APPENDIX A

Hydrologic Analysis at Shirley's Brook

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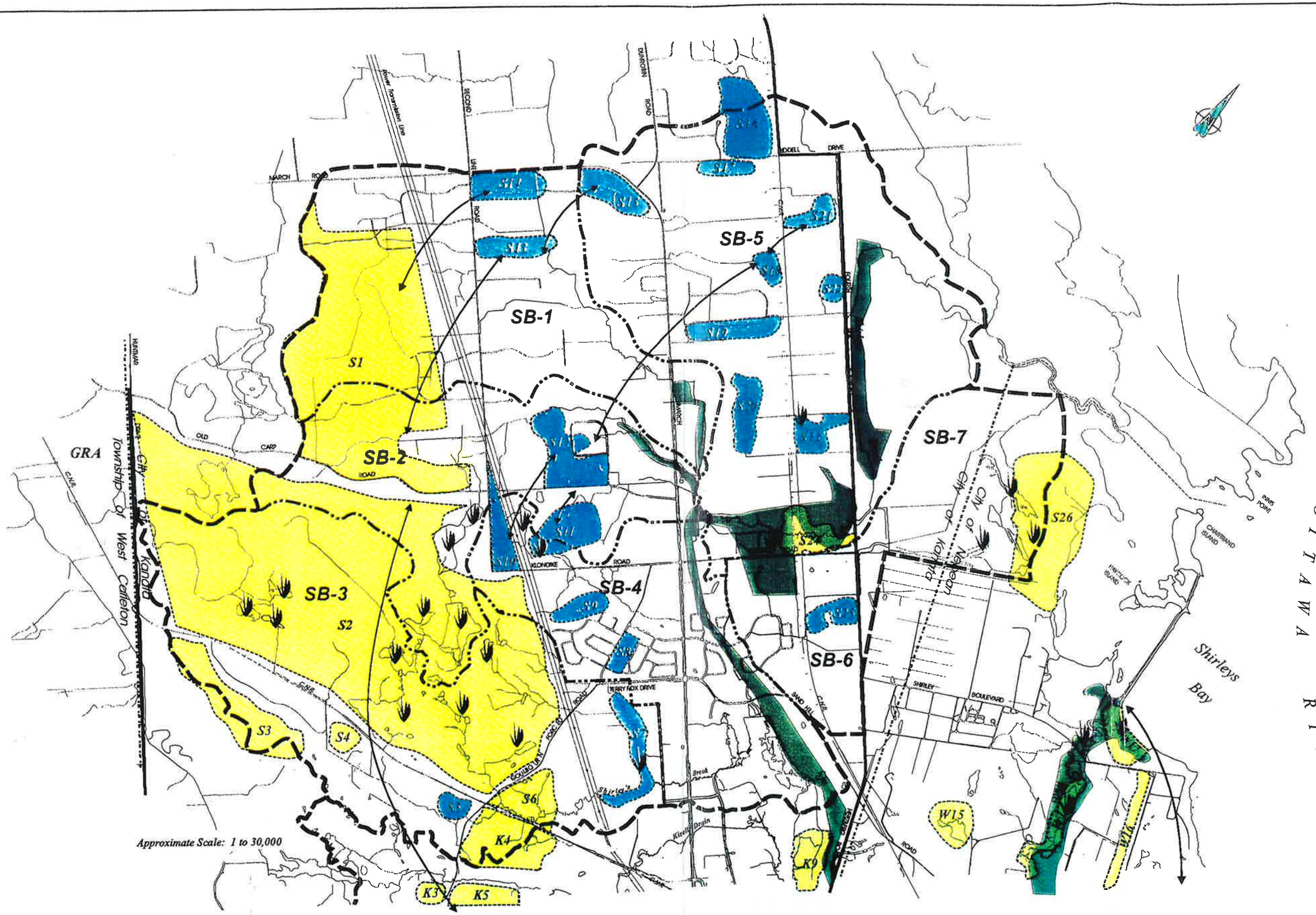
Hydrologic Analysis at Shirley's Brook

1.0 Background

This appendix provides a summary of the hydrologic analysis completed in developing the stormwater management recommendations included in Section 4.3 of this report.

The Shirley's Brook Subwatershed study was completed in 1999 by Dillon Consulting. The following provides a summary of some of the key information provided in the subwatershed report.

The creek's headwaters are located in the South March Highlands wetland complex, located in Kanata. Shirley's Brook has a total drainage area of 2700 ha. The urbanized area of the watershed is mainly in the lower reaches of the creek, however since the subwatershed study, urbanization has been on-going in much of the watershed. Of the total drainage area, 844 ha comprises wetlands or Natural Environment Areas as identified by the City of Ottawa. Thirty-nine percent (39%) of the total drainage area in 1999 was covered by forest, wetland or exposed bedrock. Figure 3.3a from the subwatershed study is included as **Figure A1**. As shown in **Figure A1**, Terry Fox Drive Phase II is partially located within the protected natural area S2.



