)^C

                       Duration of storm   = 12.00 hrs
                       Storm time step     = 10.00 min
                       Time to peak ratio  =   .49
```

TIME hrs	RAIN mm/hr	TIME hrs	RAIN mm/hr	TIME hrs	RAIN mm/hr	TIME hrs	RAIN mm/hr
.17	1.01	3.17	1.83	6.17	10.98	9.17	1.59
.33	1.04	3.33	1.93	6.33	7.60	9.33	1.53
.50	1.06	3.50	2.04	6.50	5.91	9.50	1.48

.67	1.09	3.67	2.16	6.67	4.89	9.67	1.43
.83	1.12	3.83	2.30	6.83	4.20	9.83	1.38
1.00	1.15	4.00	2.47	7.00	3.70	10.00	1.34
1.17	1.18	4.17	2.67	7.17	3.31	10.17	1.30
1.33	1.21	4.33	2.90	7.33	3.01	10.33	1.26
1.50	1.25	4.50	3.19	7.50	2.76	10.50	1.22
1.67	1.29	4.67	3.56	7.67	2.56	10.67	1.19
1.83	1.33	4.83	4.05	7.83	2.39	10.83	1.16
2.00	1.38	5.00	4.72	8.00	2.24	11.00	1.13
2.17	1.42	5.17	5.71	8.17	2.11	11.17	1.10
2.33	1.48	5.33	7.34	8.33	2.00	11.33	1.08
2.50	1.54	5.50	10.63	8.50	1.90	11.50	1.05
2.67	1.60	5.67	21.56	8.67	1.81	11.67	1.03
2.83	1.67	5.83	84.96	8.83	1.73	11.83	1.01
3.00	1.75	6.00	21.94	9.00	1.66	12.00	.99

```
--------------------------------------------------------------------------------
*
* PROPOSED NORTH INDUSTRIAL AREA - AREA 100
*
--------------------
| CALIB              |
| STANDHYD  (0100)   |   Area     (ha)=  12.80
|ID= 1 DT= 3.0 min   |   Total Imp(%)=  35.00   Dir. Conn.(%)=  25.00
--------------------
                            IMPERVIOUS    PERVIOUS (i)
    Surface Area    (ha)=      4.48          8.32
    Dep. Storage    (mm)=      1.58          2.50
    Average Slope    (%)=      2.00          2.00
    Length           (m)=    292.00        292.00
    Mannings n          =      .013          .250

      NOTE:  RAINFALL WAS TRANSFORMED TO   3.0 MIN. TIME STEP.

                            IMPERVIOUS    PERVIOUS (i)
    Max.eff.Inten.(mm/hr)=    84.96          7.59
              over (min)       6.00         72.00
    Storage Coeff.  (min)=     4.21 (ii)    69.47 (ii)
    Unit Hyd. Tpeak (min)=     6.00         72.00
    Unit Hyd. peak  (cms)=      .23           .02
                                                          *TOTALS*
    PEAK FLOW       (cms)=      .64           .10            .66 (iii)
    TIME TO PEAK    (hrs)=     5.85          7.00           5.85
    RUNOFF VOLUME    (mm)=    47.85         11.51          20.59
    TOTAL RAINFALL   (mm)=    49.42         49.42          49.42
    RUNOFF COEFFICIENT   =      .97           .23            .42

     (i) CN PROCEDURE SELECTED FOR PERVIOUS LOSSES:
         CN*  =  60.0    Ia = Dep. Storage  (Above)
```

```
     (ii) TIME STEP (DT) SHOULD BE SMALLER OR EQUAL
          THAN THE STORAGE COEFFICIENT.
    (iii) PEAK FLOW DOES NOT INCLUDE BASEFLOW IF ANY.

--------------------------------------------------------------------------------
*
* PROPOSED SOUTH INDUSTRIAL AREA - AREA 101
*
--------------------
| CALIB             |
| STANDHYD  (0101)  |    Area     (ha)=  14.60
|ID= 2 DT= 3.0 min  |    Total Imp(%)=  35.00   Dir. Conn.(%)=  25.00
--------------------
                              IMPERVIOUS    PERVIOUS (i)
    Surface Area      (ha)=      5.11          9.49
    Dep. Storage      (mm)=      1.58          2.50
    Average Slope      (%)=      2.00          2.00
    Length             (m)=    312.00        312.00
    Mannings n            =      .013          .250

