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REPORT 13

Water Resources of the South Nation River Basin – Summary

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INTRODUCTION

Concerns about large-scale flooding in the basin and about the quality and availability of surface and ground waters locally has indicated the need for a comprehensive water-resource inventory study in the South Nation River basin. Anticipated urban development on the fringes and extensive agricultural activities within the basin have intensified the need for basic hydrologic data in order that the planning for future growth can consider the availability of water.

Investigations in the South Nation River basin commenced in 1975 and continued for two years. Field investigations were made of surficial geology, streamflows, ground-water occurrence and ground-water levels, water quality and water uses. Ten test holes were drilled and automatic water-level recorders were installed on nine observation wells. Two permanent and eight temporary streamflow water-level recorders were also installed. Major field investigations were completed with a synoptic survey of ground-water and surface-water quality at the end of the summer of 1976.

The report deals with the occurrence, distribution, quantity, quality and the use of surface and ground waters. General hydrologic conditions in the basin are discussed rather than specific situations on a local scale. Special attention is paid to problems of natural water quality and polluted waters.

Topics in the report are presented as maps, graphs and tables, with accompanying explanatory notes, on a set of eight sheets:

Sheet 1. Climate and Physical Setting
Sheet 2. Locations and Specific Capacities of Water Wells
Sheet 3. Hydrogeologic Cross Sections
Sheet 4. Quality and Availability of Ground Water
Sheet 5. Tile and Improved Surface Drainage
Sheet 6. Surface-Water Hydrology
Sheet 7. Quality of Surface Waters, 1976
Sheet 8. Water Resources Management

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SUMMARY

The study area lies east-southeast of Ottawa and covers an area of 1595 square miles, of which 1512 square miles are drained by the South Nation River and 83 square miles by small tributaries to the Ottawa River.

The 25-year average annual water budget (1950-1974) indicates that 39 percent (13 inches) of the average annual precipitation (33 inches) occurs as streamflow, with approximately 61 percent (20 inches) being lost through evapotranspiration (Sheet 1). The annual ground-water contribution to streamflow at the mouth of the South Nation River near Plantagenet Springs, estimated from daily stream discharges exceeded 60 percent of the time for the same 25-year period, amounts to 1.8 inches, or 5 percent of the annual precipitation.

The characteristic topographic feature in this basin is the low relief. Surface elevations range between 150 feet above mean sea-level in the north and 400 feet in the south (Sheet 1). There are numerous swamps and bogs in topographically low areas, the largest ones being Alfred, Mer Bleu, Winchester and Moose Creek bogs.

Much of the basin is underlain by limestones of the Ottawa and Oxford formations, with localized occurrences of shale belonging to other formations (Sheet 1). Faulting is noticeable throughout the watershed, with downfaulting of the Paleozoic rocks adjacent to the Ottawa River.

Surficial overburden deposits consist predominantly of marine sediments, which vary from fine-grained (deep water) clay, silt and silty sand to coarse-grained (shallow water) sand, and sand and gravel in beach and bar deposits (Sheet 1). Glacial deposits of till occur sporadically throughout the basin.

Hydrogeologic interpretations have been based on data obtained from water-well records on file with the Ontario Ministry of the Environment, on past documented studies of ground-water availabilities, and on results of test drilling and pumping tests carried out during the study in 1976. Most wells in the basin are drilled to bedrock and are used to supply individual domestic requirements (Sheet 2). Because of generally low specific capacities of most wells in the basin, yields of 2-3 gpm from both overburden and bedrock wells are common. Yields from overburden tend to be slightly higher than from bedrock.

Five cross-sections throughout the basin indicate that the overburden consists primarily of poorly permeable clays, silts, and tills that are poor sources of ground water (Sheet 3). Moderately

permeable sands occur as surficial deposits over large areas in the north, and highly permeable surficial sands and gravels occur along the western boundary of the basin. The latter are generally over 50 feet thick. Elsewhere, sands and gravels occur as thin lenticular and discontinuous layers in buried deposits and are generally less than 10 feet thick.

Overburden aquifers are generally the main sources of ground water in the north (Sheet 4). Bedrock aquifers are the principal sources of ground water in the south where there are no extensive overburden aquifers.

The largest overburden aquifer, the Champlain aquifer, is composed of surficial sands that cover an area of nearly 220 square miles. The Rideau Front aquifer, which is composed of surficial sands and gravels, is of smaller extent (40 square miles) but is significant because of its potential for high well yields. Nine smaller aquifers composed of buried sands and gravels occupy a total area of 60 square miles.