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- Protected Natural Areas
- Natural Areas Not Protected from Development
- Valleylands
- **SB-1** Catchment Area ID
- Subwatershed Boundary
- Catchment Area Boundary
- Wildlife Corridor
- Wetlands

FIGURE 1

Shirley's Brook Subwatershed Location of Natural Areas

Figure 3.3a

1.1 Geology and Soils

The Terry Fox Drive project falls within subwatershed S3 of Shirley's Brook, which is part of the upper reaches of the creek. According to the Subwatershed Study, *"The upper reaches of the subwatershed areas are dominated by exposed or shallow Precambrian and Palaeozoic bedrock that comprises roughly 50% of the Shirley's Brook and Kizell Drain subwatersheds. Where unexposed, the shallow bedrock cover is typically less than 1 m in thickness and is generally comprised of silt/clay till."* Figure 3.4 from the Subwatershed Study is included here as **Figure A2.** Most of subwatershed 3b is shown to have sandy loam to silty loam soils. The Soil Map of Carleton County was also consulted. While very old, this map is considered representative since much of the drainage area of interest has remained relatively undisturbed. This map shows that much of drainage area comprises sands, either Nepean Sand or Anstruther Sand. Nepean Sand is defined as "Shallow sandy soils with sandstone bedrock within three feet," and Anstruther Sand is described as "Shallow brown sandy soils over granitic rocks; large areas of bare rock, local clay pockets. A localized deposit of Rideau Clay – rock knob phase is present along the rail line. This material is defined as mixed areas of Rideau clay, Rideau sand spot phase and preCambrian rock knobs with moderate to slow drainage. The area of interest of the map is provided in **Figure A3**. The soil definitions are provided in **Figure A4**.

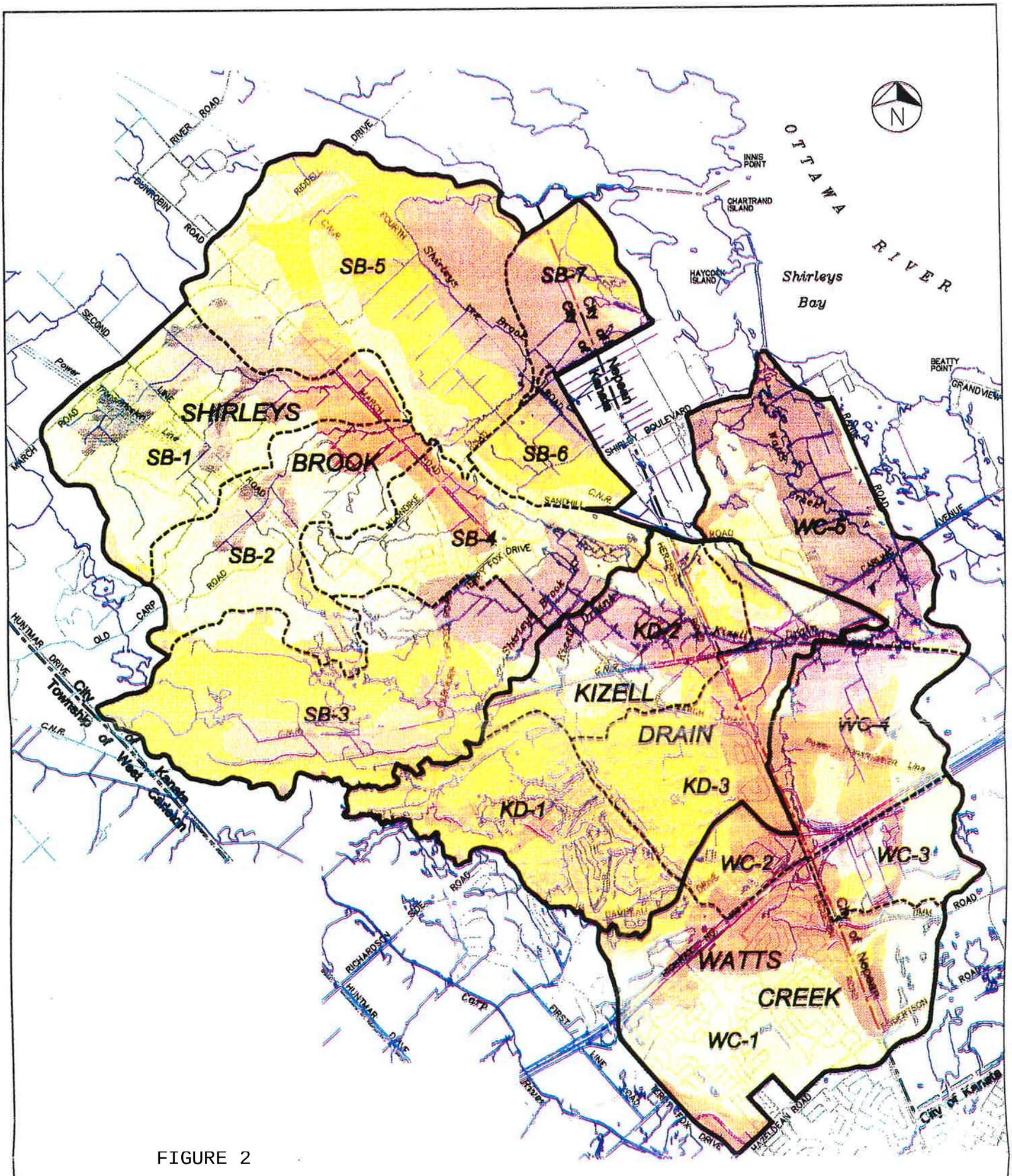

FIGURE 2

SHIRLEYS BROOK/WATTS CREEK SUBWATERSHED STUDY

REGION OF OTTAWA-CARLTON AND CITY OF KANATA

SURFICIAL SOILS

LEGEND

- Watershed Boundary
- Subarea Boundary
- Watercourse/Ditch/Pond
- Roads
- Railway
- Municipal Boundary
- SB-1 Subarea Number

Soil Textural Types:	Hydrologic Soil Group
Sand/Gravel	A
Sandy Loam	AB
Sandy Loam to Silty Loam	B
Silty Loam	BC
Silty Loam to Clay Loam	C
Clay	D