    Max.eff.Inten.(mm/hr)=      84.96          7.59
               over (min)        6.00         75.00
    Storage Coeff.  (min)=       4.38 (ii)    72.29 (ii)
    Unit Hyd. Tpeak (min)=       6.00         75.00
    Unit Hyd. peak  (cms)=        .22           .02
                                                           *TOTALS*
    PEAK FLOW       (cms)=        .73           .11            .75 (iii)
    TIME TO PEAK    (hrs)=       5.85          7.05           5.85
    RUNOFF VOLUME    (mm)=      47.85         11.51          20.59
    TOTAL RAINFALL   (mm)=      49.42         49.42          49.42
    RUNOFF COEFFICIENT   =        .97           .23            .42


      (i) CN PROCEDURE SELECTED FOR PERVIOUS LOSSES:
           CN*   =  60.0    Ia = Dep. Storage  (Above)
     (ii) TIME STEP (DT) SHOULD BE SMALLER OR EQUAL
          THAN THE STORAGE COEFFICIENT.
    (iii) PEAK FLOW DOES NOT INCLUDE BASEFLOW IF ANY.

--------------------------------------------------------------------------------
*
* EXISTING LOW DENSITY RESIDENTIAL AREA - AREA 102
*
--------------------
| CALIB             |
| STANDHYD  (0102)  |    Area     (ha)=  36.20
|ID= 3 DT= 3.0 min  |    Total Imp(%)=  35.00   Dir. Conn.(%)=  25.00
--------------------
                              IMPERVIOUS    PERVIOUS (i)
    Surface Area      (ha)=     12.67         23.53
    Dep. Storage      (mm)=      1.58          2.50
```

```
     Average Slope      (%)=        2.00          2.00
     Length             (m)=      491.00        491.00
     Mannings n            =        .013          .250

     Max.eff.Inten.(mm/hr)=        84.96          7.59
                over (min)          6.00         96.00
     Storage Coeff.  (min)=         5.75 (ii)    94.89 (ii)
     Unit Hyd. Tpeak (min)=         6.00         96.00
     Unit Hyd. peak  (cms)=          .19           .01
                                                              *TOTALS*
     PEAK FLOW       (cms)=         1.70           .22          1.72 (iii)
     TIME TO PEAK    (hrs)=         5.85          7.40          5.85
     RUNOFF VOLUME    (mm)=        47.85         11.51         20.59
     TOTAL RAINFALL   (mm)=        49.42         49.42         49.42
     RUNOFF COEFFICIENT   =          .97           .23           .42

      (i) CN PROCEDURE SELECTED FOR PERVIOUS LOSSES:
           CN*  =  60.0    Ia = Dep. Storage  (Above)
     (ii) TIME STEP (DT) SHOULD BE SMALLER OR EQUAL
          THAN THE STORAGE COEFFICIENT.
    (iii) PEAK FLOW DOES NOT INCLUDE BASEFLOW IF ANY.

--------------------------------------------------------------------------------
*
* EXISTING MEDIUM DENSITY RESIDENTIAL AREA - AREA 103
*
--------------------
| CALIB             |
| STANDHYD  (0103)  |   Area     (ha)=    1.30
|ID= 4 DT= 2.0 min  |   Total Imp(%)=   35.00   Dir. Conn.(%)=  25.00
--------------------
                             IMPERVIOUS    PERVIOUS (i)
     Surface Area      (ha)=        .46           .84
     Dep. Storage      (mm)=       1.58          2.50
     Average Slope      (%)=       2.00          2.00
     Length             (m)=      93.00         93.00
     Mannings n            =       .013          .250

         NOTE:  RAINFALL WAS TRANSFORMED TO   2.0 MIN. TIME STEP.

                             IMPERVIOUS    PERVIOUS (i)
     Max.eff.Inten.(mm/hr)=       84.96         12.58
                over (min)         5.00         30.00
     Storage Coeff.  (min)=        2.12 (ii)    28.95 (ii)
     Unit Hyd. Tpeak (min)=        4.00         30.00
     Unit Hyd. peak  (cms)=         .40           .04
                                                             *TOTALS*
     PEAK FLOW       (cms)=         .08           .02           .08 (iii)
     TIME TO PEAK    (hrs)=        5.83          6.27          5.83
     RUNOFF VOLUME    (mm)=       47.85         11.51         20.58
```

```
TOTAL RAINFALL    (mm)=       49.42          49.42            49.42
RUNOFF COEFFICIENT    =         .97            .23              .42

   (i) CN PROCEDURE SELECTED FOR PERVIOUS LOSSES:
        CN*   =  60.0     Ia = Dep. Storage  (Above)
  (ii) TIME STEP (DT) SHOULD BE SMALLER OR EQUAL
       THAN THE STORAGE COEFFICIENT.
 (iii) PEAK FLOW DOES NOT INCLUDE BASEFLOW IF ANY.