The largest bedrock aquifers are the limestone/shale aquifer (810 square miles) in the north and the limestone/dolomite aquifer (410 square miles) in the south. Of the two, the limestone/dolomite aquifer is the more important one because wells in this aquifer have the potential for higher yields and it usually contains fresher water than the limestone/shale aquifer. Other bedrock aquifers in the area are composed of shale (220 square miles) and sandstone 50 square miles).

Although ground water in the South Nation River basin is available from both overburden and bedrock sources for private domestic supplies, it is not readily available to meet the needs of large municipalities or industries. Of the aquifers identified in the basin, only the Rideau Front overburden aquifer along the western boundary of the basin appears to have the potential for large-capacity municipal and industrial wells.

Recent hydrogeologic investigations have identified a small area of buried sands and gravels to the south of Embrun which may be capable of providing adequate ground-water supplies for a small community. Small areas of surficial or buried sands and gravels such as the one above, are not identified in this report due to generally inadequate hydrogeologic data. Detailed hydrogeologic investigations are of course essential to determine the adequacy of ground water for large supplies in any area.

The Rideau Front and the Champlain aquifers, which are exposed at the surface over large areas, are most susceptible to contamination. The Plantagenet, Sarsfield and Maple Ridge aquifers, which are exposed at the surface over smaller areas, are in places also susceptible to contamination.

The most common ground-water quality concerns (Sheet 8) relate to salty, highly mineralized and sulphurous waters. These waters have been classified by water-well drillers (not by chemical analyses) at the time of construction of the wells. Salty and highly mineralized waters are of major concern and are derived from bedrock wells in the northern parts of the basin. Sulphurous waters occur mainly in bedrock wells in the central parts of the basin.

Ground-water samples were obtained from overburden and bedrock wells, and analyses for the common inorganic constituents (Sheet 4) indicate that the majority of the samples are of calcium-bicarbonate type, i.e., calcium and bicarbonate are the dominant ions. A few samples are of sodium-bicarbonate, calcium-chloride and sodium-chloride types. All four types of waters are found in both overburden and bedrock wells.

Total dissolved solids in ground water, and iron to a lesser extent, often exceed Provincial drinking water criteria of 500 mg/l and 0.3 mg/l, respectively. Chloride and sulphate concentrations are generally lower than the criteria of 250 mg/l for both parameters, as is nitrate (less than 10 mg/l as N). Many samples show very hard waters (greater than 180 mg/l as $CaCO_3$).

Because land drainage in many parts of the basin is poor, extensive tile and improved surface drainage works have been constructed (Sheet 5). Concern has been expressed that these drainage works may contribute to flooding in various parts of the basin, and furthermore, that these works may reduce baseflows in some streams. At the present time, it is difficult to precisely evaluate the effects of these drainage works with regard to flooding and baseflow reduction.

There are currently eleven streamflow gauging stations in the basin (Sheet 6). Two of these, station 02LB007 on the South Nation River at Spencerville and station 02LB005 on the South Nation River near Plantagenet Springs, each have more than 20 years of continuous data, while the other stations have ten years or less. Streamflows throughout the basin are unevenly distributed from year to year and during each year. Mean annual discharges out of the basin, as recorded at the Plantagenet Springs station (1950-1974), is 1390 cfs (12.9 inches). However, large variations of the mean may occur during different years, as for example, indicated by a mean annual discharge of 698 cfs (6.5 inches) in 1964 and a mean annual discharge of 2380 cfs (23.0 inches) in 1972. Daily discharges usually show even larger variations, as indicated by a minimum daily

discharge of 10* cfs and a maximum daily discharge of 41,000 cfs recorded at this same station (1950-1974).

Flooding is the most prominent surface-water problem in the basin and is virtually an annual occurrence. Major flooding in the spring and some flooding in the summer occurs on the South Nation River above Chesterville and above Plantagenet. Spring floods covering up to 16,000 acres and 18,000 acres in these areas have been reported. Low streambed gradients and small channel capacities in these areas are primarily responsible for these floods. Problems of flooding and the feasibility of alleviating flooding have been investigated in past studies and are not discussed in detail in this report.

Lowest flows usually occur during June through October. Low-flow contributions per square mile from the southern parts of the basin, as estimated from the daily discharges exceeded 90 percent of the time, are about an order of magnitude smaller than from the northern areas. This is attributed to thin overburden deposits of generally low permeability in the south.