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SCALE	FIGURE	PROJECT NO.
1 : 40,000	3.4	97-4771

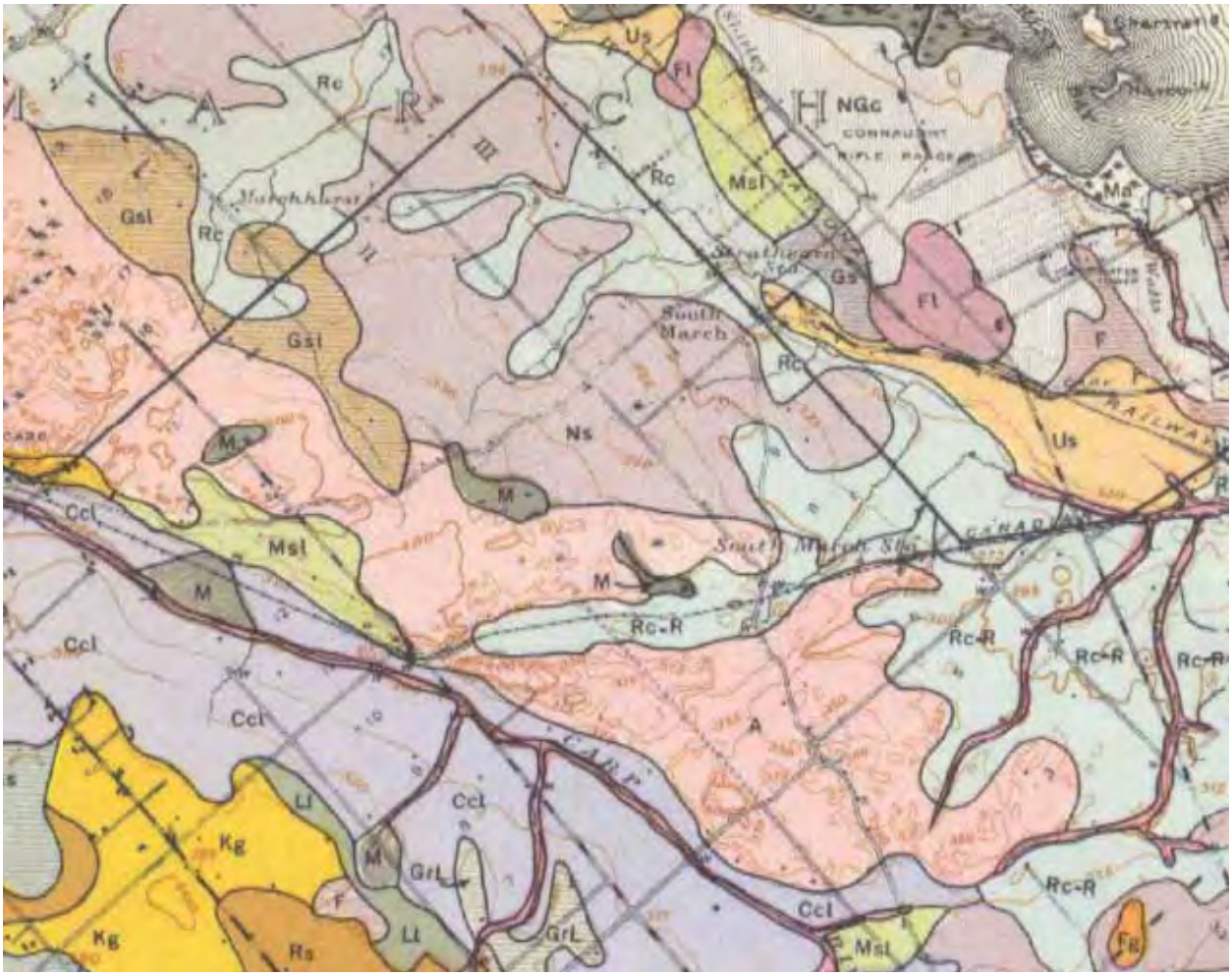
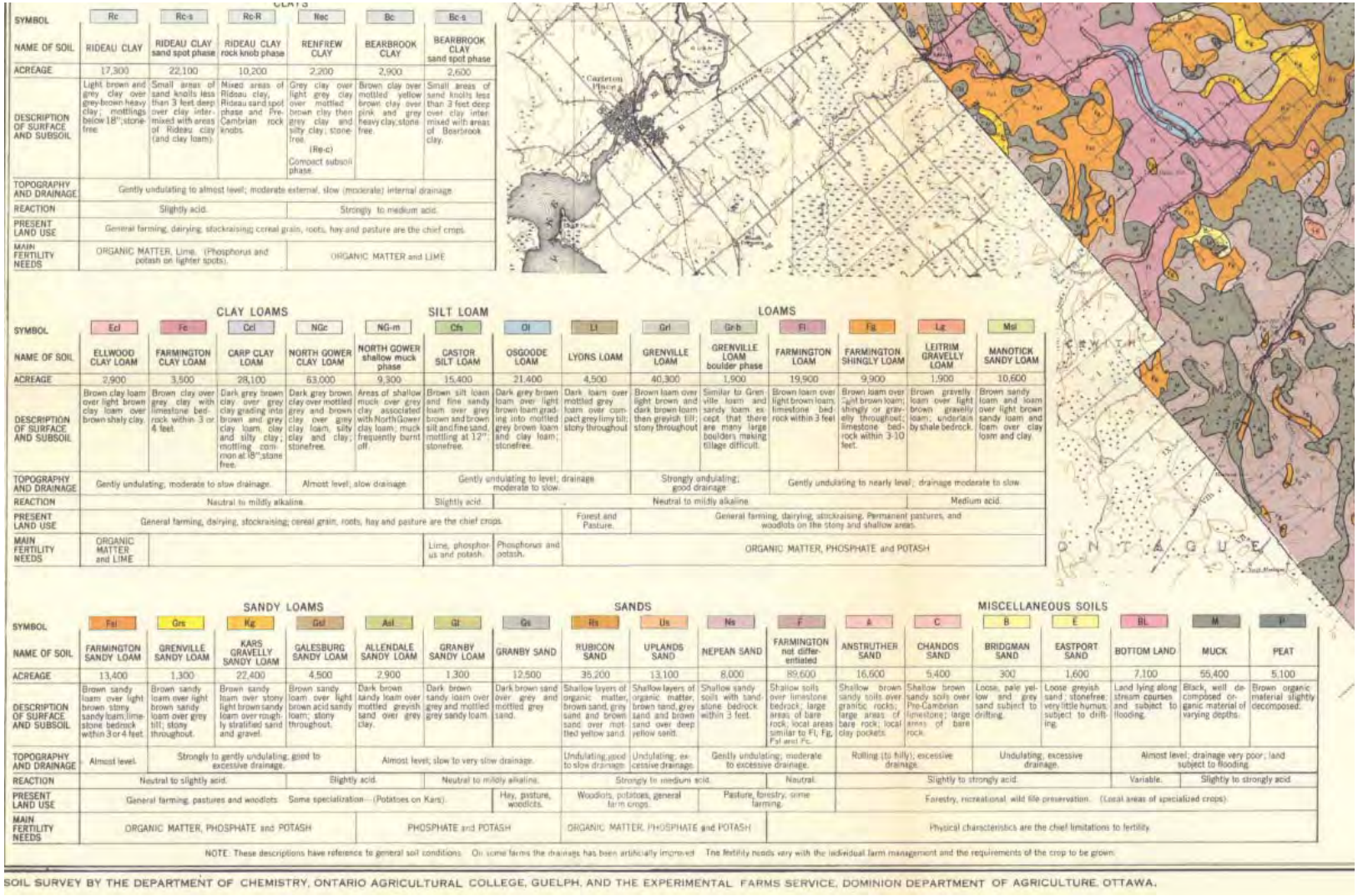