-------------------------------------------------------------------------------
*

--------------------
| ADD HYD    (0104) |
|   3 +  4 =  5     |          AREA     QPEAK     TPEAK       R.V.
--------------------           (ha)     (cms)     (hrs)       (mm)
          ID1= 3 (0102):      36.20      1.72      5.85      20.59
        + ID2= 4 (0103):       1.30       .08      5.83      20.58
          ==================================================
          ID = 5 (0104):      37.50      1.75      5.83      20.59

  NOTE:  PEAK FLOWS DO NOT INCLUDE BASEFLOWS IF ANY.

-------------------------------------------------------------------------------
*

--------------------
| ADD HYD    (0105) |
|   5 +  2 =  6     |          AREA     QPEAK     TPEAK       R.V.
--------------------           (ha)     (cms)     (hrs)       (mm)
          ID1= 5 (0104):      37.50      1.75      5.83      20.59
        + ID2= 2 (0101):      14.60       .75      5.85      20.59
          ==================================================
          ID = 6 (0105):      52.10      2.48      5.83      20.59

  NOTE:  PEAK FLOWS DO NOT INCLUDE BASEFLOWS IF ANY.

-------------------------------------------------------------------------------
*

 FINISH
===============================================================================
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APPENDIX C

Cost Estimates

COST ESTIMATE
HERCHIMER AVENUE
STORMWATER MANAGEMENT

ITEM NO.		DESCRIPTION	QUANTITY	UNIT	UNIT PRICE	TOTAL
		CONVEYANCE CONTROLS				
1		**BASIN 100**				
	.01	Pervious Pipe - Herchimer Ave. and Station St.	670	lm	$150.00	$100,500.00
	.02	Pervious Catch Basins - 65m spacing.	22	ea	$3,500.00	$77,000.00
	.03	Enhanced Grass Swales - west side of Herchimer Ave. and both sides of Station St.	1110	lm	$30.00	$33,300.00
2		**BASIN 101**				
	.01	Pervious Pipe - Herchimer Ave.	340	lm	$150.00	$51,000.00
	.02	Pervious Catch Basins - 65m spacing.	10	ea	$3,500.00	$35,000.00
	.03	Enhanced Grass Swales - west side of Herchimer Ave.	290	lm	$30.00	$8,700.00
3		**BASIN 102**				
	.01	Pervious Pipe - re and re existing pipe.	1750	lm	$180.00	$315,000.00
	.02	Pervious Catch Basins - 65m spacing and retrofit existing basins.	54	ea	$1,500.00	$81,000.00
	.03	Pervious Catch Basins - 65m spacing and retrofit existing basins (Herchimer Ave. only)	14	ea	$1,500.00	$21,000.00
	.04	Enhanced Grass Swales - in areas of existing conveyance system and retrofit to suit.	3500	lm	$50.00	$175,000.00
		END-OF-PIPE FACILITIES				
4		**BASIN 100**				
	.01	Extended Wet Detention Pond.	1792	m^3	$45.00	$80,640.00
	.02	Constructed Wetland.	1024	m^3	$40.00	$40,960.00
	.03	Oil/Grit Separator (storm sewer system not incl.).	1	ls	$30,000.00	$30,000.00
5		**BASIN 101**				
	.01	Extended Wet Detention Pond.	2044	m^3	$45.00	$91,980.00
	.02	Constructed Wetland.	1168	m^3	$40.00	$46,720.00
	.03	Oil/Grit Separator (storm sewer system not incl.).	1	ls	$30,000.00	$30,000.00
6		**BASIN 102**				
	.01	Extended Wet Detention Pond.	5250	m^3	$45.00	$236,250.00
	.02	Constructed Wetland.	3000	m^3	$40.00	$120,000.00
	.03	Oil/Grit Separator.	1	ls	$60,000.00	$60,000.00

NOTES:
1. Estimates include contingencies and engineering.
2. Estimates do not include any required land acquisition costs.

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