Because of low summer flows throughout much of the basin, treated industrial and municipal waste waters are not discharged continuously into streams, but only in the fall and spring when flows are higher. However, some streamflows in the fall are not much greater than flows in the summer and consequently, as communities in the basin grow, future expanded discharges of treated waste waters may have to be confined to the spring period when flows are high. Maintenance of adequate baseflows and augmentation of low flows in some streams are vital to allow increased waste water discharges into streams in the basin.

Surface-water quality analyses (1976) indicate that total dissolved solids concentrations are generally less than 500 mg/l. The most significant in-stream water quality concerns relate to excessive bacteria and nutrient (phosphorus) concentrations (Sheet 7).

*Streamflow records for the period 1915 to 1932 that have recently become available, show zero flows at the Plantagenet Springs station from August 13, 1930 to March 15, 1931. Annual precipitation at Kemptville in 1930 was 22.5 inches, or nearly 11 inches below normal.

Bacterial contamination is evident throughout much of the basin and is attributable to both human and animal sources. The construction of communal sewage treatment systems at a number of municipalities will alleviate most of the contamination from human sources. The animal sources, however, are not easily controlled or corrected, and considering present agricultural practices, it is unlikely that these sources can be reduced substantially or eliminated in the foreseeable future.

Concentrations of total phosphorus are considered to be high enough to contribute to excessive aquatic plant growth and nuisance conditions in basin streams. The relative contributions of total phosphorus from various sources cannot be differentiated by existing data. Based on the Ministry of the Environment's studies of pollution from various land-use activities in southern Ontario, it is felt that the contributions of total phosphorus from municipal and industrial point sources in the basin may be insignificant in comparison with contributions from agricultural non-point sources.

A number of water quality problems have been encountered at Casselman in the treatment of surface waters for municipal uses: high water temperatures, objectionable taste and odour, and the possibility of anaerobic conditions developing under ice. The experience at the Casselman water treatment plant indicates that similar problems with the treatment of surface waters may be encountered elsewhere in the basin and may add considerably to the final cost of treated surface waters.

An inventory of major water uses based on information from the Ministry's Permit to Take Water and abatement programs, indicates an area of concentrated ground-water withdrawals in the Rideau Front aquifer on the western boundary of the basin (Sheet 8). Major areas of surface-water withdrawals are concentrated in the Castor River basin from upstream of Russell to below Embrun.

Total permitted water uses in the study area in 1975 amounted to 8.5 million gallons per day (mgd). These major uses were: industrial - 4.4 mgd, irrigation - 2.6 mgd and municipal - 1.5 mgd. The estimated total water use in the study area in 1975, based on an average per capita withdrawal of 150 gallons per day for all water uses, is 13.5 mgd. The difference between the estimated total water use and the total permitted water uses amounts to 5.0 mgd, and has been attributed to private-domestic and stock watering uses.

This water resource inventory indicates that future water supply and waste assimilation are major water management issues in the South Nation River basin. While ground water is not readily available in large quantities in the basin, it is used for municipal supplies by many small communities, and as such, it represents an important asset. Once contaminated, restoration of ground-water quality may

be both difficult and expensive. The protection and proper utilization of water from existing aquifers, therefore, is vital to water management in the basin.

As communities grow, surface waters will have to play an increasingly important role in augmenting ground-water supplies, or providing the sole source of water for some large municipalities. At the same time, the same surface waters will be required for the assimilation of waste water discharges from industries and municipalities, together with runoff from agricultural areas. In light of this, a significant water management goal will be to deal with maintaining and enhancing the quality of surface waters in the basin as well as ensuring an adequate quantity of water for consumptive and in-stream uses.

Cognizance of area-specific hydrologic and hydrogeologic conditions will be required in order to resolve competing and sometimes conflicting water uses, as illustrated by an example in the Castor River basin. In this sub-basin, withdrawals from streams are used for crop irrigation, but available flows can be critical during years of below normal precipitation when the need for irrigation is highest. In addition, flows in the Castor River are currently needed for assimilation of waste waters from the communities of Embrun and Russell. Consequently, streamwater management must ensure the compatibility of takings for irrigation and the use of the stream for assimilation of waste, while still maintaining the natural functions of the stream.

Because ground-water discharges to streamflows are critical during low-flow periods, it is essential that these discharges be maintained to protect established uses. Since the Rideau Front aquifer is an important source of baseflow to streams in the headwaters of the Castor River sub-basin, and also a potential source for large ground-water supplies for municipalities and industries, land-use planning may need to deal with the protection of ground-water quantity and quality in the area.

Because of the many major water management issues encountered in the basin, a comprehensive study of water management options is being undertaken. This study may be comparable in scope to similar studies that have been carried out in the Thames River and the Grand River basins in southern Ontario.