Figure A3 – Extracted from Soil Map of Carleton County – Terry Fox Drive Study Area



CLAYS

SYMBOL	Rc	Rc-s	Rc-R	Rec	Bc	Bc-s
NAME OF SOIL	RIDEAU CLAY	RIDEAU CLAY sand spot phase	RIDEAU CLAY rock knob phase	RENFREW CLAY	BEARBROOK CLAY	BEARBROOK CLAY sand spot phase
ACREAGE	17,300	22,100	10,200	2,200	2,900	2,600
DESCRIPTION OF SURFACE AND SUBSOIL	Light brown and grey clay over grey-brown heavy clay; mottlings below 18"; stone-free	Small areas of sand knolls less than 3 feet deep over clay intermixed with areas of Rideau clay (and clay loam).	Mixed areas of Rideau clay, Rideau sand spot phase and Pre-Cambrian rock knobs.	Grey clay over light grey clay over mottled brown clay then grey clay and silty clay; stone-free. (Re-c) Compact subsoil phase.	Brown clay over mottled yellow brown clay over pink and grey heavy clay, stone-free.	Small areas of sand knolls less than 3 feet deep over clay intermixed with areas of Bearbrook clay.
TOPOGRAPHY AND DRAINAGE	Gently undulating to almost level; moderate external, slow (moderate) internal drainage					
REACTION	Slightly acid.			Strongly to medium acid.		
PRESENT LAND USE	General farming, dairying, stockraising; cereal grain, roots, hay and pasture are the chief crops.					
MAIN FERTILITY NEEDS	ORGANIC MATTER, Lime. (Phosphorus and potash on lighter spots).			ORGANIC MATTER and LIME		

	CLAY LOAMS					SILT LOAM		LOAMS						
SYMBOL	Ecl	Fc	Ccl	NGc	NG-m	Cfs	Ol	Ll	Grl	Gr-b	Fl	Fs	Lg	Msl
NAME OF SOIL	ELLWOOD CLAY LOAM	FARMINGTON CLAY LOAM	CARP CLAY LOAM	NORTH GOWER CLAY LOAM	NORTH GOWER shallow muck phase	CASTOR SILT LOAM	OSGOODE LOAM	LYONS LOAM	GRENVILLE LOAM	GRENVILLE LOAM boulder phase	FARMINGTON LOAM	FARMINGTON SHINGLY LOAM	LEITRIM GRAVELLY LOAM	MANOTICK SANDY LOAM
ACREAGE	2,900	3,500	28,100	63,000	9,300	15,400	21,400	4,500	40,300	1,900	19,900	9,900	1,900	10,600
DESCRIPTION OF SURFACE AND SUBSOIL	Brown clay loam over light brown clay loam over brown shaly clay.	Brown clay over grey clay with limestone bedrock within 3 or 4 feet.	Dark grey brown clay over grey clay grading into brown and grey clay loam, clay and silty clay; mottling common at 18"; stone free.	Dark grey brown clay over mottled grey and brown clay over grey clay loam, silty clay and clay; stonefree.	Areas of shallow muck over grey clay associated with North Gower clay loam; muck frequently burnt off.	Brown silt loam and fine sandy loam over grey brown and brown silt and fine sand, mottling at 12"; stonefree.	Dark grey brown loam over light brown loam grading into mottled grey brown loam and clay loam; stonefree.	Dark loam over mottled grey compact grey limy till; stony throughout	Brown loam over light brown and dark brown loam then greyish till; stony throughout	Similar to Grenville loam and sandy loam except that there are many large boulders making tillage difficult.	Brown loam over light brown loam, limestone bedrock within 3 feet	Brown loam over light brown loam; shingly or gravelly throughout; limestone bedrock within 3-10 feet.	Brown gravelly loam over light brown gravelly loam; underlain by shale bedrock.	Brown sandy loam and loam over light brown sandy loam and loam over clay loam and clay.
TOPOGRAPHY AND DRAINAGE	Gently undulating; moderate to slow drainage.			Almost level; slow drainage.		Gently undulating to level; drainage moderate to slow.		Gently undulating; drainage moderate to slow.	Strongly undulating; good drainage		Gently undulating to nearly level; drainage moderate to slow.			
REACTION	Neutral to mildly alkaline.					Slightly acid.	Neutral to mildly alkaline.						Medium acid.	
PRESENT LAND USE	General farming, dairying, stockraising; cereal grain, roots, hay and pasture are the chief crops.							Forest and Pasture.	General farming, dairying, stockraising. Permanent pastures, and woodlots on the stony and shallow areas.					
MAIN FERTILITY NEEDS	ORGANIC MATTER and LIME					Lime, phosphorus and potash.	Phosphorus and potash.	ORGANIC MATTER, PHOSPHATE and POTASH						

	SANDY LOAMS						SANDS				MISCELLANEOUS SOILS						
SYMBOL	Fsl	Grs	Kg	Gsl	Asl	Gl	Gs	Rs	Us	Ns	F	A	C	B	E	BL	M	P
NAME OF SOIL	FARMINGTON SANDY LOAM	GRENVILLE SANDY LOAM	KARS GRAVELLY SANDY LOAM	GALESBURG SANDY LOAM	ALLENDALE SANDY LOAM	GRANBY SANDY LOAM	GRANBY SAND	RUBICON SAND	UPLANDS SAND	NEPEAN SAND	FARMINGTON not differentiated	ANSTRUTHER SAND	CHANDOS SAND	BRIDGMAN SAND	EASTPORT SAND	BOTTOM LAND	MUCK	PEAT
ACREAGE	13,400	1,300	22,400	4,500	2,900	1,300	12,500	35,200	13,100	8,000	89,600	16,600	5,400	300	1,600	7,100	55,400	5,100
DESCRIPTION OF SURFACE AND SUBSOIL	Brown sandy loam over light brown stony sandy loam; limestone bedrock within 3 or 4 feet.	Brown sandy loam over light brown sandy loam over grey till; stony throughout.	Brown sandy loam over stony light brown sandy loam over roughly stratified sand and gravel.	Brown sandy loam over light brown acid sandy loam; stony throughout.	Dark brown sandy loam over mottled greyish sand over grey clay.	Dark brown sandy loam over grey and mottled grey sandy loam.	Dark brown sand over grey and mottled grey sand.	Shallow layers of organic matter, brown sand, grey sand and brown sand over mottled yellow sand.	Shallow layers of organic matter, brown sand, grey sand and brown sand over deep yellow sand.	Shallow sandy soils with sandstone bedrock within 3 feet.	Shallow soils over limestone bedrock; large areas of bare rock; local areas similar to Fl; Fg, Fsl and Fc.	Shallow brown sandy soils over granitic rocks; large areas of bare rock; local clay pockets.	Shallow brown sandy soils over Pre-Cambrian limestone; large areas of bare rock.	Loose, pale yellow and grey sand subject to drifting.	Loose greyish sand; stonefree; very little humus; subject to drifting.	Land lying along stream courses and subject to flooding.	Black, well decomposed organic material of varying depths.	Brown organic material slightly decomposed.
TOPOGRAPHY AND DRAINAGE	Almost level.	Strongly to gently undulating; good to excessive drainage.			Almost level; slow to very slow drainage.			Undulating; good to slow drainage.	Undulating; excessive drainage.	Gently undulating; moderate to excessive drainage.		Rolling (to hilly); excessive drainage.		Undulating; excessive drainage.		Almost level; drainage very poor; land subject to flooding.		
REACTION	Neutral to slightly acid.			Slightly acid.	Neutral to mildly alkaline.			Strongly to medium acid.		Neutral.		Slightly to strongly acid.				Variable.	Slightly to strongly acid.	
PRESENT LAND USE	General farming, pastures and woodlots. Some specialization (Potatoes on Kars).					Hay, pasture, woodlots.		Woodlots, potatoes, general farm crops.		Pasture, forestry, some farming.		Forestry, recreational, wild life preservation. (Local areas of specialized crops).						
MAIN FERTILITY NEEDS	ORGANIC MATTER, PHOSPHATE and POTASH				PHOSPHATE and POTASH			ORGANIC MATTER, PHOSPHATE and POTASH			Physical characteristics are the chief limitations to fertility.							

NOTE: These descriptions have reference to general soil conditions. On some farms the drainage has been artificially improved. The fertility needs vary with the individual farm management and the requirements of the crop to be grown.

SOIL SURVEY BY THE DEPARTMENT OF CHEMISTRY, ONTARIO AGRICULTURAL COLLEGE, GUELPH, AND THE EXPERIMENTAL FARMS SERVICE, DOMINION DEPARTMENT OF AGRICULTURE, OTTAWA.

Figure A4 – Soil Descriptions from Soil Map of Carleton County

1.2 Groundwater and Base Flows

Most of the S3 subwatershed is identified as a bedrock groundwater recharge area. Based on physiography, and the overburden, groundwater discharge contributions are considered to be relatively minor in terms of quantity, but important based on relatively low flows.

Floodplain mapping has been completed for Shirley's Brook and begins just upstream of Goulbourn Forced Road. There is no regulatory floodplain mapped for Shirley's Brook in the Terry Fox Drive study area.

1.3 Previous Hydrologic Analysis

The subwatershed study also completed continuous and single-event hydrologic modeling of the watershed. A stream gauge was installed on the main branch of the creek well downstream of the Terry Fox Drive study area. For Shirley's Brook, rainfall events of less than 9 mm generally do not result in measurable runoff due to initial abstractions related to interception, depression storage and infiltration (p. 3-40). The single-event model used was QUALHYMO. The model applied 12-hour SCS type II storm events. **Figure A5**, shows the drainage areas used as part of that study.

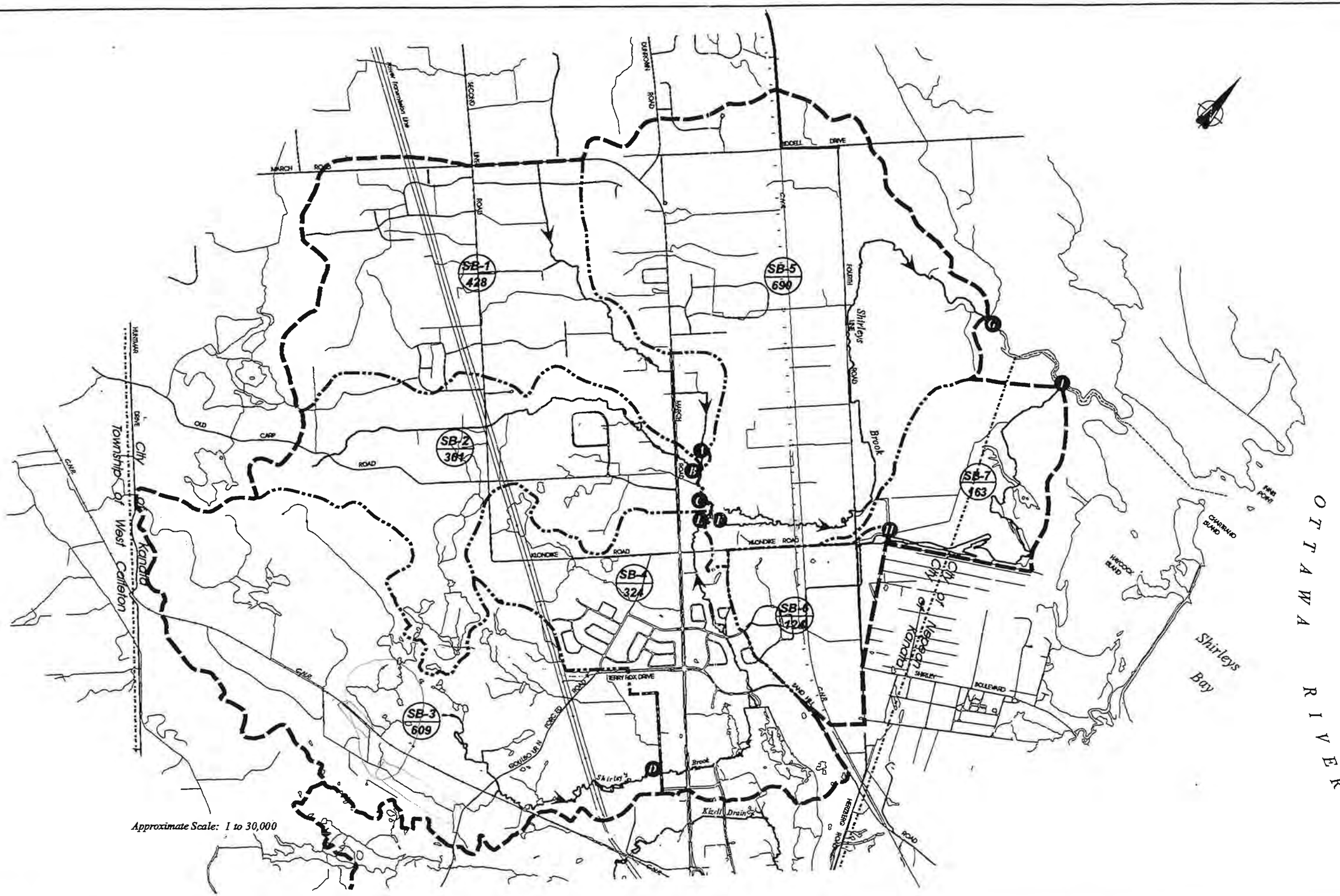
2.0 Design Criteria

The Shirley's Creek subwatershed study requires quality and quantity control for future development. The reach within the study area, Reach S3, is classified as a coldwater/warmwater fish habitat, requires enhanced water quality treatment. With respect to quantity control, post development peak flows are to be controlled to pre-development levels for a range of design storms up to and including the 100-year design event.

In keeping with the subwatershed study, the 12 hour SCS type II design storm will be used for modeling purposes. Total precipitation for each design event was obtained from the City of Ottawa IDF curves as provided in the City of Ottawa Sewer Design Manual and are summarized in **Table A1**.

Table A1: Summary of Total Precipitation

Return Storm Interval (year)	Total Precipitation (mm)
2	43.2
5	57.6
10	67.2
25	79.2
50	87.6
100	96



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SB-6 / 124 ← Catchment Area ID
← Area (ha)

Subwatershed Boundary
Catchment Area Boundary
Flow Point
Watercourse

FIGURE 5

Shirley's Brook Subwatershed
Existing Drainage Conditions

Figure 3.6a

3.0 Hydrologic Analysis

3.1 Modelling Approach

Because previous modeling work relied on actual stream data from 1999, it was decided that a new hydrologic model would be more appropriate for the purposes of this study with respect to quantifying peak flow impacts. A new hydrologic model was developed using Visual Otthymo 2. However, the previous modeling work forms the basis for this modeling work with respect to the selection of design storm and initial abstraction.

The SCS 12-hour storm distribution was applied for all events with a 10 minute time-step. The equivalent slope method was used to calculate the watershed slope for the time to concentration calculations. Segments approach 0 slope through the pond were included in an effort to account for some of the attenuation to be expected from the natural storage. CN and initial abstraction values were determined based on a review of existing soil types.

Table A2: Summary of Drainage Area Characteristics

Parameter	SB1	SB2	SB3	SB4	SB5	SB6	SB7	SB8	SB9
Drainage Area (ha)	158.9	28.3	21.70	65.90	22.19	3.57	2.43	9.76	11.95
Time to Peak (hrs)	11.0	7.2	7.7	9.8	9.3	6.3	6.3	7.3	6.7
CN	55	68	50	50	50	50	50	68	68
Initial abstraction (mm)	9	9	9	9	9	9	9	9	9

The peak flows for the 2-year to 100-year events for existing conditions were modeled for the reach of Shirley's Brook impacted by Terry Fox Drive as shown in **Figure A6.** The existing depression storage in the upstream catchments were not quantified in the model. The ultimate and interim conditions were modeled by dividing the two watersheds SB8 into urban and rural hydrographs. Flow from SB3-SB7 are routed into SB1 for the ultimate hydrologic condition. Flow patterns related to SB3-SB7 are maintained in the interim condition model. The ultimate and interim modelling schematics are shown in **Figure A7** and **Figure A8** respectively.

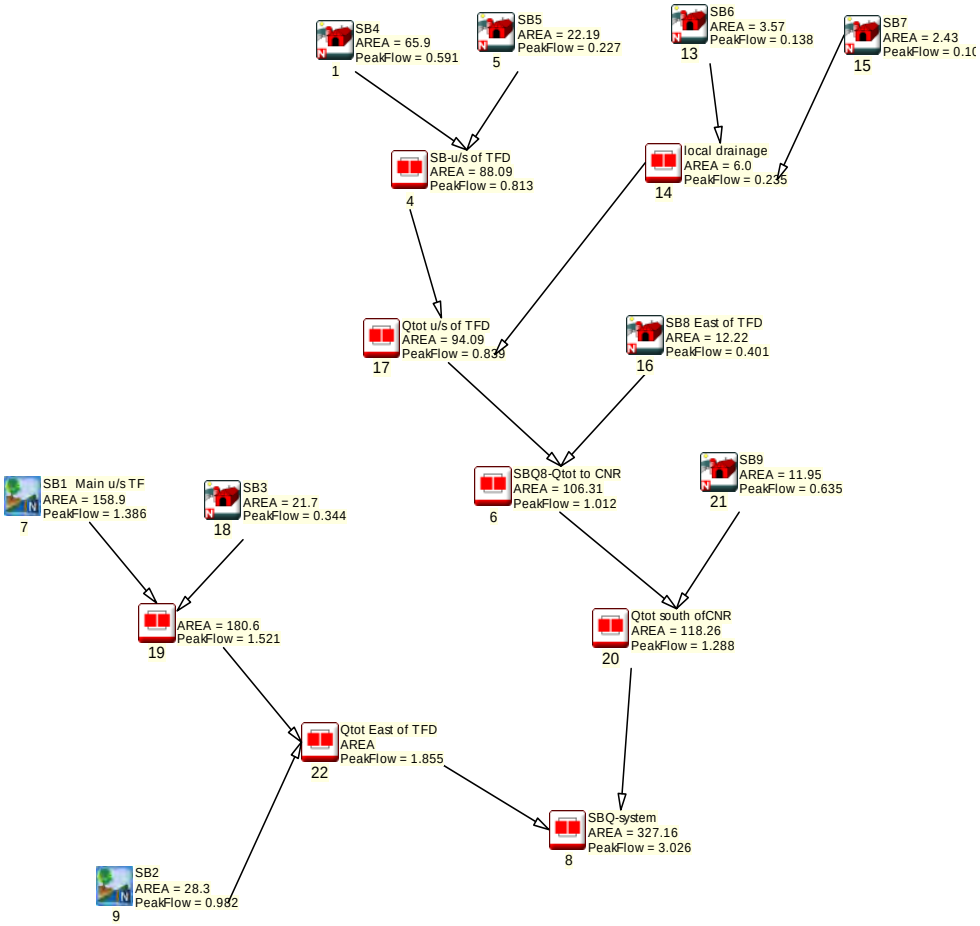

Figure A6 – Existing Conditions at Shirley's Brook VO2 Model Configuration

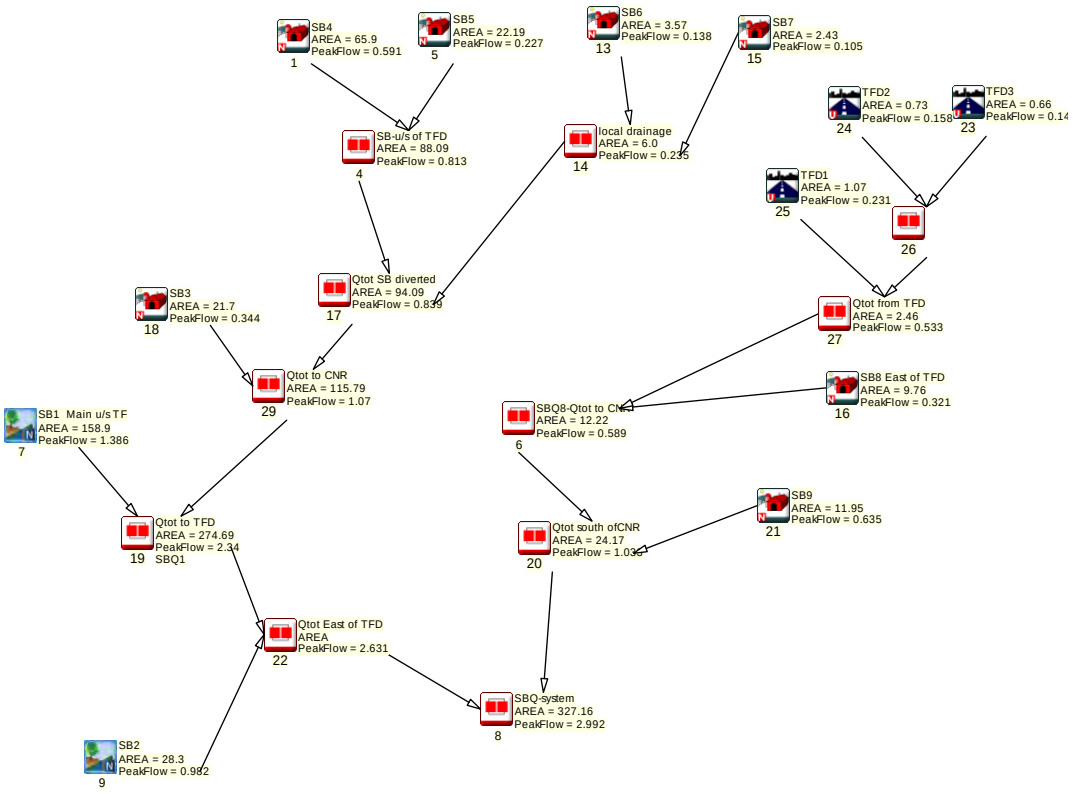

Figure A7 – Ultimate Conditions at Shirley's Brook VO2 Model Configuration

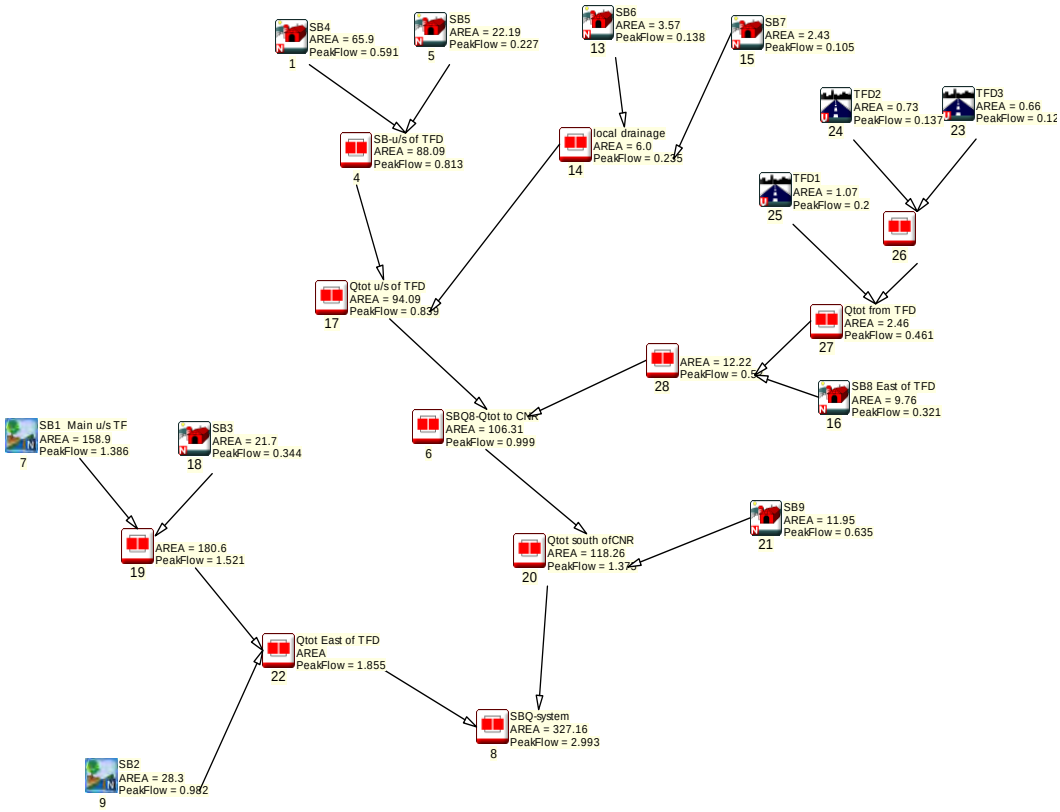

Figure A8 – Interim Conditions at Shirley's Brook VO2 Model Configuration